IN THIS ISSUE:

From the President’s Desk: Advocating for equine practice ‘inside the beltway’

Osteochondral dysplasia of the coxofemoral joints in a Friesian foal: Clinical findings and methods of diagnosis

Successful surgical management of abdominal abscessation secondary to *Strongylus edentatus* migration
TRADE-INS WELCOME

Upgrade and Save on Refurbishments

Features That Matter

Smaller and Lighter
Even together with the carrying case, the neoVET weighs just under 40lbs.

More Powerful
Only the neoVET features a power probe with the capability to go beyond current standards.

Cable Free Trigger
Trigger is now conveniently located on the therapy head. Double click for continuous firing mode.

Longer Therapy Cord
Therapy cord is 30” longer for better reach. Treating backs or simply maintaining a safe distance is now so much easier.

- Electrohydraulic
- Focused
- High Powered

3 FREE Refurbishments When You Mention This Ad!
AAEP News: In this issue

From the President's Desk: Advocating for equine practice ‘inside the beltway’ .................. III
AAEP Foundation chairman selected as AAEP vice president ........................................ V
Sport horse medicine in the spotlight at 2017 Resort Symposium ........................................XI

Highlights of Recent Clinically Relevant Papers
S. WRIGHT ..................................................................................................................................475

Case Reports
Primary hyperparathyroidism in a 17-year-old Arab × Welsh Cob pony mare with a functional parathyroid adenoma
H. J. COTTLE, K. J. HUGHES, H. THOMPSON, P. E. J. JOHNSTON and A. W. PHILBEY .......................477

Osteochondral dysplasia of the coxofemoral joints in a Friesian foal: Clinical findings and methods of diagnosis
H. HERMANS, S. VERAA, M. PLOEG, S. BOERMA, H. A. W. HAZEWINKEL and W. BACK ....................486

Standing removal of the proximal aspect of an olecranon fracture in a mature horse
C. R. B. ELLIOTT and B. G. A. MIDDLETON ..................................................................................492

Traumatic coccygeal luxation and distal amputation of the tail of an Appaloosa mare
M. MCMASTER, A. MUNSTERMAN and V. ALBANESE ....................................................................497

Successful surgical management of abdominal abscession secondary to Strongylus edentatus migration
R. P. BELL, S. K. REED and N. T. MESSER, IV ........................................................................497

Clinical Commentaries
Traumatic coccygeal luxation and distal amputation of the tail of a mare
B. GRANT ..................................................................................................................................503

Abdominal abscesses in horses
E TÓTH ......................................................................................................................................510

Original Article
Primary closure of equine laryngotomy incisions: Healing characteristics and complications of 180 cases
C. LINDEGAARD, L. KARLSSON, C. T. EKSTRØM and J. FJELDBORG ........................................512

Review Article
Basics of equine dermatology
M. M. SLOET VAN OLRUITENBORGH-OOSTERBAAN and G. C. M. GRINWIS .................................520

Critically Appraised Topic
Does radiography help or hinder in apical infection?
N. DU TOIT .................................................................................................................................530A-F

Marketplace ................................................................................................................................530A-F

Advertisers’ Index ......................................................................................................................519

Cover photo by Dr. Ruth Sobeck.
From the President’s Desk: Advocating for equine practice ‘inside the beltway’

By Kathleen Anderson, DVM

Politics seems to be the subject on everyone’s mind these days as the U.S. election cycle nears the stretch run toward Tuesday, Nov. 8. But what of the individual citizens—what is the impact of politicians? Economic policies? Health and safety policies? Education policies? World events?

The AAEP can be considered in parallel on some of these issues. You name it, we likely have a role to play: economics, health, safety, education, international trade, Equitarian efforts and more. Often, the footprint of the AAEP’s efforts extends far beyond the immediate awareness horizon of our members.

As your 2016 president, I thought it might be useful to review some of our unseen work in the hope that members will contribute ideas and questions to keep our association in touch with the daily issues affecting your practice.

During the summer, many of you likely became aware of a potential shortage of flunixin injectable solution. The AAEP has been in frequent contact since June with the U.S. Food and Drug Administration’s Center for Veterinary Medicine to gauge the impact on horse health so that we can provide our membership with the most current information and suggested alternative products for treatment. These relationships at the national level are critical to our ability as equine veterinarians to affect horse health. The open lines of communication our association has achieved with agencies like the FDA continue to be invaluable.

Through the American Horse Council and American Veterinary Medical Association’s Governmental Relations Division, the AAEP has many relationships that connect industry and congressional stakeholders on areas of common concern. The AHC’s Health and Regulatory Committee provides solutions through the guidance of AAEP members such as Drs. Peter Timoney and Rick Mitchell. The Animal Welfare Committee, chaired by our own Dr. Jerry Black, and the Horse Show Committee, chaired by our former executive director Gary Carpenter, similarly evaluate equine issues on the national level. Dr. Black is the chair of the AHC’s board of trustees.

The AHC’s annual meeting in Washington, D.C., is another opportunity for the AAEP to meet in person with various politicians. This past June, we met with Congressman Andy Barr (R-KY-6) to discuss the Thoroughbred Horse Racing Integrity Act (H.R.3084) and Congressman and veterinarian Dr. Ted Yoho (R-FL-3) concerning the Prevent All Soring Tactics (PAST) Act (H.R.3268).

The Thoroughbred Horse Racing Integrity Act, introduced in 2015, appears to be in transition, with the pending addition of all racing breeds to the manifesto and some proposed changes to the governance structure. The AAEP is uniquely positioned to provide guidance, as our association encompasses all racing breeds and has expertise across all the areas of jurisdiction—from lab testing and regulatory to practitioner care. We are in the process of providing input about the legislation. Although we hold the official position of “No Action,” meaning we have reviewed the bill but have not taken a position to actively support passage or defeat, we do support many basic tenants of the bill.

On a much longer timeline, the AAEP continues to be actively engaged in the battle to end the inhumane practice of soring. The USDA/APHIS announced in late July its proposed changes to the regulations governing enforcement of the Horse Protection Act, which was passed in 1970 to end the soring of horses in some sectors of the Tennessee Walking Horse, Racking Horse and Spotted Saddle Horse industries.

The AAEP is very pleased with many of the USDA’s suggested changes, some of which were recommended by an AAEP task force back in 2008. You can revisit our AAEP white paper on the subject at www.aaep.org/custdocs/AAEPWhitePaperonTWHSoring.pdf. Chief among the USDA’s proposed changes will be a ban on all action devices and performance packages, as well as the use of only veterinarians to perform inspections at horse shows.

The USDA is accepting public comment until September 26, and the AAEP’s Welfare and Public Policy Advisory Council has reviewed the proposed changes as well in order to suggest modifications that may make the regulations even more effective. We will continue to advocate for the passage of the PAST Act, which is a federal bill in both the House of Representatives and the Senate. Soring is an intentional, cruel act and we as veterinarians will continue to work to end this practice.

In a nutshell, these are just a few of the political issues on the federal level your AAEP leadership and staff pursue to make our practice lives better on all fronts. We are all part of the process, both as contributors and as recipients, so stay engaged!

Parting thought: “Never doubt that a small group of thoughtful, committed citizens can change the world. Indeed, it is the only thing that ever has.”
—Margaret Mead
Summer meetings yield short- and long-term direction for AAEP

By David Foley, AAEP Executive Director

In the days preceding the July Focus meetings in New Orleans, La., the AAEP board of directors along with the Foundation Advisory Council and Nominating Committee each conducted their summer meetings. Following is a synopsis of each meeting in chronological order.

Foundation Advisory Council
The Foundation Advisory Council’s two-day strategic planning and development session focused on fine-tuning priority areas for funding and developing a strategy for future fundraising. Council members identified education, research, and horse wellness and benevolence for priority funding, largely affirming member feedback on surveys. Discussions of future funding centered on growing the donor base and involving more members in the process. Over the two days, I was struck by the council members’ passion for the work our Foundation accomplishes and just how many more opportunities AAEP and its members have to make a difference in the welfare of horses and support of our student population.

Nominating Committee
The Nominating Committee reviewed and recommended candidates for our board of directors’ ballots, 2017 vice president and our annual awards. Ballots for the two open board positions have been established and robust voting is ongoing until Sept. 21. Dr. Jeff Berk was selected as the next AAEP vice president and will assume the presidency in 2019. The award recipients will be kept under wraps until our President’s Luncheon during the annual convention in Orlando at the Orange County Convention Center (not the Gaylord Hotel—we heard you loud and clear!). Much like the commitment of Foundation Advisory Council members, the Nominating Committee spends countless hours during the meeting and in conference calls ensuring the board maintains an appropriate balance of skills and perspectives to best serve our membership.

Board of Directors
At the day-long board of directors meeting, board members listened, discussed and voted on the recommendations from the Foundation Advisory Council and Nominating Committee (our system of checks and balances) before reviewing the ongoing progress of the AAEP’s strategic plan. A board subcommittee is assigned to each goal of the plan to ensure proper oversight and continued momentum. The following items were covered:

- A new AAEP website, also to be launched by year’s end.
- Updated membership management software offering efficiencies in the office and an improved member experience.
- Wellness-related features added to the Focus meetings and planned for the convention, including a continuing education component.
- “Interactive” features planned for this year’s convention, with even greater changes in the coming years.

During its review of reports and mid-year updates from other committees, councils and task forces, the board approved recommendations from two task forces relative to videoendoscopy protocols for horses offered for sale at public auction and EIPH research funding as a priority for the Foundation.

Many of the public policy issues discussed during the meeting are noted in Dr. Anderson’s column on the preceding page so I won’t repeat them. Suffice it to say, however, it takes a lot of dedicated volunteer members to be in all of these places to ensure that AAEP is involved and influential in these discussions. This kind of dedication and willingness to jump in has always been perhaps our greatest strength.
AAEP Foundation chairman selected as AAEP vice president

AAEP Foundation Chairman Dr. Jeffrey T. Berk has been named the 2017 AAEP vice president. He will be installed during the Dec. 6 President’s Luncheon at the 62nd Annual Convention in Orlando, Fla., and will assume the role of AAEP president in 2019.

Dr. Berk is an associate veterinarian with Equine Medical Associates in Lexington, Ky., where his primary focus is international Thoroughbred sales work. A 1981 graduate of the University of Pennsylvania School of Veterinary Medicine, Dr. Berk began his career as a racetrack practitioner and was a partner at Ocala Equine Hospital in Florida prior to joining Equine Medical Associates in 2010.

Throughout his career, Dr. Berk has devoted considerable time and expertise toward advancement of the AAEP’s mission. In addition to his current term as chairman of the AAEP Foundation, Dr. Berk served as AAEP treasurer from 2009-2011; on the board of directors from 2004-2006; as chair of the Professional Conduct and Ethics Committee; and as a member of the Biologics and Therapeutic Agents, Convention Planning, Finance, Public Policy and Purchase Exam committees. He also has volunteered on various AAEP task forces and as moderator of the Public Auction Rounds; and has presented at both the AAEP’s Annual Convention and Resort Symposium.

