EQUINE VETERINARY EDUCATION/AMERICAN EDITION
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EQUINE VETERINARY EDUCATION

American Edition
August 2026

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- AAEP 72nd Annual Convention & Trade Show Registration Kit
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- Sidewinder syndrome associated with complete rupture of the *ligamentum capitis ossis femoris* in a horse

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EQUINE
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American Association of Equine Practitioners
4033 Iron Works Parkway
Lexington, KY 40511
TEL (800) 443-0177 • (859) 233-0147
FAX (859) 233-1968
EMAIL aaepoffice@aaep.org
aaep.org

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Address advertising inquiries to Dana Kirkland
(859) 233-0147 / dkirkland@aaep.org

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EQUINE VETERINARY EDUCATION
AMERICAN EDITION
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Equine Veterinary Education is a refereed educational journal designed to keep the practicing veterinarian up to date with developments in equine medicine and surgery. Submitted case reports are accompanied by invited reviews of the subject (satellite articles) and clinical quizzes. Tutorial articles, both invited and submitted, provide in-depth coverage of issues in equine practice.

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72nd AAEP Annual Convention
Dec. 7-11, 2026 • Las Vegas, NV
Mandalay Bay Convention Center

A Full House of Possibilities

AAEP Vegas

REGISTRATION KIT

AAEP Vegas

A Full House of Possibilities

Revel in neon lights and keen insights when the AAEP's 72nd Annual Convention returns to ***Fabulous*** Las Vegas for the first time in 11 years!

Play your convention hand from a CE deck stacked with clinical advances and how-tos—from head to hoof and field to hospital—along with practice management and sustainability strategies to enrich professional and personal vitality.

Forget the old cliché—what happens in Vegas this December won't stay there. Instead, you'll bring it home and put it to work, boosting the health of your patients and the pulse of your practice.

KEYNOTE ADDRESS:
Let's Go Wild! Wildlife as Inspiration for a Happy Life

Martine van Zijll Langhout, DVM, MSc (WAH), DECZM (Zoo Health Management)

Like wild animals, the lives of equine veterinarians require performing at a high level, facing constant challenges, and collaborating to thrive. But how do wild animals build strong, effective teams? How do they manage high-pressure situations? And what can we learn from this?

During her work in the African wilderness, wildlife veterinarian Dr. Martine van Zijll Langhout experienced life much like a wild animal herself—needing to trust her team, remain physically and mentally fit, and even run for her life on several occasions. Through these experiences, she discovered how profoundly nature can teach us about being human—and about developing resilience, adaptability, and mental strength.

After a career as a mixed-animal veterinarian, including equine medicine, Dr. van Zijll Langhout specialized in wildlife medicine in 2005. Since then, she has worked as a wildlife vet under free-roaming conditions with most African wildlife species, including gorillas, lions, elephants, giraffes, buffalo, and rhinos.

Dr. van Zijll Langhout is currently head of the Veterinary Department at Amsterdam Zoo. She is also a professional coach, public speaker, and leads wilderness trails in Botswana. Her book, *Lessons from the Wild: A Wildlife Vet's Journey into the African Wilderness – Rediscovering What Nature Teaches Us*, is a bestseller in the Netherlands and will be published in English this year.

Sponsored by MERCK Animal Health

FRANK J. MILNE STATE-OF-THE-ART LECTURE:
Conquering Colic: State-of-the-Art Management of the Acute Abdomen and the Role of Next Generation Science

Anthony Blikslager, DVM, PhD, DACVS

Although no two colic cases are the same, they share one commonality: The time it takes to make decisions has the greatest effect on survival.

During his Milne Lecture, pioneering colic and gastrointestinal researcher Dr. Anthony Blikslager will provide the tools needed to conquer the "black box" of the equine abdomen. He will help you recognize the subtle causes of colic through use of pain scoring, delineate between common analgesics that hinder and help gut healing, advance understanding of intestinal repair, and investigate evolving science at the cellular level that is likely to drive new therapeutic targets.

A 1989 graduate from the Virginia-Maryland Regional College of Veterinary Medicine, Dr. Blikslager is a professor of equine surgery and the associate dean and director of Veterinary Medical Services at North Carolina State University (NCSU). His research is focused on equine colic and mechanisms of intestinal mucosa recovery following strangulating obstruction.

Dr. Blikslager received the AVMA Clinical Research Award in 2020 and the Applied Equine Research Award from the World Equestrian Veterinary Association in 2011. He was named an Alumni Distinguished Professor and awarded the Ned E. Huffman Leadership Award in 2017 from NCSU, from which he also received the Pfizer Award for Excellence in Research in 2006.

Sponsored by PLATINUM PERFORMANCE Good Nutrition is Good Medicine™

Session Descriptions

RACE CE SESSIONS

Burst
Acquire impactful knowledge on related subjects in a fast-paced, bite-sized format.

Business and Practice Life
Focus on the non-medical aspects that are essential to a healthy bottom line and to practitioner well-being.

Collaborative Case Studies (NEW)
Test your clinical reasoning by solving real-world patient challenges in small groups during facilitator-led discussions. Completion of 60- to 90-minutes of pre-session materials is required. Limited to 50 pre-registered attendees.

How-to
Walk step-by-step through procedures successfully deployed by colleagues. You'll acquire the information to critically evaluate the technique and determine whether to implement.

In-Depth
Dig deeper into important medical topics. These sessions feature fewer but longer presentations, enabling a thorough exploration of key components of the topic.

Table Topics
Draw upon the collective expertise of colleagues to address shared challenges during facilitated discussions valued for clinically actionable insights.

NON-RACE CE SESSIONS

The Mane Connection
Learn from others during casual 45-minute lunchtime conversations on specific topics in the AAEP Connect area of the trade show.

Stable Education
Discover new products, equipment, and research during 30-minute exhibitor presentations in the trade show Stable Education theaters.

Partner Sunrise Sessions
Explore a variety of medical topics during early morning sessions presented by AAEP Educational Partners.

SESSION KEYS

Core Concept
Denotes a presentation or session containing foundation knowledge that is central to the veterinary care of equids.

HISA-approved
Denotes a presentation or session approved by HISA for attending and regulatory veterinarian CE.

HEALTHY Practice

Denotes a presentation or session devoted to the wellbeing of the veterinarian and/or their practice team.

Denotes a Table Topic being re-offered live post-convention via Zoom the week of Dec. 14-18.

Wrangler NFR LAS VEGAS ★ 2026 PRESENTED BY TRACTOR SUPPLY CO

2026 Wrangler National Finals Rodeo

To purchase general public tickets for the 2026 Wrangler National Finals Rodeo, occurring Dec. 3-12 in Las Vegas, please visit https://fanaccount.axs.com/nfrexperience/login.

All tickets will be sold based on availability after season ticket purchases. Please be aware that ticket quantities are limited. Please visit https://www.nfrexperience.com/ticket_faqs for more information.

NFR tickets will not be available through AAEP registration.

PRCA photo by Mallory Beinborn. Photo courtesy of PRCA.

TUESDAY, DECEMBER 8

Morning

6:30-7:30 a.m. **Partner Sunrise Sessions**
See session listing on page 16.
No RACE CE credit awarded.

8:00 a.m. **Opening Session**
Moderator: P.O. Eric Mueller

9:00-10:00 a.m. **Keynote: Let's Go Wild! Wildlife as Inspiration for a Happy Life**
Martine van Zijll Langhout (see page 3)
Sponsored by Merck Animal Health.

10:15 a.m. **Kester News Hour**
Sponsored by Merck Animal Health.

Enabled by a grant from the estate of Dr. Wayne O. Kester, the Kester News Hour highlights the latest scientific papers in specific areas of equine medicine. Presenters listed below and pictured from left.

Anchors: *Carrie Finno and Laurie Goodrich*
Forecaster: *Karen Wolfsdorf*
Sportscaster: *Elizabeth J. Davidson*
Field Reporter: *Bernie Loomis Smith*

Afternoon

Noon-1:45 p.m. **The Mane Connection**
See page 15 for tentative conversation topics.
No RACE CE credit awarded.
Sponsored by American Regent, Inc., manufacturer of Adequan i.m.® (polysulfated glycosaminoglycan) and BetaVet® (betamethasone sodium phosphate & betamethasone acetate injectable suspension).

1:30 p.m. **Foundation Scholarship Awards**
Moderator: Emma Adam

2:00 p.m. **Foundation Research Spotlight**
Moderator: Carrie Finno

2:30-4:45 p.m. **Frank J. Milne State-of-the-Art Lecture: Conquering Colic: State-of-the-Art Management of the Acute Abdomen and the Role of Next Generation Science**
Anthony Blikslager (see page 3)
Moderator: Luke Bass
Sponsored by Platinum Performance, "Good Nutrition is Good Medicine."

BIZ Strategic Practice Management for Equine Veterinarians

Moderator: Becky Tees
Sponsored by Sponsored by CareCredit, a Synchrony Solution. Flexible financing for clients. Fast payment for you.

2:00 p.m. Business News Hour – *Shane Baird, Becky Ruemmuler-Mederios, Fred Nostrant*

3:00 p.m. Exit Strategies for Solo Practitioners – *Amy Grice*

3:20 p.m. Malpractice and State Board Risk in Veterinary Practice: Prevention, Response, and Risk Mitigation Strategies – *Charlotte Lacroix*

3:40 p.m. Ethical Navigation of Conflicts of Interest in Equine Practice – *Barb Crabbe*

4:00 p.m. Non-Compete Agreements in Veterinary Employment: Enforceability, Risk, and Strategic Considerations for Practitioners – *Charlotte Lacroix*

4:20 p.m. How To Prevent Barn Fires in Equine Veterinary and Client Facilities – *Rebecca Husted*

4:40 p.m. Review of the Use of Technology, Including Artificial Intelligence (AI) Tools, to Produce Medical Records – *Cynthia MacKenzie*

5:00-5:20 p.m. Review of Spectrum of Care in Equine Medicine – *David Ramey*

WEDNESDAY, DECEMBER 9

Morning

6:30-7:30 a.m. **Partner Sunrise Sessions**
See session listing on page 16.
No RACE CE credit awarded.

Practical Applications of Advanced Equine Imaging

Moderator: Kate Chope
Sponsored by Hagyard Equine Medical Institute. Enduring Passion. Unrivaled Expertise.

8:00 a.m. How to Use PET to Identify Suspensory Apparatus Injury in the English Sport Horse – *Alycia Crandall*

8:20 a.m. Ultrasonographic Diagnosis of Septic Temporomandibular Joint Arthritis in Horses – *Angela Fleming*

8:40 a.m. Narrative Review of Recent Developments in Myelo-CT Diagnostics, Findings, and Surgical Options – *Anja Kasparek*

9:00 a.m. Ultrasonographic Abnormalities of the Equine Eye and Orbit: 121 Horses – *Betsy Vaughan*

9:20 a.m. Ultrasonographic Evaluation of Limb Wounds: Feasibility and Findings in 96 Horses – *Gabriela Castellanos*

9:40 a.m. How to Perform Standing Medial Oblique Radiographs of the Equine Coxofemoral Joint – *Julie Wright*

10:00 a.m. Computed Tomographic Arthrography of the Equine Distal interphalangeal Joint Provides Valuable Information About Cartilage and Soft Tissue Pathology – *Linda Dillenbeck*

10:20 a.m. Computed Tomography of the Equine Caudal Spine and Pelvis – *Nadine Ogden*

10:40-11:00 a.m. How to Perform Transcutaneous Ultrasonography of the Equine Esophagus – *Zachary Blakeney*

Practice the techniques discussed in the highlighted presentations during drop-in mini labs using models on **Wednesday** between noon-2:00 p.m. in the Stable Education area of the trade show. See page 15 for more information.

Burst©

Moderator: Elizabeth Acutt and Allen Page
Sponsored by Zoetis Equine: Long Live the Horse.

This session presents highly informative, 7-minute talks on related subjects of interest to the general practitioner. Practical knowledge is presented dynamically in a fast-paced, "bite-sized" format that allows the audience to come away with impactful, useable information they can add to their knowledge base and skills sets.

8:00-9:00 a.m.

Blood, Sweat, and Fears: Emergency Transfusion Basics – *Garett Pearson*

Out in the Open (Even When They're Not): Managing Cryptorchid Castrations in the Field – *Luke Bass*

A Pain in the Neck (and How to Image It): Optimizing Cervical Spine Radiographs – *Will French*

Hit the Ground Running: The Newborn Foal Exam – *Piper Norton*

Don't Shoot the Messenger: Surviving the Equine Pre-Purchase Exam – *Cricket Russillo*

Precision Under Pressure: Temporary Tracheostomy Technique and Decision-Making – *Garett Pearson*

Panel Discussion with the Hour 1 Speakers

9:00-10:00 a.m.

Sound-ish: Interpreting Musculoskeletal Findings During the PPE – *Cricket Russillo*

Navel Intelligence: Ultrasonographic Assessment of the Foal Umbilicus – *Piper Norton*

Gut Feeling: A Practical Approach to Umbilical Hernia Repair in the Field – *Luke Bass*

How to Use the Equine Disease Communication Center as a Tool to Manage and Increase Awareness of Infectious Disease – *Krista Estell*

Buying Time or Buying Trouble? Antimicrobial Stewardship in the Pre-Referral Period – *Garett Pearson*

Knee-d to Know: Sonographic Evaluation of the Lateral Stifle – *Will French*

Panel Discussion with the Hour 2 Speakers

10:00-11:00 a.m.

Fetlock Forward: Positioning, Technique, and What Not to Miss – *Will French*

How To Splint Contracted Distal Limbs in Foals – *Craig Lesser*

Something Seems Off: Recognizing Neurological Red Flags During the PPE – *Cricket Russillo*

Flushing Out Trouble: Practical Lavage Techniques for Managing Septic Synovial Structures – *Garett Pearson*

Eye Can Do It: A Practical Guide to Field Enucleation – *Luke Bass*

Threading the Needle: Tips for Over-the-Wire Catheter Placement – *Piper Norton*

Panel Discussion with the Hour 3 Speakers

How to Navigate Modern Equine Reproduction: Diagnostics, Management, and Optimization

Moderator: Maria Schnobrich
Sponsored by EquineIVF, Building the Future, One Embryo at a Time.

8:00 a.m.	How-To Collect Samples for Genetic Testing/ What to Test For – *Carrie Finno*
8:20 a.m.	How Stallion Factors Can Affect Pregnancy Rate, Early Embryonic Loss – *Camilo Hernandez-Aviles*
8:40 a.m.	Aspects of OPU, Oocyte Handling and Shipping to Optimize ICSI Embryo Production – *Hunter Ortis*
9:00 a.m.	Clinical Application of Ultrasound in Gestational Age Estimation, Foaling Date Prediction, and Readiness for Birth – *Catherine Renaudin*
9:35 a.m.	Transrectal Ultrasonographic Pregnancy Evaluation in Mares Beyond 100 Days of Gestation: Ambulatory Practice Applications – *Kristina Lu*
9:55 a.m.	How to Understand Fescue and Ergovaline Toxicity in Equine Reproduction – *Krista Lea*
10:15-11:00 a.m.	Panel Discussion with the Speakers

Soundness in Motion: Performance Issues in Western Performance

Moderator: Ty Corbiell
Sponsored by Dechra Veterinary Products.

8:00 a.m.	Back Pain: More than Just Kissing Spine in Western Performance Horses – *Will French*
8:30 a.m.	The Pastern: The Overlooked Joint in Poor Performance of the Reined Cowhorse and Reiner – *Joe Carter*
9:00 a.m.	Common Lameness Issues Seen in Cutting Horses with a Focus on Stifle-Related Issues – *Jeff Folland*
9:30 a.m.	Lameness Diagnostic and Treatment Strategies for Challenging Cases in Western Performance Horses – *Lane Easter*
10:00 a.m.	PRCA: Vetting a Western Performance Event – *Ben Espy*
10:30-11:00 a.m.	Arena Gate Issues in Barrel Racing Horses – *Ty Corbiell*

Table Topics

Sponsored by Dechra Veterinary Products.
Seating is limited so please arrive early.

8:30-10:00 a.m.

USEF: Drugs and Medications Update – *Kent Allen and Stephen Schumacher*

Discussion of the Interplay of Diagnostic Testing, Nutrition, and Clinical Outcomes in Endocrine Disease – *Pat Harris and Amy Polkes*

Medical Devices and/or Compounding – *Kenton Morgan and FDA Representative*

10:30 a.m.-Noon

Navigating the Evolving FEI Landscape for Veterinarians – *Christiana Ober and Jan-Hein Swagemakers*

Working Effectively with Equine Nutritionists to Support Client Outcomes – *Shannon Pratt-Phillips and Stephanie Valberg*

New World Screwworm: What We Know—and What We Don't Know – *USDA and FDA Representatives*

Navigating the Equine Pre-Purchase Exam: A Roundtable for New and Seasoned Practitioners – *TBD*

Afternoon

Noon-1:45 p.m. **The Mane Connection**
See page 15 for tentative conversation topics.
No RACE CE credit awarded.
Sponsored by American Regent, Inc., manufacturer of Adequan i.m.® (polysulfated glycosaminoglycan) and BetaVet® (betamethasone sodium phosphate & betamethasone acetate injectable suspension).

How-to, Go-Do Mini Labs

See page 15 for more information.
No RACE CE credit awarded.

Noon-2:00 p.m.	Creating and Applying Splints on Contracted Limbs in Foals
	Hands-on Experience with Standing Coxofemoral Joint Radiograph Acquisition – with Discussion

Burst: Business Edition

Moderator: Joe Pluhar
Sponsored by CareCredit, a Synchrony Solution. Flexible financing for clients. Fast payment for you.

This session presents highly informative, 7-minute talks on practice management-related subjects. Practical knowledge is presented dynamically in a fast-paced, "bite-sized" format that allows the audience to come away with impactful, useable information for their practice.

2:00-3:00 p.m.

Know Your Sheets – *Joe Pluhar*

Can You Hear Me Now? The Remote Receptionist Revolution – *Chelsea Luedke*

Avoid Sticker Shock – *Kelly Zeytoonian*

Don't Wait Until It's Too Late: Encouraging Honest Conversations – *Melanie Barham* HEALTHY Practice

Practice Performance: The KPI Checkup – *Doug Anez*

Belonging Happens One Conversation at a Time – *Melanie Barham*

Panel Discussion with the Hour 1 Speakers

3:00-4:00 p.m.

Finding Your Herd – *Joe Pluhar*

One Foot Out the Barn Door? – *Melanie Barham* HEALTHY Practice

Beyond the Price Sheet: The Art of the Lab Deal – *Charlotte Lacroix*

Belonging and Culture: By Design, Not by Chance – *Melanie Barham*

Becoming a Better Ally: Lessons Learned Along the Way – *Melanie Barham*

Onboarding: Where Belonging Begins – *Melanie Barham* HEALTHY Practice

Panel Discussion with the Hour 2 Speakers

4:00-5:00 p.m.

Equine Practice: Breaking Barriers, Building Bridges – *Johnathan Yardley*

Opening Gates for the Next Generation – *Melanie Barham*

Sustainability in Equine Practice – *Kelly Zeytoonian*

Retire Right: A Fast Track to Retirement Plans – *Chelsea Luedke*

Planning Your Best Ride Into the Sunset – *Doug Anez*

Corporate Practice: What's Your Stake? – *Charlotte Lacroix*

Better Together: Harnessing the Power of Community – *Melanie Barham* HEALTHY Practice

Panel Discussion with the Hour 3 Speakers

In-Depth: Metabolic and Endocrine Diseases

Moderator: Dianne McFarlane
Sponsored by Boehringer Ingelheim.

2:00 p.m.	Clinical Presentation and Pathophysiology of Equine Endocrine Disease – *Diane McFarlane*
2:30 p.m.	Diagnosis and Treatment of Insulin Dysregulation and the Equine Metabolic Syndrome – *Andrew van Eps*
3:00 p.m.	Diagnosis and Treatment of PPID with and without Insulin Dysregulation – *Kelsey Hart*
3:30 p.m.	Review of Endocrine Disorders with Implications for the Equine Athlete – *Jane Manfredi*
4:00-5:00 p.m.	Panel: Session Summary and Practice Tips with the Speakers

Equine Performance, Biomechanics, and Rehabilitation

Moderator: Emma Adam
Sponsored by American Regent, Inc., manufacturer of Adequan i.m.® (polysulfated glycosaminoglycan) and BetaVet® (betamethasone sodium phosphate & betamethasone acetate injectable suspension).

2:00 p.m.	Motion Analysis Differs Between Racing Thoroughbreds at Risk of Exercise-Associated Sudden Death and the General Population – *Denise Mc Sweeney*
2:20 p.m.	Equine Digital Perfusion and Load Patterns at Various Capsular Palmar Angles as Evaluated with Venography and Force Plate Analysis – *Emily Hicks*
2:40 p.m.	Intra-System and Inter-Operator Reliability of Commercially Available Objective Lameness Evaluation Systems in Horses – *Jenna McPeek*
3:00 p.m.	Air Pollution Exposure During Training Impairs Performance in Thoroughbred Racehorses – *Danielle Scott*
3:20 p.m.	Review of Equine Reproductive Conditions that Affect Behavior – *Sarah Eaton*
3:40 p.m.	The Impact of Dynamic Mobilization Exercises on the Cross-Sectional Area of the Equine Multifidus Cervicis and the Longus Colli Muscles – *Keana McCosh*
4:00 p.m.	How to Perform Advanced Equine Physiotherapy Exercises – *Katie Ellis*
4:20-4:40 p.m.	How to Retrain Proprioception and Motor Control in Equine Rehabilitation – *Sybille Molle*

Practice the techniques discussed in the highlighted presentation during drop-in mini labs using models on **Thursday** between noon-2:00 p.m. in the Stable Education area of the trade show. See page 15 for more information.

In-Depth: Advanced Imaging Techniques

Moderator: Charlène Pigé

Sponsored by IMV Technologies: Faster imaging, smoother diagnostics with connectDR.

2:00 p.m. Subchondral Bone and Articular Cartilage Injuries: Bridging Science and Practice – *Annamaria Nagy*

2:30 p.m. Subchondral Bone and Articular Cartilage Damage: What Can We Get Out of Radiographs and Ultrasound? – *Myra Barrett*

3:00 p.m. Advanced Imaging of Subchondral Bone and Cartilage injury in Horses: MRI, CT and PET Across Multiple Disciplines – *Charlène Pigé and Mathieu Spriet*

3:20 p.m. Managing Subchondral Bone Injuries in Practice: Prognosis, Treatment and Monitoring – *Carter Judy*

3:50-4:35 p.m. Panel Discussion with the Speakers

Table Topics

Sponsored by Dechra Veterinary Products.

Seating is limited so please arrive early.

1:30-3:00 p.m.

Equine Insurance – *Reynolds Cowles, Ryland Edwards, and Steve Reed*

Vitamin E/Vitamin Deficiencies – *Carrie Finno and Stephanie Valberg*

In-Arena Emergencies at Equestrian Events – *Ben Espy and Madelyn Kalscheur*

Practical Pain Management in the Field – *Lori Bidwell and Kristen Messenger*

3:30-5:00 p.m.

Neuro vs Orthopedic Gait Abnormalities – *Caitlyn Horne and Amy Johnson*

Field Anesthesia – *Lori Bidwell and John Hubbell*

Outbreak Management – *Katie Flynn and Tabitha Moore*

Reproductive Microbiology in Clinical Practice: Mistakes, Successes, and Revenue – *Mariah Pearson and Sheila Spacek*

AAEP HEALTHY Practice

Las Vegas Fun Run & Walk

Wednesday, Dec. 9, 6:30 a.m. $35

Advance registration required at convention.aaep.org.

Enjoy the rare, serene calm of the Las Vegas Strip under a desert sunrise during a 3- to 4-mile tour led by running guides who will share a bit of history at iconic stops along the way. All paces, including walkers, are welcome.
Participants will depart from the shark reef entrance at Mandalay Bay.

THURSDAY, DECEMBER 10

Morning

Bridling Bullying: Creating a Culture of Respect in Equine Practice

Moderator: Jim Zeliff
Sponsored by Zoetis Equine: Long Live the Horse.

6:30-8:00 a.m. Instead of just talking about the theory of workplace bullying, this panel dives straight into the messy, real-world situations that happen in the truck, clinic, university, breeding shed, and show or race barns. Through a series of realistic scenarios, the panelists will follow common work-place friction points from start to finish, examining the roles we play in practice and how to reinforce a culture of respect within equine practice.

Clinical Updates in Equine Non-Infectious Disease

Moderator: Jennifer Cassano
Sponsored by Nutrena, "What's Inside Counts."

8:00 a.m. A Review of Photodynamic Dye Therapy for Equine Squamous Cell Carcinoma: A Retrospective of 274 Cases – *Leslie Easterwood*

8:20 a.m. Vitamin E and Vitamin A Serum Profiles in 629 Horses Imported from Europe – *Mathilde Fournier*

8:40 a.m. Comparison of Analytical Methods for Measuring Vitamin E in Horses – *Carrie Finno*

9:00 a.m. Review of Equine Endocrinopathies in Critical Illness: Moving Beyond the Basic Endocrine Care – *Katarzyna Dembek*

9:20 a.m. ACTH Suppression and Adverse Effects of Cab-ergoline in Horses with Pituitary Pars Intermedia Dysfunction (PPID) – *Anna Bracken*

9:40 a.m. How to Treat Periocular Sarcoids in Horses with Injectable Mitomycin-C – *Leslie Easterwood*

10:00 a.m. Association Between Blood Lactate Concentration and the Incidence of Exercise-Induced Pulmonary Hemorrhage in Barrel Racing Horses – *Maria Tula*

10:20 a.m. Efficacy of Injectable Omeprazole in Horses with Gastric Ulcers (ESGD, EGGD) – *Frank Andrews*

10:40-11:00 a.m. How to Diagnose Hindgut Inflammation: Out of Sight, Not Out of Mind – *Rebecca Bishop*

Back to Basics: Ophthalmology

Moderator: Nicole Scherrer
Sponsored by SmartPak, Your Trusted Partner for Equine Supplements.

8:00 a.m. When to Refer Ophthalmic Cases – *Nicole Scherrer*

8:25 a.m. Ocular Neoplasia – *Kathryn Wotman*

8:50 a.m. Uveitis and Glaucoma of the Horse: An Update – *Dennis Brooks*

9:10 a.m. Break

9:20 a.m. Infected Ulcers – *Erica Tolar*

9:45 a.m. Ophthalmic Field Surgery – *Catherine Nunnery*

10:10-11:00 a.m. Panel Discussion with the Speakers

How to Optimize Outcomes of Emergency Case Referrals

Moderator: Kira Epstein
Sponsored by CareCredit, a Synchrony Solution. Flexible financing for clients. Fast payment for you.

8:00 a.m. How to Optimize Outcomes Through Early Referral: Recognition of Key Clinical Features – *Jesse Tyma*

8:30 a.m. How and When to Start Treatment in Emergency Cases in the Field Prior to Referral – *Kira Epstein*

9:00 a.m. How to Establish and Maintain Relationships Between Referring and Receiving Veterinarians – *Katharine Christie and Emily Spengler*

9:20 a.m. How to Identify and Address Barriers to Referral – *Kira Epstein and Lily Haywood*

9:40 a.m. How to Prepare Clients for What to Expect When They Go to a Referral Hospital – *Katharine Christie and Jesse Tyma*

10:00 a.m. How to Keep the Success Going After Discharge – *Lily Haywood and Emily Spengler*

10:20-11:00 a.m. Case-Based Panel Discussion with the Speakers

Current Concepts in Equine Lameness Diagnosis

Moderator: Amy Armentrout
Sponsored by Merck Animal Health.

8:00 a.m. Effect of Heel or Toe Elevation on Fore- and Hindlimb Joint Angles in 7 Standing Warmblood Horses: Preliminary Results – *Johanna Wilm*

8:20 a.m. How to Manage Lameness and Optimize Hoof Balance: The Role of Acrylic Repair in Hoof Compression Rehabilitation – *Mariah Kerr*

8:40 a.m. Comparison of 18F-Sodium Fluoride Positron Emission Tomography and Magnetic Resonance Imaging for Assessment of the Fetlock in 61 Sport Horses – *Charlène Pigé*

9:00 a.m. How to Use a Non-Articulating Borescope as a Rudimentary Overground Dynamic Endoscope – *Chloe Bening*

9:20 a.m. Catastrophic Pelvic Fractures in California Thoroughbred Racehorses – *Jeanette Espil*

9:40 a.m. Diagnostic Considerations for the General Practitioner when Referring Horses for Advanced Imaging of Distal Limb Musculoskeletal Injury – *Alexandra Scharf and Natashy Werpy*

10:00 a.m. A Review of Serial Monitoring of Distal Limb Musculoskeletal Injury in Horses: An Advanced Imaging Guide for the Equine Practitioner – *Alexandra Scharf and Natasha Werpy*

10:20 a.m. Imaging Diagnosis of a Plantarolateral Osseous Projection of the Third Metatarsal Bone in Lame Horses: A Novel Finding – *Bianca Drumond and Natasha Werpy*

10:40-11:00 a.m. Cannabidiol Treatment in Horses with Chronic Thoracolumbar Pain – *Camila Guidi*

Practice the techniques discussed in the highlighted presentation during drop-in mini labs using models on **Thursday** between noon-2:00 p.m. in the Stable Education area of the trade show. See page 15 for more information.

Collaborative Case Studies

Limited to 50 participants; advance registration required at no additional cost at convention.aaep.org.
See page 15 for more information.

8:30-10:00 a.m.

Frustrating Respiratory Cases – *Cossette Faivre and Kayla Le*

10:30 a.m.-Noon

Equine Dystocia – *Sarah Eaton and Ahmed Tibary*

Table Topics

Sponsored by Dechra Veterinary Products.
Seating is limited so please arrive early.

8:30-10:00 a.m.

Estrus Suppression: Are the Ovaries Really to Blame? – *Justin McNaughten and Lauren Pasch*

Mentorship Architecture: Factors Shaping Mentorship from the Mentor Perspective – *Meggan Graves and Ashley Whitehead*

Navigating the Veterinarian/Farrier Relationship – *Craig Lesser and Betsy Lordan*

10:30 a.m.-Noon

How to Navigate When You Suddenly Find Yourself Bought by Corporate – *Amy Grice and Rachael Levine*

Practical Cardiology for the General Practitioner – *Ben Buchanan and Cris Navas de Solis*

Foals in the Field – *Piper Norton and Karen Wolfsdorf*

> "AAEP is my 'go-to' conference for a wide breadth of equine-specific continuing education. The multi-disciplined perspective is so unique compared to other conferences and so important."
>
> —*2025 attendee*

Afternoon

Noon-1:45 p.m. **The Mane Connection**
See page 15 for tentative conversation topics.
No RACE CE credit awarded.
Sponsored by American Regent, Inc., manufacturer of Adequan i.m.® (polysulfated glycosaminoglycan) and BetaVet® (betamethasone sodium phosphate & betamethasone acetate injectable suspension).

How-to, Go-Do Mini Labs

See page 15 for more information.
No RACE CE credit awarded.

Noon-2:00 p.m. Equine Physiotherapy Exercises

How to Manage Hoof Compression and Restore Hoof Balance Using Acrylic Repair

Top of License: A Community Discussion on Technician Utilization, Retention, and the Future of Equine Practice

Sponsored by Standlee, Built on a Forage Foundation.

1:00-2:30 p.m.
Moderator: Rebecca Maldonado

Six voices. One stage. One conversation. Join three equine veterinarians and three equine veterinary technicians for an interactive discussion exploring how practices can maximize technician utilization, improve retention, create career pathways, and strengthen the veterinary team. Bring your questions, share your perspective, and be part of the conversation.

Modern Approaches to Equine Reproductive Medicine

Moderator: Ahmed Tibary
Sponsored by Platinum Performance, "Good Nutrition is Good Medicine."

2:00 p.m. Prevalence, Origins, and Risk Factors for Aneuploidy Associated with Pregnancy Loss – *Amanda de Mestre*

2:20 p.m. Oral Resveratrol Improves Clinical and Molecular Markers of Post-Breeding Inflammation in Mares Susceptible to Persistent Breeding-Induced Endometritis – *Carleigh Fedorka*

2:40 p.m. Pregnancy Efficiency and Live Foal Rates from OPU-ICSI-Derived Embryos – *Claudia Fernandes*

3:00 p.m. Review of Extracellular Vesicles and Their Future Applications in Equine Reproduction – *Josefina Ghersa*

3:20 p.m. Clinical Safety and Reproductive Outcomes Following Intrauterine Administration of Allogeneic Platelet Lysate in Mares – *Lorenzo Segabinazzi*

3:40-4:00 p.m. Stranger Things: Managing Equine Twins That Enter the Post-Fixation Abyss – *Margo Macpherson*

Advances in Equine Sports Medicine Therapeutics

Moderator: David Wilson
Sponsored by Contura Vet. Start with the Synovium, Start with Arthramid.

2:00 p.m. Review of the Production Methods, Compositions, and Clinical Applications of Blood-Based Therapies in Equine Practice – *Mark Revenaugh*

2:20 p.m. Straight Sesamoidean Ligament Desmopathy Commonly Occurs with Proximal Interphalangeal Joint Osteoarthritis – *Charlotte Barton*

2:40 p.m. A Prospective Longitudinal Study of Orthobiologics and Regenerative Medicine for the Treatment of Sport Injuries in Horses – *Mark Revenaugh*

3:00 p.m. Investigation of the Validity of Commercially Offered Genetic Tests for Type 2 Polysaccharide Storage Myopathy and Myofibrillar Myopathy – *Stephanie Valberg*

3:20 p.m. Effects of Phytogenic Supplementation on Cardiovascular Fitness and Post-Exercise Recovery in Steeplechasers Under Field Conditions – *Adeline Tischmacher*

3:40 p.m. Equine Umbilical Tissue (equicenta® CTM) had Greater Effectiveness and Safety Compared to Standard of Care in Performance Horses: A Prospective, Controlled, Randomized Clinical Study – *Alicia Bertone*

4:00 p.m. Endocrine Effects of Intra-Articular Methylprednisolone Acetate in Metabolically Normal Horses – *Allen Page*

4:20 p.m. Effects of Common Horse Show Medications (Phenylbutazone, Dexamethasone, and Esomeprazole) on Gastric pH and Ulcer Development Under Show-Like Conditions – *Natalie Azzolini*

4:40-5:00 p.m. Intra-Articular 2.5% Cross-Linked iPAAG in Sport Horses: Safety in 1,000 Cases and Longitudinal Outcomes in 252 Horses – *Sandra Kurras*

Emerging Issues: Toward Safer Racing: Pathology, Prevention, and Future Directions

Moderator: Sara Langsam
Sponsored by Sponsored by CareCredit, a Synchrony Solution. Flexible financing for clients. Fast payment for you.

2:00 p.m. Atrial Fibrillation and Equine Sudden Death – *Cris Navas de Solis*

2:45 p.m. Prevention of Humeral, Scapular, Tibial, Pelvis, and Lumbar Fracture (Proximal Limb and Spine) Fatalities – *Susan Stover*

3:30 p.m. Common Necropsy Findings and Pathology Associated with Thoroughbred Racehorses – *Julie Engiles*

4:15 p.m. Panel Discussion with the Speakers

In-Depth: Miniature and Draft Horses

Moderator: Jarred Williams

2:00 p.m. Metabolic Diseases and Their Potential Complications in Miniatures – *Allison Palmer*

2:30 p.m. General Anesthesia in Draft and Miniature Horses: Physiologic Challenges and Clinical Management – *Michelle Barletta*

3:00 p.m. Reproductive Management of the Miniature Horse: From Conception to Delivery and Beyond – *Robyn Ellerbrock*

3:30 p.m. Lameness in Draft Horses – *Travis Tull*

4:00 p.m. Upper Airway Abnormalities of Draft Horses – *Keith Brown*

4:30 p.m. Review of Hoof Morphology and Adaptive Scaling in Draft Horses and Miniature Horses – *Brian Beasley*

Collaborative Case Studies

Limited to 50 participants; advance registration required at no additional cost at convention.aaep.org.
See page 15 for more information.

1:30-3:00 p.m.

Internal Medicine – *Joe Bertone and Kesley Hart*

3:30-5:00 p.m.

Wounds – *Rebecca Bishop and Annette McCoy*

Table Topics

Sponsored by Dechra Veterinary Products.
Seating is limited so please arrive early.

1:30-3:00 p.m.