Practical skills, valuable insights dispensed at AAEP’s summer CE meetings

The AAEP’s summer continuing education meetings equipped participants with the practical knowledge and skills to surpass client expectations when administering care in the diverse but important areas of cervical spine issues, soft tissue lameness and reproduction.

At a sold-out 360° Pain in the Neck: What’s the Story from Anatomy to Treatment at Colorado State University, 20 practitioners received hands-on training in the diagnostics and therapeutic modalities necessary to identify and treat various neck problems.

Meanwhile, 197 practitioners ventured to New Orleans, La., for the AAEP’s combined Focus meetings. Participants learned new approaches to the diagnosis, treatment and rehabilitation of the most common cause of lameness during Focus on Soft Tissue Lameness in the Performance Horse; and absorbed essential knowledge to improve the efficiency and success of client reproductive programs during Focus on the Breeding Shed.

A total of 47 students joined their DVM colleagues in New Orleans for Focus on Students, where they honed their practical skills during interactive dry labs, gained ethical clarity during a professional development session and networked with Avenues-participating practices.

Small-group, hands-on learning is a core component of AAEP 360° meetings.

Details about next summer’s 360° and Focus meetings will be available later this year at www.aaep.org/info/education.
AAEP Foundation grant helps establish benefits of therapeutic riding for military veterans

Research at the University of Missouri College of Veterinary Medicine, funded by the Horses and Humans Research Foundation with an assist from the AAEP Foundation and others, found clear evidence that participation in therapeutic horseback riding contributed to a decrease in military veterans’ Post-Traumatic Stress Disorder (PTSD) symptoms.

The study, led by principal investigator Dr. Rebecca A. Johnson, investigated if participation in a structured, six-week therapeutic riding program decreased PTSD symptoms, as well as improved self-efficacy, emotion regulation and social engagement among veterans.

An estimated 300,000 military veterans deployed since 2001 have returned home with PTSD, and 20 veterans each day commit suicide.

Thirty-eight veterans were randomly assigned to participate in the six-week therapeutic riding program, either without a wait control period or assigned to a six-week wait control period prior to the six weeks of riding. No significant changes were found for any outcome measure during the wait control period, indicating that changes in outcome measures were due to the therapeutic riding rather than other extraneous factors.

Veterans participating in therapeutic riding had statistically significant decreases in their PTSD symptoms throughout the study period, and the benefit increased the longer an individual was in the riding program. Veterans also expressed great enjoyment when interacting with the horses, other veterans, researchers and riding center staff.

The findings indicated that these positive interactions helped engage the veterans, especially as compared to frequent resistance found with clinical counseling sessions. Several of the participants have continued with therapeutic riding and others volunteer as side walkers or leaders at the center where the study was conducted.

Additional information about this study, including summary results and a webinar, is accessible at www.horsesandhumans.org/Research_AwardedProjects.html. To help the AAEP Foundation continue to fund worthy projects and initiatives, visit www.aaepfoundation.org and click the “Donate” button.

New AAEP podcast tells of life as an equine veterinarian

AAEP Practice Life, a new monthly podcast of career and occasional clinical case discussions with AAEP members, is now available for download on iTunes.

In the debut episode, entitled “Conversations with New Practitioners,” Drs. Amy Bennett, Melinda Crowley and Jenna Donaldson discuss the challenges and rewards they’ve experienced since entering the profession within the past few years.

AAEP Practice Life is hosted by Dr. Mike Pownall, co-founder of McKee-Pownall Equine Services in Campbellville, Ontario, Canada, and a frequent presenter on practice management and social media topics at AAEP continuing education meetings.

Search “AAEP Practice Life” on iTunes to download the current episode or subscribe to future episodes. Listen in your truck between calls, in the clinic between appointments or at home in your spare time.
AAEP Foundation distributes nearly $460,000 for equine welfare

The AAEP Foundation has awarded $459,198 in support of 27 equine organizations and projects committed to improving the welfare of the horse. The 2016 disbursement brings the cumulative amount distributed since its inception to more than $3.7 million.

Among the initiatives receiving support are veterinary student scholarships and educational programs, Equitarian workshops, unwanted horse programs, important equine research, and professional and youth development.

New initiatives receiving funds are veterinary student training in working equid medicine through the American Fondouk and Tufts University, disaster response training through the Louisiana State Animal Response Team, the 2016 Donkey Welfare Symposium at Cornell University, the U.S. Pony Club’s Equine Management Curriculum and Support Limb Laminitis research projects at the University of Florida and University of Pennsylvania.

For a complete list of 2016 grant recipients, visit www.aaepfoundation.org and click the “Our Work” tab.

USDA proposes changes to Horse Protection Act in fight against soring

Comments being accepted through Sept. 26

The U.S. Department of Agriculture’s (USDA) Animal and Plant Health Inspection Service on July 26 announced proposed regulation changes governing enforcement of the Horse Protection Act with the goal of ending the practice of soring.

“The AAEP is extremely pleased with the USDA’s work in proposing regulation changes to end the inhumane act of soring, which is one of the most significant welfare issues affecting any equine breed or discipline in the United States,” said AAEP President Dr. Kathleen Anderson.

“As doctors of veterinary medicine, we have previously recommended the use of only veterinarians to inspect horses at shows for evidence of soring, as well as a ban on action devices and performance packages. Both of these items are included in the USDA’s proposed rule changes.

“Soring is an intentional, cruel act which must end. The AAEP will continue to support the Prevent All Soring Tactics (PAST) Act and work to eliminate this practice.”

You can read the proposed rule and submit comments until Sept. 26 at http://tinyurl.com/hparule. The USDA will review all comments before releasing a final rule.
Begin planning for the AAEP’s 62nd Annual Convention and enhance your on-site experience in Orlando with the upgraded AAEP Convention App, sponsored by Zoetis.

From a more intuitive dashboard, you can:
- Browse sessions and speakers, create your personal itinerary and take notes
- Search, filter, mark to visit and contact exhibitors
- Create your own profile, and then search for and message other attendees
- View and swap ideas, photos and lessons learned with other attendees
- Connect with others by viewing and posting to the event stream on Twitter

Closer to the convention, you’ll be able to access the Proceedings papers as well as view the convention center floor plans and maps.

You can download the app to any of your mobile devices and sync your event information and itineraries across devices. To download, search “AAEP Education” at the App Store or Google Play.

In addition to the app, you can further engage with the convention on social media by using the hashtag #AAEP16 when joining the conversation.

Like the convention at www.facebook.com/AAEPConvention; and follow @AAEPHorseDocs on Instagram and Twitter.

Reinforce the clinical knowledge acquired during the AAEP’s 62nd Annual Convention, with exclusive insights from more than 6,100 horse owners and trainers on how to deliver that knowledge in ways that build and strengthen relationships with your clients.

On the morning of Tuesday, Dec. 6, In-Depth: AAEP Touch – Tools to Connect to Your Clients and Their Horses will travel three key paths to help you increase your clients’ satisfaction with your services, grow your practice and improve the health of your patients.

Performing a Client-Focused Examination: Learn the principles of performing a client-focused examination and how to use these techniques to deliver important client-satisfaction drivers as well as excellent veterinary care.

Customize Your Care for Practice Success: Discover the attributes valued by specific demographic groups to help you better understand the needs of your clients, deliver personalized care and develop enduring relationships.

From Smartphones to Skype – Client Communication in the 21st Century: Explore how different modes of communication appeal to different clients and how you can manage the daily flow of information.

Mark this session on your calendar, and visit touch.aaep.org to access the full suite of exclusive AAEP member tools. Log in to the Touch website using the same username and password as you use for aaep.org.

Benjamin Davids, a fourth-year student at the University of Florida, has been selected by the AAEP’s Educational Programs Committee as the winner of the 2016 case study project. Davids’ case study, “Septic Peritonitis in an Adult Horse” is available as an educational resource at www.aaep.org/info/case-studies.

As winner of the contest, which was open to veterinary students and first-year graduates, Davids will receive complimentary registration for the AAEP’s 62nd Annual Convention and $500 to support travel to the meeting.
62nd Annual Convention & Trade Show

Make a splash!

December 3-7, 2016
Orange County Convention Center

Save $70 when you register by November 1!

www.aaep.org/info/annual-convention
American Horse Council to update National Economic Impact Study

The American Horse Council (AHC) will update the Economic Impact Study of the Horse Industry in 2017 to establish the current size of the industry and its impact on the national economy.

The 2005 study found the horse industry in all its segments to have a $39 billion effect on the U.S. economy, support 1.4 million full-time jobs, and involve more than 4 million Americans and 9.2 million horses. The study has been a valuable resource in the industry’s efforts in Congress and state legislatures as well as in documenting its size and diversity to the media and general public.

The 2017 study will include expanded demographic information and more in-depth analysis of all industry segments such as rescues, sanctuaries and therapeutic riding centers. It will again feature state breakouts that establish the scope of the horse industry within individual states.

For more information, contact the AHC at (202) 296-4031 or info@horsecouncil.org.

The AAEP welcomes new members and congratulates recent graduates

New Members:
Stephanie Bond, DVM, Calgary, AB, Canada
Jennie Marie Cook, DVM, Paducah, KY
Deanna M. Gazzerro, VMD, Worcester, MA
Olli Kauko, DVM, Valkola, Finland
Michael C. Maher, DVM, St. Paul, MN
Megan Jill McCracken, DVM, Bothell, WA
Ferderique Pilon, DVM, Montreal, QC, Canada
Ana Malone Oliver, VMD, Saratoga Springs, NY
W. Wesley Sutter, DVM, Lexington, KY
John T. Sweeney, DVM, Altoona, IA
Elizabeth M. Tadros, DVM, Lansing, MI
Jessica Yankus, DVM, Princess Anne, MD

Recent Graduates:
Hayley Adams, DVM, Jarreau, LA
Lisa Ann Marie Anderson, DVM, Waverly, OH
Erica Roberts Beadle, DVM, Bryan, TX
Carissa Katharina Bellflower, DVM, Columbus, OH
Sophie Boorman, DVM, Lexington, KY
Emily Brenner, VMD, Philadelphia, PA
Samantha Burkh, DVM, Acton, CA
Ashley Cameron, DVM, Reddick, FL
Annie Chavent, DVM, Middleburg, VA
Gina Clouse, DVM, Manhattan, MT
Amber Conway, DVM, Pullman, WA
Elizabeth Crabtree, DVM, Pound Ridge, NY
Megan Crouse, DVM, Charlottetown, PE, Canada
Trevor Davis, DVM, Pocahontas, AR
Jillian Deets, DVM, St. Paul, MN
Krystyna Dross, DVM, Ballston Lake, NY
Lindsay Dykstra, DVM, Longmont, CO
George Elane, DVM, Laurel, MD
Blake Everett, DVM, Knoxville, TN