Starting Your Own Practice – *Sarah Cohen-Festerman and Kelly Zeytoonian*

Nutraceuticals: The Good, the Bad, and the Ugly – *Shannon Pratt-Phillips and Sarah White-Springer*

3:30-5:00 p.m.

How to Decide When Advanced Imaging Referral is Appropriate – *Elizabeth Acutt and Alexandra Scharf*

Telemedicine in Equine Veterinary Practice – *Mike Pownall and Laura Stokes-Greene*

Tune in to Post-Convention Virtual Table Topics

Both in-person and virtual convention registrants can participate in the live post-convention Table Topics held via Zoom the week of Dec. 14-18. Following is the tentative schedule. All times are ET. *Sponsored by Dechra Veterinary Products.*

Monday, Dec. 14
Noon Vitamin E/Vitamin Deficiencies
4:00 p.m. Outbreak Management
8:00 p.m. Foals in the Field

Tuesday, Dec. 15
Noon Practical Cardiology for the General Practitioner
4:00 p.m. Practical Pain Management in the Field
8:00 p.m. Reproductive Microbiology in Clinical Practice: Mistakes, Successes, and Revenue

Wednesday, Dec. 16
Noon Medical Devices and Compounding
8:00 p.m. Navigating the Veterinarian/Farrier Relationship

Thursday, Dec. 17
Noon Neuro vs Orthopedic Gait Abnormalities
4:00 p.m. Nutraceuticals: The Good, the Bad, and the Ugly
8:00 p.m. Starting Your Own Practice

Friday, Dec. 18
4:00 p.m. How to Navigate When You Suddenly Find Yourself Bought by Corporate

FRIDAY, DECEMBER 11

Morning

Equine Infectious Disease: From Detection to Disease Control

Moderator: Kate Echeverria
Sponsored by Purina Animal Nutrition, empowering veterinary professionals with nutrition resources at EquineVetNutrition.com.

8:00 a.m. An Intensive Cattle Exposure is Associated with Increased Subclinical Salmonella Shedding in Horses – *Carolyn Arnold*

8:20 a.m. Evaluation of Two Immunochromatographic Point-of-Care Tests for Detection of Coccidioides spp. Antibodies in Horses – *Ernesto Rojas-Sanchez*

8:40 a.m. How to Monitor and Reduce the Spread of EHV-1 at Equestrian Events – *Nicola Pusterla*

9:00 a.m. Review of Equine Botulism: A Practical Guide for a Rapid Response During an Outbreak – *Nathan Slovis*

9:20 a.m. The Effects of Clostridioides Difficile Toxin B on Equine Colonic Monolayers – *Keeley Copper*

9:40 a.m. Immunological Analysis of Antibody Responses to an Experimental Equine Lyme Disease Vaccine – *Richard Marconi*

10:00 a.m. Equine Coronavirus: From Emerging to Endemic Virus – *Nicola Pusterla*

10:20 a.m. Safety, Immunogenicity, and Protective Efficacy of a Recombinant Equine Rotavirus B Vaccine – *Olivia Jacob*

10:40-11:00 a.m. Validation of a Point-of-Care Polymerase Chain Reaction Assay for the Detection of Selected Respiratory Pathogens from Horses with Acute Onset of Fever and Respiratory Signs – *Nicola Pusterla*

In-Depth: Podiatry/Laminitis

Moderator: Andrew Van Eps
Sponsored by Kentucky Performance Products, makers of Insulin-Wise—research-proven to maintain normal insulin sensitivity.

8:00 a.m. Recent Advances in Diagnosing and Treating Laminitis – *Andrew Van Eps*

8:30 a.m. Nutritional Management Strategies for Prevention and Treatment of Hyperinsulinemia-Associated Laminitis – *Pat Harris*

9:00 a.m. Medical Management for Prevention and Treatment of Hyperinsulinemia-Associated Laminitis in Practice – *François-René Bertin*

9:30 a.m. Diagnostic Imaging for Different Stages of Laminitis – *Mathieu Spriet*

10:00 a.m. Podiatry Approaches for Chronic Laminitis – *Sammy Pittman*

10:30-. 11:00 a.m. Panel Discussion with the Speakers

Equine Surgery and Dentistry: Practical Approaches for Clinicians

Moderator: Joe Bertone

8:00 a.m. The Effect of Arthroscopic Lavage Volume on Bacterial Culture of Egress Fluid in Horses with Experimentally Induced Septic Arthritis and Synovitis – *Alannah Friedlund*

8:20 a.m. Review of the Anatomic Basis for Dental Extraction in the Horse – *Bruce Whittle*

8:40 a.m. How to Decide When and How to Perform Whole Blood Transfusion in Horses with Acute Hemorrhage – *Camilla Quattrini*

9:00 a.m. How to Decide Whether a Palmar/Plantar Digital Neurectomy is Indicated in Horses with Chronic Refractory Caudal Heel Pain – *Grant Myhre*

9:20 a.m. Centrifugation of Peritoneal Fluid Improves the Diagnostic Utility of Visual Assessment to Distinguish Strangulating and Non-Strangulating Gastrointestinal Lesions in Horses Presenting with Colic – *Isabelle Kilcoyne*

9:40 a.m. How to Formulate a Treatment Plan After EOTRH Diagnosis: A Practical Clinical Framework – *Olivia James*

10:00 a.m. How to Manage the Difficult Equine Dental Patient Using a Five-Domain Clinical Framework – *Olivia James*

10:20 a.m. How to Respond When Every Drop Counts: Practical Strategies for Managing Hemorrhage – *Rebecca Bishop*

10:40-11:00 a.m. Thermal and Mechanical Antinociceptive Effects of Subcutaneous Butorphanol in Horses – *Taylor Masters*

USDA Accreditation Training

The USDA's National Veterinary Accreditation Program (NVAP) **will not** be offering convention sessions applicable to the mandatory training requirements for accreditation renewal for equine veterinarians. Those assigned accreditation renewal dates should visit the USDA-APHIS NVAP website at www.aphis.usda.gov/nvap for more information.

Member Roundtables

Monday, Dec. 7, 1:00-2:30 p.m. & 3:00-4:30 p.m.

Engage, exchange, and elevate your practice by joining colleagues for a pair of facilitated discussions on topics essential to career success and satisfaction for many practitioners. Share your perspective, gain actionable ideas, and bring fresh approaches back to your practice. *No RACE CE credit awarded.*

1:00-2:30 p.m.
Solo but Not Alone: Tips and Tricks for Thriving in Solo Practice

3:00-4:30 p.m.
Emergency Coverage: New Solutions for Equine Practice

The Mane Connection

Sponsored by American Regent, Inc., manufacturer of Adequan i.m.® (polysulfated glycosaminoglycan) and BetaVet® (betamethasone sodium phosphate & betamethasone acetate injectable suspension).

Tuesday, Dec. 8-Thursday, Dec. 10
Noon-12:45 p.m. & 1:00-1:45 p.m.

Keep the learning going during each day's lunch break by joining colleagues for casual peer-led conversations that add authentic value to your daily practice. Two consecutive 45-minute discussions will occur each day in the AAEP Connect area of the trade show. While the final schedule and presenters are being finalized, the tentative topics are:

Mentorship that Matters: Strategies for Supporting Young Practitioners

Challenges Facing the Early Career Equine Practitioner

Confessions of a Seasoned Vet: Mistakes Made and Wisdom Gained

Your AAEP: A Conversation with Leadership

Working with Law Enforcement on Equine Abuse & Neglect Cases

Ambulatory Practice: Tips for Road Warriors

These sessions are not eligible for RACE CE credit.

How-to, Go-Do Mini Labs

Wednesday, Dec. 9-Thursday, Dec. 10, Noon-2:00 p.m.

Go from concept to confidence by practicing techniques discussed during selected presentations from Wednesday and Thursday educational sessions at free drop-in mini labs using models. Simply stop by the Stable Education area in the trade show during the lunch break both days to refine techniques or expand your skill sets in the following areas.
No RACE CE credit awarded.

Wednesday, Dec. 9
Creating and Applying Splints on Contracted Limbs in Foals

Hands-on Experience with Standing Coxofemoral Joint Radiograph Acquisition—with Discussion

Thursday, Dec. 10
Advanced Equine Physiotherapy Exercises

How to Manage Hoof Compression and Restore Hoof Balance Using Acrylic Repair

NEW!

Collaborative Case Studies

Thursday, Dec. 10 FREE

Each session is limited to 50 participants; advance registration required at no additional fee. Register at convention.aaep.org.

Put your clinical reasoning to the test by solving real-world patient challenges during new case-based learning opportunities. These highly engaging, "reverse classroom" sessions skip the traditional lecture to focus entirely on interactive case management and decision-making in the following areas:

8:30-10:00 a.m.
Frustrating Respiratory Cases – *Cassette Faivre and Kayle Le*

10:30 a.m.-Noon
Equine Dystocia – *Sarah Eaton and Ahmed Tibary*

1:30-3:00 p.m.
Internal Medicine – *Joe Bertone and Kelsey Hart*

3:30-5:00 p.m.
Wounds – *Rebecca Bishop and Annette McCoy*

You'll complete 60- to 90-minutes of required pre-session materials before attending the 90-minute facilitated session. During the session, you'll work in small groups of 8–10 to analyze challenging cases, develop solutions, and compare approaches before reconvening for facilitator-led discussion.

RACE CE credit is awarded for both the required pre-session work and the in-person session. Please note that these sessions will **not be** offered through the Virtual Convention.

MEETINGS & SUNRISE SESSIONS

Council and Committee Meetings

These meetings are open to all AAEP members unless specified otherwise and will conclude with a brief "closed" business session for council/committee members only.

Monday, Dec. 7

1:00-2:30 p.m.	CE Steering/Educational Programs Committees
1:00-3:00 p.m.	Racing Committee
3:00-5:00 p.m.	Early Career Committee
	Member Engagement Committee
	Welfare & Public Policy Advisory Council

Tuesday, Dec. 8

11:00 a.m.-12:30 p.m.	Performance Horse Committee
11:30 a.m.-12:30 p.m.	Infectious Disease Committee
Noon-1:30 p.m.	Healthy Practice Committee
1:00-2:00 p.m.	Belonging, Opportunity & Access Committee
1:00-2:30 p.m.	Professional Conduct & Ethics Committee*
4:00-5:30 p.m.	President's Advisory Council*

Wednesday, Dec. 9

1:00-3:00 p.m.	Horse Owner Education Committee
	Student Education & Outreach Committee

General Membership Meeting
Wednesday, Dec. 9, 5:15-6:00 p.m.

Discover the AAEP's progress on important issues over the past year. Then, join the conversation during an open town hall to discuss the issues impacting the profession and your practice.

PARTNER SUNRISE SESSIONS

Join AAEP Educational Partners for complimentary breakfast (while supplies last) and exploration of equine healthcare and practice topics on Dec. 8-9 in the Mandalay Bay Convention Center.

Tuesday, Dec. 8

6:30-7:30 a.m.

Equine Lyme Disease in Practice: Expert Panel on Comprehensive Management – *Tom Divers, Toby-Pinn Woodcock, and Eric Swinebroad; Moderator: Abby Sage. Presented by Zoetis.*

Outsmarting OA: A Vet-Driven Framework – *Sherry Johnson. Presented by American Regent.*

The Forage Factor: What Every Equine Veterinarian Should Know – *Lizz Share. Presented by Purina Animal Nutrition.*

From PPID to the Bigger Picture: Long-Term Endocrine Insights – *Harold Schott. Presented by Dechra Veterinary Products.*

Wedesday, Dec. 9

6:30-7:30 a.m.

Updates from the Equine Endocrinology Groups (PPID & EMS/ID) and Open Q&A – *Kelsey Hart and Francois-Rene Berin. Presented by Boehringer Ingelheim.*

Defining the Clinical and Structural Impact of 2.5% iPAAG® for Synovial Joint Health – *Erin Contino, Lynn Pezzanite, and Markus Wimmer. Presented by Contura Vet.*

What's Inside Counts: A Veterinarian's Guide to Smarter Nutrition Choices from Feed to Forage – *Abby Pritchard. Presented by Cargill.*

From Bench to Barn: Translational Evidence for Nutritional Joint Support in the Horse – *Canaan Whitfield-Cargile, Wendy Pearson, Darci Agin, and Matt Durham. Presented by Platinum Performance.*

The material presented is done so at the discretion of the Educational Partner; does not reflect the opinions or views of, or an endorsement by, the AAEP; and has not undergone review by the Educational Programs Committee. No CE credit is given for these sessions unless RACE approval has been previously obtained by the presenting company.

Optimize Your Practice

Tuesday, Dec. 8: 10:00 a.m.-6:00 p.m.
Wednesday, Dec. 9: 10:00 a.m.-6:00 p.m.
Thursday, Dec. 10: 10:00 a.m.-4:00 p.m.

Enhance patient care and practice efficiency inside the ultimate equine marketplace. With over 300 exhibitors, this is your chance to get hands-on with the latest imaging equipment, surgical tools, service offerings, and more. Comparison-shop leading vendors to ensure your next investment is the right one!

Be sure to stop by the **AAEP Connect** area to chat with AAEP and Foundation staff, attend a Mane Connection conversation, and take a breather with these complimentary perks:

Massage Service

Sponsored by CareCredit, A Synchrony Solution. Flexible financing for clients. Fast payment for you.
Tuesday, Dec. 8: 11:00 a.m.-5:00 p.m.
Wednesday, Dec. 9: 11:00 a.m.-5:00 p.m.
Thursday, Dec. 10: 11:00 a.m.-3:00 p.m.

Let the tension fade with a complimentary upper-body massage from the licensed pros at BodyWorks; or revive your feet with electronic foot massagers. A device charging station is also available. Get your free massage ticket at the CareCredit booth (5106).

Portrait Hub

Wednesday, Dec. 9-Thursday, Dec. 10
11:00 a.m.-1:00 p.m.

Make a winning first impression with a complimentary professional headshot for your practice website and socials.

Coffee Café

Satisfy your caffeine craving all day and stop by from 3:00-4:00 p.m. daily for savory treats and little eats to help power through your afternoon. *Convention coffee is sponsored by MAI Animal Health and Professional Embryo Transfer Supply Inc. (PETS).*

Trade Show Reception

Tuesday, Dec. 8, 4:30-6:00 p.m

Sip, shop, and socialize! Browse the exhibit hall with friends while enjoying complimentary wine, beer, and snacks along the way.

Stable Education

Tuesday, Dec. 8–Thursday, Dec. 10, 10:30 a.m.-2:00 p.m.

Fast-track your product knowledge before you buy with the inside scoop on new equipment and research during focused, exhibitor-sponsored 30-minute presentations. No CE credit is given, and the presentation lineup will be available in the on-site program and on the convention app and website.

Meeting Pods

Sponsored by EQUUS, EquiManagement, and The Horse: Your sources for horse health and veterinary business information.

Need a quiet spot for a private meeting? Conduct business on the fly by reserving one of four meeting pods at the Equine Network booth (3126) and stay powered up with a device charging station.

Happy Tails Play Space

Sponsored by Chewy Health.
Tuesday, Dec. 8-Wednesday, Dec. 9
11:30 a.m.-1:30 p.m.

Unwind after a busy morning of learning with adorable, adoptable puppies! Stop by to decompress with a daily dose of puppy therapy, and maybe even meet your new best friend. It's the perfect prescription for a midday reset.

Trade Show B-I-N-G-O!

Turn your floor walk into a win! Grab a bingo card from the kiosk near the convention registration desk, collect stickers on every exhibitor's square as you go, and turn in your completed card at the AAEP booth. You'll instantly receive a $10 AAEP General Store gift certificate and be entered in daily prize drawings for Visa gift cards and more.

Internship/Externship Career Night
Monday, Dec. 7, 5:00-7:00 p.m.
AAEP Internship/Externship Program practices: Find future team members from among hundreds of ambitious students seeking to ignite their careers by advancing their clinical and client interaction skills.

Welcome Reception
Monday, Dec. 7, 5:30-7:00 p.m.
Kick off days of discovery with drinks and hors d'oeuvres among friends old and new. This is the perfect casual environment to find your footing before educational sessions begin.

Student Faculty Advisors' Breakfast
Tuesday, Dec. 8, 6:30-7:30 a.m.
AAEP student chapter advisors are invited to a casual breakfast forum to discuss issues relevant to student programming.

Early Career Practitioners' Reception
Sponsored by Merck Animal Health.
Tuesday, Dec. 8, 6:30-8:00 p.m.
Expand your community of peers in their first five years of practice in this supportive gathering offering free food and beverages. As a bonus, obtain a professional headshot at no charge for your practice website or LinkedIn profile.

American Board of Veterinary Practitioners' Breakfast
Wednesday, Dec. 9, 7:00-8:00 a.m.

Christian Veterinary Mission Fellowship Breakfast
Wednesday, Dec. 9, 8:00-9:00 a.m.
Start your morning with breakfast and encouragement among CVM friends. No registration required..

Community Social Hour
Sponsored by VMRD – Celebrating 45 Years of Commitment to One Health and Personalized Service.
Wednesday, Dec. 9, 5:00-6:00 p.m.
Hosted by the Belonging, Opportunity and Access Committee.
Join colleagues for a relaxed, welcoming social hour focused on building connections and community.

Alumni Receptions
Wednesday, Dec. 9, 6:00-8:00 p.m.
Swap stories with former classmates and share experiences with other graduates of your alma mater. A list of schools hosting receptions will appear in the on-site program and on the convention app and website. For more information, contact your school's alumni office.

Vet Story Night

Benefiting The Foundation for The Horse
Hosted by Merck Animal Health.
Tuesday, Dec. 8, 8:00-10:30 p.m.
Mandalay Bay Convention Center

$65 – General Admission
$35 – Students, Residents, Interns, and Technicians
Ticket purchase includes theater seating and one drink. Purchase ticket(s) when completing your convention registration.

Join us for new and seasoned veterinary storytellers, including a surprise storyteller who will provide a little magic, during this one-of-a-kind evening. Proceeds support the mission of The Foundation: Transforming the lives of horses!

Table sponsorships are available and include a one-hour pre-event reception.

For more information, visit **convention.aaep.org/events**

Hosted by

MERCK Animal Health

International Events

Sponsored by Sound™. For 30 years, Sound has been your trusted source for diagnostic imaging equipment and services. In partnership with SCIL, Sound is proud to provide a global solution for you, the equine practitioner. Visit Booth 4711 for more information.

Enjoy cross-border camaraderie at these exclusive events for AAEP members from outside of the U.S. and Canada.

International Members' Breakfast
Wednesday, Dec. 9, 6:30-7:30 a.m.
Begin the day with complimentary breakfast and discussion of issues affecting the profession on a global level.

International Members' Reception
Wednesday, Dec. 9, 6:30-8:00 p.m.
Unwind after a day or learning by enjoying the company of members from around the world during this casual social gathering. Refreshments provided.

The President's Luncheon t
Thursday, Dec. 10
11:30 a.m.-1:30 p.m. $60

Enjoy lunch and a salute to service during our annual banquet at which we'll honor our incoming and outgoing leadership as well as celebrate exceptional colleagues during an inspiring awards ceremony spotlighting service, accomplishment, and voluteerism.

The After Party

Sponsored by Zoetis Equine: Long Live the Horse.
Thursday, Dec. 10, 8:00-10:30 p.m.
Mandalay Bay Convention Center

t Free for all registered attendees and exhibitors. **Ticket required. RSVP when completing your convention registration.**

Dust off your boots for an unforgettable night!

Enjoy live country music from the Rustyn Vaughn Lee band, show off your two-step moves on the dance floor, and attempt to outlast the mechanical bull—all while celebrating with colleagues and friends.

Whether you're sporting your favorite cowboy hat, boots, or denim, this is one celebration you won't want to miss!

Sponsored by

zoetis

Bet on Yourself Through Virtual Career Fair

Hit the career jackpot by securing a new opportunity with one of the dozens of practices looking to hire during the convention. Beginning Oct. 16:

1. Create or log into your AAEP Career Center account at jobs.aaep.org.

2. Upload your résumé if you haven't already done so.

3. Indicate your Career Fair attendance on your account page, which will flag your résumé for participating practices to review and contact you (confidentially if preferred) about meeting while in Las Vegas.

You'll also be able to view a list of participating practices and create email job alerts to be notified of new Career Fair listings. For more information, contact Megan Gray at mgray@aaep.org.

Balance Family and Learning: On-Site Childcare Offered in Vegas

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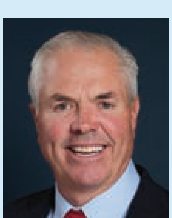
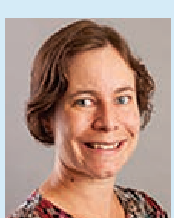
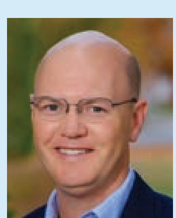
Thanks to Convention Organizers

This meeting's educational program is brought to you by the combined efforts of the program chair, the CE Steering Committee (CESC), and the Educational Programs Committee (EPC).

From left:

P.O. Eric Mueller, DVM, PhD, DACVS – Program Chair

Amy Johnson, DVM, DACVIM (LAIM & Neurology) – CESC & EPC Chair

Allen Page, DVM, PhD – CESC & EPC Vice Chair

The AAEP also thanks the following members of the CESC and/or EPC for their efforts organizing the 72nd Annual Convention:

Emma Adam, Amy Armentrout, Myra Barrett, Chris Bell, Joe Bertone, Lori Bidwell, Rebecca Bishop, Suzanne Brenner, Sabrina Brounts, Jennifer Cassano, Luis Castro, Kate Chope, Kevin Claunch, Michael Conaway, Bobby Cowles, Alejandro De La Fuentes, Lindsay Deacon, Katarzyna Dembek, Pouya Dini, Matt Durham, Sarah Eaton, Kate Echeverria, Robyn Ellerbrock, Carrie Finno, Jen Gold, John Hubbell, Carrie Jacobs, Kate Kiger, Katie Larson, Kayla Marie Le, Rebecca Legere, Susannah Lewis, Chelsea Luedke, Taralyn McCarrel, Annette McCoy, Nick Moore, Valerie Moorman, Courtney O'Connell, Lauren Pasch, Ryan Penno, Lynn Pezzanite, Charlène Pigé, Joe Pluhar, Kaitlin Quinter, Shannon Reed, Sarah Reuss, Chris Sanchez, Mary Scollay-Ward, Holly Stewart, Tom Stout, Wes Sutter, Eric Swinebroad, Ben Sykes, Ahmed Tibary, David Wilson, and Phoebe Smith (board liaison).

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Both in-person and virtual registration can be completed at convention.aaep.org.

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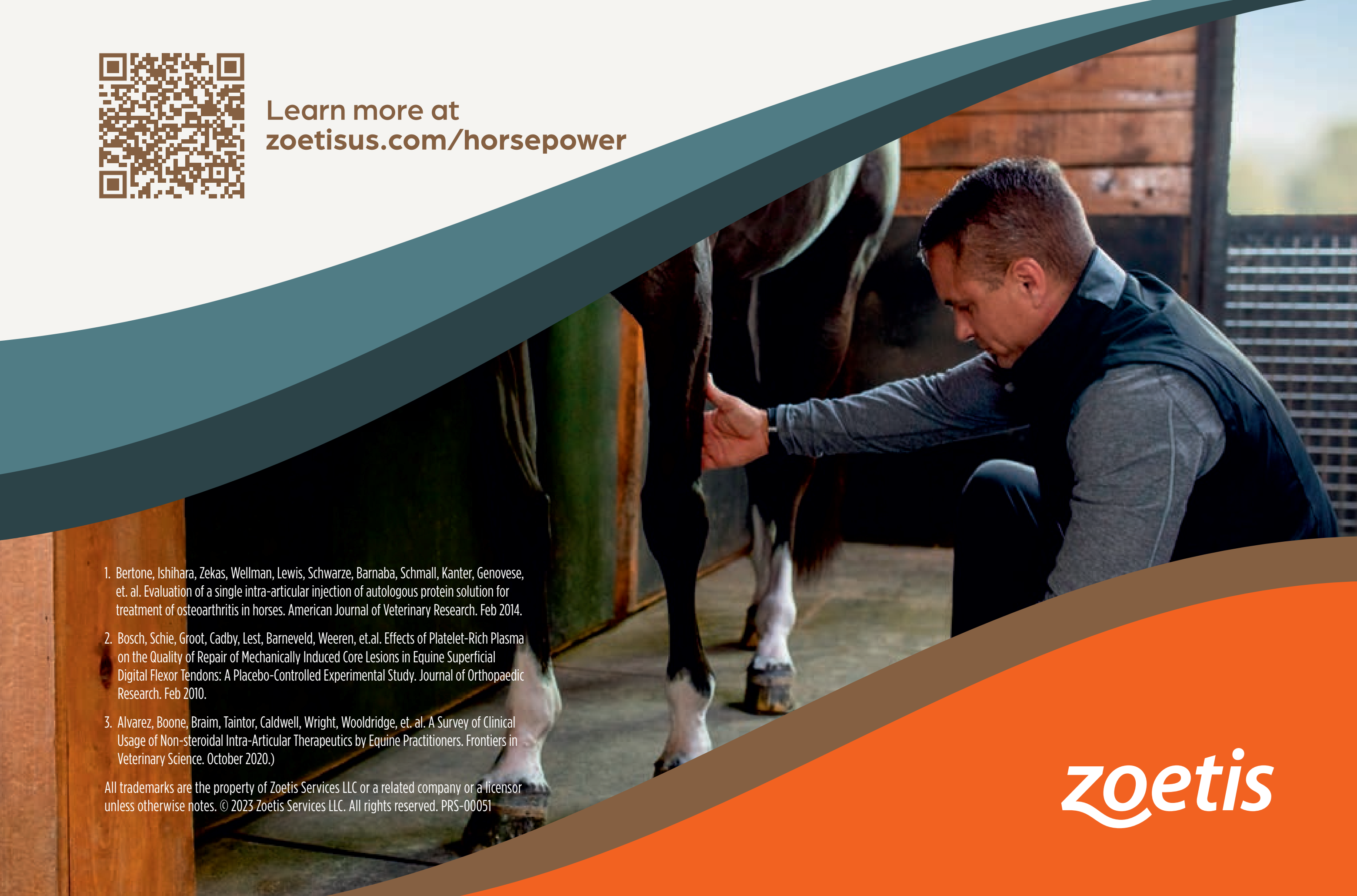

1. Bertone, Ishihara, Zekas, Wellman, Lewis, Schwarze, Barnaba, Schmall, Kanter, Genovese, et. al. Evaluation of a single intra-articular injection of autologous protein solution for treatment of osteoarthritis in horses. American Journal of Veterinary Research. Feb 2014.
2. Bosch, Schie, Groot, Cadby, Lest, Barneveld, Weeren, et.al. Effects of Platelet-Rich Plasma on the Quality of Repair of Mechanically Induced Core Lesions in Equine Superficial Digital Flexor Tendons: A Placebo-Controlled Experimental Study. Journal of Orthopaedic Research. Feb 2010.
3. Alvarez, Boone, Braim, Taintor, Caldwell, Wright, Wooldridge, et. al. A Survey of Clinical Usage of Non-steroidal Intra-Articular Therapeutics by Equine Practitioners. Frontiers in Veterinary Science. October 2020.)

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Equine Veterinary Education BEVA

CASE REPORT

An unusual presentation of osteochondrosis in the elbows and tarsi of a Friesian colt

A. Torrent-Crosa[1] | **A. Merchán-Muñoz**[1] | **C. Co**[2] | **E. Borkowski**[2]

[1]Department of Clinical Studies, Ontario Veterinary College, University of Guelph, Guelph, Ontario, Canada

[2]Department of Pathobiology, Ontario Veterinary College, University of Guelph, Guelph, Ontario, Canada

Correspondence: A. Torrent-Crosa
Email: atorrent@uoguelph.ca

SUMMARY

This case report describes the clinical presentation of a 2.5-month-old Friesian colt with acute onset severe gait abnormalities, which occurred 1 month after undergoing surgical management of varus angular limb deformities of the fetlocks, along with the diagnostic imaging and post-mortem findings. Upon re-valuation, the foal showed bilateral medial front limb collapse during the stance phase, abnormal stiff gait in all four limbs and severe effusion in the elbow and tarsal joints. Radiographs revealed severe osteochondral lesions in both the elbows and the tarsi. Ultrasonography of the elbow joints showed mildly echogenic effusion consistent with haemarthrosis. The tarsi presented firm, raised and marked soft tissue deformation near the calcaneus. Ultrasonography revealed bone callus formation around the calcaneal lesions. Diagnostic imaging was key in identifying the severity of the lesions. Due to the severity of these findings and the poor prognosis, euthanasia was elected. Post-mortem examination revealed severe osteochondral dissecans (OCD) lesions in both elbow joints and Salter-Harris type II fractures in the tarsi, consistent with the radiographical findings. Histopathology confirmed extensive chondronecrosis and fibrocartilaginous repair attempts in the affected joints, with necrosis in the cartilage and subchondral bone. This case report features an unusual and severe presentation of OCD and associated fractures in a young foal. The colt's rapid growth was likely a predisposing factor, exacerbating the progression of osteochondrosis and leading to joint instability. The case highlights the importance of early diagnosis and intervention in managing developmental orthopaedic conditions, particularly in foals with rapid growth rates.

https://onlinelibrary.wiley.com/doi/pdf/10.1111/eve.70058

Key points

- Severe osteonecrosis leading to severe OCD lesions in the elbow and Salter-Harris type II fractures of the calcaneus are very rare conditions, but they were the cause of the stiffness and severe gait abnormalities observed in this colt.
- The onset of developmental disease may present with subtle clinical changes, highlighting the importance of a thorough examination of less commonly affected joints when evaluating young animals presenting with other primary complaints.
- It is suggested in this case report that rapid growth rate contributed significantly to the development of severe orthopaedic lesions in the elbow and tarsal joints, leading to poor prognosis and euthanasia.

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Equine Veterinary Education BEVA

CASE REPORT

Osteomyelitis of the lateral humeral epicondyle secondary to trauma in a Franches-Montagnes gelding

D. Blau-Huber[1] | L. Geitzenauer[1] | S. Montavon[2] | E. Van der Vekens[3] | C. Koch[4]

[1]National Equestrian Center, Bern, Switzerland

[2]Veterinary Department Swiss Armed Forces, Ittigen, Switzerland

[3]Division of Clinical Radiology, Department of Clinical Veterinary Sciences, Vetsuisse Faculty, University of Bern, Bern, Switzerland

[4]Division of Equine Surgery, Department of Clinical Veterinary Sciences, Vetsuisse Faculty, Swiss Institute of Equine Medicine (ISME), University of Bern, Bern, Switzerland

Correspondence: D. Blau-Huber
Email: d.blau@npz.ch

SUMMARY

A 4-year-old Franches-Montagnes gelding was diagnosed with traumatic osteomyelitis of the lateral humeral epicondyle following a kick injury to the left elbow. Initial signs included 4/5 lameness, significant swelling and a draining wound. Radiographs and ultrasonography revealed avulsion fragments, a fistulous tract and abscessation. Broad spectrum antimicrobial therapy yielded transient improvement but deteroration prompted referral. At the secondary referral centre, advanced imaging, including ultrasonography and intraoperative cone beam computed tomography (CBCT), confirmed osteomyelitis with osteolytic lesions gas foci, and periosteal reactions (Figure 1). CBCT imaging revealed a triangular-shaped area of mixed soft tissue and small gas attenuating foci (asterisk) within the swollen tissues at the lateral humeral epicondyle, extending to the osseous surface. A mild to moderate, partially irregular periosteal reaction (arrowheads) was present at the lateral humeral metaphysis. Here, the medullary cavity was heterogeneous, showing moth-eaten to permeative osteolysis (arrows) surrounded by mild sclerosis.Surgical debridement and fragment removal were performed under general anaesthesia and antimicrobial therapy was adjusted to doxycycline based on results from culture and sensitivity testing. Despite later sequestrum formation, conservative management resulted in resolution without additional surgery. The horse returned to soundness within four months and remained sound with near-complete radiographic resolution 9 months post-injury.

FIGURE 1 Dorsal multiplanar reconstructed cone-beam computed tomographic image in a bone kernel showing the left elbow with traumatic osteomyelitis 4 weeks after the initial trauma. Within the swollen soft tissues at the lateral aspect of the humeral epicondyle, small gas attenuating foci (asterisk) are visible extending to the osseous surface. The wound is visible as an irregular bulging surface. A mild to moderate amount of periosteal reaction (arrowheads) is present at the lateral aspect of the humeral metaphysis. At this level, the medullary cavity of the humerus is heterogeneous, showing moth-eaten to permeative osteolysis (arrows), surrounded by poorly defined areas of mild sclerosis.

https://onlinelibrary.wiley.com/doi/pdf/10.1111/eve.70077

Key points

- This is the first documented case of traumatic osteomyelitis of the lateral humeral epicondyle in a horse with concurrent avulsion fragments and abscess.
- Intraoperative cone beam CT (CBCT) imaging was essential for diagnosing medullary involvement and guiding surgical treatment.
- Surgical debridement, combined with targeted antimicrobial therapy following culture and sensitivity testing, led to complete recovery despite initial treatment failure.

D. Blau-Huber and L. Geitzenauer contributed equally to this work.

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Equine Veterinary Education BEVA

CASE REPORT

Unusual presentation of osteomyelitis of the tuber calcanei in a 16-month-old gelding

A. M. Arreola | C. Serna | K. G. Mitchell | A. Merchán

Department of Clinical Studies, Ontario Veterinary College, University of Guelph, Guelph, Ontario, Canada

Correspondence: A. Merchán
Email: amerch03@uoguelph.ca

SUMMARY

A 16-month-old Morgan gelding was referred for severe right hindlimb lameness with calcaneal swelling. Signs had been present for 4 weeks. Radiography and ultrasonography identified a plantaromedial tuber calcanei defect with mild intertendinous bursal effusion; synovial fluid was unremarkable. Five-day repeat imaging showed rapid lesion enlargement and osteolysis. CT on day 8 further defined the defect. Due to lack of improvement, surgical exploration via a caudal approach was performed, including debridement of the osteolytic region. Bone culture yielded *Actinobacillus* spp. Postoperatively, comfort improved immediately, and lameness resolved. Two-year follow-up confirmed sustained clinical soundness without recurrence.

https://onlinelibrary.wiley.com/doi/pdf/10.1111/eve.70098

FIGURE 1 Computed tomographic image of the right tarsus showing a soft tissue–attenuating region associated with complete disruption of the plantar cortical margin of the tuber calcanei (arrowhead).

Key points

- Clinical manifestations of the tuber calcanei lesion included marked hindlimb lameness, localised soft tissue swelling of the tarsal region—most pronounced medially—and mild synovial effusion within the intertendinous calcaneal bursa.
- Computed tomography of the right tarsus allowed further characterisation of the lesion's extent and morphology.
- Surgical management consisted of thorough debridement and lavage of the osteolytic defect. Bacterial culture of the affected osseous tissue identified *Actinobacillus* spp. as the causative pathogen.

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Equine Veterinary Education BEVA

CASE REPORT

Primary cardiac T-cell rich large B-cell lymphoma causing aortic stenosis with metastasis in a Warmblood

S. E. Talbot[1] | F. Z. X. Lean[2] | H. M. Martineau[2] | B. Dunkel[1] | J. Reed[1]

[1]Department of Clinical Science and Services, Royal Veterinary College, Hertfordshire, UK

[2]Department of Pathobiology and Population Sciences, Royal Veterinary College, Hertfordshire, UK

Correspondence: J. Reed
Email: jenreed@rvc.ac.uk

SUMMARY

This case report describes an 18-year-old Warmblood mare with primary cardiac T-cell rich large B-cell lymphoma (TCRBCL), culminating in aortic stenosis. The mare presented with progressive peri-ocular swelling, submandibular lymphadenopathy, weight loss and tachycardia. Cardiac auscultation revealed bilateral pansystolic murmurs (grade 5/6 basilar left-sided, 2/6 right-sided), loudest over the aortic valve. Echocardiography revealed valvular and septal thickening (Figure 1). Computed tomography identified no discrete mass. Progressive deterioration necessitated euthanasia. Post-mortem examination demonstrated neoplastic infiltration and thickening of the pulmonic artery, interventricular septum and cardiac valves, causing severe outflow tract stenosis. Large colon and palpebral metastases were present. Histopathology confirmed mixed CD3+ T-cells and CD20+/CD79a+ B-cell populations, characteristic of TCRBCL. The cardiac neoplasm was considered primary, as lesions were not typical of gastrointestinal lymphoma. This case complements previous documentation of peri-ocular swelling with equine lymphoma. Obstructive aortic stenosis (AS) murmurs are exceptionally rare in horses. They must be distinguished from relative AS (from left ventricular volume overload), mitral regurgitation or occasionally, high-grade ejection murmurs. Echocardiography is essential for definitive diagnosis. Unusually, this mare did not present in congestive heart failure. The severe outflow tract obstruction is suspected to have induced cardiac 'forward failure', characterised by exercise intolerance, systemic hypoperfusion and cardiogenic shock. Humans with AS can compensate for prolonged periods, perhaps explaining why the mare's clinical signs manifested only 48h before presentation. Pre-mortem diagnosis is possible in up to 60% of lymphoma cases. Palpebral biopsy, contrast-enhanced computed tomography, MRI or endomyocardial biopsy may have aided diagnosis. Lymphoma should be considered in horses presenting with peri-ocular swelling and acute-onset cardiac murmurs. Although rare, outflow tract obstruction and forward failure can occur with equine cardiac neoplasms.

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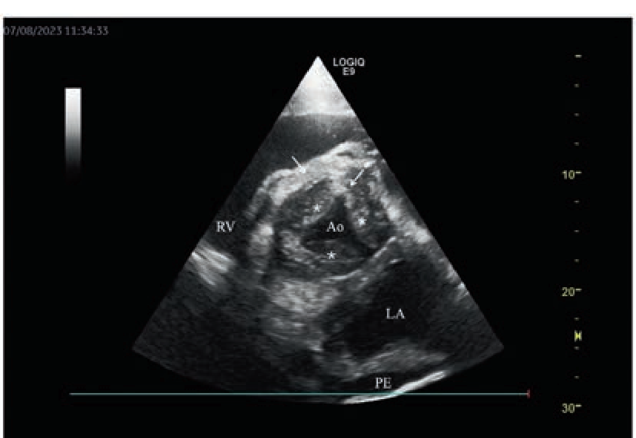

FIGURE 1 B-mode right-parasternal short-axis view. Tumour infiltration (arrows) causes aortic valvular stenosis. Ao, aorta; LA, left atrium; RV, right ventricle.

Key points

- Peri-ocular swelling may present in early cases of equine lymphoma.
- Aortic stenosis may present as pansystolic, plateau-shaped murmurs with a point of maximal intensity overlying the aortic valve.
- Forward failure of the heart may occur in horses with cardiac outflow tract obstruction.

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Equine Veterinary Education

CLINICAL COMMENTARY

‘Eyes are the window to the soul’…or is it the heart?

F. C. F. Worsman

Avenel Equine Hospital, Avenel, Victoria, Australia

Correspondence: F. C. F. Worsman
Email: francesca.worsman@avenelequine.com.au

KEYWORDS
horse, aortic stenosis, cardiac, lymphoma, peri-ocular swelling

Are you looking at lymphoma or perhaps listening to it? The diagnosis of lymphoma can be challenging, reflecting the often-insidious effects of either the primary mass or secondary spread. The case report in this issue by Talbot et al. (2025) describes an unusual location for a primary lymphoma tumour, in the interventricular septum extending around the aortic valve. Significant cardiac findings were noted on auscultation; qualities of cardiac murmurs were consistent with findings attributable to an uncommonly encountered differential diagnosis of effective aortic stenosis. Though presumably not acute in onset at this location, clinical presentation was only prompted when overt signs of periocular swelling were observed by the owner.

Lymphoma accounts for 1.3–2.8% of equine neoplasms (Taintor & Schleis, 2011) and T-cell rich, large B-cell lymphoma (TCRBCL) is the most common subtype (40–45% of cases) (Durham et al., 2012; Valli et al., 2016). Lymphoma associated with peri-ocular swelling (Murphy et al., 1989; Rendle et al., 2012) has also been reported; in this case, the peri-ocular swelling was an early sentinel, preceding detection of the primary cardiac infiltration. The accompanying case report also highlights pertinent nuances when interpreting cardiac findings and provides an important aide-mémoire for presentations and manifestations of TCRBCL.

PATHOPHYSIOLOGICAL CONTEXT

Lymphoma is the most common haematopoietic equine neoplasia (Muñoz et al., 2009). Lymphoma arises from lymphoid tissue that includes lymph nodes, spleen and gut-associated lymphoid tissue. In human medicine, the presence of Reed Sternberg cells, a giant cell usually derived from B lymphocytes, identified from aspiration or biopsy determines the classification of Hodgkin lymphoma. Non-Hodgkin lymphoma, however, is the most common recognised type of lymphoma in domestic animals (Taintor & Schleis, 2011) and can be classified further by immunophenotyping neoplastic lymphocytes as B cell, T cell or NK cell. Equine lymphoma is classified into one of five forms: cutaneous, multicentric, alimentary, mediastinal and solitary tumours of extranodal origin (Durham et al., 2012). Veterinary adaptation of the World Health Organization classification for human lymphoma has determined most equine lymphomas are TCRBCL and present typically as subcutaneous nodules (Durham et al., 2012). TCRLBCL is determined by presence of large neoplastic B-lymphocytes with irregular nuclei and coarse chromatin with prominent nucleoli and adjacent sheets of small, reactive T-lymphocytes (Rissi et al., 2023). TCRBCL diagnosis is confirmed by collective results from histopathology, immunohistochemistry and PCR antigen receptor arrangement can be used adjunctively (Collar et al., 2019; Rissi et al., 2023). Case reports of equine presentations of TCRBCL in scientific literature in the past 2 years describe invasive primary lesions located in the mouth, brain, retropharyngeal region and heart (de Bruijn et al., 2025; Peretti et al., 2024; Rissi et al., 2023; Talbot et al., 2025).

Clinical signs of lymphoma typically develop insidiously and at presentation are non-specific and may reflect the function of the organs involved or the extent and duration of involvement. Common findings are weight loss and anorexia (Durham et al., 2012; Taintor & Schleis, 2011; Valli et al., 2016). Peri-ocular swelling was highlighted in the accompanying case report as an early indicator of disease. A variety of multicentric lymphoma-associated ocular manifestations have been recognised and include intermittent unilateral or bilateral blepharitis, chronic ocular discharge, oedematous third eyelid, unilateral exophthalmos, corneoscleral masses and chronic uveitis unresponsive to treatment (Germann et al., 2008; Murphy et al., 1989; Rebhun & Del Piero, 1998; Rendle et al., 2012; Stoppini et al., 2005). In light of the peri-ocular region being an apparent predilection site (Rebhun & Del Piero, 1998), the authors of the case report by Talbot et al. (2025) highlight that peri-ocular swelling should be considered as a potential early sign of lymphoma in horses.

Cardiac lymphoma has been reported previously (Hargreaves et al., 2018; Penrose et al., 2012), the difference in presentation with the case report by Talbot et al. (2025) included markedly expanded and nodular valvular leaflets and evidence of effective aortic stenosis and suspected forward failure of the heart. Aortic stenosis was determined from echocardiography with marked thickening of the interventricular septum, aortic, mitral, tricuspid and pulmonary valves; no significant valvular regurgitation was observed. Aortic stenosis with forward failure of the heart is considered exceptionally rare in horses (Hammond et al., 2023), and the lack of left or right sided congestive heart failure is unusual. The report highlights how the pertinent cardiac murmur qualities of point of maximal intensity and radiation detected on auscultation corroborated the rare cardiac pathology.

DIAGNOSIS AND MANAGEMENT

A definitive diagnosis of lymphoma can be challenging and it was not achieved pre-mortem in the accompanying case report. This case highlights that comprehensive evaluation of lymphoma cases is indicated, including but not limited to, physical examination, blood analysis, thoracic and abdominal ultrasonography/diagnostic imaging and further investigation associated with lesion location and organ involvement. Serum globulin concentrations are associated with location of lymphoma and survival times (Wensley et al., 2023). Following collective interpretation of diagnostic investigation and clinicopathological findings and as discussed in the case report, fine needle aspirate or biopsy has been reported for definitive diagnosis in up to 60% of cases antemortem (Rebhun & Bertone, 1984) but may be limited by tumour location. Understandably, the cardiac biopsy technique (Decloedt et al., 2016) was not employed in this case.

The prognosis for horses with lymphoma depends on the form of lymphoma and the stage at which the horse is presented. Multidrug chemotherapy protocols have been described for treatment of multicentric lymphoma (Luethy et al., 2019) with partial responses in multicentric cases; reported treatment is generally considered palliative.

CLINICAL TAKE HOME MESSAGES

Lymphoma is the most common haematopoietic neoplasm, accounting for 1.3%–2.8% of all equine neoplasms.

T-cell rich large B-cell lymphoma is the most common type of lymphoma and has a myriad of manifestations and thus presentations.

Aortic stenosis and forward failure of the heart in horses are rare.

Horses with acute-onset cardiac murmurs and peri-ocular swelling should have comprehensive investigation.

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None.

CONFLICT OF INTEREST STATEMENT

No conflicts of interest have been declared.

ETHICS STATEMENT

Not applicable.

ORCID

F. C. F. Worsman https://orcid.org/0000-0002-7273-9846

REFERENCES

Collar, E.M., Parker, J.E., Gorman, E.M., Russell, D.S. & Valentine, B.A. (2019) PCR for antigen receptor rearrangement (PARR) clonality testing in a horse with a solitary retropharyngeal lymphoma. *Equine Veterinary Education*, 31, 413–418.

de Bruijn, E., Rutigliano, L., Hiltrop, R., Chiers, K., Raes, E. & Paulussen, E. (2025) Uncommon presentation of an invasive T-cell lymphoma in a young warmblood stallion. *Equine Veterinary Education*, 37(8), e153–e158. Available from: https://doi.org/10.1111/eve.14099

Decloedt, A., de Clercq, D., Ven, S., van der Vekens, N., Chiers, K. & van Loon, G. (2016) Right atrial and right ventricular ultrasound-guided biopsy technique in standing horses. *Equine Veterinary Journal*, 48, 346–351.

Durham, A.C., Pillitteri, C.A., Myint, M.S. & Valli, V.E. (2012) Two hundred three cases of equine lymphoma classified according to the World Health Organization (WHO) classification criteria. *Veterinary Pathology*, 50, 86–93.

Germann, S.E., Richter, M., Schwarzwald, C.C., Wimmershoff, J. & Spiess, B.M. (2008) Ocular and multicentric lymphoma in a young racehorse. *Veterinary Ophthalmology*, 11(Suppl 1), 51–56.

Hammond, A., Savage, V., Harley, R. & Borgeat, K. (2023) Aortic valve stenosis associated with valvular heterotopic ossification with extramedullary haematopoiesis in a horse. *Equine Veterinary Education*, 35, e260–e267.

Hargreaves, L., Gosling, L. & Dixon, J.J. (2018) Pericardial effusion and congestive heart failure in a horse with multicentric lymphoma. *Veterinary Record Case Reports*, 6, e000631.

Luethy, D., Frimberger, A.E., Bedenice, D., Byrne, B.S., Groover, E.S., Gardner, R.B. et al. (2019) Retrospective evaluation of clinical outcome after chemotherapy for lymphoma in 15 equids (1991–2017). *Journal of Veterinary Internal Medicine*, 33, 953–960.

Muñoz, A., Riber, C., Trigo, P. & Castejon, F. (2009) Hematopoietic neoplasias in horses: myeloproliferative and lymphoproliferative disorders. *Journal of Equine Science*, 20, 59–72.

Murphy, C.J., Lavoie, J.P., Groff, J., Hacker, D., Pryor, P. & Bellhorn, R.W. (1989) Bilateral eyelid swelling attributable to lymphosarcoma in a horse. *Journal of the American Veterinary Medical Association*, 194, 939–942.

Penrose, L.C., Brower, A., Kirk, G., Bowen, I.M. & Hallowell, G.D. (2012) Primary cardiac lymphoma in a 10-year-old equine gelding. *Veterinary Record*, 171, 20.

Peretti, J.C., dos Santos, A.B., Davi Santos, E., Machado, T.P., Pescador, C.A., Quillas, L.J.A. et al. (2024) Oral T-cell-rich large B-cell lymphoma in a horse. *Veterinary Research Communications*, 48, 4067–4071.

Rebhun, W. & Bertone, A. (1984) Equine lymphosarcoma. *Journal of the American Veterinary Medical Association*, 184, 720–721.

Rebhun, W.C. & Del Piero, F. (1998) Ocular lesions in horses with lymphosarcoma: 21 cases (1977-1997). *Journal of the American Veterinary Medical Association*, 212, 852–854.

Rendle, D., Hughes, K., Farish, C. & Kessell, A. (2012) Multicentric T-cell lymphoma presenting as inferior palpebral swelling in a standardbred mare. *Australian Veterinary Journal*, 90, 485–489.

Rissi, D.R., Avery, A.C. & Burnett, R.C. (2023) T-cell-rich, large B-cell lymphoma in the brain of a horse. *Journal of Veterinary Diagnostic Investigation*, 35(3), 327–331.

Stoppini, R., Gilger, B.C., Malarkey, D.E., Ratto, A. & Brigati, G. (2005) Bilateral nodular lymphocytic conjunctivitis in a horse. *Veterinary Ophthalmology*, 8, 129–134.

Taintor, J. & Schleis, S. (2011) Equine Lymphoma. *Equine Veterinary Education*, 23(4), 205–213.

Talbot, S.E., Lean, F.Z.X., Martineau, H.M., Dunkel, B. & Reed, J. (2025) Primary cardiac T-cell rich large B-cell lymphoma causing aortic stenosis with metastasis in a warmblood. *Equine Veterinary Education*, 38(8), e488–e495. Available from: https://doi.org/10.1111/eve.70022

Valli, V.E., Bienzle, D. & Meuten, D.J. (2016) Tumors of the hemolymphatic system. In: *Tumors in domestic animals*. Berkeley: University of California Press, pp. 203–321.

Wensley, F.M., Berryhill, E.H. & Magdesian, K.G. (2023) Association of globulin concentrations with prognosis in horses with lymphoma. *Frontiers in Veterinary Science*, 9, 1086010. Available from: https://doi.org/10.3389/fvets.2022.1086010

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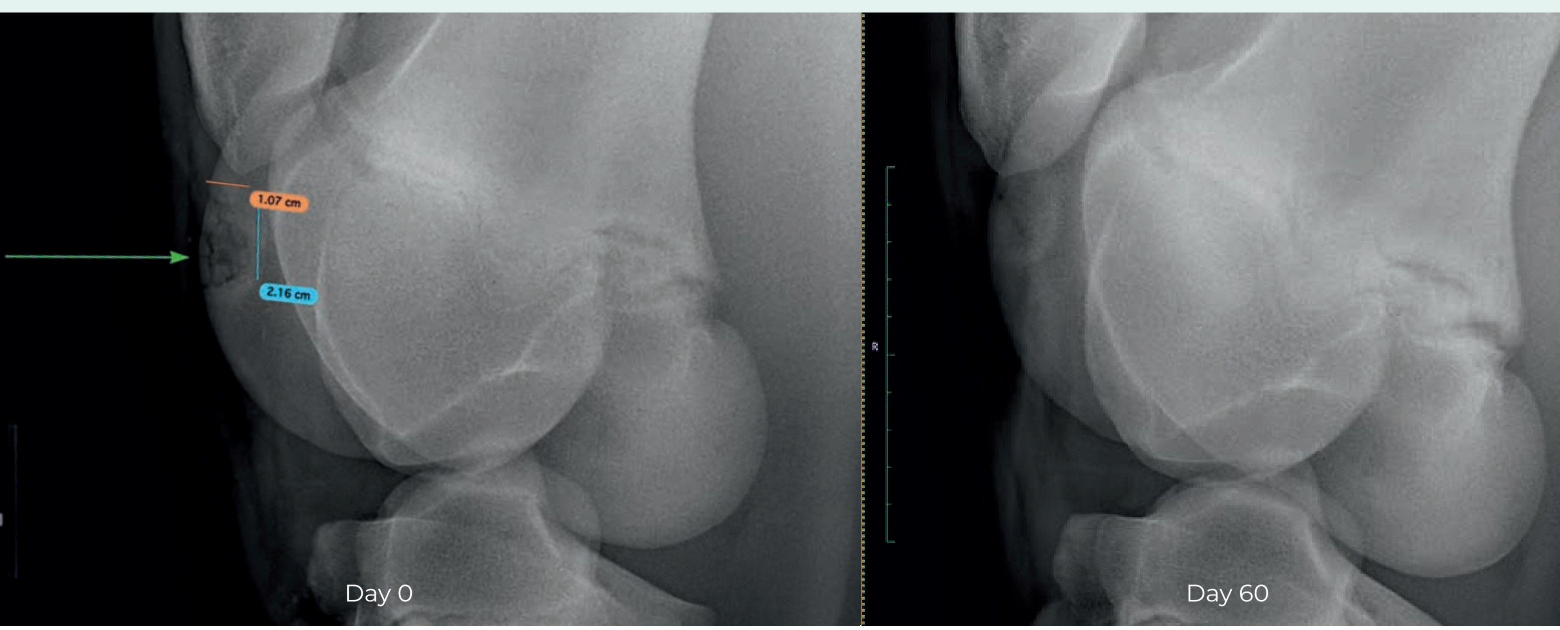

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CASE REPORT

Equine Veterinary Education BEVA

Sidewinder syndrome associated with complete rupture of the *ligamentum capitis ossis femoris* in a horse

T. N. Burdette[1] | C. L. Hsiou[2] | S. P. McDonough[2] | S. Pell[3] | J. Ayers[3] | T. J. Divers[1] | B. Delvescovo[1]

[1]Department of Clinical Science, Cornell University College of Veterinary Medicine, Ithaca, New York, USA

[2]Department of Population Medicine and Diagnostic Sciences, Cornell University College of Veterinary Medicine, Ithaca, New York, USA

[3]Genesee Valley Equine Clinic, Scottsville, New York, USA

Correspondence: B. Delvescovo
Email: bd382@cornell.edu

SUMMARY

This case report describes a 10-year-old gelding presented for acute onset of a left-sided sidewinder gait (Figure 1). The abnormal gait was first observed when the horse stood after rolling. The horse had a 3-week history of right hindlimb lameness prior to this event. Initial medical management, consisting of anti-inflammatory and anti-protozoal medications administered for 1–2 weeks, did not result in improvement. The horse was subsequently referred for further evaluation. Given the normal neurological examination findings, a musculoskeletal aetiology for the abnormal gait was considered most likely. Further diagnostic investigations were proposed, including advanced imaging of the coxofemoral joints and thoracolumbar region, cerebrospinal fluid (CSF) collection and analysis (including EPM titres), and electromyography of the abductor and adductor muscles. However, given the guarded prognosis for resolution and return to function, and the lack of response to previous medical management, the owner elected not to pursue additional diagnostics. Post-mortem examination revealed complete rupture of the right *ligamentum capitis ossis femoris* (LCOF) with associated osteoarthritic changes in the acetabulum. No other significant pathology was identified at necropsy; therefore, this lesion was determined to be the most likely cause of the abnormal gait. Sidewinder syndrome, while well-documented in the literature, remains poorly understood due to its many, diverse aetiologies. A review of recent reported cases has brought to our attention how pathology involving the LCOF and coxofemoral joint is a potential cause in cases of sidewinder gait. The aim of this case report is to describe clinical and post-mortem findings in a horse with an acute onset of clinical signs typical of the 'sidewinder' syndrome and to summarise the current literature of the disorder.

Figure 1 Horse exhibiting a sidewinder gait, characterised by marked leaning of the hindquarters to the left while standing.

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Key points

- Sidewinder syndrome is a complex and poorly understood syndrome with many different causes reported.
- In neurologically normal horses with sidewinder gait, coxofemoral pathology should be investigated.
- Complete rupture of the *ligamentum capitis ossis femoris*, contralateral to the leaning side, should be considered amongst the differential diagnoses for sidewinder gait in horses.

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Equine Veterinary Education

BEVA

CLINICAL COMMENTARY

Coxofemoral instability in equids caused by *Ligamentum capitis ossis femoris disruption*: The key role of clinical findings and ultrasonography

F. Geburek

Clinic for Horses, University of Veterinary Medicine Hannover, Hannover, Germany

Correspondence: F. Geburek
Email: florian.geburek@tiho-hannover.de

ANATOMY OF THE COXOFEMORAL LIGAMENTS

The ligament of the head of the femur (*Ligamentum capitis ossis femoris*, LCOF) is reinforced by the accessory ligament (*Ligamentum accessorium*, LA), a strong band detached from the symphyseal tendon, passing through the acetabular notch dorsal to the transverse acetabular ligament which spans this notch. The LA ends caudal to the LCOF in the notch on the femoral head. Interestingly, the LA is not found in other domestic animals than equids (Nickel et al., 1992). The horse in the case report by Burdette et al. (2025) showed a complete disruption of the ligamentous structures attached to the femoral head including the LA during post-mortem examination. As in previous reports (Sauer et al., 2025), the combined LCOF and LA have been collectively referred to as 'LCOF'. This ligamentous complex, hereafter addressed as LCOF-LA, is relatively short, which complicates preservation of potentially intact fibres during *post-mortem* preparation of an equine coxofemoral joint (CFJ) with incomplete disruption of these ligaments.

ETIOPATHOGENESIS OF LCOF-LA DISRUPTION AND DIFFERENTIAL DIAGNOSES

In the case report by Burdette et al. (2025), the 'sidewinder gait' was observed approximately 3 weeks after onset of an acute lameness after rolling, raising the general question of mechanisms leading to LCOF-LA disruption. Purely traumatic ruptures causing complete coxofemoral luxations have been associated with falls, catching of the limb and anaesthetic recovery (Brenner & Whitcomb, 2009). Exaggerated attempts to rise after rolling may be associated with forced adduction or abduction of the limb combined with inward or outward rotation generating substantial tensile and shear forces on the LCOF-LA, amplified by the long equine limb lever arm. Compared with humans, the short femoral neck in adult horses usually resists these forces rendering intra-articular ligaments and the acetabular rim more susceptible to injury (Brenner & Whitcomb, 2009). Nevertheless, complete (type I) or partial (type II) ruptures of the LCOF have been categorised in humans after major and minor trauma, respectively (Gray & Villar, 1997).

Depending on the magnitude and direction of the traumatic forces and other factors (a) incomplete dislocation (subluxation) of the femur from the acetabulum like in the current case or (b) complete dislocation (luxation) may occur which should be considered as distinct entities (Brenner & Whitcomb, 2009). Acute or chronic disruption of the LCOF may cause CFJ 'microinstability' in humans (Cerezal et al., 2012) and does not necessarily lead to complete luxation, although it has to be considered as a potential precursor stage: The CFJ is a 'ball and socket' joint, but immediate exarticulation is prevented even after disruption of the LCOF-LA as the acetabulum is deepened by an incomplete ring of fibrocartilage, the acetabular lip (*Labrum acetabulare*) which is attached to its bony margin and completed medially by the transverse acetabular ligament. It increases the height of the acetabular rim so that it extends over the femoral head beyond its maximal diameter (Nickel et al., 1992).

In humans, partial and complete disruption of the *Ligamentum teres*, the functional equivalent of the LCOF-LA, has been reported to cause hip pain and impaired joint function, although the role of the ligament as a CFJ stabiliser is discussed controversially (Bardakos

& Villar, 2009). Besides the mechanical role of the ligament, the ligament contains neurovascular elements in humans indicating its involvement in the perception of pain, potentially caused by impingement of torn ligamentous fibres between articular surfaces. Disrupted neural structures may also contribute to altered proprioception (Perumal et al., 2019), although this clinical finding has not been observed in the case reported by Burdette et al. (2025) and historically, neurovascular structures have not been described in the equine LCOF-LA (Oncken, 1922). Persistent instability can lead to joint effusion, labral tears, osteochondral damage, and eventually, osteoarthritis (Chahla et al., 2016). This pathway of osteoarthritis has also been assumed in the current case with cartilage erosions on the femoral head surrounding the LCOF-LA insertion which is consistent with previous reports of full-thickness cartilage loss in chronic cases including the opposing acetabular joint surface (Sauer et al., 2025).

Primary degeneration of the LCOF-LA in the context of longstanding overuse and CFJ osteoarthritis or other orthopaedic disease represents another important mechanism commonly found in humans (type III after Gray & Villar, 1997) potentially leading to subsequent secondary traumatic disruption of the ligament (Bardakos & Villar, 2009). In the current case, histopathology indicated degenerative changes consistent with secondary rupture potentially triggered by low-impact trauma in the context of rolling. Notably, bilateral ligament disruptions have been identified incidentally at necropsy in horses with unilateral clinical signs of LCOF-LA pathology and CFJ osteoarthritis (Aleman et al., 2020; Sauer et al., 2025). This highlights the potential relevance of a primary degenerative pathway in equids, making comparative imaging as well as post mortem examination of both CFJs particularly advisable.

Dysplasia of the CFJ may predispose to LCOF pathology but compared to other species remains rare in horses with isolated reports, for example, in a Friesian and a Mangalarga Marchador foal (Hermans et al., 2016; Kneipp et al., 2025). Finally, avulsion fractures of the femoral attachment of the LCOF-LA represent another uncommon cause of CFJ instability (O'Brien et al., 2012). It is noteworthy that avulsion included only the LCOF but not the LA in one case (Meister et al., 1991).

DIAGNOSTIC STEPS, CLINICAL EXAMINATION AND IMAGING

Beyond the characteristic posture caused by shifting the centre of mass to the unaffected side while standing and the indicative gait pattern, further clinical findings provide valuable information for the diagnosis of LCOF disruption. Elevation of the contralateral, unaffected hindlimb may be impossible or achievable only after several attempts with discomfort when the horse is required to bear weight on the affected limb (Aleman et al., 2020).

Interestingly, manipulation of the affected limb while being elevated often leads to inconclusive results as in the current case report (Burdette et al., 2025). The CFJ has its greatest range of motion during flexion and extension, and the main function of the LCOF-LA is to limit abduction of this joint. In summary, flexion of the CFJ with external rotation of the limb and extension combined with internal rotation are assumed to impose the greatest tensile loads on these ligaments. Accordingly, provocation tests should not only include passive flexion and extension but also abduction and adduction. If feasible in an adult horse, the limb should be abducted in flexion and with external rotation, followed by adduction in extension with concurrent internal rotation to provoke an abnormal mobility or elicit a painful response.

Depending on the duration of the disorder, the degree of gluteal muscle atrophy is variable and typically more pronounced unilateral on the affected side in chronic cases (Sauer et al., 2025). In the case report by Burdette et al. (2025), mild gluteal and epaxial muscle atrophy was symmetrical and likely attributed to the onset of severe lameness only 3 weeks prior to presentation.

After clinical examination, transcutaneous ultrasonography using a convex probe at a frequency of 2–3.5 MHz represents a valuable next diagnostic step in patients with CFJ disorders. Muscle atrophy facilitates ultrasonography by reducing penetration depth requirements and improving probe angulation as it allows a more perpendicular probe coupling angle relative to the dorsal and craniodorsal contours of the joint. However, image quality may be markedly reduced in heavy breeds due to increased skin thickness (Sauer et al., 2025). Parts of the dorsolateral and dorsolaterocranial contours of the neck of the femur, of the femoral head and the acetabulum can be visualised by transcutaneous ultrasonography. This comprises the joint space as well as the fibrous cartilage of the *Labrum acetabulare* merging into the joint capsule. In the current case, mild irregularity of the right acetabulum was observed during basic ultrasonographic examination showing that even minor findings have the potential to be indicative of clinically relevant pathology.

However, instability of the coxofemoral joint caused by disruption of the LCOF-LA may not lead to an obvious ultrasonographic widening of the joint space during static weight bearing examination, so that only joint effusion, abnormalities of the joint capsule or signs of secondary osteoarthritis may be detected. In contrast, dynamic ultrasonography as described by Brenner and Whitcomb (2009) with the weight of the horse being shifted away from the affected limb and back in a latero-lateral direction during the examination can reveal joint instability. Abduction and adduction of the elevated limb can also be actively performed by a second person lifting the limb during ultrasonography. Consequently, this procedure should be incorporated into diagnostic protocols as it is the key diagnostic modality to detect CFJ instability in the standing horse.

Conclusive evidence of CFJ instability other than luxation cannot be expected from a standing latero-lateral oblique radiographic view (Barrett et al., 2006). In contrast, standing modified ventro-dorsal radiography with the affected limb being abducted leads to an anatomical representation of the CFJ resembling that in dorsal recumbency and to images of acceptable to excellent quality depending on the size of the equid and the degree of muscle atrophy (Sauer et al., 2025). Apart from secondary findings of OA in long-standing cases, an abnormal width of the joint space or position of the femur may theoretically be found. However, reliable interpretation requires exact comparative views of the contralateral joint, which are often difficult to obtain in standing horses with restricted weight-bearing on the affected limb.

Arthrocentesis and intra-articular anaesthesia of the CFJ are ideally performed under ultrasound guidance, which allows for a more reliable approach to the joint than the blind technique (David et al., 2007). The inevitable instability caused by LCOF-LA disruption leads to mechanical alterations of the gait, so that only limited improvement of lameness can be expected (Sauer et al., 2025).

Advanced imaging modalities of potential high value to diagnose LCOF-LA pathology and CFJ osteoarthritis include computed tomography (CT) (Ogden et al., 2025) and contrast arthrography. While the latter has proven to reliably detect intra-synovial ligament pathology of the equine stifle (Bergman et al., 2007), its application to LCOF-LA has not been reported to date (Ogden et al., 2025). Currently, the maximum diameter of CT scanner gantries in clinical settings is 85–90 cm so that their use is limited relative to the size of the pelvis.

Arthroscopy of the CFJ is a routine procedure in humans to visualise and potentially debride the LCOF (Chahla et al., 2016). In normal horses, this ligament and the notch of the acetabulum are visible after distraction of the limb. However, longer instruments are needed in adult horses weighing more than 300 kg. In a series of nine horses, tearing of the LCOF was identified in two cases, with improvement reported in one case with partial disruption (Nixon, 1994). The potential relevance of arthroscopic LCOF-LA debridement in equids should be further investigated.

CONCLUSION

The case report by Burdette et al. (2025) provides additional evidence that primary or secondary disruption of the LCOF-LA, including osteoarthritis, should be considered as a highly relevant source of significant CFJ pain causing a non-neurological 'sidewinder gait'. In addition to careful clinical examination, bilateral in-depth ultrasonography including dynamic evaluation offers substantial diagnostic value in cases of LCOF-LA disruption. Contrast-enhanced CT arthrography and diagnostic arthroscopy should be considered in smaller equids or in cases that remain inconclusive.

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No conflicts of interest have been declared.

ETHICS STATEMENT

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ORCID

F. Geburek https://orcid.org/0000-0002-3161-9055

REFERENCES

Aleman, M., Berryhill, E., Woolard, K., Easton-Jones, C.A., Kozikowski-Nicholas, T., Dyson, S. et al. (2020) Sidewinder gait in horses. *Journal of Veterinary Internal Medicine*, 2020, 2122–2131. Available from: https://doi.org/10.1111/jvim.15870

Bardakos, N.V. & Villar, R.N. (2009) The ligamentum teres of the adult hip. *The Journal of Bone and Joint Surgery*, 2009, 8–15. Available from: https://doi.org/10.1302/0301-620X.91B1.21421

Barrett, E.L., Talbot, A.M., Driver, A.J., Barr, F.J. & Barr, A.R. (2006) A technique for pelvic radiography in the standing horse. *Equine Veterinary Journal*, 38(3), 266–270. Available from: https://doi.org/10.2746/042516406776866435

Bergman, E.H.J., Puchalski, S.M., van der Veen, H. & Wiemer, P. (2007) Computed tomography and computed tomography arthrography of the equine stifle: technique and preliminary results in 16 clinical cases. *Proceedings of the American Association of Equine Practitioners*, 53, 46–55.

Brenner, S. & Whitcomb, M.B. (2009) Ultrasonographic diagnosis of coxofemoral subluxation in horses. *Veterinary Radiology & Ultrasound*, 2009, 423–428. Available from: https://doi.org/10.1111/j.1740-8261.2009.01560.x

Burdette, T.N., Hsiou, C.L., McDonough, S.P., Pell, S., Ayers, J., Divers, T.J. et al. (2025) Sidewinder syndrome associated with complete rupture of the *ligamentum capitis ossis femoris* in a horse. *Equine Veterinary Education*, 38(8), e496–e500. Available from: https://doi.org/10.1111/eve.70036

Cerezal, L., Arnaiz, J., Canga, A., Piedra, T., Altónaga, J.R., Munafo, R. et al. (2012) Emerging topics on the hip: ligamentum teres and hip microinstability. *European Journal of Radiology*, 81, 3745–3754. Available from: https://doi.org/10.1016/j.ejrad.2011.04.001

Chahla, J., Soares, E.A., Devitt, B.M., Peixoto, L.P., Goljan, P., Briggs, K.K. et al. (2016) Ligamentum Teres tears and Femoroacetabular impingement: prevalence and preoperative findings. *Arthroscopy*, 2016, 1293–1297. Available from: https://doi.org/10.1016/j.arthro.2016.01.045

David, F., Rougier, M., Alexander, K. & Morisset, S. (2007) Ultrasound-guided coxofemoral arthrocentesis in horses. *Equine Veterinary Journal*, 2007, 79–83. Available from: https://doi.org/10.2746/042516407x153093

Gray, A.J. & Villar, R.N. (1997) The ligamentum teres of the hip: an arthroscopic classification of its pathology. *Arthroscopy*, 1997, 575–578. Available from: https://doi.org/10.1016/s0749-8063(97)90182-1

Hermans, H., Veraa, S., Ploeg, M., Boerma, S., Hazewinkel, H.A.W., Back, W. (2016) Osteochondral dysplasia of the coxofemoral joints in a Friesian foal: Clinical findings and methods of diagnosis. *Equine Veterinary Education*, 28, 486–491. Available from: https://doi.org/10.1111/eve.12210

Kneipp, M.L.A., Sousa, L.N., Cota, L.O., Malacarne, B.D., Winter, I.C., Santana, C.H. et al. (2025) Bilateral coxofemoral dysplasia in a Mangalarga Marchador foal. *Journal of Equine Veterinary Science*, 144, 105253. Available from: https://doi.org/10.1016/j.jevs.2024.105253

Meister, D., Kägi, B., Kaser, B., Honegger, R. & Meier, D. (1991) Ungewöhnliche fraktur des caput ossis femoris bei einem 11jährigen Wallach [Uncommon fracture of the caput ossis femoris in a 11-year-old gelding]. *Pferdeheilkunde*, 8, 11–13.

Nickel, R., Schummer, A., Wille, K.-H. & Wilkens, H. (1992) Passiver Bewegungsapparat, Skelettsystem. In: Nickel, E., Schummer, A. & Seiferle, E. (Eds.) *Lehrbuch der Anatomie der Haustiere. Band I: Bewegungsapparat*, 6th edition. Berlin, Hamburg: Verlag Paul Parey, pp. 15–272.

Nixon, A.J. (1994) Diagnostic and operative arthroscopy of the coxofemoral joint in horses. *Veterinary Surgery*, 23(5), 377–385. Available from: https://doi.org/10.1111/j.1532-950x.1994.tb00498.x

O'Brien, T., Koch, C. & Livesey, M.A. (2012) What is your diagnosis? Avulsion fracture of the insertion of the round ligament of the head of the femur. *Journal of the American Veterinary Medical Association*, 240(9), 1059–1060. Available from: https://doi.org/10.2460/javma.240.9.1059

Ogden, N.K.E., Winderickx, K. & Stack, J.D. (2025) Computed tomography of the equine caudal spine and pelvis. Pathological findings in 56 clinical cases (2018-2023). *Equine Veterinary Journal*, 57(5), 1279–1289. Available from: https://doi.org/10.1111/evj.14426

Oncken, J. (1922) *Zur vergleichenden Histologie des ligamentum teres acetabuli (und des Acetabulumabschnittes des lig. accessorium beim Pferd) bei den Haussäugetieren, mit besonderer Berücksichtigung der Insertion am caput femoris. [Comparative histology of the ligamentum teres acetabuli (and the acetabular section of the lig. accessorium in the horse) in domestic mammals with particular emphasis on its insertion at the caput femoris.] Dr. med. vet.* Thesis, University of Veterinary Medicine Berlin, 1922.