Lauren Fischer, DVM, Ravenna, OH
Kathleen Gerdes, DVM, College Station, TX
Katrina Glaude, DVM, North Scituate, RI
Elizabeth Amanda Gorrell, DVM, Lexington, KY
Amanda Grieco, DVM, Gardnerville, NV
Jennifer Hartman, DVM, Fort Collins, CO
Chelsea Hinson, DVM, Hampshire, TN
Allison Howard, DVM, Versailles, KY
Kathryn Austin Lacy, DVM, Timonium, MD
Hannah Rani Leventhal, DVM, Columbus, NC
Laura K. Marley, DVM, Driftwood, TX
Erin McCauley, DVM, Durham, NC
Coralie Morauw, DVM, Savoy, IL
Ashley Nixon, DVM, Berwyn, PA
Anna Norwood, DVM, Baton Rouge, LA
Elizabeth Odywiec, DVM, Lebanon, NJ
Laura A. Petroski, DVM, Lexington, KY
Allison Michelle Plettner, DVM, Ocala, FL
Jessica Quigg, DVM, Three Forks, MT
Hayley Austin Rasmussen-Ball, DVM, Los Olivos, CA
Jessica Robertson, DVM, Encinitas, CA
Alyson Nicole Rogers, DVM, Boca Raton, FL
Jase Skelton, DVM, Oakdale, CA
Bernadette Loomis Smith, DVM MS, Fort Collins, CO
Stephanie Smith, DVM MS, Roscoe, SD
Alex Stone, DVM, Pullman, WA
Jacob M. Swink, DVM, Columbus, OH
Colton Roy Thacker, DVM, Lexington, KY
Rebecca Vollrath, DVM, Houghton, MI
Luis Von Chong, DVM, Panama, Pty, Panama
Stephanie Anne Wardius, DVM, West Chester, PA
Amanda Ruth Watkins, DVM, Rhinebeck, NY
Julianna Wessels, DVM, Lake St. Louis, MO
Danielle Leigh Whitehead, DVM, Outlook, SK, Canada
Randi Wood, DVM, Phoenix, AZ
Sport horse medicine in the spotlight at 2017 Resort Symposium
Registration now open for midwinter CE meeting in Grand Cayman

If your clients’ horses run, jump, spin or slide, make plans now to attend the AAEP’s 19th Annual Resort Symposium, which will focus exclusively on the latest thinking in sport horse medicine. The tropical CE event will be held Jan. 30-Feb. 1, 2017, at the Westin Grand Cayman Seven Mile Beach Resort and Spa.

The Jan. 30 session, led by Dr. Amy Johnson and focused on sport horse medicine, will help you differentiate neurologic from musculoskeletal disease, distinguish between Lyme Disease and neuroborreliosis, interpret cervical radiographs and diagnose and treat both EPM and headshaking.

The Jan. 31 session, led by Dr. Sarah Puchalski and devoted to imaging for the sport horse, will help you overcome challenges with acquisition and interpretation of digital radiographs, determine when to employ advanced imaging techniques, take a fresh approach to imaging the fetlock and proximal cannon bone region, and enhance diagnostic imaging through case examples from various anatomic regions.

The Feb. 1 session, led by Dr. Tracy Turner and focused on sport horse lameness and rehabilitation, will equip you to identify subtle lameness clues, discern the effectiveness of new therapies, implement appropriate training and rehabilitation protocols, and incorporate equine rehabilitation into everyday practice.

Following half-day educational sessions, grab the sunscreen and enjoy the soft coral sand and crystal-clear waters of Grand Cayman’s Seven Mile Beach, ranked the No. 1 beach in the world for 2015-2016 by U.S. News and World Report Travel; or join your colleagues for optional group excursions.

View the complete educational program and register for the meeting and optional group excursions at www.aaep.org/info/resort-symposium.

Thanks to IDEXX and Merial for their sponsorship of the 19th Annual Resort Symposium.

AAEP Educational Partner Profile: Platinum Performance®

Platinum Performance is proud to be an Educational Partner with AAEP, and to continue to collaborate with the AAEP Foundation to support the Race for Education in the Winners’ Circle Scholarship Program.

For 20 years, Platinum Performance has been providing veterinarians with the nutritional formulas and research needed to help support wellness, athletic performance and equine patients with health conditions. The formula that was originally developed to help speed healing in patients at Alamo Pintado Equine Medical Center, is now part of a full line of nutritional support products, including Bio-Sponge®, Osteon®, Platinum Refresh and Platinum Performance CJ.

Visit www.platinumperformance.com or call (866) 553-2400 to learn about all the ways Platinum Performance can support your patients.
AAEP Meetings and Continuing Education

December 3-7, 2016
62nd Annual Convention
Orlando, Florida

January 30-
February 1, 2017
19th Annual Resort Symposium
The Westin, Grand Cayman

For more information, contact the AAEP office at (859) 233-0147 or (800) 443-0177 or online at www.aaep.org.

Membership Benefits

Knowledge and networking merge at AAEP Annual Convention

“Attending the AAEP Annual Convention has always been a priority for me. Besides the excellent scientific program, AAEP is the one meeting where I can reconnect with old colleagues and interact with industry leaders, researchers, academicians and private practitioners.”—Leslie Easterwood, DVM, College Station, Texas

The AAEP’s Annual Convention is the world’s largest continuing education event dedicated to equine veterinary practice, and AAEP members receive a substantial discount on their registration compared to non-members.

With a choice from approximately 100 hours of continuing education credit, practitioners can acquire the most current clinical knowledge in diverse and important areas of equine medicine along with best business practices that are essential to a healthy bottom line.

The vast educational program is supplemented by daily networking and social events, which connect colleagues and expand professional footprints; and an expansive trade show that offers innovative solutions to practice challenges from more than 300 exhibitors.

The AAEP’s 62nd Annual Convention will be held Dec. 3-7, 2016, at the Orange County Convention Center in Orlando, Fla. Prospective attendees are encouraged to register by Nov. 1 to receive a $70 discount on the standard registration rate. To register, book a hotel room or view the educational program, visit www.aaep.org/info/annual-convention.

AAEP group purchasing program qualifies your practice for substantial savings

As an AAEP member, you are eligible for substantial savings on supplies and services to operate your veterinary practice. The AAEP and The Veterinary Club have partnered to provide all AAEP members with access to the industry’s most robust catalog of contracts offering substantial, quantifiable savings. Discounts are available at such companies as Verizon, Sprint, UPS, FedEx, Staples, Office Depot and Sherwin-Williams.

Participation in the group purchasing program is free with your AAEP membership. Depending on usage, savings could exceed the annual cost of your AAEP membership.

To participate, AAEP members must register at www.theviluntaryclub.com. For more information about this membership benefit, contact Nick Altwies, membership services coordinator, at naltwies@aaep.org.
VALIDATED
Multi Radiance has proven its technology works, without limitations!

OPTIMIZED
The ACTIVet PRO has been optimized to safely deliver the most light to deep tissue and facilitate absorption.

UNRIVALED
Super Pulsed Lasers have outperformed Class IV lasers head to head in clinical studies.*

* Data on file

TRADE IN YOUR OLD LASER FOR THE NEW ACTIVet PRO & SAVE!

* Restrictions apply. Please call for details

NEW
ACTIVet PRO

50W OF PEAK SUPER PULSED LASER POWER
300% MORE TOTAL POWER THAN ORIGINAL ACTIVET
900% MORE BLUE LIGHT

For more info:
Call: 800.373.0955
multiradiance.com

Trade Up and SAVE Up to $6,000
Offers Expires: 9/30/16

Proud Sponsor of:

Multi Radiance Medical
Laser Longevity™

2.9% Special Financing for Qualified Buyers™
Multi Radiance Medical offers many financing options.

*** 3rd party financing partner NCMIC / PSFS

For more info:
Call: 800.373.0955
multiradiance.com
Scientifically proven formula:
Contains *Saccharomyces boulardii* and fermentation metabolites, which sustain both healthy gut tissues and a robust microflora population.

**Recommended for:**
Horses with acute or chronic diarrhea, scouring foals; stressed or ill horses.

**ProbioticWise supports:**
- Agglutination and suppression of the pathogenic bacterium
- Complete digestion of starch/sugar (NSC feedstuffs) in the foregut
- Growth and activity of beneficial bacteria
- Optimal functionality and healing of the mucosal lining
- Restoration of normal GI tract function

**ProbioticWise™** offers benefits beyond those of other probiotic formulas.

Available at veterinary suppliers. For more information, call 800-772-1988.
**Highlights of recent clinically relevant papers**

**Photosensitisation in horses fed alfalfa hay**

In this study B. Puschner and colleagues in the USA investigated primary photosensitisation in horses fed primarily alfalfa hay.

Photosensitisation occurs when photosensitive substances accumulate in the skin and interact with sunlight resulting in an often severe, crusting, itching or painful dermatitis in unpigmented and/or lightly haired areas of the skin. Primary photosensitisation, caused by direct ingestion of photosensitising agents, has been reported anecdotally in horses after ingestion of alfalfa hay. Between 2004 and 2014, several large outbreaks of primary photosensitisation in horses fed primarily alfalfa hay were investigated in California. Alfalfa hay samples were collected and carefully examined: no known photosensitising plants or pesticide residues were identified, and no unusual fungal infestation or phototoxicity were found using a specific Candida albicans assay. In the 2004 outbreak, a feeding study was conducted with three horses exclusively fed alfalfa hay that was suspected to have caused the outbreak. Two weeks after ingestion of alfalfa hay, two horses developed several lesions in nonpigmented skin characterised as chronic ulcerative and necrotising dermatitis with super ficial vasculitis, which was consistent with photosensitisation. In the 2014 outbreak, seven different implicated alfalfa hay samples were analysed for chlorophyll a and b, and pheophorbide a. These compounds had been suspected to play a role in alfalfa-induced primary photosensitisation. The chlorophyll contents ranged from 0.90 to 2.30 mg/g in the alfalfa hay samples, compared with 1.37 and 2.94 mg/g in locally grown alfalfa and orchard grass hay. The pheophorbide a levels ranged from 3.36 to 89.87 μg/g in alfalfa samples compared with 81.39 and 42.33 μg/g in control alfalfa and orchard grass hay samples. These findings eliminate chlorophyll a, chlorophyll b, and pheophorbide a as possible causes for alfalfa-hay induced primary photosensitisation.

**Liver fluke survey**

This study by Aoife Quigley and colleagues in Ireland determined the prevalence of Fasciola hepatica infection in horses in Ireland, and evaluated an indirect ELISA as a diagnostic tool.

Horses (n = 200) selected at random at an abattoir were categorised into four groups based on their ante-mortem health status at ante-mortem examination. On gross post-mortem examination, liver samples were graded from 1 to 6 (1 being lack of visible pathology, through mild to moderate changes, and 6 observation of fluke in the liver). Periductular fibrosis, periductular cellular infiltrates and hyperplastic changes in the biliary epithelium were graded from 0 to 3 giving a maximum score of 9. Blood was collected for haematology, biochemistry and an indirect ELISA test based on F. hepatica recombinant cathepsin L1 antigen (CL1) and faecal egg counts (FEC) were performed.

The prevalence of liver fluke infection was 9.5% (19 of 200 horses). Most of the positive horses had clinical grade 2 (lesions of no clinical significance) or 3 (evidence of underlying chronic disease), with only four showing nonspecific signs of current clinical disease, highlighting that liver fluke infection is often subclinical. In 16 of the 19 positive cases, adult fluke were seen in the liver. In fluke positive horses, the mean histological score was 6.5 (of a maximum 9), compared with 2.2 in the fluke-negative horses.

There was no association between fluke status and total protein, albumin/globulin ratio and eosinophilia although these variables were strongly associated with strongyle infection. There was also no association between fluke and any of the biochemical parameters (including GGT activity) and bile acid concentrations (an indicator of liver function) were within normal limits in all horses. Importantly, this suggests that haematology and blood biochemistry are not reliable for detecting potentially affected horses. When the recombinant CL1 ELISA results were compared with the fluke status (based on post-mortem findings and FEC), the ELISA had low sensitivity (42.1%) but high specificity (95.6%), suggesting that the immune response to fluke infection in horses may be different to other species in which similar ELISA tests are more sensitive.

Fluke eggs were observed on faecal sedimentation in six horses, four of which also had adult fluke on gross post-mortem. The faecal coproantigen ELISA was performed on samples from 42 horses and failed to detect infestation in any of them, including six which had adult fluke on gross post-mortem, showing this to be a very unreliable diagnostic tool.

The results of this study show that blood markers and the faecal coproantigen ELISA are not reliable tests for fluke infection. The recombinant CL1 ELISA has a high specificity but low sensitivity. Other methods of ante-mortem diagnosis warrant investigation.

**Oral glucose test repeatability**

In this study Melody de Laat and Martin Silience from Australia aimed to determine the repeatability of an oral glucose test in ponies.

The oral glucose tolerance test is commonly used to detect insulin dysregulation. The standard protocol involves feeding 1 g/kg bodyweight of D-glucose (dextrose) powder in bran and collecting postprandial blood samples for insulin. These researchers used 0.75 g/kg bwt D-glucose for greater palatability, mixed with a fixed amount of wheat bran and lucerne chaff. Of 12 ponies originally sourced for the study, 8 were finally included as they showed good acceptance of the glucose test diet.

First a repeatability study was undertaken: following overnight fasts, oral glucose tests were performed on two ponies at a time (to ensure consistent washout periods) on three separate occasions over a three-week period. Blood glucose and serum insulin concentrations were taken before the glucose meal, and at 90 and 180 min and 24 h. Blood glucose levels were also measured immediately after feeding. Blood insulin and glucose concentration were higher than basal concentrations after the D-glucose feed in all horses and had returned to baseline within 24 h. Overall, insulin concentrations did not alter significantly in individuals between the three tests and there was no significant difference in insulin concentrations at different time points after feeding. Glucose results showed a higher degree of variability than insulin concentrations, particularly in the postprandial samples. Overall the oral glucose test had a...
good degree of repeatability in most ponies; however, there was a large degree of variability in one individual pony, indicating that the test may not be reliable in all individuals and results must be interpreted within the individual clinical context. The study also demonstrated that blood sampling at around 2 h post-feeding as per the current recommendations is suitable for achieving diagnostic results.

As some ponies found the test diet unpalatable, an alternative test diet consisting of commercial cereal-based pellets was explored. Pellets containing 0.75 g/kg bw of nonsoluble carbohydrate were mixed with wheat bran and lucerne chaff. Blood glucose and serum insulin concentrations with the pellets correlated well with those in the D-glucose diet and there was good agreement with improved compliance and better palatability.

The authors concluded that with D-glucose the oral glucose test has a good degree of repeatability in ponies under controlled conditions. A carbohydrate-based feed is a suitable alternative test substrate.

**Cartilage defect repair in horses**

This review article by Stefan Cokelaere and colleagues in the Netherlands discusses current strategies and recent developments in regenerative medicine of the equine joint with emphasis on the surgical approach.

Chondral and osteochondral lesions owing to injury or other pathology are highly prevalent conditions in horses and commonly result in the development of osteoarthritis and progression of joint deterioration. Regenerative medicine of articular cartilage is an emerging clinical treatment option for horses with articular cartilage injury or disease. Functional articular cartilage restoration, however, remains a major challenge, but the field is progressing rapidly and there is an increasing body of supportive clinical and scientific evidence. This review gives an overview of the established and emerging surgical techniques used for cartilage repair in horses.

**Colic in horses with ocular or orthopaedic disease**

This cross-sectional study by Nicole Scherrer and colleagues in the USA aimed to determine interval prevalence of and factors associated with colic in horses hospitalised for ocular or orthopaedic disease.

Medical records of 105 horses with ocular disease and 197 horses with orthopaedic disease admitted to a veterinary hospital over a one-year period were reviewed to determine whether colic (abnormal behaviour prompting abdominal palpation per rectum or nasogastric intubation) was observed during hospitalisation. Data were collected on putative risk factors for colic, including reason for admission, signalment, and medical or surgical interventions received.

No significant difference in interval prevalence of colic was identified between horses with ocular disease (8/105 [8%]) or orthopaedic disease (9/197 [5%]). However, horses with ocular disease differed significantly from other horses in median age (10 vs. 3 years, respectively); proportions of sexually intact males (3% vs. 30%); Thoroughbreds (28% vs. 62%), and those receiving general anaesthesia (65% vs. 80%); and median duration of hospitalisation (3 vs. 2 days). For every 1 mg/kg increase in daily NSAID dose, the odds of colic increased by 98%. No difference between groups was identified in median duration of colic (1 day), hospitalisation (7 vs. 3 days), or systemic NSAID administration (7 vs. 5 days).

Colic in both groups resolved with medical management for all horses except one with ocular disease.

Horses hospitalised for ocular disease were at no greater risk for colic than were horses hospitalised for orthopaedic disease. Medical management of colic appeared adequate for most horses.

**Role of palmar digital nerves in dorsal hoof wall sensation**

In this study C. Paz and colleagues in Brazil and the USA examined the hypothesis that the palmar digital nerves (PDNs), not the dorsal branches (DBs) of the digital nerves, innervate the sensitive dorsal laminae of the equine foot.

The authors evaluated the effects of perineural anaesthesia of the PDNs and DBs separately on pain sensation evoked via mechanical stimulation of the dorsal laminae and other regions of the equine foot in six clinically normal mares. A portable dynamometer was used to evaluate mechanical nociceptive thresholds at different points on the dorsal laminae, bulbs of the heel, coronary band and sole before and after the horses underwent perineural injection of PDNs or DBs with a local anaesthetic solution (treated group) or an isotonic saline solution (control group). Cornified tissue was removed from the sole and the dorsal aspect of the hoof wall before performing the evaluations.

Anaesthetising PDNs distal to the DBs increased mechanical nociceptive thresholds compared with baseline values at sites assessed in the dorsal laminae, sole, and the bulbs of the heels. Anaesthetising DBs increased mechanical nociceptive thresholds compared with baseline values only at sites assessed at the most proximal aspect of the foot (i.e. coronary band sites). The authors concluded that PDNs, not DBs, are primarily responsible for pain signal transmission evoked by pressure in the dorsal laminae of the foot of clinically normal horses.

S. WRIGHT

**References**


Although not well-known, *Leptospira interrogans* serovar Pomona can cause devastating problems. *L. pomona* can colonize in the kidneys, be shed in the urine and the horse can become septicemic, which can potentially lead to abortion, uveitis and acute renal failure. LEPTO EQ INNOVATOR® is the first *Leptospira* vaccine developed specifically for horses to help prevent leptospirosis caused by *L. pomona*. It also helps prevent infections of the blood, which could, but has not been demonstrated to, help reduce the potential risk of equine recurrent uveitis, abortion or acute renal failure caused by *L. pomona*. An efficacy trial demonstrated LEPTO EQ INNOVATOR safely helps prevent *L. pomona* infections and urinary shedding. A safety trial showed it was 99.8% reaction-free. To learn more, visit LEPTOEQINNOVATOR.com.

*Currently, there are no vaccines available with USDA-licensed label claims against equine abortions, uveitis or acute renal failure due to *L. pomona*. 

---

All trademarks are the property of Zoetis Inc., its affiliates and/or its licensors. ©2015 Zoetis Inc. All rights reserved. LEI-00011
ISELP has grown to over 800 Members World-Wide

Join Us in celebrating our 10th Year Anniversary in providing worldwide educational opportunities. Featured below is our second half of 2016 Three Day World-Wide Modules:

ONLINE REGISTRATION NOW OPEN

Registration Now Open for All Modules

- **Stifle & Thigh**
  At Hagyard Equine Lexington, KY
  August 25 - 27

- **Shoulder & Elbow**
  at Sporthorse Medical Diagnostic Centre
  Heesch, The Netherlands
  September 16-18

- **Hock & Crus**
  At Kleider Veterinary Services
  Langley, British Columbia
  Sept. 29 – Oct. 1

- **2 Day Advanced**
  Pre-Purchase Exam
  Clinique de Grosbois
  Boissy St. Leger, France
  October 26 - 27

- **Prox. Susp. To Distal Hind Limb**
  At Clinique de Grosbois
  Boissy Saint Leger, France
  October 28-30

VISIT US AT BEVA & AAEP
Watch the ISELP Web Site
For More Information

For More Information Please Visit www.iselp.org

www.iselp.org  540-687-4663  info@iselp.org
Case Report

Primary hyperparathyroidism in a 17-year-old Arab × Welsh Cob pony mare with a functional parathyroid adenoma

H. J. Cottle†, K. J. Hughes‡, H. Thompson§, P. E. J. Johnston# and A. W. Philbey*†

†Southern Veterinary Centre, Invercargill, New Zealand; ‡School of Animal and Veterinary Sciences, Charles Sturt University, Wagga Wagga, New South Wales, Australia; §Mill House, Camis Eskan, Helensburgh, UK; #School of Veterinary Medicine, University of Glasgow, Glasgow, UK; and *Royal (Dick) School of Veterinary Studies, University of Edinburgh, Edinburgh, UK.

*Corresponding author email: adrian.philbey@ed.ac.uk

Keywords: horse; primary hyperparathyroidism; parathyroid adenoma; osteodystrophia fibrosa; osteopenia; 99mTc-technetium-sestamibi scintigraphy

Summary

Primary hyperparathyroidism was identified in a 17-year-old Arab × Welsh Pony mare that experienced weight loss for 6 months and was presented with mild facial asymmetry, right forelimb lameness and weight shifting amongst all limbs. Osteodystrophia fibrosa was demonstrated on radiographic examination of the head and there was radiographic evidence of osteopenia of the appendicular skeleton. The horse had persistent hypercalcaemia (4.0 mmol/l), hypophosphataemia (0.59 mmol/l) and an increased concentration of circulating parathyroid hormone (1401 pg/ml). On scintigraphic examination, a subjective focal increase in uptake of 99mTc-technetium-sestamibi was identified in the right thyroid gland and at the thoracic inlet in delayed images. Surgical exploration of the thyroid region was undertaken. One year later, the horse developed a pathological fracture of the third metacarpal bone and was subjected to euthanasia. At post mortem examination, a parathyroid adenoma was found at the level of the thoracic inlet adjacent to the trachea. Gross and histological examination also confirmed severe osteodystrophia fibrosa and osteopenia.