Perumal, V., Woodley, S.J. & Nicholson, H.D. (2019) Neurovascular structures of the ligament of the head of femur. *Journal of Anatomy*, 234(6), 778–786. Available from: https://doi.org/10.1111/joa.12979

Sauer, F.J., Hellige, M., Beineke, A. & Geburek, F. (2025) Osteoarthritis of the coxofemoral joint in 24 horses: evaluation of radiography, ultrasonography, intra-articular anaesthesia, 246 treatment and outcome. *Equine Veterinary Journal*, 57(1), 101–114. Available from: https://doi.org/10.1111/evj.14053

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Equine Veterinary Education

CASE REPORT

Air embolism secondary to suspected lymphatic tissue disruption with severe exercise-induced pulmonary haemorrhage

J. Wittenberg[1] | K. Drozdzewska[1] | K. Landmann[2] | A. Voß[2] | K. Kunze[1] | D. Rutenberg[1] | A. D. Gruber[2] | H. Gehlen[1]

[1]Equine Clinic, Freie Universität Berlin, Berlin, Germany

[2]Institute of Veterinary Pathology, Freie Universität Berlin, Berlin, Germany

Correspondence: J. Wittenberg
Email: j.wittenberg@fu-berlin.de

SUMMARY

Air embolism in horses is rare and usually reported as an iatrogenic complication following intravenous catheterisation or specific surgical procedures. This case report describes a noniatrogenic air embolism in a 4-year-old Thoroughbred racehorse with exercise-induced pulmonary haemorrhage (EIPH), representing a previously undescribed pathogenic mechanism. The mare presented with acute, severe neurological symptoms, including circling, shivering and convulsions. Clinical examination revealed tachypnoea, tachycardia and a striking continuous systolic–diastolic cardiac murmur (grade 4–6/6) with a 'mill-wheel' quality—a churning sound indicative of gas within the heart chambers. Diagnostic imaging via transthoracic echocardiography was pivotal, identifying numerous small hyperechoic structures (air bubbles) in all four heart chambers, with a continuous air inflow to the right atrium. Laboratory findings indicated systemic hypoxia, myocardial involvement and muscle injury, including increased muscle enzyme activities, elevated troponin I concentration and decreased arterial oxygen partial pressure. Despite intensive supportive treatment, the mare's condition deteriorated rapidly with progressive neurological deficits and multiple collapses, leading to euthanasia 12 h after admission. Importantly, no immediate clinical deterioration occurred following the only documented intravenous procedure performed 1 day prior to admission. Echocardiography demonstrated continuous air inflow into the right atrium, a pattern not limited to a single bolus of air. Together with the absence of further invasive procedures before the onset of clinical signs, these findings are consistent with a noniatrogenic origin of the air embolism in this case. Postmortem examination provided critical insights into a novel pathogenesis. Necropsy confirmed evidence of EIPH, characterised by acute pulmonary emphysema and intra-alveolar haemosiderophages. Most notably, massive air bubbles (up to 1 cm) were detected within the tracheobronchial lymph nodes. While PCR analysis detected equine herpesvirus 5 (EHV-5) in the lung tissue, its clinical significance remained unclear as typical fibrotic lesions were absent. The authors hypothesise that the air entered the circulatory system through a pulmonary-lymphatic pathway. In racehorses, the extreme intravascular pressures associated with EIPH may cause structural ruptures not only in capillaries but also potentially in the pulmonary lymphatic tissue. This case highlights air embolism as an important differential diagnosis in racehorses with EIPH presenting with acute neurological signs. Transthoracic echocardiography proved essential for antemortem diagnosis, and the presence of a loud, continuous 'mill-wheel' murmur may represent a valuable clinical clue.

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Key points

- **Novel pathogenesis:** Air embolism may occur in racehorses as a complication of severe EIPH, potentially via rupture of pulmonary lymphatic tissue rather than iatrogenic causes.
- **Diagnostic indicators:** A continuous 'mill-wheel' cardiac murmur and hyperechoic bubbles in all four cardiac chambers on echocardiography are key indicators of air embolism.
- **Clinical relevance:** Air embolism should be considered in horses with EIPH and acute neurological signs, as progression may be rapid and fatal despite treatment.

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Equine Veterinary Education BEVA

CASE REPORT

Long-term outcomes of gastric bypass surgery in two Lusitano foals: Contemporary evidence for surgical decision-making

P. Fernández Hernández[1,2] | M. Valero González[1,3] | F. Bulnes Jiménez[1] | N. Venegas Chávez[1,3] | B. Fuentes Romero[4] | M. Iglesias García[4] | J. Jiménez Fragoso[3] | M. Martín Cuervo[3] | L. J. Ezquerra Calvo[3]

[1]Veterinary Teaching Hospital, Universidad de Extremadura, Cáceres, Spain

[2]Animal Medicine Department, MINVET Group, Universidad de Extremadura, Cáceres, Spain

[3]Animal Medicine Department, MECIAN Group, Universidad de Extremadura, Cáceres, Spain

[4]Veterinary Teaching Hospital, Department of Veterinary Science, School of Biomedical and Health Sciences, Universidad Europea de Madrid, Madrid, Spain

Correspondence: P. Fernández Hernández
Email: pablofh@unex.es

SUMMARY

Gastric outflow obstruction (GOO) occasionally requires surgical intervention in foals when medical management fails. Current literature lacks consensus on several surgical decisions, with most comprehensive reports dating back over a decade. Critical aspects—including jejunal loop orientation and necessity of jejunojejunostomy—remain debated among surgeons. Long-term data regarding complications, growth, and athletic performance are scarce. This case series documents the long-term outcomes of two Lusitano dressage foals that underwent bypass surgery, providing contemporary outcome data for specific surgical decisions where evidence remains limited. Two Lusitano foals underwent bypass procedures for GOO. Case 1: A 15-day-old orphan foal with pyloric stenosis underwent gastrojejunostomy without jejunojejunostomy, with jejunal loop oriented left-to-right. Six years post-operatively, the horse performs dressage competitively with normal growth and conformation. Case 2: A 12-hour-old foal underwent gastroduodenostomy; nearly three years later, it continues without complications. This series contributes recent outcome data for specific surgical decisions in bypass procedures including early surgical intervention, gastrojejunostomy without jejunojejunostomy, and left-to-right anastomotic orientation. Both foals achieved favourable results. Left-to-right orientation gastrojejunostomy without jejunojejunostomy worked well. Importantly, extended follow-up documents absence of long-term complications, normal growth, and athletic performance—critically needed information for surgical decision-making and owner communication regarding these uncommon, costly procedures.

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Key Points

- Gastrojejunostomy without jejunojejunostomy (left-to-right jejunal orientation) and gastroduodenostomy both resulted in excellent long-term outcomes in two Lusitano sport foals.
- Early surgical intervention would likely reduce the risk of long-term complications and improve prognosis in sport horses.
- GOO aetiology may be acquired or congenital, the latter being rarely documented. Given the lack of consensus on postoperative anti-ulcer prophylaxis and surgical technique, this case series provides valuable information for these uncommon and costly procedures in non-Thoroughbred sport horses.

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Equine Veterinary Education BEVA

ORIGINAL ARTICLE

Balancer-assisted sling recovery of critical equine patients after general anaesthesia

J. Kuhlmann[1] | C. Spadavecchia[2] | C. Koch[1]

[1]Division of Equine Surgery, Department of Clinical Veterinary Science, Vetsuisse-Faculty, Swiss Institute of Equine Medicine (ISME), University of Bern, Bern, Switzerland

[2]Division of Anaesthesiology and Pain Therapy, Department of Clinical Veterinary Medicine, Vetsuisse Faculty, University of Bern, Bern, Switzerland

Correspondence: J. Kuhlmann
Email: jovana.kuhlmann@unibe.ch

Summary

Background: Traditional sling-based systems to assist horses during recovery from general anaesthesia (GA) could be improved by adding a balancer to obtain a dynamic weight relief.

Objectives: To evaluate the applicability of a novel balancer-assisted sling system during recovery of horses after GA and to report initial experiences with high-risk clinical cases.

Study Design: Pilot clinical trial and a case series.

Methods: The system and its clinical applicability were evaluated in a pilot study involving two healthy horses and subsequently applied in 17 recoveries of 16 high-risk clinical cases. Recovery quality was scored on a scale from 0 to 5 (0 = poor, 5 = perfect). System tolerability was subjectively assessed as good, moderate or poor, and the balancer system's effect on the overall success of recovery was categorised as positive, neutral or negative.

Results: In the pilot study, two test runs were sufficient to optimise integration into the existing infrastructure and to provide confidence for clinical applicability. In clinical high-risk cases, recovery quality scores varied (score 5, $n = 0$; score 4, $n = 4$; score 3, $n = 6$; score 1, $n = 1$ and score 0, $n = 6$). One horse with a recovery score of 0 was euthanised due to implant failure sustained during recovery. Tolerability was good in seven cases, moderate in nine cases and poor in one case. The effect of the balancer for successful recovery was judged positive in five cases, neutral in nine cases and negative in three cases.

Main Limitations: Low case number, subjective assessments, lack of a control group.

Conclusions: The sling-balancer system can be used in clinical practice to assist horses during anaesthetic recovery in selected cases. While some horses appeared to benefit from the assistance, others showed limited activity while supported (moderate tolerability), reducing their effectiveness or necessitating sling removal. Further clinical experience and improved criteria for patient selection are warranted.

KEYWORDS

horse, assisted recovery, balancer, general anaesthesia, sling

INTRODUCTION

Surgical procedures under general anaesthesia (GA) in horses are associated with notably higher risks compared to other species (Brodbelt et al., 2008; Johnston et al., 2002). The latest results of the fourth confidential inquiry into perioperative equine fatalities (CEPEF-4) show an overall mortality rate for GA and a seven-day outcome period of 1.2%, with a lower risk of 0.6% for horses not undergoing exploratory laparotomy and a higher risk of 4.2% associated with colic surgery (Gozalo-Marcilla et al., 2025). Besides colic surgeries, orthopaedic procedures with open reduction and internal fixation (ORIF) and ophthalmic procedures are associated with an elevated risk of GA-related complications (Johnston et al., 2002; Laurenza et al., 2019; Parviainen & Trim, 2000). The individual risk is influenced by a variety of factors, including the patient's ASA grade, age, bodyweight, duration of anaesthesia, cardiovascular status and positioning on the table, but also the patient's temperament and pain level need to be considered (Laurenza et al., 2019; Loomes & Louro, 2022). Most complications occur during the recovery phase, which presents unique challenges in horses due to their flight response, size and body weight (Laurenza et al., 2019). Thus, musculoskeletal injuries caused by uncoordinated recovery attempts are frequent GA-related complications, with fractures being the leading cause of fatal outcomes in horses (Dugdale et al., 2016).

Despite their limited effectiveness in preventing recovery-related injuries and potential risks for the veterinary personnel, numerous assisted recovery systems have been proposed for use in equine anaesthesia. These include the most commonly used head- and tail-rope support (Arndt et al., 2020; Louro et al., 2022), inflatable air pillows (Ray-Miller et al., 2006; Vandaele et al., 2025), tilt-tables (Elmas et al., 2007), adjustable ceiling (Lindqvist et al., 2025), different types of sling-recovery systems (Fürst et al., 2008; Schatzmann, 1998; Taylor et al., 2005) and hydro-pool (Tidwell et al., 2002) or pool-raft systems (Sullivan et al., 2002). All systems come with specific inherent limitations, and there is neither a current consensus nor an evidence-based recommendation for a gold standard or preferred technique for the recovery of horses undergoing GA.

The recovery of horses in a sling is a cost- and personnel-efficient method that can be readily implemented in most equine hospitals, compared to elaborate pool recovery systems. In existing sling recovery systems, the support provided during recovery is inherently limited by the need for manual height adjustment of the connected hoist and its operating speed. To overcome this limitation, this study evaluated the use of a sling in combination with a balancer to assist horses during recovery from GA. A balancer is an industrial lifting device that is used in equine medicine for permanent weight relief in orthopaedic patients (PM Pferdeschwinglifter, Michael Puhl GmbH). To implement a more responsive and dynamic weight relief during sling recoveries, the balancer is positioned between the hoist and the support frame of the sling. The mechanical spring mechanism of the balancer can provide dynamic and continuous weight relief for the horse throughout the recovery, which is particularly beneficial for the recovery of weak horses or those with compromised limb stability. Therefore, balancer-assisted recoveries address a longstanding challenge, as no other system currently ensures continuous weight relief without requiring significant infrastructural adaptations.

This study aimed to evaluate the applicability and tolerability of a novel sling-balancer system for assisted recovery of horses following general anaesthesia, and to report initial experiences with its application in high-risk clinical cases.

MATERIALS AND METHODS

Study design

This study was designed in two parts. First, a pilot study, approved by the committee for animal experimentation of the Canton of Bern, Switzerland (approval number: BE37/2023), was conducted in two horses to test and optimise the balancer-assisted sling system prior to its clinical implementation. Subsequently, the system was used to assist recoveries of high-risk patients, described as a retrospective case series in the second part of the study.

Equipment

The commercially available sling-balancer system consists of a sling in combination with a four-point carrying frame (Equiporter Pre OP Safety Sling and support frame, Dr Fritz Endoscopes GmbH) and a balancer (Balancer Typ 7261, Kromer GmbH), connecting the hoist of the recovery box and the support frame (Figure 1). The sling (Figure 2) is available in two different sizes (for cobs and small chested warmbloods/regular-sized to big warmbloods) and is suitable for horses with a maximum bodyweight of 600 kg (manufacturer's recommendation). It is best applied before anaesthesia induction, as it is designed to allow standard surgical procedures without interfering with the surgical field. The four-point carrying frame is attached to the sling just prior to recovery, ensuring even load distribution.

Balancers were originally designed as lifting aids for industrial applications. The built-in, conical rope drum generates a uniform retraction force through a spring tension mechanism when the wire cable is extended beyond the total tensile capacity. This mechanism ensures continuous and consistent weight relief for the horse, provided that the hoist height is adjusted to ensure that the wire cable remains in a pulled-out position, thereby keeping the system under maximum load (Figure 3). The balancer alone has a maximum tensile force of 1962 N (200 kg), which can be adjusted manually on the balancer if needed. The balancer is additionally equipped with a pulley that increases the tensile force by 50%, resulting in a total tensile force of 2943 N (300 kg).

FIGURE 1 Balancer-assisted sling recovery system consisting of a sling in combination with a 4-point support frame (SF; red) and a balancer (B; orange housing). The balancer is connected between the hoist (arrow) and the support frame. The system is used in combination with a head rope.

FIGURE 2 The Equiporter Pre OP Safety Sling (here: Small size) consists of two connected parts (orange front, blue hind) and is ideally applied before induction.

FIGURE 3 Balancer under full load indicated by the pulled-out balancer wire cable. Arrow: Mechanical cable-stop at the end of the balancer wire cable.

Recovery setup

Recoveries were performed in a standard padded recovery box (dimensions: 3.35 m × 3.20 m). The recovery box was equipped with a manually controlled overhead hoist (Demag chain hoist, Germany, load capacity 1250 kg, reeling velocity 8 m/min) with a maximum hook height of 3.90 m above floor level, as well as a system for head- and tail-rope assistance. Additionally, a video camera was installed in one corner of the recovery box to record the recovery phases. Horses were positioned in lateral recumbency at the centre of the recovery box. The balancer was fixed to the hoist and connected to the carrying frame. The hoist was then positioned centrally above the horse, and its height was adjusted to ensure that the balancer would not interfere with the horse in case of a sudden attempt to stand. Additionally, a head rope was used to provide additional control over the horse's position. A tail rope was added in most cases for enhanced control and support. With the horse's first strong movement or when transitioning from lateral to sternal recumbency, the system was manually adjusted to achieve maximum tension and support by altering the hoist height, ensuring continuous weight relief. This was indicated by the balancer wire cable being pulled out of the (orange coloured) housing of the balancer drum (Figure 3). During the rising phase, the tension was manually reduced by lowering the hoist (balancer wire fully pulled in) if necessary, depending on how the horse tolerated being supported. In all cases, including the pilot trials, the same person (JK) controlled the hoist.

Pilot study

The system was tested, and the setup was refined in an experimental trial involving healthy horses of the teaching herd of the ISME Equine Clinic Bern. The horses were subjected to a short-time GA followed by balancer-assisted sling recovery.

Animals

The use of a maximum of three horses and two trials per horse was approved for the pilot study. Inclusion criteria were ASA grade of I or II, age ≤ 15 years and a bodyweight between 400 and 600 kg. The health status of the horses was assessed within each experimental trial through a pre-anaesthetic clinical examination and routine haematology. After each trial, three experienced observers (JK, CK and CS) present during the recovery evaluated and discussed the necessity for further trials before implementation in clinical cases.

Anaesthesia

After placing an intravenous catheter in one of the jugular veins, horses were sedated with acepromazine (0.03 mg/kg bwt i.v.) followed by romifidine (0.06 mg/kg bwt i.v.) and levomethadone hydrochloride (0.05 mg/kg bwt i.v.). Ketamine (2.5 mg/kg bwt i.v.) and diazepam (0.05 mg/kg bwt i.v.) were used for anaesthetic induction. Thiopental sodium was administered to effect (1–2 mg/kg bolus i.v.) in case the horses did not reach an adequate depth of anaesthesia (in case of movement, increased muscle tone, nystagmus or a marked palpebral reflex) after induction. No further sedation was given for recovery. Anaesthesia and recovery took place in the same padded recovery box.

Balancer-assisted sling recovery

No prior adaptation phase was performed to familiarise the horses with the system. The sling was applied to the standing, sedated horse before anaesthetic induction. The support frame was attached while the anaesthetised horse was lifted in a hanging position using the hoist. In addition to the balancer, a headrope was used for better control of the horse. Two people familiar with the system were permanently available throughout the entire recovery phase. One person operated the hoist, and the anaesthetist took control of the headrope.

Recovery evaluation

Recovery quality was scored using a semi-descriptive scale (Young & Taylor, 1993, shown in Table S1) ranging from 0 (poor) to 5 (perfect). The duration of anaesthesia, the number of rising attempts and the total duration of the recovery phase (defined as recovery time) were documented. Additionally, the tolerability of the balancer-assisted sling system was subjectively evaluated for each trial, with a descriptive scale, including the categories 'good', 'moderate' and 'poor'. Recovery was rated as 'good' if horses appeared to accept the support, 'moderate' for horses that did not show aversion but rather reacted with inactivity to the tension applied by the balancer. 'Poor' was assigned to horses that exhibited fear and aversion in response to the balancer system. Further individual behavioural reactions to the balancer-assisted sling system and the additional rope assistance were also noted. After each trial, the technical procedure was evaluated for potential areas of improvement.

The analysis was carried out by one observer (JK) and was based on observations made during the recovery phase and supplemented by the analysis of video recordings.

Clinical case series

Following the pilot trials, the sling-balancer system was integrated as a standard method for assisted recoveries in high-risk cases selected at the ISME Equine Clinic Bern. Detailed patient data, surgery type, anaesthesia and recovery characteristics were reported.

Case selection

The availability of at least two persons experienced with the recovery system was mandatory for the conduction of balancer-assisted sling recoveries. Ideally, horses were cooperative, and their bodyweight ranged between 400 and 600 kg. The final decision to perform a balancer-assisted recovery was made on a case-by-case basis by the attending surgeon and the anaesthetist.

Balancer-assisted sling recoveries were considered for all horses fulfilling one or more of the following criteria:

- Age ≥ 20 years.
- Repair of unstable fractures by means of ORIF.
- ASA category ≥ IV.
- Pre-existing or post-surgical expected ataxia.

Anaesthetic protocol

General anaesthesia was performed according to the clinic's standard protocols and varied slightly depending on the specific case. In general, the same induction protocol was used as described in the pilot trial, and anaesthesia was maintained using isoflurane in air and oxygen, supplemented by one or more intravenous drugs, such as romifidine (20–40 mcg/kg/h), ketamine (0.5–1 mg/kg/h) or lidocaine (1.8 mg/kg/h) administered as CRI. Standard monitoring (including capnometry, ECG, invasive blood pressure monitoring, pulse oximetry, end-tidal inhalant concentration and arterial blood gas analysis) and blood pressure support (dobutamine CRI, 0.5–2 mgc/kg/min) were guaranteed throughout anaesthesia. An alpha-2 agonist, either romifidine (dose range: 0.01 mg/kg–0.05 mg/kg i.v.) or xylazine (dose range: 0.1–0.5 mg/kg i.v.), was always administered prior to recovery. Dosage and timing of administration were decided on a case-to-case basis with the goal to obtain a quiet and smooth recovery (individual sedation dosages are provided in Table S2).

Balancer-assisted sling recovery

Balancer-assisted sling recoveries were performed as described previously. Whenever possible, the sling was placed before the induction of anaesthesia. If the decision for sling recovery was made after induction or the condition of the horse made the placement prior to GA impossible, the sling was applied after surgery while the horse was lifted by the hoist. The attending surgeon or the anaesthetist also decided if an additional tail rope was to be used.

Recovery evaluation

The evaluation of the recoveries was performed as in the pilot trial. Furthermore, a subjective assessment of the balancer's effect on the overall success of recovery was made and categorised as either 'positive' (balancer-assistance seemed to facilitate recovery), 'neutral' (no clear positive or negative influence observed) or 'negative' (balancer-assistance seemed to impair recovery).

RESULTS

Pilot study

In the pilot study, two balancer-assisted sling recoveries were performed in two horses. During the first trial, a defect in the balancer's wire cable was identified, which did not impact the recovery process but required repair. To confirm the system's functionality and tolerability, an additional trial was conducted. As the second trial was successful and no further areas needing improvement were detected, the pilot study was concluded.

Animals

A 15-year-old Freiberger gelding (Pilot 1) and a 15-year-old trotter gelding (Pilot 2) with bodyweights of 575 and 537 kg, respectively, were included.

Anaesthesia and balancer-assisted sling recovery

General anaesthesia was induced without complications in both cases. Pilot 1 exhibited minor limb movements during hoist lifting for positioning prior to recovery and therefore received an additional dose of thiopental sodium (250 mg i.v.). No additional medication was necessary for Pilot 2. Pilot 1 stood up 50 min after anaesthetic induction following one single rising attempt, and Pilot 2 stood up 29 min post-induction after three attempts.

No aversion toward the system was observed in either trial. Tolerability was judged as good in Pilot 1 and moderate in Pilot 2, as the horse became inactive as soon as tension was applied. Consequently, the balancer's height was continuously adjusted to prevent any tension during rising or standing, while still ensuring immediate support in the event of a fall.

Case series

All balancer-assisted sling recoveries conducted at the ISME Equine Clinic Bern between August 2023 and July 2025 were included in this retrospective case series.

Case selection

In total, 17 balancer-assisted sling recoveries of 16 horses were conducted and evaluated. Horses were of multiple breeds and sizes, with a mean age of 14 years (range: 5–28 years) and mean bodyweight of 517 kg (range: 400–653 kg). For each horse, one or more predefined inclusion criteria were met. Demographic and procedural details are summarised in Table 1.

Anaesthesia and surgery

Details about performed surgical procedures and anaesthesia are presented in Table 2. The GA duration ranged from 77 min (Case 8, imaging) to 342 min (Case 9, ORIF procedure) with a mean of 218 min.

Balancer-assisted sling recovery

Recovery data are presented in Table 2. Due to technical issues, video recordings were incomplete in four cases (Case 1, Case 11B–13). In these cases, data were completed using protocolled notes recorded during the recovery phase.

Additional tail-rope assistance was used in all clinical cases except Case 3. In Cases 1 and 2, an additional thick mattress was utilised to prolong lateral recumbency, based on the surgeon's preference. Details on drugs administered during the recovery phase after GA can be found in Table S2.

Recovery duration ranged from 50 min (Cases 1 and 3) to 329 min (Case 14), with a median of 95 min. The number of attempts to stand ranged from 1 (Cases 7 and 16) to more than 10 (Case 10).

Out of 17 recoveries, moderate to good recoveries were observed in 10 cases (score = 4, n = 4; score = 3, n = 6). In the remaining 7 cases, recovery quality was poor (score = 1, n = 1; score = 0, n = 6). In 4 of these cases, balancer assistance was discontinued and changed to free recovery (Case 5), hand-assisted (Case 6) or rope recovery (Case 10, Case 13). One horse (Case 10, ORIF procedure) was ultimately euthanised due to implant failure sustained during recovery; all other cases recovered successfully.

Out of 17 recoveries, the effect of the sling-balancer system on the overall success of recovery was judged as positive in five, neutral in nine and negative in three cases. In one of these last three cases, one horse (Case 6) showed poor system tolerability and actively resisted the rope restraints. The horse recovered uneventfully after transitioning to hand-assisted recovery. For the other two cases (Cases 9 and 10), the balancer mitigated the

TABLE 1 Individual patient details.

	Breed	Age years	Bodyweight kilogram	Inclusion criteria
1	Warmblood	13	653	ASA IV
2	Selle Français	12	585	ASA IV
3	Irish Cob	6	506	Ataxia grade 2/5
4	Warmblood	12	512	Articular process fracture, risk of ataxia
5	Friesian	14	≈550	ASA V
6	French Trotter	7	≈500	P1 Fracture (ORIF)
7	Warmblood	18	525	Ataxia grade 1/5
8	Connemara	11	≈400	Ataxia grade 4/5, pelvic fracture
9	Arabian	9	464	Tarsal subluxation, fracture MTIII (ORIF)
10	Arabian	11	≈400	Olecranon fracture (ORIF)
11	Freiberger	13	591	Ataxia grade 3/5
12	Irish Cob	24	538	ASA IV, age
13	Freiberger	28	513	ASA IV, age
14	Warmblood	24	480	Risk of ataxia, age
15	Thoroughbred	5	≈500	Olecranon fracture (ORIF)
16	Mixed Breed	12	≈550	Olecranon fracture (ORIF)

impact of initial rising attempts and was used to reposition the horses' limbs into a favourable starting position. However, during the subsequent recovery phase, the horses failed to rise successfully while supported by the balancer, and balancer assistance was discontinued. In Case 9, the horse appeared disturbed by the sling even after the balancer was disconnected. Once the sling was removed, the horse stood on the first attempt with additional rope assistance. Case 10 exhibited multiple unsuccessful rising attempts and showed adverse head shaking against the head rope restraint, even after the balancer was removed. The horse stood up unassisted within the next attempt after rope removal, but was not weight-bearing on the operated limb. Subsequent radiographs revealed implant failure of the repaired olecranon fracture, and the horse was euthanised. The exact time of implant failure could not be determined, and it remains unclear whether it occurred with or without the sling system in place.

Tolerability of the balancer-assisted sling system was judged as good in seven recoveries and moderate in nine recoveries. The horse that underwent two recoveries with balancer assistance showed good tolerability the first time (Case 11A) and moderate tolerability during the second recovery (Case 11B). One Horse (Case 6) showed poor system tolerability with active aversion against the balancer and rope restraint (see above).

DISCUSSION

The overall modest number of good recoveries observed and the occurrence of a fatal injury within the group of evaluated clinical cases highlight that the risks associated with equine recovery could not be fully eliminated with the use of the balancer-assisted sling system, as has also been reported for other assisted recovery systems (Arndt et al., 2020; Sullivan et al., 2002). These results should be interpreted with the understanding that the balancer system was applied exclusively in high-risk cases with an expected poor prognosis. Despite these considerations, the present study primarily demonstrates the general clinical applicability of the balancer-assisted sling recovery system and suggests that its integration into routine clinical practice is feasible.

The tested balancer-assisted sling system addresses some limitations of existing sling recovery devices, such as the Anderson sling (Taylor et al., 2005) or other rescue nets like the Animal Rescue and Transportation Sling (ARTS; Fürst et al., 2008). Potential sling-associated complications during recovery have been discussed in previous studies, including myopathies, neuropathies and cardiovascular, respiratory or gastrointestinal negative effects (Steffey et al., 2009; Taylor et al., 2005). None of these complications were observed with the equipment used in this study, suggesting that the design of the applied sling in combination with a four-point carrying frame provided adequate fit and weight distribution. Unlike the Anderson sling, which maintains horses in a standing position, lateral recumbency recovery avoids continuous suspension forces before lifting and may reduce pressure-related complications. The sling could be applied before induction without interfering with the surgical field, facilitating preparation and improving personnel safety. Based on our clinical experience using the ARTS for sling recoveries, lifting support is inherently limited by manual hoist adjustment and the hoist's operating speed. In contrast, the spring mechanism of the balancer has the potential to provide continuous weight relief of up to 300 kg and rapid responsiveness throughout recovery.

TABLE 2 Case details of surgical procedures, general anaesthesia (GA) and recovery duration, and recovery outcomes with balancer assistance.

	Procedure	GA time	Recovery time	Rising attempts	Recovery score	Effect balancer	System tolerability	Comments
1	Emergency laparotomy	210 min	50 min	3	3	Neutral	Good	Additional use of mattress, final rising attempt with balancer in neutral position
2	Emergency laparotomy	250 min	55 min	2	3	Positive	Good	Additional use of mattress
3	Castration, sarcoid removal	110 min	50 min	3	3	Neutral	Moderate	No tail rope, inactivity under tension
4	Osteosynthesis (CAS)	290 min	101 min	3	3	Positive	Good	Prolonged absent breathing reflex, transient ataxia after surgery, focal myopathy of left triceps muscle
5	C-Section	NE	>180 min	2	0	Neutral	Moderate	No rising attempts with system in place; episode of ventricular tachycardia during recovery; assisted recovery discontinued; standing after one attempt without assistance after repositioning into other lateral recumbence
6	ORIF (CAS)	194 min	95 min	10	1	Negative	Poor	Active resistance and panic against restraint; rope and balancer-assistance discontinued; successful hand-assisted recovery
7	Ceratohyoidectomy	156 min	70 min	1	4	Neutral	Good	Final rising attempt with balancer in neutral position
8	Imaging (CBCT)	77 min	57 min	2	4	Positive	Moderate	Accepted balancer support during rising, but showed inactivity under tension in standing position
9	ORIF (CAS)	342 min	100 min	7	3	Negative	Moderate	No successful rising attempts due to inactivity under tension; balancer assistance discontinued; standing within one attempt after prolonged time in sternal recumbency
10	ORIF (CAS)	325 min	190	>10	$0^{\dagger}$	Negative	Moderate	No successful rising attempts due to inactivity under tension; aversion against head rope; further unsuccessful attempts after removal of balancer, successful at first attempt after rope removal; euthanasia due to implant failure
11A	Imaging (MRI)	124 min	65 min	1	4	Positive	Good	Balancer support seemed to prevent falling

TABLE 2 (Continued)

	Procedure	GA time	Recovery time	Rising attempts	Recovery score	Effect balancer	System tolerability	Comments
11B	Ceratohyoidectomy	154 min	176 min	> 5	0	Neutral	Moderate	Staggering absorbed by the balancer during final attempt to stand
12	Emergency laparotomy	242 min	190 min	3	0	Neutral	Moderate	Repositioning into other lateral recumbence with aid of balancer; final rising attempt with balancer in neutral position
13	Emergency laparotomy	211 min	329 min	5	0	Neutral	Moderate	Balancer assistance discontinued 3.5 h due to prolonged inactivity of the horse
14	CAS bursa nuchalis resection	240 min	70 min	4	3	Positive	Good	Violent and uncoordinated premature rising attempts; balancer in neutral position during final rising attempt
15	ORIF (CAS)	276 min	162 min	6	0	Neutral	Moderate	Violent and uncoordinated premature rising attempts; active resistance against head rope; balancer in neutral position during final rising attempt
16	ORIF (CAS)	300 min	68 min	1	4	Neutral	Good	Balancer in neutral position during rising attempt

Abbreviations: CAS, computer assisted surgery; CBCT, cone beam computer tomography; MRI, magnetic resonance imaging; ORIF, open reduction and internal fixation; †, euthanasia.

Adverse behaviour toward sling suspension has been reported (Taylor et al., 2005) and was also observed in one case (Case 6) of the present study. Three horses (Cases 6, 9, and 10) did not tolerate the additional rope assistance. The absence of a control group and the heterogeneity of cases in the present study prevent firm conclusions as to whether the implant failure in one case (Case 10) was directly related to the assistance or to other concomitant factors, such as the level of pain or the stability of the osteosynthesis construct in this individual case. Nevertheless, these findings highlight that the risk of self-inflicted injury may increase if an individual poorly tolerates the assistance system.

System tolerability was subjectively classified as moderate in 9 of the 17 cases, based on the observation of inactivity or aborted standing attempts under the influence of the balancer's tension, already noted during the pilot study. To the authors' knowledge, this behaviour has so far not been reported in other studies, although available information on the use of slings for this indication remains limited in the literature. Moderate system tolerability required dynamic adjustment of hoist height to reduce tension, which limited the full potential of assistance throughout recovery. The system could generally be adapted to the horse's behaviour by lowering the hoist or setting the balancer to a neutral position. This approach was preferred over complete disconnection, as it maintained support and mitigated falls even in cases of inactivity under tension. A newly developed computer-controlled belay system, designed to slow the acceleration of a horse during recovery and connected to the horse via a saddle-like harness, has shown improved recovery scores compared with unassisted recoveries (Campoy et al., 2024). Although only a small number of horses were used in the experimental study, the results indicate the importance of fall prevention and impact reduction during recovery, which can also be achieved with the use of a balancer.

The findings of this study suggest that the usefulness of the balancer in horses with moderate system tolerability may be limited, as four of the seven horses in this subgroup had poor recovery scores (0 or 1), and the effect of the balancer on the overall success of recovery was unanimously assessed to be positive in only one case of this subgroup. A negative effect was seen in one horse (Case 9), as no successful rising attempts occurred under tension, whereas the horse stood up on the first attempt after a prolonged sternal phase once the balancer was removed. Multiple factors, including the extended sternal recumbency in this specific case, may have contributed to this result.

Many horses suspended in a sling for a prolonged period of time, for example, for immobilisation due to long bone fractures or fissures, start to accept and use the given support with time (Fürst et al., 2008). Further studies are needed to assess whether horses would also adapt to the balancers' support after a period of acclimatisation. Sling training can be performed in selected cases when poor acceptance is expected due to the horse's general temperament (Taylor et al., 2005), but time for acclimatisation is rarely available in emergency situations. One horse of our study group (Case 11) underwent two balancer-assisted recoveries and showed good tolerability during the first recovery after an imaging procedure. However, during the second recovery, following a considerably longer anaesthesia (65 vs. 176 min) and a painful procedure, inactivity under the balancer's tension was observed, leading to a classification of moderate system tolerability. This suggests that a horse's behaviour in the sling may not only depend on the applied tension and the lack of habituation but could also be influenced by other factors, such as the duration of anaesthesia, potential weakness of the horse and the type of intervention necessitating GA. Caution is warranted in interpreting this finding, as it is based on a single horse with two balancer-assisted recoveries in this small group of cases. Aversive behaviour and agitation have also been described for other methods of assistance, such as air-inflated pillow (Vandaele et al., 2025) and pool recoveries (Sullivan et al., 2002; Tidwell et al., 2002), and remain an unpredictable factor, even in well-handled horses such as those in the present study.

The decision on assistance during recovery should always be based on a thorough case-by-case assessment, weighing the individual risk factors for recovery against the potential risk of system-associated complications, including personnel safety. Only horses with a high risk of poor recoveries were selected for balancer-assisted recovery, as reflected by the overall low number of good recoveries observed in this study. The weight relief offered by the balancer may be particularly beneficial for horses with limb instability, such as fracture patients. However, in this study, implant failure occurred during a balancer-assisted recovery following ORIF of an olecranon fracture, demonstrating that fractures and related complications cannot be fully prevented. Nevertheless, the system may have reduced the likelihood of fatal incidents in these high-risk cases, although the absence of a control group limits further conclusions.

In addition to the risk-based case selection, certain basic requirements must be met to perform the balancer-assisted sling recovery. The two available sling sizes and the manufacturer's recommendations regarding maximum bodyweight are suitable only for cob and warmblood-sized horses up to 600 kg. In this study group, the sling was also used in a heavier horse (653 kg) without complications. In the present study group, the lightest horse weighed approximately 400 kg. For lighter breeds, it may be necessary to reduce the tension force of the balancer to prevent excessive pulling or inadvertent lifting. Further experience with the use of the balancer in lighter horses is needed to determine optimal tension settings in these cases. Furthermore, at least two experienced staff members are needed throughout the recovery period. Interpreting the horse's reaction to the applied tension—such as adjusting the hoist height accurately and promptly—requires expertise with recovering horses; therefore, this task was always performed by the same experienced person in our study.