Introduction

Primary hyperparathyroidism is rare in horses and may result from functional parathyroid adenomas (Bienfet et al. 1964; Peauroi et al. 1998; Wong et al. 2004; Tomlinson et al. 2014) or parathyroid hyperplasia (Toribio 2004), or may be idiopathic (Roussel and Thatcher 1987; Frank et al. 1998). Persistent hypercalcaemia, hypophosphataemia and increased parathyroid hormone (PTH) concentrations are consistent with a diagnosis of primary hyperparathyroidism (Roussel and Thatcher 1987; Peauroi et al. 1998; Wong et al. 2004). Clinical signs of primary hyperparathyroidism in the horse include weight loss, facial swelling, inappetence, difficulty eating and shifting lameness (Frank et al. 1998; Wong et al. 2004).

Although technetium (99mTc)-sestamibi scintigraphy is frequently used in human patients to locate abnormal parathyroid tissue, the use of this technique in the horse has met with mixed success (Wong et al. 2004; Tomlinson et al. 2014). This report describes the presentation, clinicopathological findings, diagnostic procedures, treatment and outcome in a pony with primary hyperparathyroidism due to a functional parathyroid adenoma.

History

A 17-year-old Arab × Welsh Cob pony mare was presented to the Weipers Centre Equine Hospital at the University of Glasgow in July 2007 for investigation of weight loss of 6 months duration. The horse had been treated regularly with anthelmintic drugs. Lameness involving the right forelimb had developed 2 weeks prior to presentation.

Clinical examination

On presentation, the mare was thin (body condition score 3/9; Fig 1a), weighed 225 kg and had a dull demeanour. Heart and respiratory rates were 48 beats/min and 18 breaths/min, respectively. Grade 4/5 lameness involving the right forelimb and persistent weight shifting amongst all limbs was present. Hoof testers applied to the heel of the right forefoot and flexion of the joints of the distal right forelimb elicited mild painful responses. The pony had marked dorsopalmar hoof imbalance of both forelimbs.

Nonpainful firm swellings were identified at the rostral aspect of the facial crest bilaterally (Fig 1b). Slow mastication and dropping of feed from the mouth were observed when a small concentrate meal was offered. Oral examination revealed malocclusions of the dental arcades (‘shear mouth’ and ‘wave mouth’), which were corrected using manual dental floating equipment. No evidence of periapical accumulation of food or loosening of teeth was identified. There were no abnormal findings on transrectal palpation of the abdomen. Following dental intervention, phenylbutazone (Equipalazone Injection, Equipalazone Powder 2.2 mg/kg bwt i.v. followed by 2.2 mg/kg bwt per os q. 24 h) was administered for 6 days. Slow mastication of food was observed during the first 2 days of hospitalisation. On Day 7, the mare exhibited a good appetite and no right forelimb lameness was observed at the walk. Clinical ancillary testing was undertaken to determine the cause of the weight loss.

Diagnostic investigations and case management

Clinical pathology

Blood biochemical analysis at admission (Day 0) revealed hypercalcaemia, hypophosphataemia, and an increased serum alkaline phosphatase (ALP) activity (Table 1). Haematological analysis, blood gas analysis and urinalysis, including fractional excretion (FE) of chloride, sodium and potassium, were within normal limits (Table 2).

© 2014 EVJ Ltd
Hypercalcaemia, hypophosphataemia and increased ALP activities persisted on Days 6 and 13 (Table 1). The ionised calcium (iCa²⁺) concentration was increased (Day 6; Table 3). There were no abnormal findings on cytological and biochemical analysis of peritoneal fluid obtained by abdominocentesis.

**TABLE 1: Blood biochemical examination results for a 17-year-old Arab × Welsh Cob pony mare with primary hyperparathyroidism**

<table>
<thead>
<tr>
<th>Parameter</th>
<th>Day 0</th>
<th>Day 6</th>
<th>Day 13</th>
<th>Day 33</th>
<th>Day 47 (post surgery)</th>
<th>Reference range</th>
<th>Unit</th>
</tr>
</thead>
<tbody>
<tr>
<td>Sodium</td>
<td>137</td>
<td>133</td>
<td>132</td>
<td>136</td>
<td>139</td>
<td>130–151</td>
<td>mmol/l</td>
</tr>
<tr>
<td>Potassium</td>
<td>3.3</td>
<td>3.6</td>
<td>3.6</td>
<td>4.0</td>
<td>2.5</td>
<td>2.6–5.2</td>
<td>mmol/l</td>
</tr>
<tr>
<td>Chloride</td>
<td>103</td>
<td>103</td>
<td>104</td>
<td>100</td>
<td>104</td>
<td>94–113</td>
<td>mmol/l</td>
</tr>
<tr>
<td>Total calcium</td>
<td>4.01</td>
<td>4.58</td>
<td>4.74</td>
<td>4.34</td>
<td>4.44</td>
<td>2.78–3.30</td>
<td>mmol/l</td>
</tr>
<tr>
<td>Phosphate</td>
<td>0.6</td>
<td>0.7</td>
<td>0.6</td>
<td>0.8</td>
<td>0.7</td>
<td>0.9–2.1</td>
<td>mmol/l</td>
</tr>
<tr>
<td>Alkaline phosphatase</td>
<td>605</td>
<td>683</td>
<td>614</td>
<td>517</td>
<td>606</td>
<td>&lt;280</td>
<td>U/l</td>
</tr>
<tr>
<td>Aspartate aminotransferase</td>
<td>179</td>
<td>163</td>
<td>154</td>
<td>133</td>
<td>266</td>
<td>&lt;240</td>
<td>U/l</td>
</tr>
<tr>
<td>Total plasma protein</td>
<td>68</td>
<td>74</td>
<td>73</td>
<td>73</td>
<td>72</td>
<td>60–83</td>
<td>g/l</td>
</tr>
<tr>
<td>Albumin</td>
<td>28</td>
<td>28</td>
<td>29</td>
<td>30</td>
<td>29</td>
<td>26–35</td>
<td>g/l</td>
</tr>
<tr>
<td>Globulin</td>
<td>40</td>
<td>46</td>
<td>44</td>
<td>43</td>
<td>43</td>
<td>30–55</td>
<td>g/l</td>
</tr>
<tr>
<td>Blood urea nitrogen</td>
<td>5.3</td>
<td>4.5</td>
<td>4.0</td>
<td>4.7</td>
<td>4.0</td>
<td>&lt;6.8</td>
<td>mmol/l</td>
</tr>
<tr>
<td>Creatinine</td>
<td>94</td>
<td>102</td>
<td>101</td>
<td>91</td>
<td>109</td>
<td>62–140</td>
<td>μmol/l</td>
</tr>
</tbody>
</table>

**TABLE 2: Calculated fractional excretion (FE) rates of a 17-year-old Arab × Welsh Cob pony mare with primary hyperparathyroidism (Day 33)**

<table>
<thead>
<tr>
<th>Electrolyte</th>
<th>FE (%)</th>
<th>Reference values (%)</th>
</tr>
</thead>
<tbody>
<tr>
<td>Sodium</td>
<td>0.29</td>
<td>&lt;1.00</td>
</tr>
<tr>
<td>Chloride</td>
<td>1.23</td>
<td>&lt;2.00</td>
</tr>
<tr>
<td>Potassium</td>
<td>18.7</td>
<td>1.0–65.0</td>
</tr>
<tr>
<td>Calcium</td>
<td>1.64</td>
<td>&gt;2.50</td>
</tr>
<tr>
<td>Phosphorus</td>
<td>7.98</td>
<td>&lt;0.75</td>
</tr>
</tbody>
</table>

Hypercalcaemia, hypophosphataemia and increased ALP activities persisted on Days 6 and 13 (Table 1). The ionised calcium (iCa²⁺) concentration was increased (Day 6; Table 3). There were no abnormal findings on cytological and biochemical analysis of peritoneal fluid obtained by abdominocentesis.

**Radiography**

Digital radiographic (Indico 100 RF generator², Q5 3.5: Agfa CR³) views of the head (laterolateral, left and right oblique, and dorsoventral) and distal forelimbs (lateromedial and dorsoopalmar) were obtained. Multiple smooth radiodensities adjacent to the maxillary and mandibular premolars and molars, loss of premolar and molar periodontal lamina dura denta and generalised osteopenia of the bones of the skull were identified (Fig 2a). A prominent fine trabecular pattern in the medullary cortices and a marked reduction in the osteodensity of the third metacarpal bone, proximal sesamoid bones and phalanges were identified bilaterally (Fig 2b and c).

**Endoscopy**

Endoscopic (Storz 3 m Videoendoscope)⁴ examination of the oesophagus and stomach performed after withholding feed for 18 h revealed generalised hyperkeratosis of the squamous mucosa of the stomach. There were no abnormal findings on endoscopic examination of the upper respiratory tract, gullet pouches and nasal passages.

**Oral glucose absorption test**

An oral glucose absorption test (OGAT) revealed a peak in blood glucose concentration 48% above the fasting blood glucose concentration 90 min after administration of 1 g glucose/kg bwt in a 20% solution via nasogastric tube. The blood glucose concentration returned to the baseline concentration after 210 min. Similar results were obtained in an OGAT repeated 4 days later. The OGAT results were considered to be equivocal, since they could have reflected partial malabsorptive capacity of the small intestine or a variation of normal (Mair et al. 1991). The fasting serum insulin concentration (Immulite 2000)⁵ was normal, indicating that the reduced glucose peak in this pony was not due to hyperinsulinaemia.
Rectal biopsy

A biopsy sample of the rectal mucosa was obtained using a mare endometrial biopsy instrument with the pony sedated (detomidine: Dormosedan® 0.01 mg/kg bwt i.v.). Histological examination of the sample identified a moderate, diffuse infiltration of lymphocytes and plasma cells, along with a lower density of eosinophils into the lamina propria, consistent with mild lymphocytic-plasmacytic proctitis.

In view of the histological appearance of the rectal biopsy sample suggestive of inflammatory bowel disease and equivocal OGAT results, administration of dexamethasone7 (Dexadresson 2 mgs/ml, Dimazon 5% Solution, Depocillin, 0.1 mg/kg bwt i.v. q. 24 h for 2 days), followed by prednisolone (5 mg tablets)8 (1 mg/kg bwt per os q. 24 h for 2 weeks, then 1 mg/kg bwt per os every other day for 7 days) was commenced on Day 10 in an attempt to manage any malabsorptive component of the weight loss. The mare was discharged from hospital on Day 13. At re-examination of the mare at the hospital on Day 33, there was a marked improvement in demeanour; however, the body condition and bodyweight were unchanged. Blood biochemical examination findings were similar to Day 0 values (Table 1). Results of qualitative urinalysis were unremarkable; however, FE of calcium was decreased, FE of phosphorus was increased and FE values for sodium, chloride and potassium were normal (Table 2).

PTH and PTH-related protein assays

Whole blood collected on Day 6 identified an increased concentration of intact PTH (1401 pg/ml, reference value <10)9 and a normal concentration of PTH-related protein (<0.2 pg/l, reference value <1)9, consistent with primary hyperparathyroidism. In view of these results, further diagnostic investigations were undertaken in an attempt to identify abnormal parathyroid gland tissue in the mare.

Ultrasonography

Ultrasonographic imaging of the ventral neck from the mandible to the thoracic inlet was performed using a 13.5 MHz linear array transducer (Sonoline Elegra®). There were discrete areas of heterogeneous echogenicity (approximately 7 x 5–6 mm) within the cranial poles of both the left and right lobes of the thyroid gland, consistent with the cranial parathyroid glands (Fig 3a and b). Several small heterogeneous areas of echogenicity caudal to both lobes of the thyroid gland and a discrete (20 mm diameter) area of heterogeneous echogenicity at the level of the thoracic inlet between the left and right jugular veins and common carotid arteries were identified (Fig 4). There were no abnormal findings on imaging of the abdomen and thorax using a 4–7 MHz convex transducer5.

Scintigraphy

The mare was sedated (detomidine6 0.01 mg/kg bwt i.v.) and a 99mTc-sestamibi scintigraphic scan of the neck was performed from the ramus of the mandible to the thoracic inlet (Wong et al. 2004). Lateral and ventrodorsal images were acquired at 15 and 45 min, and 1, 2, 3, 4, 6 and 8 h, after

| TABLE 3: Concentrations of ionised calcium (iCa²⁺) in whole blood measured during hospitalisation in a 17-year-old Arab x Welsh Cob pony mare with primary hyperparathyroidism |
|----------------|---|---|---|---|
|               | Day 6 | Day 39 | Day 42 | Day 43 |
| iCa + concentration | >2.5 | 2.36 | 1.84 | 2.46 |
| Reference range | 1.50–1.80 | Unit | mmol/l |

© 2014 EVJ Ltd
intravenous administration of 2.5 GBq $^{99m}$Tc-sestamibi (Cardiolite)$^{10}$, using a large field-of-view scintillation camera with a low energy, all-purpose collimator Nucline X-Ring/R$^{11}$, and processed using software MicasXplus Version 5.2$^{12}$ software. Initial images revealed uptake of the radiopharmaceutical agent in areas attributable to the thyroid and salivary glands bilaterally (Fig 5a and b), and focally at the thoracic inlet (Fig 5c). In delayed images obtained 4 h later, a subjective increase in uptake and reduced radiopharmaceutical clearance was identified in the region of the right lobe of the thyroid gland in comparison with the left thyroid gland (Fig 5d and e) and at the level of the thoracic inlet (Fig 5f).

Cytological analysis of fine needle aspirates obtained from the region of the thoracic inlet mass identified lymphocytes consistent with lymphoid tissue. Although inconclusive, the scintigraphic and ultrasonographic findings suggested that the right lobe of the thyroid gland and the thoracic inlets were possible sites of abnormal parathyroid tissue.

**Surgery**

**Preanaesthetic patient preparation**

Surgical exploration of the region of the thyroid gland under general anaesthesia was planned in an attempt to identify and remove abnormal parathyroid gland tissue. Surgical exploration of the thoracic inlet was not undertaken because of concerns of not achieving adequate access and the risk of iatrogenic damage to vital structures due to the proximity to the jugular veins, carotid arteries and vagosympathetic trunk.

Preanaesthetic diuresis was performed in an attempt to lower the concentration of iCa$^{2+}$ in peripheral blood. Furosemide$^{7}$ (1 mg/kg bwt i.v. b.i.d.) and a polyionic electrolyte solution (30 g each of sodium chloride, potassium chloride and sodium bicarbonate in 5 l of water via nasogastric tube b.i.d.) were administered for 3 days preceding surgery. Intravenous 0.9% NaCl$^{13}$ (100 ml/kg bwt /day) was administered during the 24 h preceding anaesthesia. Post diuresis, the iCa$^{2+}$ concentration was reduced in comparison to the prediuresis value and approached the upper limit of the reference range (Table 3).

**Electrocardiography**

Electrocardiography (Televet 100)$^{14}$ performed prior to diuresis, using a base-apex lead configuration, revealed a heart rate of 21–31 beats/min, P wave duration of 120 ms, PR interval of 280 ms, QRS duration of 146 ms, QT interval of 544 ms and sinus rhythm with occasional sinoatrial block; these findings were considered to be within normal physiological limits. Electrocardiography performed after diuresis was normal.

**Anaesthesia and surgery**

The mare was premedicated with romifidine (Sedivet)$^{15}$ (0.1 mg/kg bwt i.v.). General anaesthesia was induced by intravenous administration of ketamine (Narketan 10)$^{16}$ (2.4 mg/kg bwt i.v.) and diazepam (Diazepam Injection)$^{17}$ (0.05 mg/kg bwt i.v.), and maintained using inhalational isoflurane (Isoflo)$^{18}$ and 100% oxygen. The mare was positioned in dorsal recumbency, with the head extended,
Fig 5: Scintigraphic images obtained 15 min (initial phase: a, b and c) and 4 h (delayed phase: d, e and f) after injection of 99mTc-sestamibi in ventrodorsal (a and d) and lateral (b and e) views of the head and ventrodorsal views of the caudal cervical region and thoracic inlet (c and f). Intense radiopharmaceutical uptake is seen in both lobes of the thyroid gland (solid black arrows) and salivary glands (open arrows) at 15 min (a and b). Focal uptake is also evident at the thoracic inlet (white arrow) at 15 min (c). There is evidence of increased uptake and delayed clearance in the right thyroid gland lobe region (solid black arrow) when compared to the left side at 4 h after injection of 99mTc-sestamibi (d and e). Delayed clearance is evident focally at the level of the thoracic inlet (white arrow) at 4 h (f).

and a linear ventral midline incision was made from the level of the larynx caudally for 20 cm to expose the left and right lobes of the thyroid gland. The right lobe of the thyroid gland was larger and the cranial pole was firmer than that of the left lobe. A firm, nodular mass, 5 × 5 × 5 mm, corresponding to the region of heterogeneous echogenicity detected during ultrasonographic examination, was identified caudal to the right lobe of the thyroid gland. Surgical exploration of the left lobe and surrounding tissue was unremarkable. The right lobe of the thyroid gland and the nodular mass were removed and fixed in 10% neutral buffered formalin for histological examination. After closure of the surgical incision, recovery from anaesthesia was uneventful. Procaine penicillin G7 (33,000 iu/kg bwt i.m. b.i.d.) and flunixin meglumine (Finadyne Solution)19 (1 mg/kg bwt i.v. b.i.d.) were administered post operatively for 2 days, followed by phenylbutazone2 (2.2 mg/kg bwt per os q. 24 h) for a further 4 days.

Post surgical management
Following surgery, the mare remained bright, exhibited a capricious appetite and was discharged. The blood concentration of iCa2+ was increased 24 h after surgery (Day 43 post admission; Table 3) and total hypercalcaemia and hypophosphataemia were evident 5 days after surgery (Table 1), indicating failure to remove the source of excessive PTH production. Histological examination identified normal thyroid tissue in the right lobe and lymphoid tissue in the nodular mass. No parathyroid tissue was identified in either sample. Follow-up information obtained 8 months later via a telephone call revealed the pony to be bright in demeanour and exhibiting a good appetite; however, there had been no appreciable gain in body condition. Subsequently, the pony was subjected to euthanasia after developing a pathological fracture of the right third metacarpal bone and was submitted for post mortem examination in June 2008, approximately 10 months after initial presentation.

Post mortem examination
Gross pathological examination confirmed the presence of an open fracture of the right third metacarpal bone, with contusion and haemorrhage in the surrounding tissue (Fig 6a). Pathological fractures surrounded by haemorrhage were present in the 7th to 16th ribs on the right side of the thorax. There was evidence of widespread osteopenia and osteodystrophia fibrosa, with marked loss of bone density and variable thickening of the cortices of multiple bones due to deposition of soft, spongy, mineralised, periosteal bone. Affected bones of the head included the mandible (Fig 6b), maxilla and nasal turbinates (Fig 6c). The long bones exhibited osteopenia (Fig 7a). Several long bones contained proliferative endosteal nodules of bone within the medullary cavity (Fig 7b). A 2 cm diameter, encapsulated, nodular mass, with a reddened surface and an off-white homogeneous centre, was located in the adventitia adjacent to the right side of the trachea at the level of the thoracic inlet (Fig 8a). On histological examination, the mass consisted of sheets and packets of polygonal neuroendocrine cells in a fine fibrous connective tissue stroma, with palisading around blood vessels (Fig 8b). The cells had round, heterochromatic nuclei, 1–3 basophilic nucleoli and moderate amounts of pale, vacuolated, eosinophilic cytoplasm. The mitotic index was low (<1 mitosis/10 high power fields). Apart from mild scarring at the site of previous surgical biopsy of the right lobe, the thyroid gland was grossly and histologically unremarkable. The pathological diagnoses were parathyroid adenoma, osteopenia, osteodystrophia fibrosa and pathological fracture of the right third metacarpal bone.

Discussion
A clinical diagnosis of primary hyperparathyroidism was made in this pony due to the findings on physical examination and the presence of persistent hypercalcaemia and hypophosphataemia, increased plasma concentration of PTH.
and normal plasma concentration of PTH-related protein. Post mortem examination confirmed the presence of a parathyroid adenoma on the right side of the trachea at the level of the thoracic inlet.

In some equine cases with primary hyperparathyroidism, functional parathyroid adenomas have been identified in the neck or thoracic inlet (Bienfet et al. 1964; Peaurou et al. 1998; Wong et al. 2004; Tomlinson et al. 2014). In other reported cases of primary hyperparathyroidism in horses, no tumours or other sources of PTH were identified (Roussel and Thatcher 1987; Frank et al. 1998). Similar to the present case, Wong et al. (2004) identified a parathyroid adenoma at the thoracic inlet in a 20-year-old Quarter Horse gelding at post mortem examination; in this horse, 99mTc-sestamibi scintigraphy, ultrasonography and exploratory surgery, limited to the region of the neck, failed to identify the site of the tumour. In contrast, Tomlinson et al. (2014) identified a parathyroid adenoma at the thoracic inlet of a 20-year-old Welsh pony gelding using 99mTc-sestamibi scintigraphy and ultrasonography, and successful surgical removal and resolution of clinical and laboratory abnormalities attributed to primary hyperparathyroidism was achieved. In the horse of the current report, the focal region of reduced radiopharmaceutical clearance at the level of the thoracic inlet 4 h after injection of 99mTc-sestamibi is consistent with the post mortem examination finding of a parathyroid adenoma at the thoracic inlet, similar to the scintigraphic findings of Tomlinson et al. (2014).