While this study provides first insights into the use of the balancer system for assisted recoveries in horses, several limitations must be considered.

The balancer requires sufficient ceiling height to ensure correct adjustment of the system and enough distance between the horse and the heavy balancer. Implementing the balancer system within the existing infrastructure was feasible at our clinic, but ceiling height may limit its applicability in other facilities. Furthermore, as with all sling-based assistance systems, an electronically operated, remote-controlled hoist is indispensable.

The evaluations in this retrospective study regarding the recovery score, the effect of the balancer on overall recovery success and system tolerability were based on a single observer's subjective assessment, which introduces a potential source of bias. This, along with the small number of cases, precluded statistical analyses such as regression models or correlation testing and restricted the interpretation of the results. Future studies should aim for larger case numbers, ideally within a multi-centre design and include appropriate control groups. In addition, more objective methods of evaluation, such as blinded observer video scoring, would help strengthen the reliability of outcome assessment.

In conclusion, the sling-balancer system investigated in this study was readily integrated and applicable in clinical practice. It has the potential to support horses effectively during recovery and mitigate the injury risks associated with falls during that time. The frequent observation of inactivity under full tension limited the system's applicability in the present group of horses that were not trained to tolerate the system before surgery. This issue, however, was successfully addressed by manually adjusting the suspension height in most cases. Further studies with larger case numbers and appropriate control groups are required to confirm these findings and to further evaluate the clinical impact of the balancer system on recovery quality and safety.

CLINICAL RELEVANCE

- A balancer-assisted sling can be used to obtain a dynamic weight support in horses recovering from general anaesthesia.
- In high-risk cases, the system can contribute to a successful outcome but add procedural complexity.
- Tolerability of the balancer-assisted sling is variable among horses.

AUTHOR CONTRIBUTIONS

J. Kuhlmann: Conceptualization; writing – original draft; writing – review and editing; methodology; project administration. **C. Spadavecchia:** Conceptualization; methodology; writing – review and editing; supervision; project administration. **C. Koch:** Conceptualization; methodology; writing – review and editing; supervision; project administration.

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CONFLICT OF INTEREST STATEMENT

The authors declare no conflicts of interest related to this study.

ETHICS STATEMENT

Ethical approval for the pilot study was granted by the committee for animal experimentation of the Canton of Bern, Switzerland (approval number: BE37/2023). For the case series, only data from horses whose owners had provided written informed consent for the use of the collected data were included in the study.

ORCID

J. Kuhlmann https://orcid.org/0009-0005-0987-8981
C. Spadavecchia https://orcid.org/0000-0002-1612-6420
C. Koch https://orcid.org/0000-0002-4574-6952

REFERENCES

Arndt, S., Hopster, K., Sill, V., Rohn, K. & Kästner, S.B.R. (2020) Comparison between head-tail-rope assisted and unassisted recoveries in healthy horses undergoing general anesthesia for elective surgeries. *Veterinary Surgery*, 49, 329–338.

Brodbelt, D.C., Blissitt, K.J., Hammond, R.A., Neath, P.J., Young, L.E., Pfeiffer, D.U. et al. (2008) The risk of death: the confidential enquiry into perioperative small animal fatalities. *Veterinary Anaesthesia and Analgesia*, 35, 365–373.

Campoy, L., Martin-Flores, M., Araos, J., Parry, S.A. & Gleed, R.D. (2024) A newly developed recovery-enhancing device improves recovery scores during emergence from general anesthesia in horses: a randomized trial. *American Journal of Veterinary Research*, 85, ajvr.24.02.0024. Available from: https://doi.org/10.2460/ajvr.24.02.0024

Dugdale, A.H.A., Obhrai, J. & Cripps, P.J. (2016) Twenty years later: a single-centre, repeat retrospective analysis of equine perioperative mortality and investigation of recovery quality. *Veterinary Anaesthesia and Analgesia*, 43, 171–178.

Elmas, C.R., Cruz, A.M. & Kerr, C.L. (2007) Tilt table recovery of horses after orthopedic surgery: fifty-four cases (1994–2005). *Veterinary Surgery*, 36, 252–258.

Fürst, A.E., Keller, R., Kummer, M., Manera, C., von Salis, B., Auer, J. et al. (2008) Evaluation of a new full-body animal rescue and transportation sling in horses: 181 horses (1998–2006). *Journal of Veterinary Emergency and Critical Care*, 18, 619–625.

Gozalo-Marcilla, M., Redondo, J.I., Bettschart-Wolfensberger, R., Domenech, L., Doménech, J., Johnston, G.M. et al. (2025) The confidential enquiry into perioperative equine fatalities: phase 4 (CEPEF4) - a worldwide observational, prospective, multicentre cohort study in 2025. *Veterinary Anaesthesia and Analgesia*, 52, 525–538.

Johnston, G.M., Eastment, J.K., Wood, J. & Taylor, P.M. (2002) The confidential enquiry into perioperative equine fatalities (CEPEF): mortality results of phases 1 and 2. *Veterinary Anaesthesia and Analgesia*, 29, 159–170.

Laurenza, C., Ansart, L. & Portier, K. (2019) Risk factors of anesthesia-related mortality and morbidity in one equine hospital: a retrospective study on 1161 cases undergoing elective or emergency surgeries. *Frontiers in Veterinary Science*, 6, 514.

Lindqvist, A., Nyman, G., Rydén, A. & Wattle, O. (2025) Effect of an adjustable ceiling to prevent premature rising attempts after general anesthesia in healthy ponies and horses: a pilot study. *Veterinary Surgery*, 54, 851–859.

Loomes, K. & Louro, L.F. (2022) Recovery of horses from general anaesthesia: a systematic review (2000-2020) of risk factors and influence of interventions during the recovery period. *Equine Veterinary Journal*, 54, 201–218.

Louro, L.F., Robson, K., Hughes, J., Loomes, K. & Senior, M. (2022) Head and tail rope-assisted recovery improves quality of recovery from general anaesthesia in horses undergoing emergency exploratory laparotomy. *Equine Veterinary Journal*, 54, 875–884.

Parviainen, A.K. & Trim, C.M. (2000) Complications associated with anaesthesia for ocular surgery: a retrospective study 1989–1996. *Equine Veterinary Journal*, 32, 555–559.

Ray-Miller, W.M., Hodgson, D.S., McMurphy, R.M. & Chapman, P.L. (2006) Comparison of recoveries from anesthesia of horses placed on a rapidly inflating-deflating air pillow or the floor of a padded stall. *Journal of the American Veterinary Medical Association*, 229, 711–716.

Schatzmann, U. (1998) Suspension (slinging) of horses: history, technique and indications. *Equine Veterinary Education*, 10, 219–223.

Steffey, E.P., Brosnan, R.J., Galuppo, L.D., Mama, K.R., Imai, A., Maxwell, L.K. et al. (2009) Use of propofol-xylazine and the Anderson sling suspension system for recovery of horses from desflurane anesthesia. *Veterinary Surgery*, 38, 927–933.

Sullivan, E.K., Klein, L.V., Richardson, D.W., Ross, M.W., Orsini, J.A. & Nunamaker, D.M. (2002) Use of a pool-raft system for recovery of horses from general anesthesia: 393 horses (1984–2000). *Journal of the American Veterinary Medical Association*, 221, 1014–1018.

Taylor, E.L., Galuppo, L.D., Steffey, E.P., Scarlett, C.C. & Madigan, J.E. (2005) Use of the Anderson sling suspension system for recovery of horses from general anesthesia. *Veterinary Surgery*, 34, 559–564.

Tidwell, S.A., Schneider, R.K., Ragle, C.A., Weil, A.B. & Richter, M.C. (2002) Use of a hydro-pool system to recover horses after general anesthesia: 60 cases. *Veterinary Surgery*, 31, 455–461.

Vandaele, Z., van den Broeke, C., Merchiers, A. & Schauvliege, S. (2025) The use of an air-inflated pillow for assisted recovery after general anaesthesia in horses: a preliminary study. *Animals*, 15, 564.

Young, S.S. & Taylor, P.M. (1993) Factors influencing the outcome of equine anaesthesia: a review of 1,314 cases. *Equine Veterinary Journal*, 25, 147–151.

SUPPORTING INFORMATION

Additional supporting information can be found online in the Supporting Information section at the end of this article.

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Equine Veterinary Education BEVA

ORIGINAL ARTICLE

Obesity and pony breed are associated with plasma L-lactate in horses with acute gastrointestinal disease

A. L. Tillisch | C. Frørup | M. B. Petersen | S. Jacobsen | T. H. Pihl

Department of Veterinary Clinical Sciences, Faculty of Health and Medical Sciences, University of Copenhagen, Taastrup, Denmark

Correspondence: T. H. Pihl
Email: thpi@sund.ku.dk

SUMMARY

Background: Plasma L-lactate (lactate) is widely used as a prognostic marker in horses with acute gastrointestinal disease (colic), but association with obesity is unclear. In humans, lactate is correlated with obesity and insulin resistance.

Objectives: This study aims to evaluate the association of obesity (body condition score ≥7/9) and equine type (horse vs. pony) with lactate concentrations in equines presenting with colic.

Study design: A prospective observational cross-sectional study.

Methods: The study included 190 equines (74 ponies, 116 horses) admitted with colic at a referral hospital. Multivariable linear regression was used to assess the associations of body condition type (obese vs. lean), equine type (pony vs. horse), lesion type (simple obstruction vs. severe intestinal disease) and circulatory status (compromised vs. not) with lactate concentrations.

Results: The overall prevalence of obesity was 27.3%, and higher in ponies (44.6%) than horses (16.4%). The final model included body condition, equine type, lesion type, circulatory status and interaction terms between equid type and body condition type and lesion type and circulatory state. The model predicted an obese pony with a simple obstruction without circulatory compromise to have a plasma lactate of 5.8 mmol/L. The prediction for a lean horse with a severe intestinal disease and circulatory compromise is 6.94 mmol/L.

Main limitations: Limited number of obese horses and lean ponies in the study.

Conclusions: Obesity and breed are associated with lactate concentration in horses with colic. Lactate concentrations were higher in ponies than in horses with colic of similar severity and particularly elevated in obese ponies. This increase is clinically relevant when using lactate for decision-making in acute abdominal disease.

https://onlinelibrary.wiley.com/doi/pdf/10.1111/eve.70056_1.

Clinical relevance

- Plasma lactate concentrations may be higher in ponies with gastrointestinal disease compared to lean horses with the same severity of illness.
- Breed and body condition should always be considered when interpreting plasma lactate concentration, especially before making decisions regarding surgery or euthanasia.
- Ponies showed a higher prevalence of severe gastrointestinal conditions, such as strangulating intestinal lesions and enterocolitis, compared to horses.


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1. Kim DY, Taylor HW, Moore RM, Paulsen DB, Cho DY. Articular chondrocyte apoptosis in equine osteoarthritis. The Veterinary Journal 2003; 166: 52-57.
2. Burba DJ, Collier MA, DeBault LE, Hanson-Painton O, Thompson HC, Holder CL: In vivo kinetic study on uptake and distribution of intramuscular tritium-labeled polysulfated glycosaminoglycan in equine body fluid compartments and articular cartilage in an osteochondral defect model. J Equine Vet Sci 1993; 13: 696-703.
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Equine Veterinary Education BEVA

ORIGINAL ARTICLE

Comparison of cone beam CT and low-field MRI of the distal limb of 85 horses

S. E. Taylor | **P. Kelly** | **C. Daniel** | **O. James** | **M. McMaster** | **T. Schwarz**

The University of Edinburgh, Royal (Dick) School of Veterinary Studies and Roslin Institute, Midlothian, UK

Correspondence: S. E. Taylor
Email: sarah.e.taylor@ed.ac.uk

SUMMARY

Background: Cone beam computed tomography (CBCT) and magnetic resonance imaging (MRI) of the equine distal limb under standing sedation are increasingly available yet there is little published information to guide veterinarians on how both modalities compare to optimise horse management.

Objective: To describe dual modality CBCT and MRI findings in the equine distal limb of images acquired in the standing sedated horse for clinical purposes.

Study design: Retrospective descriptive study.

Methods: Clinical records, CBCT and MRI DICOM images of patients that underwent advanced imaging of the distal limb with both modalities on the same day (April 2024 to April 2025) were reviewed. Key imaging findings were categorised to allow comparison of CBCT and MRI findings.

Results: Imaging studies of 85 horses met the inclusion criteria resulting in imaging of 120 foot and 38 pastern regions. Twenty-four of 85 horses had a primary soft tissue injury that was detected on MRI only. Forty-four horses had increased STIR signal intensity on MRI within the phalanges or navicular bone. CBCT identified a small sequestration of the distal phalanx that was identified on MRI retrospectively, subsequent to CBCT evaluation. CBCT allowed clearer evaluation of cortical bone specifically at the margins of the flexor cortex of the navicular bone and the articular surfaces of the phalanges.

Main limitations: Imaging findings were not verified by a gold standard and are subjective and descriptive. Categorical representation of primary diagnosis was difficult for some horses. The horses evaluated are limited to a mixed referral population of horses in Scotland.

Conclusions: The primary diagnosis was based on MRI in more horses than on CBCT due to the ability of MRI to identify soft-tissue injury. Combined MRI and CBCT imaging of the foot can provide additional information in horses with solar penetration or when careful evaluation of the cortical bone is needed.

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Clinical relevance

- Primary diagnoses were yielded by MRI in more horses than by CBCT.
- CBCT provided additional information in horses where there was a fracture of the distal phalanx, a sequestrum of the distal phalanx or osteolysis at a joint surface.
- Dual-modality CBCT and MRI imaging may be complementary in horses with osteoarthropathy of the distal interphalangeal joint.

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ORIGINAL ARTICLE

Ultrasound diagnosis of interference between costovertebral joint injuries and the eighth cervical nerve

J.-M. Denoix[1,2] | **N. Crevier-Denoix**[1,2]

[1]CIRALE-NEV, Ecole Nationale Vétérinaire d'Alfort, Goustranville, France

[2]INRAE, USC 957-BPLC, Ecole Nationale Vétérinaire d'Alfort, Maisons-Alfort, France

Correspondence: J.-M. Denoix
Email: jean-marie.denoix@vet-alfort.fr

SUMMARY

Background: Equine cervicothoracobrachial syndrome has been shown as a cause of proximal forelimb lameness and dyskinesia in horses. Because of close anatomical relationships, arthropathies of the first costovertebral joint (CVJ1) may interfere with the ventral ramus of the eighth cervical nerve (C8N), the major root of the brachial plexus.

Objectives: To describe the ultrasonographic technique to image CVJ1 and C8N in field practice, to provide normal ultrasonographic images and present abnormalities seen in horses presenting a cervicothoracobrachial syndrome.

Study design: The presentation is based on clinical cases referred for non-blockable lameness or athletic difficulties.

Methods: A regular 5-10 MHz macroconvex (curvilinear) ultrasound probe is used to examine CVBJ1 and CTJ1. After adequate preparation of the area, the forelimb is moved caudally to facilitate access to the two parts of the CVJ1: the costovertebral-body joint, CVBJ1 (between the costal head of the first rib—R1 and costal foveas of the C7 and T1 vertebral bodies), and the costotransverse joint, CTJ1 (between R1 costal tuberculum and T1 transverse process).

Results: Abnormalities identified in clinical cases include arthropathy of CVBJ1 and fracture of the costal head interfering with the cranial fibres of C8N. CTJ1 conditions include periarticular osteophytes, capsulitis, capsular enthesopathies and hypogenesis of R1 in contact with the caudal fibres of C8N or the brachial plexus itself.

Main limitations: Deep bone lesions cannot be imaged with ultrasonography; interference between CTJ1 and the ventral ramus of the first thoracic spinal nerve are hidden by the first rib.

Conclusion: Ultrasonography is presently the only imaging technique providing detailed discrimination of the soft tissues, including nerves in the cervicothoracic area. The procedure can be done in the field on the standing horse. It provides an essential contribution to the understanding and management of many unexplained lamenesses in horses.

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Clinical relevance

- Ultrasonographic examination of CVJ1 and C8N enables the diagnosis of many unexplained lamenesses in horses.
- This procedure can be done in the field on the standing horse with a macroconvex ultrasound probe.
- This examination is now routinely performed in lame horses not responsive to diagnostic analgesic techniques and in horses presenting clinical manifestations of cervicothoracobrachial syndrome or athletic difficulties.

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Equine Veterinary Education BEVA

ORIGINAL ARTICLE

Serological responses of Sport horses pre- and post-third vaccination with Strangvac

U. Hedenström[1] | **F. Righetti**[2] | **I. Zahl**[1] | **B. Henriques-Normark**[2,3] | **A. Gustafsson**[4] | **E. Hartman**[4] | **R. Paillot**[4] | **A. Ruiz**[5] | **A. S. Waller**[4]

[1]Wången AB, Krokom, Sweden
[2]Department of Microbiology, Tumor and Cell Biology, Karolinska Institutet, Solna, Sweden
[3]Clinical Microbiology, Karolinska University Hospital, Solna, Sweden
[4]Intervacc AB, Stockholm, Sweden
[5]Mybac-Vettech AB, Stockholm, Sweden

Correspondence: A. S. Waller
Email: andrew.waller@intervacc.com

SUMMARY

Background: Strangles, caused by *Streptococcus equi*, is an endemic disease of horses throughout the world. A vaccine against strangles, Strangvac, is available in Europe, but there are no published serological data following the revaccination of Sport horses.
Objectives: To measure the antibody response of Sport horses to the components of Strangvac before and after third vaccination.
Study Design: Longitudinal cohort study.
Methods: Adult Sport horses were administered their third vaccination with Strangvac at 5 months (group 1, $n=20$) or 12 months (group 2, $n=15$) after second vaccination. Horses were monitored closely for adverse signs. Blood samples were collected from both groups immediately before and 14 days after third vaccination to quantify antibody responses by ELISA.
Results: Transient signs of mild injection site swelling in 8.5% horses for 2 days, and a temperature rise of ~0.8°C in most horses for 1 day, occurred post-vaccination. Health status returned to normal within 48 h. The antibody titres to the vaccine components were 3.34 ± 0.31 and 3.14 ± 0.29 before third vaccination and increased significantly to 3.90 ± 0.29 and 3.90 ± 0.17 after third vaccination in groups 1 and 2, respectively ($p < 0.0001$ for both groups).
Main Limitations: Data and samples from a matched unvaccinated control group, or prior to, and 14 days after first and second vaccination were unavailable.
Conclusions: Strangvac was safe and the antibody responses that were generated to the vaccine components after revaccination of Sport horses at 5 or 12 months post-second vaccination were equivalent.

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Clinical relevance

- Strangvac was safe for use in Sport horses.
- Revaccination with Strangvac at 5 or 12 months after the administration of the second dose generated equivalent immune responses.
- Strangvac can be administered according to vaccination schedules for other vaccines and revaccination may be used to restore antibody titres according to the individual requirements of Sport horses as they travel to equestrian events or sales, or otherwise become at increased risk of exposure to *Streptococcus equi* (*S. equi*).

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Equine Veterinary Education BEVA

ORIGINAL ARTICLE

Surgical fixation of proximal splint bone fractures in horses using a 3.5-mm LCP: A case series

E.-M. Kruse | S. Tettke | A. Noguera Cender

Hanseklinik für Pferde, Sittensen, Germany

Correspondence: E.-M. Kruse
Email: eva.kruse@hanseklinik.com

SUMMARY

Background: Proximal fractures of the small metacarpal/metatarsal bones (splint bones) in horses are uncommon but clinically challenging due to their close association with adjacent joints, ligamentous attachments and the suspensory apparatus. These fractures are frequently comminuted, may involve open wounds and are associated with a risk of joint instability, chronic lameness and poor athletic outcome. Several treatment options have been described.
Objectives: To describe the surgical technique and clinical outcome of horses with proximal splint bone fractures treated using a 3.5-mm narrow locking compression plate (LCP).
Study Design: Retrospective case series.
Methods: Medical records of horses undergoing internal fixation of proximal splint bone fractures using a 3.5-mm narrow LCP were reviewed. Data collected included signalment, fracture configuration, imaging findings, surgical technique, postoperative management, complications and short- as well as long-term outcome. Outcome was assessed through clinical re-examination at the clinic and follow-up communication with owners and referring veterinarians.
Results: Seven horses with proximal lateral splint bone fractures were included. Four fractures were open at presentation. Stable fracture fixation was achieved in all cases. No major intra-operative or early postoperative complications occurred. All horses returned to their intended level of activity within 4–18 months (median 9 months). Implant removal was required in two horses due to persistent lameness, which resolved following additional surgical intervention.
Main Limitations: The retrospective nature of the study; small case number; there was no control group comparing different surgical treatment options or comparing surgery versus conservative treatment.
Conclusions: The use of a 3.5-mm narrow LCP plate provides a stable fracture fixation for proximal splint bone fractures with no major complications observed, even in open fractures and allowed a return to full function for the cases included in this study.

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Clinical relevance

- Stable fixation and positive outcomes: Use of a 3.5-mm narrow LCP provided stable fracture fixation in all cases, including open fractures, allowing return to intended use.
- Low complication rate: No major intra-operative or early postoperative complications were observed; persistent lameness in two horses was resolved with implant removal.
- Practical surgical guidance: The study demonstrates that LCP fixation is a viable option for managing proximal splint bone fractures, supporting clinical decision-making in complex fracture configurations.

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Equine Veterinary Education
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ORIGINAL ARTICLE

Long-term outcome of horses undergoing surgical correction of wry nose (*Campylorrhinus lateralis*): A retrospective study

H. Vasco[1] | **A. C. Cerqueira de Melo Vasco**[2] | **J. Schumacher**[3] | **J. Easley**[1]

[1]Kentucky Equine Veterinary Dental Specialists, Versailles, Kentucky, USA

[2]Department of Animal and Range Sciences, Montana State University, Bozeman, Montana, USA

[3]Veterinary Medicine, Large Animal Clinical Sciences, The University of Tennessee, Knoxville, Tennessee, USA

Correspondence: H. Vasco
Email: h.vascont@gmail.com

SUMMARY

Background: *Campylorrhinus lateralis*, or wry nose, is a rare congenital maxillofacial deformity of foals that can impair nursing, grazing, mastication, respiration and long-term welfare. Surgery to correct this deformity has been described, but published reports focus primarily on operative techniques and short-term outcomes and provide no information about long-term success from the owner's perspective.

Objectives: This study aimed to assess long-term outcomes of horses that have undergone surgical correction of wry nose by integrating surgeons' and owners' perspectives, focusing on functional outcome, cosmetic appearance, postoperative complications and perceived welfare.

Study design: Retrospective study.

Methods: Two web-based questionnaires were distributed to surgeons who performed surgery to correct wry nose and to the owners of horses that underwent this procedure. Surveys collected information about surgical technique, postoperative complications, functional outcomes and surgeon and owner satisfaction. Only horses with complete paired surgeon–owner responses were included ($n = 9$). Data were analysed for descriptive statistics.

Results: All horses were reported by owners to have severe or very severe deviation of the premaxillae and impaired respiration prior to surgery. The most common postoperative complication reported was infection at the site where the transected nasal bones were stabilised with plates. Postoperatively, most horses exhibited normal breathing at rest and adequate respiratory capacity when exercising. All were able to graze and maintain body condition, and the majority ($n = 7$) returned to their intended use. Owners and surgeons expressed a high satisfaction with the horse's cosmetic appearance. The owners perceived that the surgery improved the horse's welfare and was likely to increase its longevity.

Main Limitations: Small sample size may have limited the generalisability of this study.

Conclusions: Surgery to correct wry nose can provide lasting functional and cosmetic benefits. Integrating the owners' and surgeons' perspectives offers valuable insights for deciding whether to have surgery performed to correct wry nose.

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Clinical relevance

- Results of long-term follow-up reported by owners and surgeons indicate a one-stage procedure to correct wry nose in severely or very severely affected foals can provide long-term improvements in grazing, mastication and respiratory function.
- Postoperative complications are common (notably implant-site infection, pyrexia and dehiscence of oral incision) but are manageable.
- Residual occlusal abnormalities, including class 3 incisor malocclusion (MAL3), may persist as horses grow; long-term dental care and realistic cosmetic expectations should be discussed when presenting surgery as a treatment option.

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CASE IMAGE

Thoracic vertebrae fracture identified by scintigraphy and radiography in a horse

M. Mageed[1] | P. Zielińska[2] | M. Przewoźny[3]

[1]Equipixel Veterinary Teleradiology, Bakum, Germany
[2]Department of Surgery, Faculty of Veterinary Medicine, Wroclaw University of Environmental and Life Sciences, Wroclaw, Poland
[3]Equi Vet Serwis, Buk, Poland

Correspondence: M. Mageed
Email: mahmoud.mageed@equipixel.com

Summary

A 22-year-old Warmblood mare used for light pleasure riding presented with progressive thoracic back stiffness and mild left forelimb lameness. Clinical examination revealed epaxial muscle atrophy and reduced thoracic range of motion. Bone scintigraphy demonstrated a focal increase in radiopharmaceutical uptake at the T12–T13 level, raising suspicion of vertebral pathology. Subsequent radiography revealed findings highly suggestive of a mildly displaced compression fracture of the T13 vertebral body with associated endplate sclerosis. Conservative management resulted in marked clinical improvement. This image case highlights the diagnostic value of nuclear scintigraphy combined with radiography for identifying presumed thoracic vertebral fractures and supports conservative management in the absence of neurological deficits.

KEYWORDS
horse, nuclear scintigraphy, radiography, thoracic spine, vertebral body fracture

HISTORY

A 22-year-old, 500 kg Warmblood mare used for light pleasure riding was presented with chronic back stiffness that had progressively worsened over a 2-week period. Clinical examination revealed bilateral moderate segmental atrophy of the epaxial musculature and a moderate reduction in thoracic range of motion, most pronounced in the mid-thoracic region. Sacroiliac joint mobility was moderately reduced. Mild left forelimb lameness (Grade 1/5, AAEP scale) was observed during lameness evaluation. Due to the involvement of multiple anatomical regions, delayed bone scintigraphy was recommended and performed (Figure 1).

DIAGNOSTIC IMAGING FINDINGS AND INTERPRETATION

Bone scintigraphy demonstrated a severe focal increase in radiopharmaceutical uptake (IRU) at the T12–T13 level, most pronounced in the caudal half of T12, with an uneven uptake pattern separated by a faint region of photopenia (Figure 2). Mild diffuse IRU was also present at the dorsal spinous processes, with a more extensive area of IRU observed on a larger portion of the T12–T13 vertebral bodies (Figure 2). An incidental mild focal pooling of radiopharmaceutical was noted in the cranial aspect of the right kidney. Based on these scintigraphic findings, a vertebral body pathology such as fracture was considered the most likely diagnosis, with discospondylosis and neoplasia regarded as less likely. Subsequent right and left laterolateral radiographs of the mid-thoracic spine revealed a shortened T13 vertebral body with an ill-defined oblique radiolucent line extending from the ventral aspect of the T12–T13 intervertebral symphysis through the cranial endplate of T13, oriented cranioventrally to caudodorsally and surrounded by moderate homogeneous sclerosis (Figure 3). The ventral aspect of the intervertebral symphysis was moderately widened with loss of subchondral bone and irregular articular margins, and the vertebral endplates showed moderate diffuse sclerosis. Marked ventral displacement of the cranioventral aspect of T13 was present. The combination of vertebral body shortening, the specific oblique orientation of the fracture line, and the mild ventral displacement supported a diagnosis of a mildly displaced compression fracture of the T13 vertebral body. The vertebral body appeared moderately enlarged on right-sided laterolateral projection compared to left-sided projection. This magnification difference, combined with the asymmetrical scintigraphic uptake, suggests that the pathology was predominantly localised to the left side of the vertebral body. As

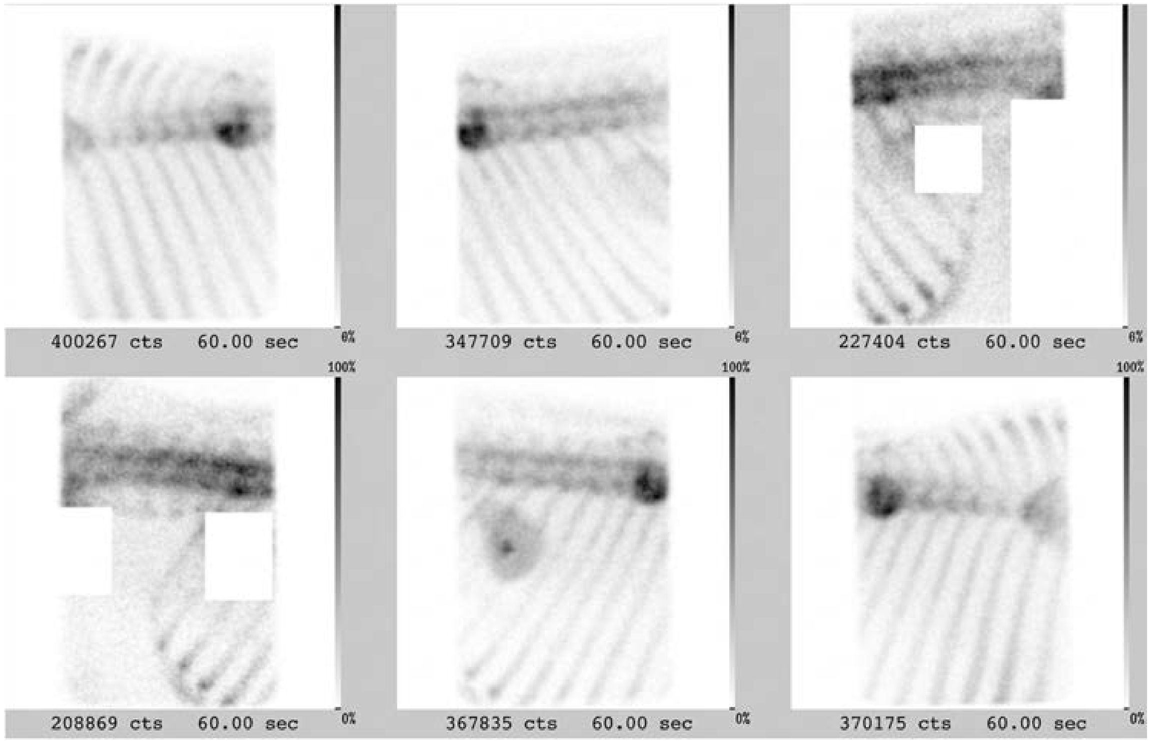

FIGURE 1 Left lateral (upper panel, head is toward the left), and right lateral (lower panel, head is toward the right) nuclear scintigraphic images of the thoracolumbar region of a horse referred with a history of chronic back stiffness and lameness in the left forelimb.

haematological parameters were within normal limits and no fever was present, conservative management was initiated, consisting of firocoxib administered at 0.1 mg/kg bwt orally once daily for 7 days followed by a reduced dose for an additional 21 days, confinement to a small paddock, and a controlled rehabilitation programme with hand walking starting at 20 min twice daily and increasing by 5 min per week. Transcutaneous electrical nerve stimulation therapy was applied to the affected thoracic region to improve epaxial muscle strength and enhance vertebral stability. At the 3-month follow-up (Figure 4), radiographs showed the fracture line to be less distinct but still visible, with a smoother and narrower ventral aspect of the T12–T13 intervertebral symphysis, and the mare demonstrated marked clinical improvement in back stiffness and lameness.

DISCUSSION

Vertebral body fractures in horses are reported to occur at sites of pre-existing maladaptive stress remodelling, including endplate sclerosis and the presence of woven bone consistent with stress fractures (Chapple et al., 2025; Denoix, 2007). Such lesions have been described predominantly between T17 and L6 and typically follow a predictable configuration, extending obliquely through the vertebral endplates in a cranioventral to caudodorsal direction (Collar et al., 2015; Haussler & Stover, 1998).

Nuclear scintigraphy is a valuable screening tool for identifying regions of increased bone turnover but requires confirmation with targeted radiography. While standard radiographs confirmed the vertebral body fracture, further oblique projections could have better delineated the involvement of the dorsal elements. Targeted radiographic views of the T13 vertebral laminae and the T12–T13 articular processes are recommended in similar cases to determine the full extent of the fracture line. Furthermore, an ultrasonographic examination of the articular processes and adjacent laminae would have been an interesting and useful adjunct. Ultrasound allows for a more detailed evaluation of the cortical surfaces of these dorsal structures and the integrity of the associated soft tissues, which may be obscured on the radiographic projections. Differential diagnoses for increased vertebral radiopharmaceutical uptake include discospondylitis and intervertebral disc degenerative disease; however, a fracture was considered most likely based on signalment, imaging characteristics, and clinical presentation. The pathology was hypothesised to be predominantly left-sided due to the more extensive spatial distribution of the radiopharmaceutical uptake on the left lateral view and the corresponding radiographic magnification findings. While a dorsal scintigraphic projection or oblique radiographic views would have been required to definitively characterise a spinal deviation (scoliosis).

The biomechanical nature of the injury in this mare is consistent with a compression fracture rather than an extension-related injury. Compression fractures in the equine mid-to-caudal thoracic spine typically result from repetitive axial loading, leading to a characteristic 'shortened' appearance of the vertebral body and fractures that propagate through the subchondral bone of the endplates. In contrast, fractures associated with spinal extension or hyperextension often manifest as tension-related avulsions of the ventral vertebral

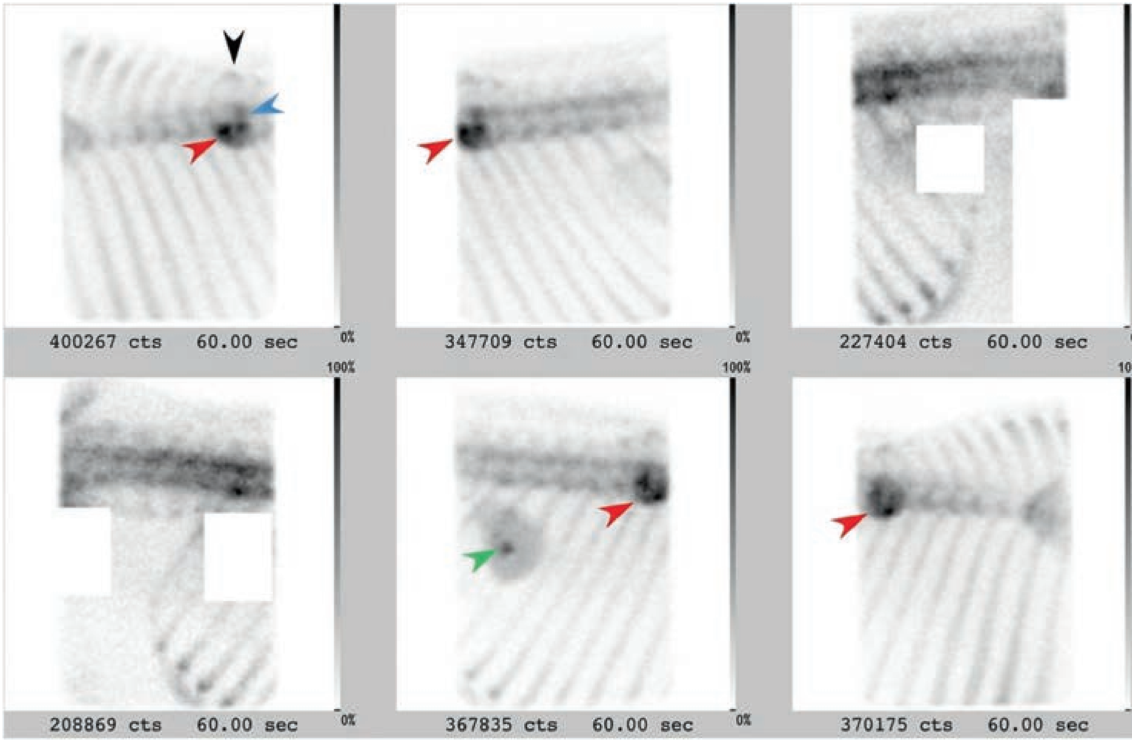

FIGURE 2 Bone scintigraphic images of the mid-thoracic spine (same images as Figure 1) showing increased radiopharmaceutical uptake in the vertebral bodies of T12–T13 (red arrows), the dorsal spinous process (black arrow), the left vertebral lamina and adjacent articular process (blue arrow). The area of abnormal uptake is more extensive on the left lateral projection compared to the right. Incidental focal radiopharmaceutical pooling is present in the right kidney (green arrow).