Hypercalcaemia in the horse can be associated with chronic renal failure, 1,25(OH)2D3 toxicity (hypervitaminosis D), humoral hypercalcaemia of malignancy (paraneoplastic syndrome) or primary hyperparathyroidism (Toribio 2004). In the mare reported here, several causes of hypercalcaemia were excluded on the basis of clinical and laboratory findings. Chronic renal failure in the horse is not associated with development of renal secondary hyperparathyroidism and was ruled out in this case because of the absence of azotaemia and the normal FE values for sodium, chloride and potassium (Brobst et al. 1982). Ingestion of compounds or plants containing high concentrations of vitamin D results in hyperphosphataemia and hypercalcaemia (Mello 2003; Toribio 2004), and horses with hypervitaminosis D have low serum PTH concentrations and radiographic evidence of increased bone density (Toribio 2004), in contrast with the findings of the pony in the present study. Furthermore, the mare had hypophosphataemia and there was no evidence of exposure to sources of excess vitamin D.
Primary hyperparathyroidism is characterised by autonomous hypersecretion of PTH by parathyroid glandular tissue and failure of the parathyroid glands to respond to negative feedback from increasing plasma concentrations of iCa$^{2+}$ or 1,25(OH)$_2$D$_{3}$ (Marx 2000; Toribio 2004; Wong et al. 2004). Excessive concentrations of PTH lead to increased osteoclast activity and bone resorption (and mobilisation of calcium), increased reabsorption of calcium and magnesium by the renal tubules, decreased reabsorption of phosphorus and increased synthesis of 1,25(OH)$_2$D$_{3}$, resulting in hypercalcaemia, hypophosphataemia, increased urinary FE of phosphorus, decreased FE of calcium and clinical signs associated with loss of cortical bone (Marx 2000; Toribio 2004).

The pony in the current report had clinical signs similar to those reported in previous cases of primary hyperparathyroidism in horses, including weight loss, inappetence, lameness, weight-shifting, osteodystrophia fibrosa and dental malocclusions (Frank et al. 1998; Peauroi et al. 1998; Wong et al. 2004; Tomlinson et al. 2014). Osteodystrophia fibrosa resulting from excessive PTH-mediated bone resorption and proliferation of fibro-osseous connective tissue within the medullary cavity was identified clinically, radiographically and pathologically in the pony in the present study, similar to previous reports of primary (Peauroi et al. 1998) and nutritional secondary (Krook and Lowe 1964) hyperparathyroidism in horses.

Scintigraphy using $^{99m}$Tc-sestamibi was used in the pony in this case in an attempt to detect abnormal parathyroid tissue. This nuclear imaging technique has been used to detect primary parathyroid tumours in human patients (Taillefer et al. 1992) and dogs (Mathwichuk et al. 1996, 2000), but has had mixed success in horses (Wong et al. 2004; Tomlinson et al. 2014). $^{99m}$Tc-sestamibi is concentrated in the thyroid and parathyroid glands after intravenous administration, resulting in intense radiopharmaceutical uptake in the initial phase at 15 min. In normal functioning thyroid and parathyroid glands, $^{99m}$Tc-sestamibi activity decreases over time, such that no activity should remain in the delayed phase 3–4 h later (Taillefer et al. 1992). In hyperfunctional parathyroid glands, persistence of $^{99m}$Tc-sestamibi activity is detected as focal uptake in the delayed phase. Scintigraphic findings in the pony in the present investigation were suggestive of delayed clearance of $^{99m}$Tc-sestamibi from the region of the right lobe of the thyroid gland and/or associated parathyroid gland tissue, and from a discrete region at the thoracic inlet.

Fig 8: a) Gross appearance of the parathyroid adenoma (arrow) located at the thoracic inlet. b) Histological appearance of the parathyroid adenoma, showing sheets and packets of polygonal neuroendocrine cells. Original magnification 200×. Bar = 50 μm.

Excessive production of PTH-related protein by neoplastic tissue (humoral hypercalcaemia of malignancy) is a paraneoplastic syndrome that has been associated with squamous cell carcinoma of the stomach and vulva, ameloblastoma, multiple myeloma, adrenocortical carcinoma and lymphosarcoma in the horse (Fix and Miller 1987; Mair et al. 1990; Barton et al. 2004; Toribio 2004). The concentration of PTH-related protein in the mare reported here was within the reference range, indicating that humoral hypercalcaemia of malignancy was not the cause of the hypercalcaemia, and the only neoplastic process detected on post mortem examination was the parathyroid adenoma.

While nutritional secondary hyperparathyroidism results in increased blood concentrations of PTH and similar clinical findings to primary hyperparathyroidism (including osteodystrophia fibrosa, shifting lameness, difficulty eating and weight loss), important clinicopathological differences exist. Hyperphosphataemia and normocalcaemia or hypocalcaemia are evident in nutritional secondary hyperparathyroidism (Krook and Lowe 1964; Roussel et al. 1987; Benders et al. 2001). In contrast, primary hyperparathyroidism is characterised by persistent hypercalcaemia, hypophosphataemia and phosphaturia, as observed in the mare reported here (Table 2). In addition, there was no dietary history to suggest insufficient calcium intake, excessive phosphorous intake or ingestion of oxalates, as found in cases of nutritional secondary hyperparathyroidism.

Osteodystrophia fibrosa resulting from excessive PTH-mediated bone resorption and proliferation of fibro-osseous connective tissue within the medullary cavity was identified clinically, radiographically and pathologically in the pony in the present study, similar to previous reports of primary (Peauroi et al. 1998) and nutritional secondary (Krook and Lowe 1964) hyperparathyroidism in horses.

In the present case, scintigraphy using $^{99m}$Tc-sestamibi was performed to detect abnormal parathyroid tissue. However, the nuclear imaging technique had limited success in horses, with mixed results in previous studies (Wong et al. 2004; Tomlinson et al. 2014). The scintigraphic findings in the pony were suggestive of delayed clearance of $^{99m}$Tc-sestamibi from the region of the right lobe of the thyroid gland and/or associated parathyroid gland tissue, and from a discrete region at the thoracic inlet.
removal of a parathyroid adenoma from the thoracic inlet of a pony has been described recently (Tomlinson et al. 2014). In the present case, it is speculated that the focal increased activity in the region of the thoracic inlet during 99mTc-sestamibi scintigraphic examination was associated with the parathyroid adenoma identified during post mortem examination.

Treatment of primary hyperparathyroidism in dogs, human beings and horses involves medical management of hypercalcaemia or surgical removal of abnormal parathyroid tissue (Matwichuk et al. 1996; Marx 2000; Tomlinson et al. 2014). Medical management of hypercalcaemia includes volume expansion to induce diuresis, reduction of calcium intake and administration of bisphosphonates to reduce bone resorption and furosemide, which facilitate renal tubular excretion of calcium (Max 2000). Medical management of primary hyperparathyroidism was not attempted in this case due to concerns regarding the adverse effects of long-term treatment with furosemide and the lack of information on the use of bisphosphonates for this purpose in horses.

The 4 parathyroid glands in the horse are small and variably positioned. The cranial glands are located craniodorsal to the cranial pole of the thyroid gland, whereas the caudal glands are located adjacent the distal third of the trachea or at the bifurcation of the bicarotid trunk (Krook and Lowe 1964; Toribio 2004), making identification and surgical removal of abnormal tissue difficult. Successful surgical removal of a parathyroid adenoma has been reported in 2 cases of primary hyperparathyroidism in the horse (Bienfet et al. 1964; Tomlinson et al. 2014). The ultrasonographic findings of ovoid regions of heterogeneous echogenicity at the level of the cranial pole of each lobe of the thyroid gland in the pony of this report were consistent with the location of the cranial parathyroid glands.

Localisation of the tumour and treatment of primary hyperparathyroidism in horses is challenging. Although associated with a poor long-term prognosis, a diagnosis of primary hyperparathyroidism does not necessitate immediate euthanasia. Between the period of surgery and euthanasia, the pony failed to gain body condition; however, the owner reported no further signs of shifting lameness or inappetence. The case reported by Roussel and Thatcher (1987) remained clinically healthy 20 months following admission, whereas the horse with primary hyperparathyroidism reported by Wong et al. (2004) was subjected to euthanasia 4 days following surgery due to signs of depression, lethargy, inappetence and serum biochemical evidence of acute renal failure. Post operative complications in the pony reported by Tomlinson et al. (2014) included acute kidney injury, hypocalcaemic tetany, tremors, severe electrolyte derangements, anaemia and tachycardia. These complications were managed effectively and the pony was discharged home. A female mule with primary hyperparathyroidism also reported by Wong et al. (2004) was clinically well 2 years after discharge; surgical exploration failed to locate the source of PTH in this case.

In conclusion, primary hyperparathyroidism should be considered in horses presenting with hypercalcaemia and hypophosphataemia where chronic renal failure and humoral hypercalcaemia of malignancy have been excluded and an increased blood concentration of PTH is present. While short-term survival may occur after diagnosis of primary hyperparathyroidism in the horse, the long-term prognosis is poor without definitive surgical resolution of the condition, due to the effects of ongoing bone resorption, osteodystrophia fibrosa and the risks of pathological fracture.

Authors’ declaration of interests
No conflicts of interest have been declared.

Acknowledgements
The authors wish to thank staff at the Weipers Centre Equine Hospital, School of Veterinary Medicine, University of Glasgow, UK, for assistance with this case. Richard Irvine kindly assisted with the post mortem examination and photography. Staff in Veterinary Diagnostic Services, School of Veterinary Medicine, University of Glasgow, are also gratefully acknowledged for performing the clinical pathology testing and for preparing histological sections.

Manufacturers’ addresses
1Arnolds Veterinary Products, Halescott, Shrewsbury, Shropshire, UK.
2Communications & Power Industries, Georgetown, Ontario, Canada.
3Agfa Healthcare, Mortsel, Belgium.
4Karl Storz Endoscopy, Slough, Berkshire, UK.
5Sonoline Elegra, Siemens, Erlangen, Germany.
6Pfizer Animal Health, Sandwich, Kent, UK.
7Intervet, Walton, Milton Keynes, Buckinghamshire, UK.
8Milestone Veterinary, Clarborough, Nottinghamshire, UK.
9Cambridge Specialist Laboratory Services, Sawston, Cambridge, UK.
10Ben Venue Laboratories, Bedford, Ohio, USA.
12Bartec Medical Systems, Farnborough, Hampshire, UK.
13Vetivax, Ivex Pharmaceuticals, Larne, County Antrim, UK.
14Engel Engineering Service GmbH, Heusenstamm, Germany.
15Boehringer Ingelheim, Bracknell, Berkshire, UK.
16Vétoquinol, Buckingham, UK.
17Hamelin Pharmaceuticals, Gloucester, UK.
18Abbott Laboratories, Queeenborough, Kent, UK.
19Schering-Plough Animal Health, Welwyn Garden City, UK.