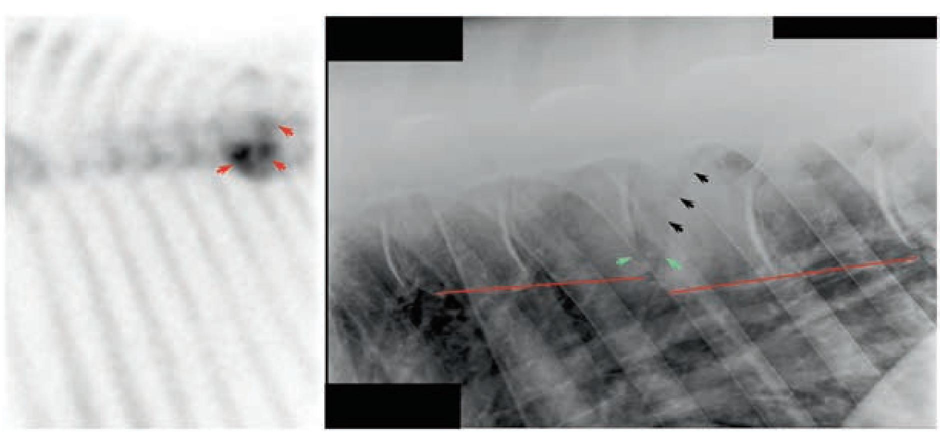

FIGURE 3 Left lateral bone scintigraphic image of the mid-thoracic spine demonstrating abnormal increased radiopharmaceutical uptake at the level of the T12 and T13 vertebral bodies (lower red arrows) and the left vertebral lamina and adjacent articular process joint (upper red arrow). The corresponding left lateral radiograph shows a radiolucent line (black arrow) originating from a widened osteolytic region at the ventral aspect of the T12–T13 intervertebral symphysis (green arrows). Mild ventral displacement of the T13 vertebral body relative to T12 is evident (red lines). The vertebral body of T13 is 7 mm shorter than T14. These findings are consistent with a compression fracture of the T13 vertebral body.

margins or involve significant trauma to the dorsal spinous processes and articular process joints due to 'overriding' or impingement. The absence of primary tension-type fragments and the presence of clear vertebral body shortening and endplate sclerosis strongly point toward a compressive mechanism.

In an older patient, the possibility of a pathologic fracture secondary to neoplasia or infectious discospondylitis must be considered. While histopathological confirmation was not available, several factors support a stress-related origin in this case. Radiographic follow-up at 3 months demonstrated organised osseous remodelling

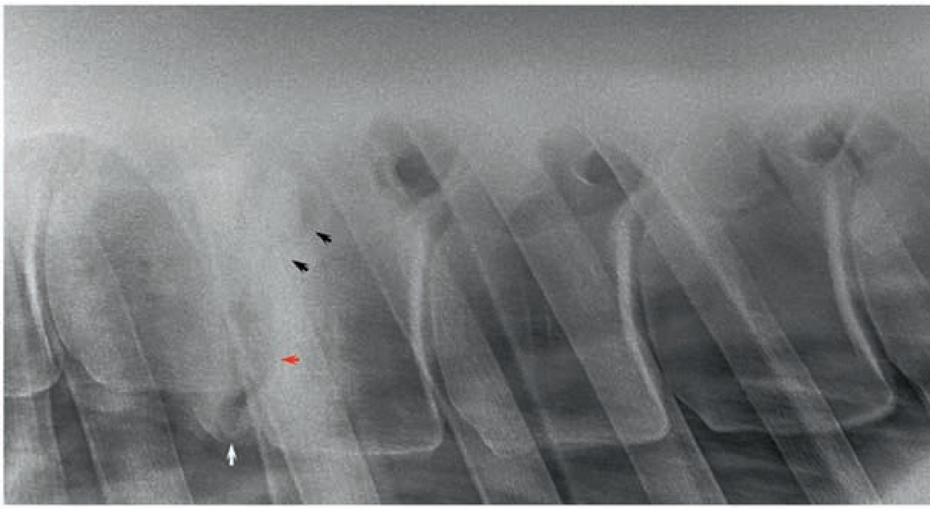

FIGURE 4 Left laterolateral radiograph obtained 3 months after conservative treatment showing the fracture line to be less distinct but still visible (black arrows). The ventral aspect of the T12–T13 intervertebral symphysis appears smoother and narrower (red arrow), and smooth, well-marginated bone proliferation bridging the adjacent vertebral bodies is present (white arrow). These findings are consistent with fracture healing.

and bridging, which is inconsistent with the progressive destruction typically seen in aggressive bone disease. Furthermore, the localisation of the lesion to the T13 vertebral body and the presence of subchondral sclerosis suggest a maladaptive response to chronic axial compression. Nevertheless, the authors acknowledge that age-related osteopenia may have served as a predisposing factor, making the bone more susceptible to failure under normal physiological loads.

Non-displaced fractures in other skeletal locations are known to carry a favourable prognosis. Recent reports indicate that approximately two-thirds of horses diagnosed with vertebral body stress fractures successfully return to athletic function when appropriately managed (Chapple et al., 2025). The treatment strategy in this case aimed to strengthen the surrounding soft tissues to provide a stabilising, splint-like effect on the affected vertebra.

A limitation of this report is the absence of pathological confirmation. As a result, the diagnosis should be interpreted as presumptive, derived from the clinical findings and the imaging appearance. Although the scintigraphic localisation and radiographic morphology were compatible with a vertebral body fracture, these techniques are not specific, and definitive diagnosis would require post-mortem or histopathological examination. Clinical improvement following conservative management is supportive but cannot be considered confirmatory.

AUTHOR CONTRIBUTIONS

M. Mageed: Conceptualization; investigation; supervision; visualization; writing – original draft; writing – review and editing. **P. Zielinska:** Conceptualization; validation; formal analysis; project administration; writing – review and editing. **M. Przewozny:** Conceptualization; data curation; validation; writing – original draft; writing – review and editing; project administration.

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CONFLICT OF INTEREST STATEMENT

No conflicts of interest have been declared.

ETHICS STATEMENT

Institutional animal care and use committee approval was not required because of the retrospective nature of this case study. Written informed consent was obtained from the owner of the animal, and anonymity is preserved.

REFERENCES

Chapple, A.R., Daglish, J., Stover, S.M., Slipchenko, N. & Phillips, K.L. (2025) Localisation and outcome of presumed thoracolumbar vertebral stress fracture in 35 UK thoroughbred racehorses using nuclear scintigraphy. *Equine Veterinary Journal*. Available from: https://doi.org/10.1111/evj.70113

Collar, E.M., Zavodovskaya, R., Spriet, M., Hitchens, P.L., Wisner, T., Uzal, F.A. et al. (2015) Caudal lumbar vertebral fractures in racehorses. *Equine Veterinary Journal*, 47, 573–579.

Denoix, J.-M. (2007) Discovertebral pathology in horses. *Equine Veterinary Education*, 19, 72–73.

Haussler, K.K. & Stover, S.M. (1998) Stress fractures of the vertebral lamina and pelvis in thoroughbred racehorses. *Equine Veterinary Journal*, 30, 374–381.

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REVIEW ARTICLE

Sheared heels as a predisposing factor for quarter crack formation in the equine hoof

S. E. O'Grady[1] | T. D. Burns[2]

[1]Virginia Therapeutic Farriery, Keswick, Virginia, USA

[2]Virginia-Maryland Regional College of Veterinary Medicine, Blacksburg, Virginia, USA

Correspondence: S. E. O'Grady
Email: sogrady@look.net

Summary

Full thickness hoof wall defects such as a quarter crack, result in loss of the structural integrity of the hoof wall, are common in equine practice and often manifest in lameness. Many causes of quarter cracks have been described, such as trauma to the coronet, pre-existing damage to the dermis from infection, abnormal hoof conformation, insufficient length of shoes, inappropriate farrier practices or an abnormal landing pattern when the foot strikes the ground. The most consistent finding in all quarter-crack cases is a hoof capsule distortion termed a 'sheared heel'. Successful management of these hoof wall defects involves identifying and addressing the underlying cause(s), stabilisation of the digit and committed follow-up. Treatment is most successful when the cause is investigated and identified, the appropriate farriery is initiated as early as possible, and when the biomechanical properties of the foot are thoroughly understood. Inadequate attention to these factors may account for the many treatment failures encountered in equine veterinary practice and the recurring nature of a quarter crack.

KEYWORDS

horse, equine foot, hoof wall defects, quarter cracks, sheared heels, therapeutic farriery

INTRODUCTION

Full-thickness hoof wall defects, such as a quarter crack, have become increasingly prevalent in equine veterinary practice. A true full-thickness quarter crack originates just distal to the coronet and migrates proximally and distally, leading to infection, lameness and is a common cause of decreased athletic performance in competition horses (Castelijns, 2006; Morrison, 2013; Moyer, 1999; O'Grady, 2001, 2003; O'Grady & Castelijns, 2011; Pleasant et al., 2012). The horse in the barefoot state is relatively free from this hoof wall defect, so there appears to be a direct correlation with farriery. Functionally, the palmar section of the hoof capsule of the barefoot horse has the unique ability to adapt to unequal loading or uneven footing as the heels are able to move vertically…independently of each other; however, when the foot is trimmed, and shoes are applied, this ability to adapt becomes modified (O'Grady & Clayton, 2023). Furthermore, a quarter crack is generally associated with a hoof capsule distortion termed a 'sheared heel' which is noted on the affected side of the hoof capsule (Figure 1). It is well accepted that abnormal weight distribution on the foot or disproportionate forces placed on a section of the hoof wall, over time, will cause the foot to assume an abnormal shape or hoof capsule distortion. Furthermore, these abnormal forces exerted on a focal section of the hoof wall will predispose the foot to a quarter crack (Figure 2) (Castelijns, 2006; Morrison, 2013; Moyer, 1999; O'Grady, 2003; O'Grady & Castelijns, 2011; Pleasant et al., 2012). Sheared heels, as a clinical entity, were first described in the veterinary literature 50 years ago (Moyer, 1980; Moyer & Anderson, 1975). However, since then, the understanding, biomechanics and clinical management of sheared heels has been shrouded in controversy in both the veterinary and farriery professions. Although numerous farriery strategies have been proposed for the management of sheared heels, consistent clinical success has not been demonstrated. In discussing the farriery practices implicated and the approach to treatment, the authors will use the limited references available as well as their clinical experience based on their combined 75 years treating a large caseload from their individual practices.

There is a myriad of materials and techniques described for repairing a hoof crack, but none will be consistently successful unless the cause of the hoof wall defect is determined and addressed using the appropriate farriery (Castelijns, 2006; Morrison, 2013; O'Grady & Castelijns, 2011; Pleasant et al., 2012). The various methods used to repair a hoof wall defect have been described in detail elsewhere and will not be included in this paper. This paper will discuss the abnormal foot conformation, the proposed pathophysiology leading to these hoof wall defects and the appropriate farriery necessary to address the cause of these conditions.

ANATOMY AND BIOMECHANICS

The equine hoof capsule is composed of the hoof wall, sole, frog and bulbs of the heel. The hoof capsule is comprised of keratinised epidermal cells and forms a resilient, obliquely oriented, truncated, incomplete conoid structure where the wall is folded inwards on each side at the heels (the bars) for stability (Figure 3a). The hoof capsule is a viscoelastic structure; that is, when subjected to constant stress (excessive or disproportionate load), it deforms slowly in a viscous manner which will reverse or resolve when the load is removed. In contrast, when subjected to a sudden high impact (load), it deforms elastically and returns to its original shape. The hoof wall is typically thickest in the toe region and becomes thinner and more elastic towards the heels to allow movement. The medial hoof wall is usually straighter (less angled) and more upright (steeper) than the lateral hoof wall (Davies et al., 2007; Pleasant et al., 2012).

FIGURE 1 Example of a 'sheared heel' hoof capsule distortion. Note the disparity between the heights of the coronets (white arrows) and the compression of the soft tissue structures (black arrow) between the coronet and the middle phalanx on the side with the displaced heel.

The hoof wall is composed of three morphologically distinct layers, namely the stratum externum (periople), stratum medium and stratum internum (Figure 3b). The stratum medium makes up the bulk of the hoof wall. It has two distinct layers, pigmented stratum medium and non-pigmented stratum medium and is composed of tubular and intertubular horn. The tubule density in the stratum medium is highest in the outermost region (pigmented stratum) and declines through the non-pigmented stratum medium towards the stratum internum (Parks, 2003; Pleasant et al., 2012; Reilly et al., 1996). This tubule density gradient reflects differences in the mechanical properties across the stratum medium and is proposed as a mechanism for modulating (dampening) the transfer of the energy of impact from the rigid outer hoof wall (high tubule density) through the softer elastic inner wall (low tubule density) to the epidermal/dermal lamellae interface (and ultimately the distal phalanx) (Parks, 2003; Pleasant et al., 2012). Furthermore, the properties of the tubular-intertubular horn interfaces and the tubule zonation within the stratum medium have been suggested to be crack-stopping/diverting mechanisms, causing externally originating cracks along the periphery of the hoof capsule to deviate along more tortuous routes, thus redirecting cracks away from the dermis (Bertram & Gosline, 1986; Kapasi & Gosline, 1997; Parks, 2003; Pleasant et al., 2012; Reilly et al., 1996).

The mechanical behaviour of the hoof capsule depends primarily on the physical properties of the materials from which it is made (affected by the environment, hydration and possibly nutrition) and on its shape (affected by load, limb conformation and hoof care) (Davies & Philip, 2007; Pleasant et al., 2012). During the stance phase of the

FIGURE 2 (a) Full-thickness quarter crack…note the thickened hoof wall with 'compacted' growth rings distal to the coronet (arrow). (b) Sheared heel…note compression of soft tissue between coronet and middle phalanx. (c) Radiograph shows sheared heel (white arrows) with displacement of distal phalanx towards the displaced heel and compacted growth rings (red arrow).

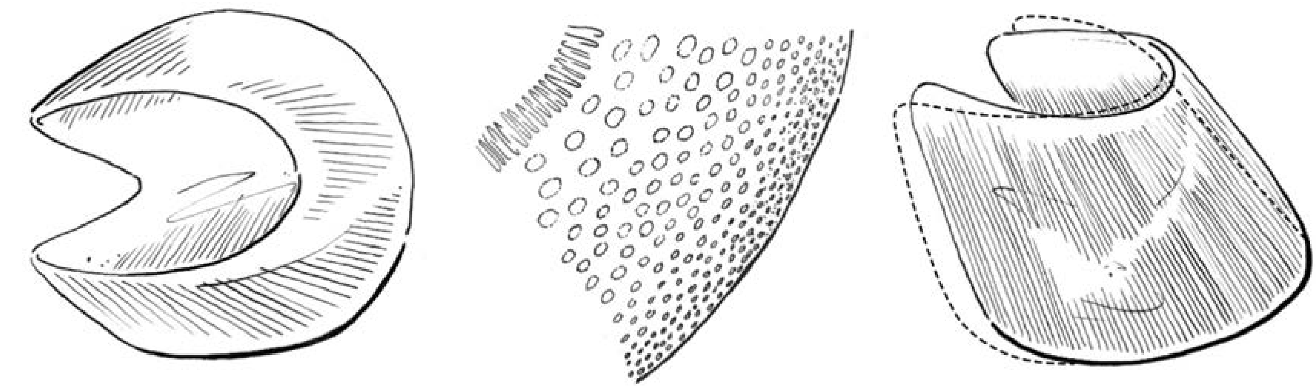

FIGURE 3 Illustration of the hoof wall. (a) Conical shape, (b) layers of hoof wall and tubular density, (c) functional movement of hoof capsule during loading.

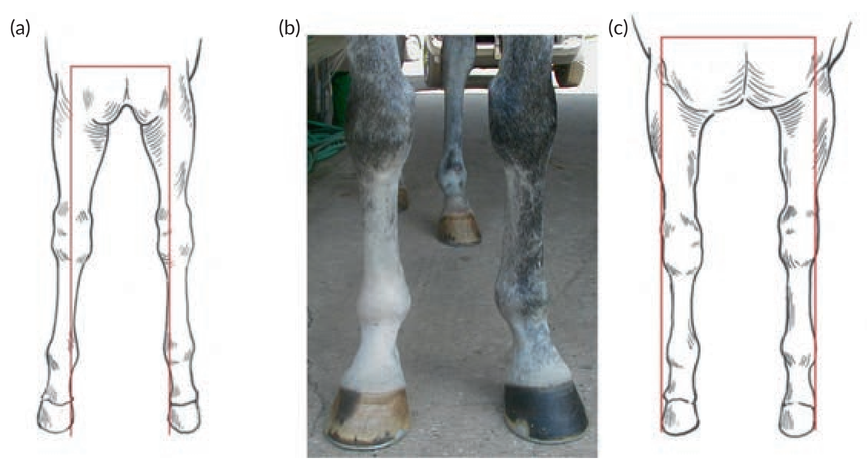

FIGURE 4 (a) Axial rotational deformity in a lateral direction (b) illustrates a lateral rotational deformity and (c) axial rotational deformity in a medial direction (Courtesy Dr. Scott Pleasant).

stride, the hoof capsule deforms under the weight of the horse and the dynamic loads of locomotion. The oblique, truncated, incomplete cone shape, along with the decrease in wall thickness from the toe to heels in the well-shaped hoof, causes the toe of the wall to bow backwards and the quarters and heels to flare at the ground surface (spread horizontally) during loading (Figure 3c). This pattern of deformation appears to be an extremely efficient mechanism for dampening and distributing the loads of weight-bearing and locomotion. Changes in hoof capsule shape away from this ideal may negatively affect its mechanical behaviour and predispose it to injury (Davies et al., 2007; Kapasi & Gosline, 1997; Pleasant et al., 2012).

PATHOPHYSIOLOGY OF A QUARTER CRACK

Many causes of quarter cracks have been described including coronet injuries, inappropriate farrier practices, poor quality hoof walls (as a result of genetics, nutrition and/or environment), white line disease and hoof capsule distortions. In the authors' experience, the most common underlying cause of a full-thickness quarter crack is an excessive focal load on a section of the foot leading to a hoof capsule distortion. Accordingly, this paper will focus on a full-thickness quarter crack caused by a hoof capsule distortion (sheared heels).

It is well accepted that the hoof capsule adapts and changes shape according to how it is loaded (Castelijns, 2006; O'Grady & Castelijns, 2011). Hoof wall growth tends to be slower where most of the weight is borne and faster where the least amount of weight is borne (Parks, 2003). Faulty limb conformation adversely affects how the hoof is loaded, and habitual disproportionate loading will change the shape of the hoof capsule over time. The resulting distortion of the hoof capsule appears to negatively affect the structural integrity of the hoof wall and its mechanical behaviour, resulting in abnormal force and stress within its tissues (Castelijns, 2006; O'Grady, 2001; O'Grady & Castelijns, 2011; Parks, 2003). If the change in forces and stress becomes excessive and the hoof wall can no longer accept the increased load, the wall can be predisposed to injuries such as a full-thickness quarter crack. Stress and strain on the hoof wall may become excessive in horses with relatively minor hoof capsule distortion, but which experience high loads on their hooves (e.g., heavy use or work on hard ground) or in horses with marked hoof capsule distortion but who experience relatively normal loads on their hooves. In either scenario, the underlying concept is that there is an imbalance

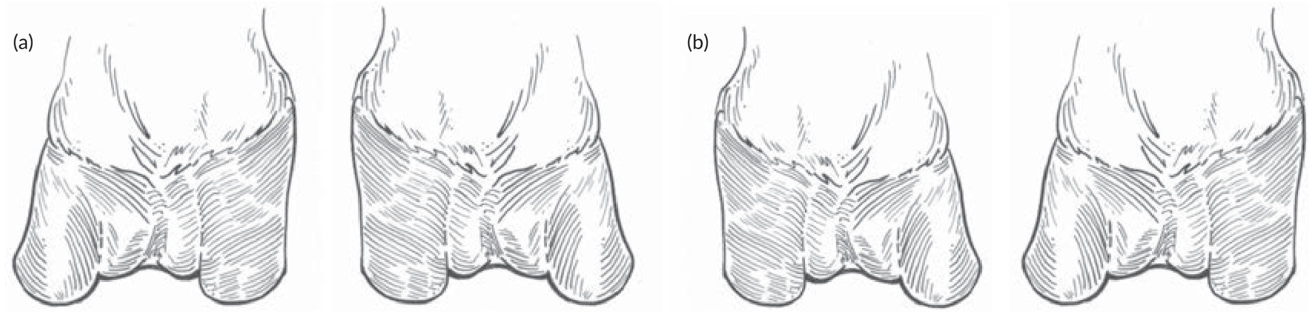

FIGURE 5 (a) Hoof wall distortion associated with lateral rotational deformity (b) Hoof wall distortion associated with medial rotational deformity (Courtesy Dr. Scott Pleasant).

between the load applied and the hoof wall's inherent capacity to withstand a given load (Pleasant et al., 2012).

It is important for clinicians (veterinarians and farriers) to recognise the cause and effect of hoof capsule distortions. The cause of a hoof capsule distortion may be multi-factorial, but the most common causes are poor limb/foot conformation and inappropriate farriery. Limb conformation directly affects hoof capsule loading, which affects hoof wall shape. For example, in horses with a rotational deformity in a lateral direction (Figure 4a,b), the medial heel quarter will bear the most weight. This may cause the hoof wall at the coronet in this area to grow slower and become more vertical. If not managed properly, the medial heel quarter will eventually become displaced axial to the coronet at the ground surface ('roll under') and the coronet at the heel will displace proximally assuming a 'sheared heel' conformation (Figure 5b). As a result of the disproportionate load, the lateral quarter/heel appears to grow relatively faster than the medial heel quarter contributing to the distortion. The resulting hoof distortion negatively affects the mechanical behaviour of the hoof wall causing the medial heel quarter to bend axially at the ground surface and bow outwards at the coronet during loading, predisposing to a full-thickness quarter crack in the medial quarter that originates near the coronet and extends distally (O'Grady, 2024) (Figure 1). On close examination, quarter cracks will usually 'open' slightly at the coronet when the foot is loaded and close when the foot is unloaded. The resulting full-thickness defect usually results in performance-limiting lameness.

To a lesser extent, in horses with a rotational deformity in a medial direction leading to a toe-in conformation (Figure 4c), the opposite will occur. The lateral heel quarter bears the most weight, tends to grow slower and becomes more vertical. The lateral heel quarter may eventually 'roll under' and the coronet on the lateral side will displace proximally (O'Grady, 2024) (Figure 5b). The resulting hoof wall distortion, although less common, predisposes to a quarter crack formation in the lateral wall.

MECHANISM

It may be helpful to look at the biomechanical mechanism that purportedly occurs in the wall on the affected side of the foot. Biomechanically, the position of the coronary band is related to the balance between hoof wall growth at the coronary band and the rate of migration of the hoof wall distally towards the ground. Furthermore, the rate of migration of the hoof wall towards the ground appears to be a balance between an active process occurring in the lamellae to cause the wall to move distally and the force on the wall exerted from the ground reaction force. Clinical evidence suggests that hoof wall growth is at least in part, if not predominantly, inversely determined by the force of weight-bearing at the ground surface of the wall (Parks, Denoix, Personal Communication, 2012). Therefore, if the rate of hoof wall growth is greater than the rate of hoof wall migration distally, the coronary band displaces proximally (Figure 6) (O'Grady, 2012). The increased load on a given side of the foot over time appears to result in a biological remodelling rather than the heel being pushed proximally, that is, the heel is 'growing' out of shape rather than being pushed out of shape. Whether or not this is a real phenomenon as suggested by clinical experience has not been confirmed in a scientific manner.

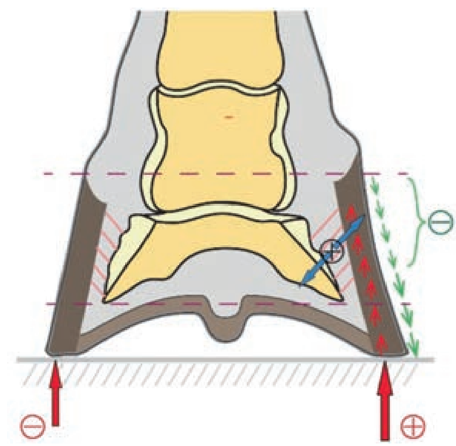

FIGURE 6 Proposed biomechanical mechanism for sheared heels… the position of the coronary band is related to the balance between hoof wall growth at the coronary band and the rate of migration of the hoof wall distally towards the ground (Courtesy Dr. Andrew Parks).

It has been speculated that decreased hoof wall growth or no growth migrating distally from the coronet may inhibit sole growth as observed clinically, but this has not been proven. The decrease in sole growth may also result from the overload on the affected side of the

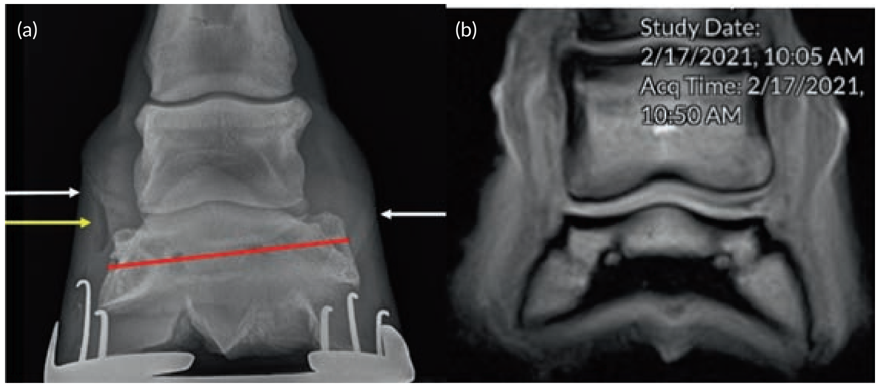

FIGURE 7 (a) Radiograph shows a change in position or 'tilt' of the distal phalanx (red line) combined with a widening of the joint space. White arrows show the position of the coronet, and the yellow arrow shows infection from a concurrent quarter crack. (b) Compression of the ungual cartilage and soft tissue axial to the coronet between the hoof wall and the middle phalanx on MRI image.

FIGURE 8 (a) Red arrow shows alignment of digit, and black arrow shows the hoof capsule offset towards the lateral side. (b) Coronet assumes a more horizontal contour with a focal displacement in the heel quarter at the origin of the hoof wall defect.

hoof. Decreased sole thickness on the affected side will allow unilateral displacement of the distal phalanx distally…the amount of descent being proportional to the amount of damage to the hoof capsule. The change in position or 'tilt' of the distal phalanx will be observed on a dorsopalmar (DP) radiograph of the foot combined with a widening of the joint space and compression of the joint space with increased sole depth and or leverage on the contralateral side of the foot (O'Grady, 2024; Pleasant et al., 2012) (Figure 7a). Proximal displacement of the heel bulb will also compress or 'trap' the ungual cartilage and soft tissue axial to the coronet between the hoof wall and the middle phalanx (Figure 7b).

CLINICAL IMPRESSIONS

Evaluation of the hoof capsule begins with visual assessment of the hoof and limb conformation with the horse standing on a hard level surface. The gross changes noted in the shape of the foot are proportional to the amount of continual focal load sustained, the extent of structural damage and the duration of the condition. When a sheared heel is present, the heel bulb on the affected side is displaced proximally and the structures above the heel bulb between the coronet and the middle phalanx will be compressed when viewed from behind the horse (Figure 1). When viewed from the front, the hoof wall on the affected side is straighter (due to increased load) and, in chronic cases, will begin to roll axially under the foot. There is generally a marked hoof wall flare present on the side opposite the affected heel in the toe quarter. Furthermore, in the case of a medial sheared heel, the hoof will generally be offset towards the lateral side thus placing additional load on the medial wall (Figure 8a). This is significant as there is more solar surface area on the lateral vs. the medial side of the foot; therefore, more load is accepted on the medial side with less surface area. Furthermore, when this foot conformation is combined with a lateral rotational limb deformity, it will potentiate the load on the medial side of the foot. When viewed from the affected side, the coronary band is displaced proximally and will assume a more horizontal contour with a focal displacement in the heel quarter, instead of having a gradual uniform slope from the toe to the heel (Figure 8b). Interestingly, this focal displacement of the coronet will always occur in the soft tissue structures palmar to the distal phalanx and not through the laminar interface between the hoof wall and the distal phalanx (Figure 9). Compacted growth rings, resulting from decreased

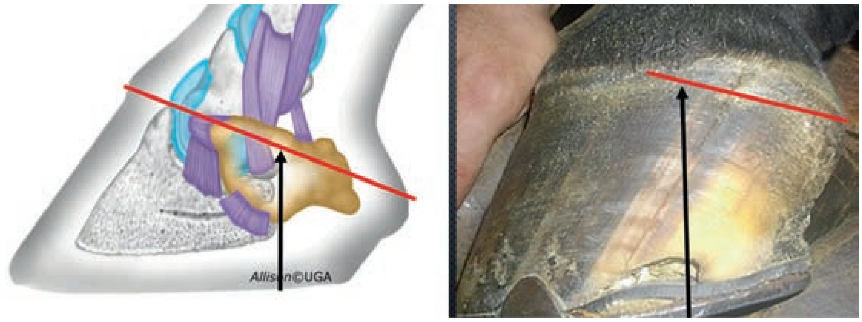

FIGURE 9 Illustration shows the relationship between the osseous and soft tissue structures within the hoof capsule. Hoof shows focal displacement of the coronet from focal overload in the soft tissue structures palmar to the palmar processes of the distal phalanx.

FIGURE 10 (a) Palpation of the ungual cartilage. (b) Measurement of the free ungual cartilage margin above the quarter crack by means of metric callipers reveals a distance of 15 mm or less (−2 to 15 mm) (Courtesy Dr. Hans Castelijns).

hoof wall growth, are generally observed in the hoof wall distal to the coronet on the displaced heel, which is a consistent sign of overload (O'Grady, 2012, 2024). The solar surface of the foot reflects changes elsewhere in the hoof capsule; the foot will be less symmetrical; the sole in the quarter and heel area will appear wider on the side with the flare and narrower on the side with the sheared heel.

The displaced coronet interferes with the abaxial movement of the ungual cartilage limiting expansion which is necessary to decrease the energy of impact. The ungual cartilage is generally palpable adjacent to the inner hoof wall in the pastern; however, when a quarter crack is present, the proximal free margin of the ungual cartilage is usually diminished in height due to the upward displacement of the hoof wall at the coronet. On palpation and measurement of a foot with a sheared heel and a quarter crack, it is not uncommon to find the proximal border of the ungual cartilage at or below the coronary band. When a quarter crack is present, palpation of the ungual cartilage and moving the cartilage outwards (abaxially) by hooking a finger axially to the cartilage tends to elicit pain and opening of the proximal margins of the crack (Figure 10a). A quarter crack appears to originate in the stratum internum (haemorrhage noted at coronet) and propagate externally, and the proximal extent of the quarter crack is always near the highest point of the vertical distortion of the coronary band when observed from the side (Figure 8b). Measurements of the free ungual cartilage margin above the quarter crack by means of metric callipers reveal that when cracks are present, this distance is 15 mm or less (−2 to 15 mm) (Figure 10b) (O'Grady, 2012; O'Grady & Castelijns, 2011; Parks, 2011).

MANAGEMENT OF QUARTER CRACKS

Management of full-thickness quarter cracks involves identification of the hoof capsule distortion, unloading the compromised section of the hoof, stabilisation of the hoof wall and committed follow-up. A 0° horizontal DP and 0° lateromedial radiographs centred on the solar margin of the distal phalanx can be helpful in evaluating hoof capsule/distal phalanx alignment and any distortion present. In horses with a sheared heel, there may be inappropriate medial-to-lateral orientation of the distal phalanx relative to the ground observed on the DP view. If medial-to-lateral imbalance of the distal phalanx is present, it will generally be opposite to the coronet displacement (i.e., the distal phalanx tilts in the opposite plane of the coronet displacement) The lateral-to-medial radiograph will show two horizontal planes of the solar surface of the distal phalanx and a disparity in the silhouette of the heel bulbs (Figure 11).

FARRIERY - PART 1

Over the years, the authors have recognised the benefits of leaving the horse barefoot for a brief period when confronted with a case

FIGURE 11 (a) 0° dorsopalmar (DP) radiograph of an LF foot demonstrates proximal imbalance of the lateral aspect of the distal phalanx in combination with proximal displacement of the medial coronet in a horse with a medial quarter crack. (b) The lateromedial radiograph shows two horizontal planes of the solar surface of the distal phalanx (red circle) and a disparity in the silhouette of the heel bulbs (white arrow). (c) DP radiograph of the same foot shows disparity in height of coronets (white arrows) and displacement 'tilt' of distal phalanx (black line) (Courtesy of Dr. Kent Allen).

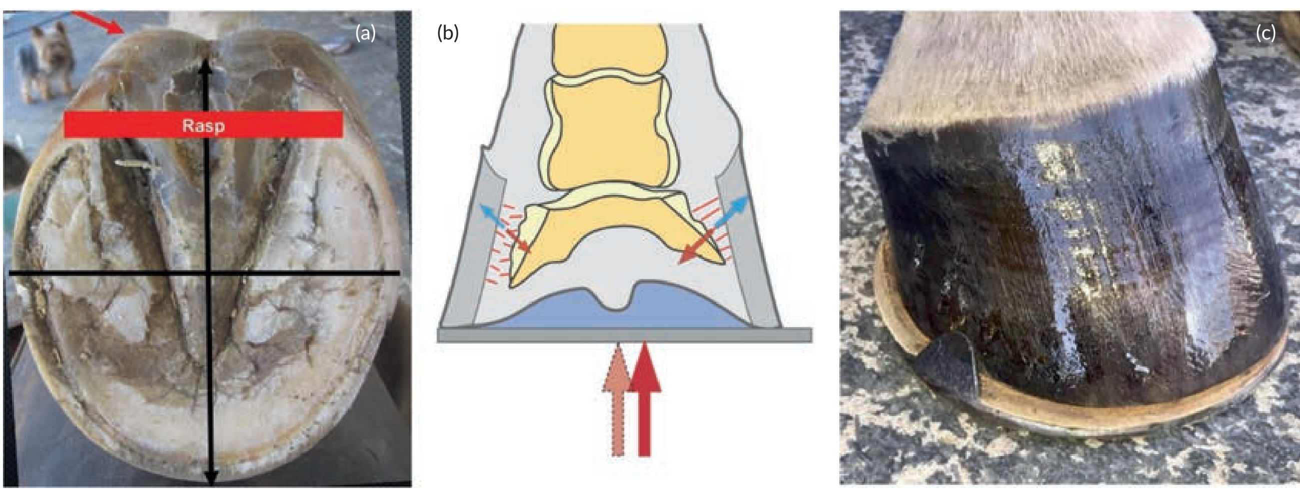

FIGURE 12 (a) First trim—basic trim with heels trimmed to the same horizontal plane as the frog (red box). Line drawn across the middle of the foot and approximate proportions of solar surface on either side. (b) Illustration shows the biomechanical concept of moving the centre of pressure (CoP) towards the stronger side of the foot. (c) Shoe with lateral extension is used to move the CoP towards the contralateral side of the foot.

of sheared heels and an acute quarter crack to manage the soft tissue structures in the palmar foot. 5–10 days are often sufficient to allow the deformable palmar section of the hoof capsule to relax, the heel structures to descend and assume a more acceptable hoof conformation. The shoes are removed, the solar surface of the foot is cleaned with a wire brush (no solar horn is removed), the heels are trimmed with a rasp such that the heels and the frog are on the same horizontal plane, and a thick bevel is created around the perimeter of the hoof to prevent breaking the hoof wall. The horse is walked twice daily on a firm surface for 15 min and then allowed regular turnout in a small paddock with firm footing. The weight of the horse will apply pressure to the palmar section of the foot without a shoe and force the structures into a more acceptable foot conformation (Castelijns, 2006; O'Grady, 2016, 2024; O'Grady & Castelijns, 2011; O'Grady & Clayton, 2023).

The 'double trim' method is used in the initial approach to farriery; the first trim is the basic trim described below, and the second trim is used to remove additional hoof wall in a tapered fashion from the toe to the heel under the affected side to create a space to unload the heel further. The distorted foot/feet should be trimmed appropriately using the guidelines of a parallel hoof-pastern axis, centre of rotation and the heels of the hoof capsule extending to the base of the frog or trimming the heel area to ensure the frog and the hoof wall are on the same horizontal plane (Figure 12a) (O'Grady, 2020, 2024; O'Grady & Castelijns, 2011; Parks, 2011). Briefly, the basic trim begins with a line visually placed or drawn across the widest part of the foot which correlates approximately with the centre of rotation. Any exfoliating horn is removed from the frog, and the heels are trimmed such that the heels of the hoof capsule and the frog are on the same horizontal plane. Excessive toe length is decreased by trimming the hoof wall at the toe from the solar surface of the foot or the outer dorsal wall or both. A line drawn from the initial line across the widest part of the foot to the base of the frog should approximate another line drawn from the widest part of the foot to the perimeter of the hoof wall

FIGURE 13 (a) Straight bar shoe with a thick leather pad. (b) Open heel shoe with a stabiliser plate and impression material. The pad and the stabiliser plate will redistribute the load across the solar surface of the foot.

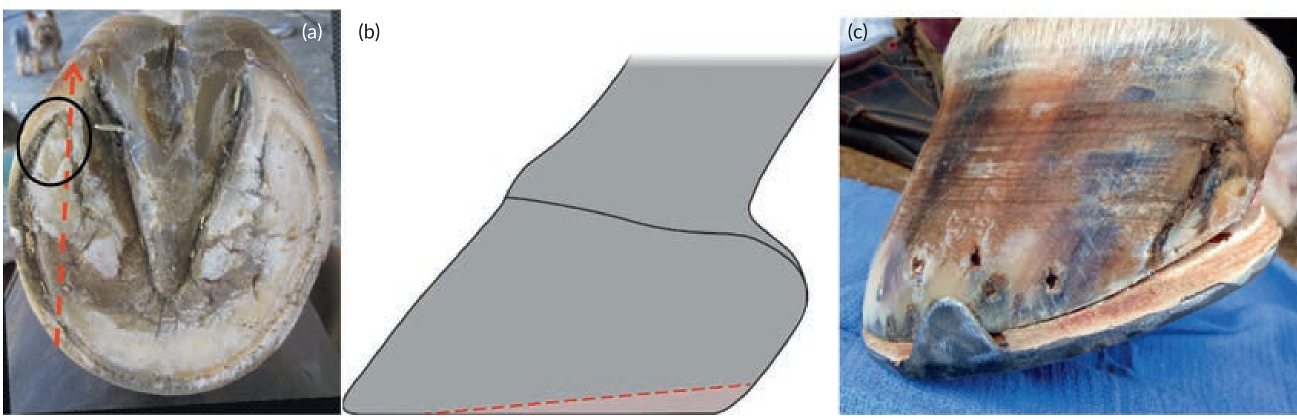

FIGURE 14 (a) Second trim—used to create a triangular space under the side of the foot with a sheared heel…circle notes the amount of removable horn at the angle of the sole used to determine the amount that can be trimmed…dotted line shows area to be trimmed. (b) Pattern and direction of tapered trim. (c) Space created between the foot and shoe.

at the toe. This constitutes the basic fundamental trim to which the appropriate size shoe can be applied. The initial line drawn across the middle of the foot will be located in the centre of the shoe (O'Grady, 2010) (Figure 12a).

Traditionally, when initially managing a sheared heel, some form of bar shoe has been used (Figure 13a). Bar shoes effectively increase the surface area of the foot, provide stability and allow the palmar section of the foot to be unloaded; however, they decrease the independent vertical movement at the bulbs of the heels. An alternative method is a wide web steel or aluminium open heel shoe with a stabiliser (spider) plate or a thick leather pad; this combination will stabilise the foot and redistribute the weight bearing across the entire solar surface of the foot with less rigid effect on the independent movement of the heels (O'Grady, 2020, 2024; Pleasant et al., 2012) (Figure 13b).

If the medial-to-lateral orientation (medial lateral balance) of the distal phalanx is displaced or 'tilted' towards the side with the sheared heel, the foot should also be trimmed in an attempt to realign the solar margin of the distal phalanx parallel to the ground. The amount of correction that is possible at any given trim is usually limited and dictated by the amount of sole depth available under the bone on affected side. It is acknowledged that complete correction of medial to lateral imbalances is rarely possible through trimming (O'Grady, 2024; Pleasant et al., 2012). The position of the distal phalanx within the hoof capsule can be further improved biomechanically by shifting the centre of pressure (CoP) towards the contralateral side of the foot which will further unload the affected side of the foot (Figure 12b). The fit of the shoe can be effectively used to shift the CoP (Figure 12c). Whatever shoe is selected is fitted to the trimmed foot such that, on the affected side of the foot, the shoe is tight against the wall and on the contralateral side of the foot, the shoe is fit full forming a ± 6 mm extension. This appears to effectively move the centre of pressure away from the overloaded side of the foot (O'Grady, 2024; Pleasant et al., 2012). It is critical that uneven growth/sole depth due to the overload is not ignored for successful long-term management.

BIOMECHANICS IN THE FRONTAL PLANE

A brief look at the biomechanics in the frontal plane of the foot may be helpful, as the emphasis has always been placed on the biomechanics in the sagittal plane (Colborne et al., 2016; Wilson et al., 1998). In the frontal plane of the foot, the distribution of forces is generally symmetrical about the mid-sagittal plane, though it is likely that the medial side may bear slightly more load due to foot conformation and landing pattern. For a horse standing at rest, the CoP is approximately in the centre of the foot. The CoP is the point at which the ground reaction force acts on the foot. Any shift in the centre of pressure alters load distribution within the structures of the foot, and this may be caused by disease, asymmetrical overload and farriery.

Manipulation of the CoP in the frontal plane is a useful farriery technique to redistribute the load within the foot with stress on injured or overloaded structures. To better understand this, it is necessary to know which structure(s) is under stress. The solar soft tissues, distal phalanx and the distal interphalangeal joint are stressed under compression, whereas the lamellae and the collateral ligaments are stressed under tension. To reduce the stress on structures under compression, the structures need to be moved further apart, while those structures under tension need to be shortened. For example, to reduce strain on a collateral ligament, the farrier would shift the CoP towards the injured side of the foot; to reduce compression on the solar tissue and distal phalanx, the CoP is shifted away from the overloaded side of the foot.

There are numerous ways using therapeutic farriery to manipulate the CoP: a wedge, wider web on one branch of the shoe or an extension on one side of the shoe will all cause the centre of pressure to move towards the side to which they are applied (Wilson et al., 1998) (AH Parks, Personal Communication 2024). Moving CoP is likely dependent on surface, that is, a firm surface vs. a deformable surface. Based on what has been discussed previously, it would appear reasonable that a horse with a sheared heel distortion, where one side is under compression, would benefit from moving the CoP towards the opposite side of the foot. Farriery techniques to move the CoP may fail for assorted reasons, such as the overload is too severe for it to be effective, the modification was not sufficient to work, the modification was excessive where it may harm other structures or the wrong technique was used. The rationale for moving the centre of pressure is further supported by observations from a large number of quarter crack cases managed in the first author's practice.

FARRIERY - PART 2

Before applying the selected shoe, the second trim is performed under the proximally displaced heel/heel quarter, which extends from 0 mm at the ipsilateral toe (e.g. medial toe for medial sheared heel) to an average of 7 mm at the affected heel. The amount of heel which can be removed in the second trim depends on the sole depth (amount of exfoliating horn) at the seat of the corn and on the severity of the proximal displacement of the coronary band at the sheared heel (Figure 14a,b). The amount of horn taken off the heel with this second trim ideally approximates the difference in length/height between the two heels. Trimming the hoof wall at the quarter/heel in this manner will create a space between the shoe and the hoof wall on the displaced side of the hoof. The space created allows the displaced heel to continually settle, due to the weight of the horse, into a more acceptable conformation (O'Grady, 2012; O'Grady & Castelijns, 2011; Pleasant et al., 2012) (Figure 14c).

These same trimming principles can be applied if the horse can remain barefoot and the horse is out of work and able to rest. If the horse has to remain in work, these principles may need to be combined with external stabilisation of the quarter crack with one of the various patching techniques. Committed follow-up using these farriery principles, paired with radiographic guidance, is essential to eliminate the risk of reoccurrence.

CONCLUSION

Sheared heels represent a significant hoof capsule distortion that predisposes horses to the development of full-thickness quarter cracks, primarily through chronic disproportionate loading and altered biomechanics of the hoof. Effective management requires more than just repairing or 'patching' the defect. Treatment requires correct identification and correction of the underlying hoof capsule distortion using specific radiographic-guided trimming to restore alignment of the distal phalanx in relation to the ground and farriery techniques to redistribute load away from the affected heel onto the remaining structures on the solar surface of the foot. A thorough understanding of hoof anatomy, biomechanics and farriery principles is essential to prevent recurrence and maintain soundness.

AUTHOR CONTRIBUTIONS

S. E. O'Grady: Conceptualization; writing – original draft; validation; visualization; writing – review and editing; investigation; methodology. **T. D. Burns:** Investigation; writing – original draft; writing – review and editing; methodology; validation.

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CONFLICT OF INTEREST STATEMENT

No conflicts of interest have been declared.

ETHICS STATEMENT

This manuscript was prepared using a literature search and client owned horses treated according to the highest standard (best practice) of veterinary care.

ORCID

S. E. O'Grady https://orcid.org/0000-0001-6243-7724

REFERENCES

Bertram, J.E.A. & Gosline, J.M. (1986) Fracture toughness design in horse hoof keratin. *Journal of Experimental Biology*, 125, 29–47.

Castelijns, H.H. (2006) Pathogenesis and treatment of spontaneous quarter cracks quantifying vertical movement of the hoof at the heels. *Pferdeheilkunde*, 2, 569–576.

Colborne, G.R., Routh, J.E., Weir, K.R., McKendry, J.E. & Busschers, E. (2016) Association between hoof shape and the position of the frontal plane ground reaction force vector in walking horses. *New Zealand Veterinary Journal*, 64(2), 76–81.

Davies, H.M.S. & Philip, C. (2007) Anatomy and physiology of the equine digit. In: Floyd, A.E. & Mansmann, R.A. (Eds.) *Equine podiatry*. Philadelphia: Saunders Elsevier, pp. 1–24.

Kapasi, M.A. & Gosline, J.M. (1997) Design complexity and fracture control in the equine hoof wall. *Journal of Experimental Biology*, 200, 1639–1659.

Morrison, S.E. (2013) The Thoroughbred racehorse foot: evaluation and management of common problems. *Proceedings of the Annual Convention of the American Association of Equine Practitioners*, 59, 443–451.

Moyer, W. (1980) Corrective shoeing. *Veterinary Clinics of North America: Large Animal Practice*, 2(1), 19–23.

Moyer, W. (1999) Hoof wall cracks. In: Colahan, J., Mayhew, I.G., Merritt, A.M. & Moore, J.N. (Eds.) *Equine medicine and surgery*, 5th edition. St. Louis: Mosby, pp. 1509–1510.

Moyer, W. & Anderson, J.P. (1975) Sheared heels: diagnosis and treatment. *Journal of the American Veterinary Medical Association*, 166, 53–55.

O'Grady, S.E. (2001) Quarter crack repair: an overview. *Equine Veterinary Education*, 13, 280–282.

O'Grady, S.E. (2003) Shoeing management of sheared heels. In: Robinson, N.E. (Ed.) *Current therapy in equine medicine*, 5th edition. Philadelphia: W.B. Saunders, pp. 528–532.

O'Grady, S.E. (2010) How to manage a quarter crack. *Proceeding of the American Assosiation of Equine Practioners*, 56, 141–148.

O'Grady, S.E. (2012) Farriery for the hoof with a sheared heel. *Veterinary Clinics of North America: Equine Practice*, 28(2), 381–392.

O'Grady, S.E. (2016) Various aspects of barefoot methodology relevant to equine veterinary practice. *Equine Veterinary Education*, 28(6), 321–326.

O'Grady, S.E. (2020) Foot care and farriery – basic foot care. In: Baxter, G.M. (Ed.) *Adams and Stashak's lameness in horses*, 7th edition. West Sussex: Wiley-Blackwell, pp. 1091–1112.

O'Grady, S.E. (2024) How to manage Hoof Wall defects. *Proceedings of the American Association of Equine Practitioners*, 70, 449–457.

O'Grady, S.E. & Castelijns, H.H. (2011) Sheared heels and the correlation to spontaneous quarter cracks. *Equine Veterinary Education*, 23, 262–269.

O'Grady, S.E. & Clayton, H.M. (2023) Barefoot methodology as a viable farriery option. *Equine Veterinary Education*, 36, 423–430.

Parks, A.H. (2003) Form and function of the equine digit. *Veterinary Clinics of North America. Equine Practice*, 19(2), 285–296.

Parks, A.H. (2011) The foot and shoeing – foot balance, conformation, and lameness. In: Ross, M.W. & Dyson, S.J. (Eds.) *Diagnosis and management of lameness in the horse*, 2nd edition. St. Louis: Elsevier Saunders, pp. 282–293.

Pleasant, R.S., O'Grady, S.E. & McKinlay, I. (2012) Farriery for Hoof Wall defects: quarter cracks and toe cracks. *Veterinary Clinics of North America. Equine Practice*, 28(2), 393–407.

Reilly, J.D., Cottrell, D.F., Martin, R.J. & Cuddeford, D. (1996) Tubule density in the equine horn. *Biomimetics*, 4, 23–35.

Wilson, A.M., Seelig, T.J., Shield, R.A. & Silverman, B.W. (1998) The effect of foot imbalance on point of force application in the horse. *Equine Veterinary Journal*, 30, 540–545.

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Equine Veterinary Education BEVA

REVIEW ARTICLE

Analgesic effects of alpha-2-adrenoreceptor agonists in equine medicine: systemic, spinal, and local applications

J. Brandly[1] | J. R. Page[2] | J. A. E. Hubbell[3] | W. W. Muir III[4] | K. Hopster[1]

[1]School of Veterinary Medicine, University of Pennsylvania, Philadelphia, Pennsylvania, USA
[2]University Libraries, Ohio State University, Columbus, Ohio, USA
[3]Rood and Riddle Equine Hospital, Lexington, Kentucky, USA
[4]Lincoln Memorial University, Harrogate, Tennessee, USA

Correspondence: J. A. E. Hubbell
Email: johnaehubbell@gmail.com

Summary

Alpha-2-adrenoreceptor agonists provide analgesia when used as sole agents but can also be used in combination with other drugs for their additive and potentially synergistic effects. Further, because of their effects on blood flow, alpha-2-adrenoreceptor agonists act to extend and perhaps intensify the effects of drugs, such as local anaesthetics, administered perineurally or epidurally. This paper will explore what is known about the analgesic effects of alpha-2-adrenoreceptor agonists administered in combination with other drugs systemically, spinally and perineurally.

KEYWORDS
horse, detomidine, pain, romifidine, xylazine

INTRODUCTION

A difficulty in the assessment of the analgesic effects of α_2-adrenoreceptor agonists is distinguishing analgesia from sedation, as previously noted. Further, the effects of sedative-hypnotic drugs on pain perception are complex and variable (Frölich et al., 2013). In anaesthetised patients, including horses, the analgesia provided by a given compound can be assessed by determining if the administration of that compound reduces the amount of an inhalant anaesthetic required to maintain a previously determined anaesthetic plane. Such studies have been called minimum alveolar concentration (MAC) reduction studies or inhalant sparing studies. Reported studies suggest differences among α_2-agonists on anaesthetic sparing effects in horses. Xylazine (0.5 mg/kg bwt, IV and 1 mg/kg bwt, IV) reduced the anaesthetic requirement for isoflurane in anaesthetised horses (Pöppel et al., 2015; Steffey et al., 2000). In a later study, the isoflurane-sparing effect of xylazine was not enhanced by the coadministration of morphine (0.1 and 0.2 mg/kg bwt IV) (Bennett et al., 2004). Detomidine infusion reduced the isoflurane requirement by over 40% in another study (Steffey & Pascoe, 2002), while dexmedetomidine infusion reduced the anaesthetic requirement for sevoflurane in ponies by approximately 50% (Gozalo-Marcilla et al., 2013) and improved the minimal sparing effect of an infusion of morphine in a similar study by the same group (Gozalo-Marcilla et al., 2014). Another study confirmed the isoflurane-sparing effect of dexmedetomidine but noted that the cardiovascular depression at equivalent depths of anaesthesia was greater in the horses receiving dexmedetomidine (Risberg et al., 2016). Medetomidine infusion in a study utilising seven ponies reduced a previously published desflurane requirement by approximately 25% (Bettschart-Wolfensberger et al., 2001). Administration of medetomidine in combination with propofol by infusion reduced the isoflurane requirement by approximately 65% in a crossover study in six horses (Villalba et al., 2014). Interestingly, a constant rate of infusion of romifidine (40 μg/kg/h) did not produce an isoflurane-sparing effect in a randomised clinical study of 30 horses, indicating that the antinociceptive potency of romifidine may require further investigation (Devisscher et al., 2010). These and other studies have led to the inclusion of xylazine and other α_2-agonist infusions in anaesthetic care plans for horses in order to provide multimodal analgesia and reduce the inhalant anaesthetic requirement (Reed et al., 2025).

Objectives

The objective of this scoping review is to identify, map and synthesise the existing evidence regarding the analgesic effects of alpha-2-adrenoreceptor agonists in horses when used:

1. As sole agents.
2. In combination with other systemic analgesic drugs (e.g., opioids, NSAIDs and ketamine).
3. When administered via local, perineural, epidural or spinal routes.

More specifically, this review aims to:

- Characterise the types of analgesic outcomes (objective, semi-objective and pain scoring) reported in equine studies utilising alpha-2-adrenoreceptor agonists.
- Summarise dose ranges, routes of administration and combinations used for analgesia in horses.
- Describe the extent, nature and heterogeneity of the available scientific literature on alpha-2-agonist–mediated analgesia.
- Identify gaps in knowledge to inform future research directions and improve multimodal analgesic strategies in equine practice.

METHODS

A modified scoping review was conducted following the PRISMA extension for scoping reviews (PRISMA-ScR): checklist and explanation (Tricco et al., 2018). Search terms were developed based on the PICO framework: The Population was defined as equine patients across all geographical regions. The Intervention was the administration of alpha-2-adrenoreceptor agonists administered alone, or (as Comparators) in combination with other drugs, including but not limited to opioids and NSAIDs. The outcome of interest was the analgesic effects of these drugs. These key elements guided the development of precise search terms to capture literature relevant to the study.

Eligibility criteria

Eligibility criteria were developed using the PICO framework and tailored to the purpose of a scoping review.

Inclusion criteria

Studies were eligible if they met the following criteria:

- Population:
  - Equine species of any age, breed, sex or geographic region.
- Intervention/Exposure:
  - Administration of alpha-2-adrenoreceptor agonists (xylazine, detomidine, romifidine, medetomidine, dexmedetomidine, clonidine or analogues)
  - Alone or in combination with other analgesic or sedative drugs (e.g., opioids, NSAIDs, ketamine and local anaesthetics).
  - Any route of administration, including systemic (IV, IM and CRI), local, perineural, epidural or spinal.
- Outcomes:
  - Reported analgesic effects, assessed via:
    - Objective nociceptive testing (mechanical, thermal and electrical),
    - Semi-objective or composite pain scoring systems or
    - Clinical analgesia descriptions when linked to physiological outcomes.
- Study type:
  - Original research, experimental studies, randomised trials, observational studies and clinical trials.
- Publication type:
  - Peer-reviewed journal articles.

Exclusion criteria

Studies were excluded if they:

- Did not involve horses.
- Evaluated alpha-2-agonists solely for sedation or anaesthetic depth, without any analgesic outcome measure.
- Were reviews, editorials, commentaries, book chapters, conference abstracts or theses without available full text.
- Focused exclusively on pharmacokinetic/pharmacodynamic data without analgesia-related outcomes.
- Involved combination protocols where the independent analgesic effect of the alpha-2 agonist could not be evaluated.

Information sources, searches and citation management

Three research databases were searched for original research related to the research question: CAB Abstracts and Global Health (access via Web of Science), Medline (access via Web of Science) and Agricola (access via EBSCOhost). A comprehensive search strategy was developed to identify the relevant scientific literature with regard to the analgesic effects of α_2-agonists administered alone or in combination with other drugs. Search terms included variations on the key concepts of horses, alpha-2 agonists and selected combination drugs (Data S1: Search strategy). Searches were validated by a second team member before being finalised. After running the searches in each database, the search results were documented and citation information was imported to Covidence for deduplication (Covidence Systematic Review Software, 2025).

Screening

Both title and abstract screening and full-text review were conducted in Covidence. One reviewer was required for both the screening and full-text review stages. Included studies were exported to a Google Sheets spreadsheet for data extraction.

Critical appraisal

Due to the scoping nature of the review and the heterogeneity of the study types involved, critical appraisal of the methodologies and risk of bias assessment of the studies was not performed.

Data extraction and synthesis of results

Data extraction

Data from all included full-text articles were extracted into a standardised spreadsheet developed for this review. One reviewer performed data extraction. The following variables were collected:

- Study characteristics: author, year, country, study design and sample size.
- Population details: horse breed, age, health status and number of animals.
- Intervention characteristics:
  - Alpha-2 agonist used (e.g., xylazine, detomidine, romifidine, medetomidine, dexmedetomidine and clonidine).
  - Dosage, route of administration, duration and use of constant rate infusions.
  - Co-administered drugs (opioids, NSAIDs, ketamine, local anaesthetics and adjuncts).
- Comparator(s): placebo, other analgesics, different doses or combinations or no comparator.
- Outcome measures:
  - Objective nociceptive testing (mechanical thresholds, thermal thresholds and electrical stimulation).
  - Semi-objective or composite pain scores.
  - Behavioural indicators associated with analgesia or chemical restraint.
  - Physiological variables, when directly linked to analgesic assessment.
- Key findings: direction and magnitude of analgesic effect, duration, side effects or adverse outcomes.
- Other extracted information:
  - Methodological notes.
  - Identified limitations.
  - Route-specific observations (e.g., epidural vs systemic).

  Extracted data were cross-checked within the spreadsheet for internal consistency. Because of the scoping nature of the review, risk of bias assessment was not performed, consistent with PRISMA-ScR guidelines.

Synthesis of results

Results were synthesised descriptively due to the heterogeneity in study aims, drug combinations, dosing regimens and outcome measures. Studies were grouped according to:

1. Objective nociceptive testing
2. Semi-objective pain assessment
3. Route of administration (systemic, spinal/epidural, local/perineural)
4. Drug combinations (alpha-2 agonist alone vs combinations with opioids, NSAIDs, ketamine or local anaesthetics).

Within each category, findings were mapped rather than pooled, highlighting:

- The range of doses used for each alpha-2 agonist.
- Evidence for analgesic effects when used alone.
- Evidence for additive or synergistic effects when combined with other agents.
- Reported differences in onset time, duration and magnitude of analgesia.
- Adverse events or clinically relevant side effects.
- Gaps in the evidence base (e.g., limited objective data for certain drug combinations).

Quantitative synthesis (meta-analysis) was not attempted due to variability in study designs and measurement methods. Instead, a narrative summary is provided to characterise the breadth and depth of available evidence related to alpha-2-adrenoreceptor agonist–mediated analgesia in horses.

RESULTS

The initial search identified 2122 manuscripts (Figure S1: PRISMA flowchart). Title and abstract screening was used to identify 93 of these studies that attempted to include a pain scoring system or semi-objective or objective pain scoring system. The full text of these studies was reviewed by one of the authors. This review identified 37 reports that used an objective method (mechanical, thermal or electrical stimulation) and an additional 32 manuscripts utilising semi-objective methods to create dose ranges for α_2-agonists alone or in combination (Table 1).

DISCUSSION

Clinical use of alpha-2-adrenoreceptor agonist drug combinations

Clinical descriptions of the use of α_2-agonists in combination with other analgesic drugs for standing chemical restraint probably date from the early 1970s, with a preliminary report on the use of xylazine and morphine in horses (Klein & Baetjer, 1974). This was followed by a report on the haemodynamic and respiratory effects of the combination that noted the synergism of the drug's individual effects (Muir et al., 1979). The haemodynamic and respiratory effects of the combination of xylazine and acepromazine were also reported

TABLE 1 Alpha −2 agonist analgesic mechanisms.

Suppression of spinal and supraspinal pain transmission
• Inhibition of spinal cord nociceptive neurons
  ○ Decrease neuronal excitability
  ○ Decease neuronal activation

Activation of α2-heteroreceptors on the presynaptic cell decreases Ca2+ entry into cells, thereby decreasing excitatory neurotransmitter release (e.g., glutamate and substance P)
Activation of α2-heteroreceptors on the postsynaptic cell increases K+ efflux, resulting in dorsal horn neuron hyperpolarisation
Inhibition of adenylyl cyclase (AV) thereby reducing neuronal and behavioural sensitisation
Downregulation of dorsal horse and sensory neuron pain receptors (e.g., purinergic, neurotrophic and vanilloid)
Activation of cholinergic interneurons that inhibit (i.e., gamma-aminobutyric acid [GABA]) pain neurotransmitter release
Anti-inflammatory and neuroprotective effects
Descending adrenergic nerve fibre sprouting and enhances alpha-2 agonist–mediated analgesia in chronic pain conditions
Synergism: activation of different sites on the adrenergic receptor, thereby enhancing drug effect and lowering individual drug dose (e.g. alpha-2 ag + opioids)
Vasoconstriction: Alpha-2 vasoconstrictive effects markedly prolong the effects of local, regional and epidural local anaesthetic effects.

Note: Alpha-2 mediated sedation suppresses pain perception by inhibiting presynaptic norepinephrine release and reducing α1 postsynaptic receptors' activation that leads to arousal and the stress response. It has been shown that the alpha-1 agonistic activity can reduce the alpha-2 mediated analgesia, and it has been suggested that coadministration of an alpha-1 antagonist (prazosin) or potentially acepromazine with the alpha-2 agonist may enhance analgesic potency.

in 1979, with the suggestion that the combination had a more pronounced calming effect and analgesia than acepromazine alone (Muir et al., 1979). Xylazine and butorphanol in combination were introduced in 1983 with a report on a new analgesic drug combination which stated that the combination produced a synergistic analgesic effect and good chemical restraint (Robertson & Muir, 1983). Butorphanol was initially marketed as an analgesic without the risk of addiction, thus its use was not tightly controlled. A study using dental dolorimetry compared xylazine alone and in combination with morphine, butorphanol and nalbuphine, noting that xylazine alone, xylazine in combination with the narcotics and the combination of xylazine and butorphanol were superior to butorphanol alone but additive effects were not found (Brunson & Majors, 1987). However, compared to other commonly used alpha-2-adrenoreceptor agonists, xylazine has demonstrated a relatively lesser impact on objective lameness measurements (Moorman et al., 2019).

Detomidine was introduced to the equine market in 1986 (Short et al., 1986) and has been examined in combination with many drugs including opiates and benzodiazepines. Clarke investigated the intravenous administration of meperidine, morphine, methadone and butorphanol after IV sedation with detomidine and determined that the opiates increased the apparent sedation and decreased the response to external stimuli while producing ataxia and muscle tremors. Generalised excitement was occasionally seen after meperidine while butorphanol produced the most useful result (Clarke & Paton, 1988). Detomidine in combination with butorphanol has been further examined and compared to methadone, levomethadone and buprenorphine with mixed results. Schatzmann et al. (2001) found that the addition of an opiate extended the duration of detomidine sedation and increased the nociceptive threshold with no differences between butorphanol and levomethadone. Kruluc & Nemec (2006) found that the addition of butorphanol was safer and more appropriate for painless and non-painless procedures in standing horses. In a randomised, blinded, clinical trial, Rigotti et al. (2014) found both butorphanol and buprenorphine suitable for premedication prior to castration, but that buprenorphine provided better intraoperative analgesia. In another study, the coadministration of butorphanol or methadone reduced the required dose of detomidine for standing sedation (Júnior et al., 2025). Others have suggested that increasing the dose of IV butorphanol above 20 μg/kg did not improve sedation but was associated with increased ataxia (de Grauw & van Loon, 2020). Compared to the combination of methadone and acepromazine, detomidine and methadone resulted in better sedation, greater increases in nociceptive thresholds and a higher mean arterial pressure under dissociative anaesthesia (Carregaro et al., 2020; Gozalo-Marcilla et al., 2017; Lopes et al., 2016). Although the addition of buprenorphine to detomidine results in more profound and longer sedation compared to morphine and butorphanol, more post-sedation complications including central nervous system excitement and box walking have been observed (Haunhorst et al., 2022; Potter et al., 2016; Taylor et al., 2014).

The use of romifidine in combination with butorphanol (Browning & Collins, 1994; Marly et al., 2014; Ringer et al., 2012), morphine (Corletto et al., 2005), tramadol (Costa et al., 2015), levomethadone (Studer et al., 2021), methadone (Nannarone et al., 2021), midazolam and ketamine (Müller et al., 2017) has been reported in the horse. The addition of butorphanol to romifidine has produced mixed results, with some suggesting additive effects (Marly et al., 2014) and others suggesting prolongation but not enhancement of the chemical restraint (Ringer et al., 2012). Enhanced analgesia is observed when romifidine is used with tramadol compared to the use of romifidine alone; however, slow controlled administration is recommended to reduce potential excitatory effects associated with tramadol (Costa et al., 2015). Romifidine alone produced insufficient sedation for cheek tooth removal, leading to increased stress levels, while the addition of butorphanol inhibited the stress response, and further improvement was achieved with small doses of midazolam and ketamine (Müller et al., 2017). Compared to detomidine and morphine, however, romifidine and morphine provided a less stable plane of sedation for standing MRI (Vullo et al., 2024).

Combinations incorporating either medetomidine or dexmedetomidine for clinical use have also been described. Dexmedetomidine in combination with butorphanol achieved comparable sedation to that of xylazine and butorphanol, with both providing sufficient sedation for the performance of standing ovariectomy in donkeys with good results (Dzikiti et al., 2024). In horses receiving a dexmedetomidine constant rate infusion, the addition of butorphanol resulted in greater sedation; however, overall there were no differences in responses to stimuli (Medeiros et al., 2017). Of note, large individual variability in plasma concentrations and level of sedation has been observed with dexmedetomidine infusions (Risberg et al., 2014). Medetomidine in combination with morphine, both given as constant rate infusions, produced reliable sedation and stable cardiorespiratory function in standing horses undergoing abdominal laparoscopy (Solano et al., 2009). Medetomidine in combination with infusions of morphine, ketamine or ketamine and morphine has been investigated in standing horses. At the doses used, the addition of ketamine, morphine or ketamine-morphine did not provide additional sedation and antinociceptive effects; however, clinically acceptable cardiopulmonary variables were maintained (Troya-Portillo et al., 2021).

Mechanisms, clinical applications, efficacy and safety of alpha-2-adrenoreceptor agonists when administered locally, epidurally and via the spinal route

Alpha-2-adrenoreceptor agonists are a cornerstone of equine anaesthesia due to their potent sedative, analgesic and sympatholytic properties. Their versatility across local, epidural and spinal routes enables tailored analgesic strategies that improve perioperative management in horses while minimising systemic side effects (Rønnow Kjærulff & Lindegaard, 2022a) (Table 2).

The mechanism of action of alpha-2-adrenoreceptor agonists involves presynaptic and postsynaptic receptors distributed throughout the central nervous system, with high densities in the dorsal horn of the spinal cord, where they inhibit nociceptive transmission. This effect is mediated through inhibition of substance P and other neurotransmitters, hyperpolarisation of dorsal horn neurons and decreased calcium influx, leading to reduced neuronal excitability (Bahari & Meftahi, 2019). These processes result in segmental analgesia with relative preservation of motor function, making alpha-2-adrenoreceptor agonists ideal for regional analgesia in horses.

Epidural administration provides reliable analgesia for hindquarter surgeries and postoperative pain control, with minimal systemic absorption and fewer cardiovascular effects compared to systemic routes (Leblanc & Eberhart, 1990; Sysel et al., 1996). Clinical studies have demonstrated a rapid onset and prolonged duration of sensory blockade, preservation of motor function when appropriately dosed and a reduction in stress responses during surgery and recovery (Fischer et al., 2009; Goodrich et al., 2002). Spinal (intrathecal) administration delivers agents directly into cerebrospinal fluid, resulting in high local drug concentrations at receptor sites and a faster

TABLE 2 Conventional alpha-2 agonist and adjunct analgesic drug doses.

Drug	IM, mg/kg bwt	IV, mg/kg bwt	CRI, µg/kg/h*	Epidural, mg/kg bwt	Other PNB
Xylazine	1.0–2.0	0.3–1.0	0.4–0.6 mg/kg/h	0.15–0.4	
Detomidine	0.1–0.2	0.005–0.04	10–20	0.02–0.03	40 µg/kg SL, TR
Romifidine	0.06–0.12	0.03–0.08	20–40	0.05	
Medetomidine	0.005–0.01	0.002–0.01	2–5	0.015	
Dexmedetomidine	0.005–0.01	0.004–0.01	1–5	0.005	0.5–2 µg/kg
Acepromazine	0.01–0.05	0.01–0.04			
Butorphanol	0.1–0.2	0.005–0.05	20–50		
Buprenorphine	0.01–0.03	0.01	4–9		
Morphine	0.1–0.2 0.6	0.05–0.1	20–30	0.2	
Fentanyl		0.005–0.01 (?)			
Hydromorphone	0.04	0.04	50	0.04	
Levorphanol		0.03			
Methadone		0.1–0.2	50		
Nalbuphine		0.75			
Tramadol		1–3			
Flunixin	2.2	1.0			
Lidocaine			0.02–0.05	0.2–0.35	0.2–0.3
Mepivacaine		0.2		0.2–0.3	0.05–0.3
Bupivacaine				0.25	0.25
Ropivacaine				0.1–0.2	
Ketamine		0.1–0.2	0.3–0.6 mg/kg/h	1.0	1.0

Note: Constant rate infusion (*usually preceded by a lower IV loading dose): CRI; peripheral nerve block: PNB; sublingual (SL); transrectal (TR). Meperidine 0.5–1.0 inconsistent/limited analgesic effects.

onset of action (Skarda & Muir, 1994). Both routes take advantage of the dorsal horn's receptor density, producing robust analgesia without the profound motor impairment seen with local anaesthetics alone (Rønnow Kjærulff & Lindegaard, 2022a). Local application of alpha-2-adrenoreceptor agonists exerts direct effects on peripheral nerve endings, providing site-specific analgesia with rapid onset and minimal systemic exposure (Brummett et al., 2011; Chen et al., 2009; Kosugi et al., 2010). This approach is particularly valuable for facilitating minor procedures as an adjunct to local anaesthetics in field settings where rapid recovery is desired.

Alpha-2-adrenoreceptor agonists are frequently combined with opioids, such as morphine, and local anaesthetics like lidocaine or ropivacaine, to enhance analgesic efficacy, reduce drug dosages and extend the duration of analgesia. This multimodal approach minimises the required doses of individual agents and optimises patient comfort, improving postoperative outcomes such as reduced lameness scores and smoother recoveries (Fischer et al., 2009; Goodrich et al., 2002; Sysel et al., 1996).

Clinically available agents such as detomidine, dexmedetomidine, clonidine and romifidine differ in receptor affinity, lipid solubility and pharmacokinetic profiles. Epidural detomidine provides effective analgesia (Fischer et al., 2009; Goodrich et al., 2002; Sysel et al., 1996); however, greater variability in the duration of analgesia and greater cardiopulmonary effects have been observed when compared to xylazine (Leblanc & Eberhart, 1990; Skarda & Muir, 1994). Dexmedetomidine offers greater alpha-2 receptor selectivity, allowing more precise modulation of analgesia (Gil et al., 2009), and when administered epidurally, provides a longer duration of analgesia than bupivacaine alone (Sampaio et al., 2020). Ultimately, drug selection should align with clinical requirements for analgesia duration, onset speed and patient-specific considerations.

When correctly dosed and administered, epidural and spinal alpha-2-adrenoreceptor agonists demonstrate excellent safety profiles. Their slow systemic absorption minimises cardiovascular depression, and the incidence of transient ataxia or recumbency is low (Rønnow Kjærulff & Lindegaard, 2022a). Potential metabolic effects, such as transient hyperglycaemia due to suppression of insulin release, have been observed but are generally not clinically significant. Safe use depends on meticulous attention to dose, volume and administration technique, particularly given the large size and anatomical variability in horses (Rønnow Kjærulff & Lindegaard, 2022b).

The advantages of epidural and spinal routes stem from their ability to concentrate the drug near target receptors while limiting systemic exposure, reducing the risks of bradycardia, hypotension, respiratory depression or excessive sedation that could impair recovery. This allows horses to retain the ability to ambulate while experiencing effective pain relief, a critical consideration for recovery safety and welfare (Fischer et al., 2009; Sysel et al., 1996).

Effective use requires proficiency in anatomical landmark identification and injection technique (Rønnow Kjærulff & Lindegaard, 2022b), with increasing use of imaging modalities such as ultrasound to improve accuracy (Edwards et al., 2025). Close monitoring during and after administration of alpha-2-adrenoreceptor agonists is essential, with heart rate, blood pressure, respiratory rate and behavioural responses providing early warning of adverse effects (Leblanc & Eberhart, 1990).

Cross-species studies, including work in donkeys and other animals such as dogs and rodents, confirm the conserved mechanisms of alpha-2 receptor-mediated analgesia and offer valuable insights for equine practice (Asano et al., 2000; Odette & Smith, 2013; Marzok et al., 2022). Findings suggest that dosing strategies and safety profiles can be adapted from these species with appropriate modifications, supporting clinical decision-making (Rønnow Kjærulff & Lindegaard, 2022a).

Epidural analgesia provided by opioids improves the quality of recovery (Louro et al., 2021), and clinical trials show that epidural alpha-2-adrenoreceptor agonist administration reduces intraoperative anaesthetic requirements and postoperative pain scores (Fischer et al., 2009; Goodrich et al., 2002), which likely contributes to shorter hospitalisation times, improved recovery quality, and greater owner satisfaction. Best practice recommendations include individualised dose titration to account for anatomical and physiological variability, use as part of multimodal analgesic regimens, and careful perioperative monitoring (Rønnow Kjærulff & Lindegaard, 2022a; Sysel et al., 1996).

CONCLUSIONS

In summary, alpha-2-adrenoreceptor agonists, when administered via local, epidural or spinal routes, provide profound analgesia and sedation with a favourable safety profile when used judiciously in horses. Their integration into multimodal analgesia regimens reflects a sophisticated understanding of receptor pharmacology, patient physiology and technical expertise to improve perioperative care and recovery outcomes.

Future directions

Alpha-2-adrenoreceptor agonists are emerging as important agents for managing analgesia in horses, offering promising alternatives to traditional analgesics. Their utility in equine medicine has stimulated significant research interest aimed at refining their application, particularly in relation to receptor-specific agonists, sustained-release formulations and novel approaches to chronic pain management. Current literature provides insight into these avenues, outlining how ongoing research may shape the future landscape of alpha-2-adrenoreceptor agonists in veterinary anaesthetic and pain management protocols.

The differential effects of various alpha-2-adrenoreceptor agonists on pain modulation are increasingly recognised, opening pathways for receptor-specific developments. Clonidine and dexmedetomidine are two commonly studied agents, both known for their analgesic properties due to their action on alpha-2 adrenergic receptors (Schwartz et al., 2022). Research indicates that the selective modulation of these receptors can result in potent antinociceptive outcomes, particularly in chronic pain conditions, as evidenced in both human studies and veterinary applications (Kumar et al., 2014; Roh et al., 2008). For instance, it has been documented that clonidine administration prominently reduces nociceptive responses, a quality that could be harnessed through selective agonist usage tailored to the individual equine patient (Yoon et al., 2015). This avenue of research aligns with findings that receptor subtype specificity—whether targeting alpha-2A or alpha-2C receptors—plays a crucial role in determining the overall effectiveness and safety profile of these agents (Chen et al., 2023; Gil et al., 2009). Investigating the nuances of receptor interaction could enable more effective pain management regimens that reduce adverse effects while maximising analgesic efficacy. Advances in receptor-specific formulations may allow for more refined therapeutic approaches, particularly for managing lameness and other chronic pain conditions prevalent in equine populations.

The exploration of sustained-release formulations represents another innovative direction for the practical application of alpha-2-adrenoreceptor agonists in veterinary medicine. Current studies are assessing how sustained-release delivery systems may extend the duration of analgesic effect post-surgery, thus, optimising recovery outcomes and enhancing comfort for equine patients (Fielding, 2018). For example, recent meta-analyses indicate that combining local anaesthetics with alpha-2-adrenoreceptor agonists like dexmedetomidine significantly prolongs the duration of analgesia compared to standalone local anaesthetics (Perritt et al., 2017), an effect also demonstrated in horses (Nichols et al., 2022). Additionally, the possibility of utilising transdermal or injectable prolonged-release formulations presents a practical solution to manage pain in equines experiencing chronic pain syndromes or recovering from surgical interventions (Kivistö et al., 1994; Ulagenthiran et al., 2024). Such innovations could drastically improve the quality of life for horses suffering from chronic lameness issues, as they would provide a more stable and prolonged analgesic effect, reducing the need for frequent dosing and potentially decreasing the incidence of related side effects. The advancement and adoption of these formulations in clinical settings could mark a considerable shift in the management of equine pain. Additional directions include precise medical approaches tailored to individual patient responses and advanced monitoring techniques to allow real-time dose adjustments. This evolving evidence base underscores the central role of alpha-2-adrenoreceptor agonists in modern equine anaesthesia.

Alpha-2-adrenoreceptor agonists have shown potential in addressing chronic pain and lameness in equines. Recent evidence demonstrates that these agents can serve as effective non-opioid alternatives in multimodal analgesia protocols, which are increasingly necessary to avoid the side effects associated with opioid misuse in veterinary settings (Gursoy et al., 2011; Patil & Anitescu, 2012). Ongoing studies are exploring the role of alpha-2-adrenoreceptor agonists in managing conditions like osteoarthritis, emphasising their utility not only for short-term postoperative pain relief but also for long-term chronic pain management (Kumar et al., 2014). The role of alpha-2-adrenoreceptor agonists, particularly agents such as dexmedetomidine, extends beyond simple analgesia; they provide sedative and sympatholytic effects, further stabilising cardiovascular parameters (Channabasappa et al., 2016; Schlereth & Birklein, 2008; Wang et al., 2019). This comprehensive effect is particularly desirable in equine medicine, where anaesthetic challenges often arise from the unique physiological characteristics of horses. Moreover, given that the analgesic effects of alpha-2-adrenoreceptor agonists have been shown to synergise with local anaesthetics and opioids, their integration into current pain management protocols could lead to enhanced outcomes in horses suffering from chronic pain or persistent lameness (Bahari & Meftahi, 2019; Kumar et al., 2014; Li et al., 2020; Stone et al., 1997).

Incorporating peripheral alpha-2-adrenoreceptor antagonists, such as vatinoxan, is another avenue for reducing side effects associated with systemic alpha-2-adrenoreceptor agonist administration. In horses receiving a single bolus of detomidine intravenously, vatinoxan resulted in improved cardiac output and gastrointestinal motility without significant change in sedation (Tapio et al., 2018). Coadministration of detomidine and vatinoxan infusions resulted in significant improvement of some markers of gastrointestinal motility, and although no significant differences in sedation or antinociception were observed, further research is warranted (Obrochta et al., 2025).

Comparative studies examining the effects of alpha-2-adrenoreceptor agonists across different species can provide invaluable insights applicable to equine medicine. For example, research showcasing the use of alpha-2 agonists in small ruminants and their effectiveness in managing pain indicates not only a broader spectrum of action but also highlights the potential for cross-species applications (Shah et al., 2014). Such findings pave the way for comparative research aimed at optimising alpha-2-adrenoreceptor agonists' use in equine patients through insights gained from responses observed in other animals. Comparing the behaviour and physiological responses to alpha-2-adrenoreceptor agonists in horses versus other animal models can enhance our understanding of their specific applications and dosages necessary for effective analgesia. The exploration of receptor subtypes and their functional relevance across different species, particularly in the context of pain modulation, can also inform veterinarians about the potential efficacy and safety profiles of these drugs in treating equine pain conditions.

In conclusion, the future directions for the use of alpha-2-adrenoreceptor agonists in equine analgesia appear promising, driven by ongoing research and technological advancements in pharmacology. The understanding of receptor-specific effects, the development of sustained-release formulations, the exploration of their role in managing lameness and chronic pain, and comparative studies all indicate a robust future for these agents in veterinary medicine. Such advancements could pave the way for not only improved analgesic strategies in horses but also a deeper understanding of pain mechanisms that could benefit diverse clinical settings.

AUTHOR CONTRIBUTIONS

J. Brandly: Conceptualization; methodology; data curation; writing – original draft; writing – review and editing; resources. **J. R. Page:** Conceptualization; methodology; writing – review and editing; data curation; resources. **J. A. E. Hubbell:** Conceptualization; methodology; data curation; writing – original draft; writing – review and editing; resources. **W. W. Muir III:** Conceptualization; methodology; data curation; writing – original draft; writing – review and editing; resources. **K. Hopster:** Conceptualization; methodology; data curation; formal analysis; resources; writing – original draft; writing – review and editing.

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ORCID

J. R. Page https://orcid.org/0000-0001-7686-8015
J. A. E. Hubbell https://orcid.org/0000-0002-5442-5165

REFERENCES

Asano, T., Dohi, S., Ohta, S., Shimonaka, H. & Iida, H. (2000) Antinociception by epidural and systemic α2-Adrenoceptor agonists and their binding affinity in rat spinal cord and brain. *Anesthesia and Analgesia*, 90(2), 400–407. Available from: https://doi.org/10.1097/00000539-200002000-00030

Bahari, Z. & Meftahi, G.H. (2019) Spinal α_2 -adrenoceptors and neuropathic pain modulation; therapeutic target. *British Journal of Pharmacology*, 176(14), 2366–2381. Available from: https://doi.org/10.1111/bph.14580

Bennett, R.C., Kollias-Baker, C., Steffey, E.P. & Sams, R. (2004) Influence of morphine sulfate on the halothane sparing effect of xylazine hydrochloride in horses. *American Journal of Veterinary Research*, 65(4), 519–526. Available from: https://doi.org/10.2460/ajvr.2004.65.519

Bettschart-Wolfensberger, R., Jaggin-Sdimucker, N., Lendl, C., Bettschart, R.W. & Clarke, K.W. (2001) Minimal alveolar concentration of desflurane in combination with an infusion of medetomidine for the anaesthesia of ponies. *Veterinary Record*, 148(9), 264–267. Available from: https://doi.org/10.1136/vr.148.9.264

Browning, A. & Collins, J. (1994) Sedation of horses with romifidine and butorphanol. *Veterinary Record*, 134(4), 90–91. Available from: https://doi.org/10.1136/vr.134.4.90

Brummett, C.M., Hong, E.K., Janda, A.M., Amodeo, F.S. & Lydic, R. (2011) Perineural dexmedetomidine added to ropivacaine for sciatic nerve block in rats prolongs the duration of analgesia by blocking the hyperpolarization-activated cation current. *Anesthesiology*, 115(4), 836–843. Available from: https://doi.org/10.1097/ALN.0b013e318221fcc9

Brunson, D.B. & Majors, L.J. (1987) Comparative analgesia of xylazine, xylazine/morphine, xylazine/butorphanol, and xylazine/nalbuphine in the horse, using dental dolorimetry. *American Journal of Veterinary Research*, 48(7), 1087–1091.

Carregaro, A.B., Ueda, G.I., Censoni, J.B., Bisetto, S.P., Alonso, B.B. & Reginato, G.M. (2020) Effect of methadone combined with Acepromazine or Detomidine on sedation and dissociative anesthesia in healthy horses. *Journal of Equine Veterinary Science*, 86, 102908. Available from: https://doi.org/10.1016/j.jevs.2019.102908

Channabasappa, S., Venkatarao, G., Girish, S. & Lahoti, N. (2016) Comparative evaluation of dexmedetomidine and clonidine with low dose ropivacaine in cervical epidural anesthesia for modified radical mastectomy: a prospective randomized, double-blind study. *Anesthesia, Essays and Researches*, 10(1), 77–81. Available from: https://doi.org/10.4103/0259-1162.167844

Chen, B., Peng, H. & Wu, S.N. (2009) Dexmedetomidine, an α2-adrenergic agonist, inhibits neuronal delayed-rectifier potassium current and sodium current. *British Journal of Anaesthesia*, 103(2), 244–254. Available from: https://doi.org/10.1093/bja/aep107

Chen, Z., Liu, Z., Feng, C., Jin, Y. & Zhao, X. (2023) Dexmedetomidine as an adjuvant in peripheral nerve block. *Drug Design, Development and Therapy*, 17, 1463–1484. Available from: https://doi.org/10.2147/DDDT.S405294

Clarke, K.W. & Paton, B.S. (1988) Combined use of detomidine with opiates in the horse. *Equine Veterinary Journal*, 20(5), 331–334. Available from: https://doi.org/10.1111/j.2042-3306.1988.tb01540.x

Corletto, F., Raisis, A.A. & Brearley, J.C. (2005) Comparison of morphine and butorphanol as pre-anaesthetic agents in combination with romifidine for field castration in ponies. *Veterinary Anaesthesia and Analgesia*, 32(1), 16–22. Available from: https://doi.org/10.1111/j.1467-2995.2004.00184.x

Costa, G.L., Cristarella, S., Quartuccio, M. & Interlandi, C. (2015) Antinociceptive and sedative effects of romifidine, tramadol and their combination administered intravenously slowly in ponies. *Veterinary Anaesthesia and Analgesia*, 42(2), 220–225. Available from: https://doi.org/10.1111/vaa.12210

Covidence Systematic Review Software. (2025) Veritas Health Innovation, Melbourne, Australia. Available from: https://www.covidence.org/

de Grauw, J. & van Loon, T. (2020) Clinical effects of two doses of butorphanol with detomidine for intravenous premedication of healthy warmblood horses. *Veterinary Anaesthesia and Analgesia*, 47(5), 681–685. Available from: https://doi.org/10.1016/j.vaa.2019.11.010

Devisscher, L., Schauvliege, S., Dewulf, J. & Gasthuys, F. (2010) Romifidine as a constant rate infusion in isoflurane anaesthetized horses: a clinical study. *Veterinary Anaesthesia and Analgesia*, 37(5), 425–433. Available from: https://doi.org/10.1111/j.1467-2995.2010.00556.x

Dzikiti, T.B., Maney, J.K., Thorogood, J., Segabinazzi, L., Peterson, E., Dzikiti, L.N. et al. (2024) Sedation with dexmedetomidine-butorphanol or xylazine-butorphanol continuous intravenous infusions during unilateral ovariectomy in standing donkeys. *Equine Veterinary Journal*, 56(6), 1243–1250. Available from: https://doi.org/10.1111/evj.14052

Edwards, V.L., Reed, R., Perlini, M. & Moorman, V.J. (2025) Cervical epidural catheter for administration of detomidine and morphine in a model of carpal synovitis in the horse. *Veterinary Surgery*, vsu.70031. Available from: https://doi.org/10.1111/vsu.70083

Fielding, C.L. (2018) Practical fluid therapy and treatment modalities for field conditions for horses and foals with gastrointestinal problems. *Veterinary Clinics of North America: Equine Practice*, 34(1), 155–168. Available from: https://doi.org/10.1016/j.cveq.2017.11.013

Fischer, B.L., Ludders, J.W., Asakawa, M., Fortier, L.A., Fubini, S.L., Nixon, A.J. et al. (2009) A comparison of epidural buprenorphine plus detomidine with morphine plus detomidine in horses undergoing bilateral stifle arthroscopy. *Veterinary Anaesthesia and Analgesia*, 36(1), 67–76. Available from: https://doi.org/10.1111/j.1467-2995.2008.00422.x

Frölich, M.A., Zhang, K. & Ness, T.J. (2013) Effect of sedation on pain perception. *Anesthesiology*, 118(3), 611–621. Available from: https://doi.org/10.1097/ALN.0b013e318281592d

Gil, D.W., Cheevers, C.V., Kedzie, K.M., Manlapaz, C.A., Rao, S., Tang, E. et al. (2009) α-1-adrenergic receptor agonist activity of clinical α-adrenergic receptor agonists interferes with α-2-mediated analgesia. *Anesthesiology*, 110(2), 401–407. Available from: https://doi.org/10.1097/ALN.0b013e3181943226

Goodrich, L.R., Nixon, A.J., Fubini, S.L., Ducharme, N.G., Fortier, L.A., Warnick, L.D. et al. (2002) Epidural morphine and Detomidine decreases postoperative Hindlimb lameness in horses after bilateral stifle arthroscopy. *Veterinary Surgery*, 31(3), 232–239. Available from: https://doi.org/10.1053/jvet.2002.32436

Gozalo-Marcilla, M., Hopster, K., Gasthuys, F., Hatz, L., Krajewski, A.E. & Schauvliege, S. (2013) Effects of a constant-rate infusion of dexmedetomidine on the minimal alveolar concentration of sevoflurane in ponies. *Equine Veterinary Journal*, 45(2), 204–208. Available from: https://doi.org/10.1111/j.2042-3306.2012.00613.x

Gozalo-Marcilla, M., Hopster, K., Gasthuys, F., Krajewski, A.E., Schwarz, A. & Schauvliege, S. (2014) Minimum end-tidal sevoflurane concentration necessary to prevent movement during a constant rate infusion of morphine, or morphine plus dexmedetomidine in ponies. *Veterinary Anaesthesia and Analgesia*, 41(2), 212–219. Available from: https://doi.org/10.1111/vaa.12090

Gozalo-Marcilla, M., Luna, S.P., Crosignani, N., Filho, J.N.P., Possebon, F.S., Pelligand, L. et al. (2017) Sedative and antinociceptive effects of different combinations of detomidine and methadone in standing horses. *Veterinary Anaesthesia and Analgesia*, 44(5), 1116–1127. Available from: https://doi.org/10.1016/j.vaa.2017.03.009

Gursoy, S., Ozdemir, E., Bagcivan, I., Altun, A. & Durmus, N. (2011) Effects of alpha 2-adrenoceptor agonists dexmedetomidine and guanfacine on morphine analgesia and tolerance in rats. *Upsala Journal of Medical Sciences*, 116(4), 238–246. Available from: https://doi.org/10.3109/03009734.2011.597889

Haunhorst, F.R., Hopster, K., Schmicke, M., Bienert-Zeit, A. & Kästner, S. (2022) Clinical effect of buprenorphine or butorphanol, in combination with detomidine and diazepam, on sedation and postoperative pain after cheek tooth extraction in horses. *The Canadian Veterinary Journal = La Revue Veterinaire Canadienne*, 63(1), 39–46.

Júnior, G.S., De Souza, J.V., De Souza Ferreira, W., Florentino, V.R.D., Valente, T.C., Comassetto, F. et al. (2025) Effects of constant intravenous infusion of detomidine alone or combined with butorphanol or methadone for standing sedation in horses: a randomized clinical trial. *Journal of Equine Veterinary Science*, 147, 105396. Available from: https://doi.org/10.1016/j.jevs.2025.105396

Kivistö, K.T., Kallio, A. & Neuvonen, P.J. (1994) Pharmacokinetics and pharmacodynamics of transdermal dexmedetomidine. *European Journal of Clinical Pharmacology*, 46(4), 345–349. Available from: https://doi.org/10.1007/BF00194403

Klein, L.V. & Baetjer, C. (1974) Preliminary report: xylazine and morphine sedation in horses. *Veterinary Anesthesia*, 1(2), 2–6.

Kosugi, T., Mizuta, K., Fujita, T., Nakashima, M. & Kumamoto, E. (2010) High concentrations of dexmedetomidine inhibit compound action potentials in frog sciatic nerves without α_2 adrenoceptor activation. *British Journal of Pharmacology*, 160(7), 1662–1676. Available from: https://doi.org/10.1111/j.1476-5381.2010.00833.x

Kruluc, P. & Nemec, A. (2006) Electroencephalographic and electromyographic changes during the use of detomidine and detomidine-butorphanol combination in standing horses. *Acta Veterinaria Hungarica*, 54(1), 35–42. Available from: https://doi.org/10.1556/avet.54.2006.1.4

Kumar, A., Maitra, S., Khanna, P. & Baidya, D.K. (2014) Clonidine for management of chronic pain: a brief review of the current evidences. *Saudi Journal of Anaesthesia*, 8(1), 92–96. Available from: https://doi.org/10.4103/1658-354X.125955

Leblanc, P.H. & Eberhart, S.W. (1990) Cardiopulmonary effects of epidurally administered xylazine in the horse. *Equine Veterinary Journal*, 22(6), 389–391. Available from: https://doi.org/10.1111/j.2042-3306.1990.tb04301.x

Li, X.-H., Chen, Q.-Y. & Zhuo, M. (2020) Neuronal adenylyl cyclase targeting central plasticity for the treatment of chronic pain. *Neurotherapeutics*, 17(3), 861–874. Available from: https://doi.org/10.1007/s13311-020-00927-1

Lopes, C., Luna, S.P.L., Rosa, A.C., Quarterone, C., Crosignani, N., Taylor, P.M. et al. (2016) Antinociceptive effects of methadone combined with detomidine or acepromazine in horses. *Equine Veterinary Journal*, 48(5), 613–618. Available from: https://doi.org/10.1111/evj.12483

Louro, L.F., Milner, P.I. & Bardell, D. (2021) Epidural administration of opioid analgesics improves quality of recovery in horses anaesthetised for treatment of hindlimb synovial sepsis. *Equine Veterinary Journal*, 53(4), 682–689. Available from: https://doi.org/10.1111/evj.13338

Marly, C., Bettschart-Wolfensberger, R., Nussbaumer, P., Moine, S. & Ringer, S.K. (2014) Evaluation of a romifidine constant rate infusion protocol with or without butorphanol for dentistry and ophthalmologic procedures in standing horses. *Veterinary Anaesthesia and Analgesia*, 41(5), 491–497. Available from: https://doi.org/10.1111/vaa.12174

Marzok, M., Almubarak, A.I., Babiker, H., Kandeel, M., El-Hawari, S.F. & El-khodery, S. (2022) Comparative evaluation of sedative and anti-nociceptive effects of epidural romifidine, romifidine–lidocaine, and lidocaine in donkeys (*Equus asinus*). *Frontiers in Veterinary Science*, 9, 966715. Available from: https://doi.org/10.3389/fvets.2022.966715

Medeiros, L.Q., Gozalo-Marcilla, M., Taylor, P.M., Campagnol, D., de Oliveira, F.A., Watanabe, M.J. et al. (2017) Sedative and cardiopulmonary effects of dexmedetomidine infusions randomly receiving, or not, butorphanol in standing horses. *Veterinary Record*, 181(15), 402. Available from: https://doi.org/10.1136/vr.104359

Moorman, V.J., Bass, L. & King, M.R. (2019) Evaluation of the effects of commonly used α2-adrenergic receptor agonists alone and in combination with butorphanol tartrate on objective measurements of lameness in horses. *American Journal of Veterinary Research*, 80(9), 868–877. Available from: https://doi.org/10.2460/ajvr.80.9.868

Muir, W.W., Skarda, R.T. & Sheehan, W. (1979) Hemodynamic and respiratory effects of a xylazine-acetylpromazine drug combination in horses. *American Journal of Veterinary Research*, 40(11), 1518–1522.

Müller, T.M., Hopster, K., Bienert-Zeit, A., Rohn, K. & Kästner, S.B.R. (2017) Effect of butorphanol, midazolam or ketamine on romifidine based sedation in horses during standing cheek tooth removal. *BMC Veterinary Research*, 13(1), 381. Available from: https://doi.org/10.1186/s12917-017-1299-6

Nannarone, S., Giannettoni, G., Laurenza, C., Giontella, A. & Moretti, G. (2021) Methadone or butorphanol as pre-anaesthetic agents combined with romifidine in horses undergoing elective surgery: qualitative assessment of sedation and induction. *Animals*, 11(9), 2572. Available from: https://doi.org/10.3390/ani11092572

Nichols, C.L., Doherty, T.J., Schumacher, J., Jones, P.D. & Sun, X. (2022) Dexmedetomidine prolongs the duration of action of mepivacaine on anesthesia of the palmar digital nerves of horses. *American Journal of Veterinary Research*, 83(2), 114–118. Available from: https://doi.org/10.2460/ajvr.20.10.0188

Obrochta, B., Tapio, H., Raekallio, M., Gracia Calvo, L.A., Pöyhönen, R.R., Hagman, K. et al. (2025) Effects of vatinoxan on gastrointestinal motility, sedation, and antinociception during and after long-lasting detomidine infusion in horses. *Equine Veterinary Journal*, 58(1), 212–219. Available from: https://doi.org/10.1111/evj.14499

Odette, O. & Smith, L.J. (2013) A comparison of epidural analgesia provided by bupivacaine alone, bupivacaine + morphine, or bupivacaine + dexmedetomidine for pelvic orthopedic surgery in dogs. *Veterinary Anaesthesia and Analgesia*, 40(5), 527–536. Available from: https://doi.org/10.1111/vaa.12050

Patil, S.K. & Anitescu, M. (2012) Opioid-free perioperative analgesia for hemicolectomy in a patient with opioid-induced delirium: a case report and review of the analgesic efficacy of the Alpha-2 agonist agents. *Pain Practice*, 12(8), 656–662. Available from: https://doi.org/10.1111/j.1533-2500.2012.00543.x

Perritt, E., Wallace, H., Singh, S. & Banerjee, A. (2017) Effect of intra-articular alpha-agonists on post-operative outcomes following arthroscopic knee surgery: a systematic review and meta-analysis. *Egyptian Journal of Anaesthesia*, 33(2), 195–201. Available from: https://doi.org/10.1016/j.egja.2017.02.004

Pöppel, N., Hopster, K., Geburek, F. & Kästner, S. (2015) Influence of ketamine or xylazine supplementation on isoflurane anaesthetized horses- a controlled clinical trial. *Veterinary Anaesthesia and Analgesia*, 42(1), 30–38. Available from: https://doi.org/10.1111/vaa.12176

Potter, J.J., MacFarlane, P.D., Love, E.J., Tremaine, H., Taylor, P.M. & Murrell, J.C. (2016) Preliminary investigation comparing a detomidine continuous rate infusion combined with either morphine or buprenorphine for standing sedation in horses. *Veterinary Anaesthesia and Analgesia*, 43(2), 189–194. Available from: https://doi.org/10.1111/vaa.12316

Reed, R.A., Carroll, A.T., Dantino, S.C., Quandt, J.E., Barletta, M. & Sakai, D.M. (2025) Retrospective evaluation of the effect of xylazine infusion on survival to discharge in horses undergoing exploratory laparotomy for colic. *Veterinary Anaesthesia and Analgesia*, 52(2), 221–227. Available from: https://doi.org/10.1016/j.vaa.2025.01.006

Rigotti, C., Vries, A.D. & Taylor, P.M. (2014) Buprenorphine provides better anaesthetic conditions than butorphanol for field castration in ponies: results of a randomised clinical trial. *Veterinary Record*, 175(24), 623. Available from: https://doi.org/10.1136/vr.102729

Ringer, S.K., Portier, K.G., Fourel, I. & Bettschart-Wolfensberger, R. (2012) Development of a romifidine constant rate infusion with or without butorphanol for standing sedation of horses. *Veterinary Anaesthesia and Analgesia*, 39(1), 12–20. Available from: https://doi.org/10.1111/j.1467-2995.2011.00681.x

Risberg, Å.I., Ranheim, B., Krontveit, R.I., Lervik, A. & Haga, H.A. (2016) The cardiovascular status of isoflurane-anaesthetized horses with and without dexmedetomidine constant rate infusion evaluated at equivalent depths of anaesthesia. *Veterinary Anaesthesia and Analgesia*, 43(4), 412–423. Available from: https://doi.org/10.1111/vaa.12315

Risberg, Å.I., Spadavecchia, C., Ranheim, B., Krontveit, R. & Haga, H.A. (2014) Antinociceptive effects of three escalating dexmedetomidine and lignocaine constant rate infusions in conscious horses. *The Veterinary Journal*, 202(3), 489–497. Available from: https://doi.org/10.1016/j.tvjl.2014.09.007

Robertson, J.T. & Muir, W.W. (1983) A new analgesic drug combination in the horse. *American Journal of Veterinary Research*, 44(9), 1667–1669.

Roh, D.-H., Kim, H.-W., Yoon, S.-Y., Seo, H.-S., Kwon, Y.-B., Han, H.-J. et al. (2008) Intrathecal clonidine suppresses phosphorylation of the N-methyl-D-aspartate receptor NR1 subunit in spinal dorsal horn neurons of rats with neuropathic pain. *Anesthesia & Analgesia*, 107(2), 693–700. Available from: https://doi.org/10.1213/ane.0b013e31817e7319

Rønnow Kjærulff, L.N. & Lindegaard, C. (2022a) A narrative review of caudal epidural anaesthesia and analgesia in horses. Part 1: safety and efficacy of epidural drugs. *Equine Veterinary Education*, 34(8), 418–431. Available from: https://doi.org/10.1111/eve.13488

Rønnow Kjærulff, L.N. & Lindegaard, C. (2022b) A narrative review of caudal epidural anaesthesia and analgesia in horses. Part 2: clinical indications and techniques. *Equine Veterinary Education*, 34(8), 432–442. Available from: https://doi.org/10.1111/eve.13489

Sampaio, B.F.B., DeRossi, R., Vieira, N., Milan, B. & Ávila, L.G. (2020) Dexmedetomidine and bupivacaine Association in Caudal Epidural Injection in mares. *Journal of Equine Veterinary Science*, 91, 103015. Available from: https://doi.org/10.1016/j.jevs.2020.103015

Schatzmann, U., Armbruster, S., Stucki, F., Busato, A. & Kohler, I. (2001) Analgesic effect of Butorphanol and Levomethadone in Detomidine sedated horses. *Journal of Veterinary Medicine Series A*, 48(6), 337–342. Available from: https://doi.org/10.1046/j.1439-0442.2001.00366.x

Schlereth, T. & Birklein, F. (2008) The sympathetic nervous system and pain. *Neuromolecular Medicine*, 10(3), 141–147. Available from: https://doi.org/10.1007/s12017-007-8018-6

Schwartz, R.H., Hernandez, S., Noor, N., Topfer, J., Farrell, K., Singh, N. et al. (2022) A comprehensive review of the use of alpha 2 agonists in spinal anesthetics. *Pain Physician*, 25(2), E193–E201.

Shah, Z., Ding, M.-X. & Hu, M.-L. (2014) Alfa2 Antagonistlerinin Küçük Ruminantlarda Kullanımı Üzerine Bir Derleme. *Kafkas Üniversitesi Veteriner Fakültesi Dergisi*, 20, 633–639. Available from: https://doi.org/10.9775/kvfd.2013.10541

Short, C.E., Matthews, N., Harvey, R. & Tyner, C.L. (1986) Cardiovascular and pulmonary function studies of a new sedative/analgetic (detomidine/Domosedan) for use alone in horses or as a preanesthetic. *Acta Veterinaria Scandinavica. Supplementum*, 82, 139–155.

Skarda, R.T. & Muir, W.W. (1994) Caudal analgesia induced by epidural or subarachnoid administration of detomidine hydrochloride solution in mares. *American Journal of Veterinary Research*, 55(5), 670–680.

Solano, A.M., Valverde, A., Desrochers, A., Nykamp, S. & Boure, L.P. (2009) Behavioural and cardiorespiratory effects of a constant rate infusion of medetomidine and morphine for sedation during standing laparoscopy in horses. *Equine Veterinary Journal*, 41(2), 153–159. Available from: https://doi.org/10.2746/042516408X342984

Steffey, E.P. & Pascoe, P.J. (2002) Detomidine reduces isoflurane anesthetic requirement (MAC) in horses. *Veterinary Anaesthesia and Analgesia*, 29(4), 223–227. Available from: https://doi.org/10.1046/j.1467-2995.2002.00107.x

Steffey, E.P., Pascoe, P.J., Woliner, M.J. & Berryman, E.R. (2000) Effects of xylazine hydrochloride during isoflurane-induced anesthesia in horses. *American Journal of Veterinary Research*, 61(10), 1225–1231. Available from: https://doi.org/10.2460/ajvr.2000.61.1225

Stone, L.S., MacMillan, L.B., Kitto, K.F., Limbird, L.E. & Wilcox, G.L. (1997) The α_{2a} adrenergic receptor subtype mediates spinal analgesia evoked by α_2 agonists and is necessary for spinal adrenergic–opioid synergy. *The Journal of Neuroscience*, 17(18), 7157–7165. Available from: https://doi.org/10.1523/JNEUROSCI.17-18-07157.1997

Studer, N., Bernal, S.D., Thormann, W., Levionnois, O. & Spadavecchia, C. (2021) Antinociceptive effects of levomethadone in standing horses sedated with romifidine. *Veterinary Anaesthesia and Analgesia*, 48(3), 451–460. Available from: https://doi.org/10.1016/j.vaa.2020.08.011

Sysel, A.M., Pleasant, R.S., Jacobson, J.D., Moll, H.D., Modransky, P.D., Warnick, L.D. et al. (1996) Efficacy of an epidural combination of morphine and Detomidine in alleviating experimentally induced Hindlimb lameness in horses. *Veterinary Surgery*, 25(6), 511–518. Available from: https://doi.org/10.1111/j.1532-950X.1996.tb01452.x

Tapio, H.A., Raekallio, M.R., Mykkänen, A., Mama, K., Mendez-Angulo, J.L., Hautajärvi, H. et al. (2018) Effects of MK-467 hydrochloride and hyoscine butylbromide on cardiorespiratory and gastrointestinal changes induced by detomidine hydrochloride in horses. *American Journal of Veterinary Research*, 79(4), 376–387. Available from: https://doi.org/10.2460/ajvr.79.4.376

Taylor, P., Coumbe, K., Henson, F., Scott, D. & Taylor, A. (2014) Evaluation of sedation for standing clinical procedures in horses using detomidine combined with buprenorphine. *Veterinary Anaesthesia and Analgesia*, 41(1), 14–24. Available from: https://doi.org/10.1111/vaa.12055

Tricco, A.C., Lillie, E., Zarin, W., O'Brien, K.K., Colquhoun, H., Levac, D. et al. (2018) PRISMA extension for scoping reviews (PRISMA-ScR): checklist and explanation. *Annals of Internal Medicine*, 169(7), 467–473.

Troya-Portillo, L., López-Sanromán, J., Villalba-Orero, M. & Santiago-Llorente, I. (2021) Cardiorespiratory, sedative and Antinociceptive effects of a Medetomidine constant rate infusion with morphine, ketamine or both. *Animals*, 11(7), 2081. Available from: https://doi.org/10.3390/ani11072081

Ulagenthiran, A., Howard, P. & Curtin, J. (2024) Transdermal clonidine for agitation and pain. *BMJ Supportive & Palliative Care*, 14(e2), e2221–e2223. Available from: https://doi.org/10.1136/spcare-2024-004872

Villalba, M., Santiago, I. & Gómez De Segura, I.A. (2014) Effects of a constant rate infusion of medetomidine–propofol on isoflurane minimum alveolar concentrations in horses. *The Veterinary Journal*, 202(2), 329–333. Available from: https://doi.org/10.1016/j.tvjl.2014.08.007

Vullo, C., Gugliandolo, E., Biondi, V., Biffarella, M., Catone, G. & Tambella, A.M. (2024) Comparison of Detomidine or Romifidine in combination with morphine for standing magnetic resonance imaging in horses. *Veterinary Sciences*, 11(3), 124. Available from: https://doi.org/10.3390/vetsci11030124

Wang, K., Wu, M., Xu, J., Wu, C., Zhang, B., Wang, G. et al. (2019) Effects of dexmedetomidine on perioperative stress, inflammation, and immune function: systematic review and meta-analysis. *British Journal of Anaesthesia*, 123(6), 777–794. Available from: https://doi.org/10.1016/j.bja.2019.07.027

Yoon, S.-Y., Kang, S.-Y., Kim, H.-W., Kim, H.-C. & Roh, D.-H. (2015) Clonidine reduces nociceptive responses in mouse orofacial formalin model: potentiation by Sigma-1 receptor antagonist BD1047 without impaired motor coordination. *Biological & Pharmaceutical Bulletin*, 38(9), 1320–1327. Available from: https://doi.org/10.1248/bpb.b15-00183

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