References
Continued on page 504
“I recommend ColiCare for all of my patients, and my own horses are enrolled, too!”

—Marsha Severt, DVM
Brown Creek Equine Hospital

ColiCare puts you back at the center of the horse’s wellness care and provides up to $7,500 of reimbursement to help ease the financial burden of colic surgery.

ColiCare™
from SMARTPak

SmartPak.com/ColiCare | 1-800-461-8898
Case Report

Osteochondral dysplasia of the coxofemoral joints in a Friesian foal: Clinical findings and methods of diagnosis

H. Hermans*†, S. Veraa‡, M. Ploeg§, S. Boerma#, H. A. W. Hazewinkel¶ and W. Back†¥

*Department of Equine Sciences, Faculty of Veterinary Medicine; †Division of Diagnostic Imaging, Department of Companion Animal Sciences, Faculty of Veterinary Medicine; ‡Division of Pathobiology, Faculty of Veterinary Medicine; §Division of Orthopaedics, Department of Clinical Sciences of Companion Animals, Faculty of Veterinary Medicine, Utrecht University, Utrecht; #Equine Clinic Garip, Garip, The Netherlands; and ¥Department of Surgery and Anaesthesiology of Domestic Animals, Faculty of Veterinary Medicine, Ghent University, Merelbeke, Belgium.

Keywords: horse; coxofemoral; osteoarthritis; osteochondral dysplasia; hip joints

Summary

Diseases of the coxofemoral (hip) joint are infrequently diagnosed in horses. Most cases are presented as an unilateral condition and usually are of traumatic origin. This case report describes a Friesian foal with a clinically obvious thoracolumbar kyphosis, combined with a weight-shifting stance and a shortened stride of both hindlimbs. General clinical and lameness examinations, computed tomographic examination of the pelvis, and macroscopic and histopathological examinations of the coxofemoral joints were performed. This revealed a final, phenotypical diagnosis of a primary osteochondral dysplasia of both coxofemoral joints with secondary osteoarthritides. Similar to the occurrence of this condition in other species and considering the small genetic basis of the Friesian horse breed, a genetic predisposing factor is suspected to play a key role in the developing mechanism of dysplastic coxofemoral joint disease in horses as illustrated with this case. Computed tomography scanning appears to be a useful imaging technique in the detection of coxofemoral joint disease in small horses and foals.

Introduction

The term ‘dysplasia’ derives from the Greek words dys (abnormal) and plasis (formation) and thus describes an abnormal development. Dysplasia of the coxofemoral joint has been described in numerous animal species, but in dogs it is the most common orthopaedic disease of large breeds (Fries and Remedios 1995; Ambjerg 1999; Keller et al. 1999; Piermattei 2006; Bracken and Ditchfield 2012; Bracken et al. 2012; Lopez 2012).

Coxofemoral joint disease in horses is, in contrast to the situation in dogs, not frequently diagnosed, while dysplastic hips are even more uncommon and diagnosed in only a few single case reports using radiographs only (Speirs and Wrigley 1979; Malark et al. 1992; Huggons et al. 2010). Recently, juvenile osteochondral conditions (JOCC) was proposed as a term in horses for developmental disorders related to immature joints or growth plates (Denoix et al. 2013). Osteochondral dysplasia is a more general term for a disorder of the development of bone and cartilage (Minor and Farnum 1988; Lachman 1998).

This case report describes a Friesian foal with osteochondral dysplasia of the coxofemoral joints, diagnosed noninvasively using computed tomography (CT). This condition, confirmed by macroscopic and histopathological examinations, has not been described previously in horses.

Case report

History

An 8-month-old Friesian colt (Foal 1) was admitted to the Equine Clinic of Utrecht University with thoracolumbar kyphosis, which had worsened progressively over the preceding few weeks (Fig 1). The foal had been treated with meloxicam (Metacam, 15 mg/ml)1 for several days, but there had been no improvement of the condition. The owner reported that the foal was reluctant to trot or galloping, and had a weight-shifting stance of both hindlimbs; no traumatic event was reported. The foal had not been weaned yet and was growing rapidly. The referring veterinarian noted swollen femoropatellar joints 3 weeks before referral and suspected the foal of having osteochondrosis. The foal was referred because of progressive worsening of the clinical signs. Two other 8-month-old Friesian foals (Foals 2 and 3) from different owners were admitted to the clinic around the same time for investigation of a disease unrelated to their coxofemoral joints and were used as clinical controls.

Clinical findings

Upon physical examination, the affected foal (Foal 1) was bright and alert and in good body condition. Its vital signs and complete blood count were within normal limits and no abnormalities at ophthalmic examination were found. The foal showed severe kyphosis and a weight-shifting stance of both hindlimbs (Fig 1) with shortened strides during walking and trotting. The femoropatellar joints were somewhat distended, but not painful on palpation. The foal showed bilaterally swollen and firm gluteal muscles. Pain could be induced by deep palpation of the longissimus dorsi muscle at both sides in the thoracolumbar region. No clear pain response was evident on palpation or manipulation of the hindlimbs. The foal appeared bilaterally lame when walking and trotting but hindlimb flexion tests were negative. Local anaesthesia of the tibial and fibular nerves of the left hindlimb was performed, and did not significantly affect locomotion. The control foals (Foals 2 and 3) were subjected to euthanasia for reasons other than an orthopaedic disease.

Diagnostic imaging

Standard radiographs of both stifle joints and of the thoracolumbar spine were taken of the affected foal (Foal 1) in the standing position; no bony abnormalities were seen. Merely for financial reasons, it was decided at this stage to
continue the diagnostic process with a CT examination of the pelvis and coxofemoral joints, so additional radiographic or ultrasound examinations of these areas were not performed. For the selected CT examination a single slice helical CT scanner was used. The affected foal (Foal 1) was premedicated with detomidine hydrochloride (Domosedan, 0.01 mg/kg bwt, i.v.) and butorphanol (Dolorex, 0.02 mg/kg, i.v.). General anaesthesia was induced with ketamine (Narketan 10, 2 mg/kg bwt) and midazolam (Midazolam Actavis, 0.06 mg/kg bwt) and maintained with ‘triple drip’ intravenous anaesthesia using guiaopenesin (Gujatal, 50 g), ketamine (1 g) and detomidine (10 mg) at 1 ml/kg bwt/h. The CT examinations of the control foals (Foals 2 and 3) were performed in a similar manner, but post mortem. All foals were positioned in right lateral recumbency with the femora at an angle of around 90° to the pelvis and the stifle joints flexed.

It appeared that the affected foal (Foal 1) had incomplete and abnormally developed acetabula bilaterally. The dorsal acetabular rims were most affected. The intra-articular bony lesions in both coxofemoral joints consisted of many patchy, mineralised areas and fragments of irregular shape and structure. The acetabula were very shallow, and, as a result, the femoral heads were subluxated. In fact, they were positioned against the remaining portions of the dorsal acetabular margins. On the caudal surfaces of the femoral heads, several irregular and ill-defined, erosions and cyst-like contour defects were evident in the subchondral bone. Some bony lipping was also visible bilaterally at the margins of the proximal femoral physis and was consistent with coxofemoral joint arthrosis. Conversely, the normal foals (Foals 2 and 3) had complete and normally developed bony acetabular rims, which were sharply defined and regular in structure and delineation. The femoral heads were positioned deeply inside the acetabula and no subluxation was seen.

**Pathological findings**

In view of the progressive nature of the clinical signs and the severity of bilateral disease, the owner elected euthanasia for the affected foal (Foal 1) upon our advice and gave consent for pathological examination. During gross pathological examination, the foal (Foal 1) exhibited irregular erosions 2–3 cm in diameter of the articular cartilage of both acetabula, exposing the underlying subchondral bone. The articular cartilage of the opposing femoral heads was roughened and irregular with small foci of ulcerative erosions. The epiphyseal plate of the femoral head had a loose cartilage fragment on its surface. The underlying cartilage was irregular with multifocal, small-to-large-sized areas of erosion, while the adjacent cartilage contained multiple clusters of irregularly proliferating, degenerative chondrocytes.

On further histological examination, the numerous focal surface cartilage lesions with underlying necrotic bone loss were filled with granulation tissue with high numbers of fibroblasts and many small blood vessels. The adjacent subchondral bone showed marked thickening of the trabecular bone. The growth plate showed irregular thickening on the epiphyseal side, necrosis and a moderate number of degenerative chondrocytes. These bilateral abnormalities of
the cartilage of the coxofemoral joints and femoral growth plates in Foal 1 were consistent with osteochondral dysplasia (Fig 5). In contrast, the normal foals (Foals 2 and 3) showed no histopathological abnormalities of the coxofemoral joints. Finally, the anatomical preparations of the affected and of the normal foals were compared (Fig 6) and the diagnosis osteochondral dysplasia was confirmed.

Discussion

The manifestations of a more generalised form of osteochondral dysplasia differ between domestic animals and humans and, based upon radiological and clinical criteria, nearly 500 skeletal dysplasias are known in man (Minor and Farnum 1988; Smit et al. 2011). However, in several dog breeds, the generalised form of osteochondral dysplasia is clearly evident in animals small for their age, particularly in regions of rapid growth (limbs, vertebrae), resulting in disproportionate dwarfism. Particularly in Labrador Retrievers, it can manifest in malformation of both coxofemoral joints, but, in selected cases, also with concurrent shortened vertebrae, ocular defects, and a severely affected locomotion (Smit et al. 2011). Disproportionate dwarfism has also been reported in Friesian foals resulting from osteochondral dysplastic physeal growth retardation in limbs (e.g. metaphysis of the distal metacarpus and metatarsus) and ribs (e.g. costochondral junction; Back et al. 2008). In addition, Huggons et al. (2010) presented a 2-month-old severely lame dwarf Friesian filly with a unilateral primary coxofemoral subluxation from a (traumatic) rupture of

Fig 3: a) Computed tomography images (plain 2D) of both coxofemoral joints in the transverse plane of (A) a normal foal (Foal 2) and (B) the affected foal (Foal 1). b) 3D reconstruction of computed tomography images of the coxofemoral joints of (A) a normal foal (Foal 2) and (B) the affected foal (Foal 1). Note the absence of a smooth acetabular rim and a normal femoral head curvature in both coxofemoral joints of the affected (Foal 1) in contrast to that of a normal foal (Foal 2).
At age 5 months, a ventral-dorsal radiograph of the pelvic region revealed subluxation of the left coxofemoral joint, secondary dysplastic femoral head flattening, excessive anteversion of the femoral head, and severe degenerative osteoarthritic changes to the acetabulum and femoral head.

In the affected foal of our study (Foal 1), both coxofemoral joints were abnormally developed, with severe osteochondral dysplasia of the acetabular margins, subsequent abnormal development of the coxofemoral joints and subluxation of the femoral heads caused by acetabula that were bilaterally very shallow. As a result, the radiological and pathological findings in that foal were thought to resemble the generalised, manifestation of osteochondral dysplasia, similar to those found in man such as multiple epiphyseal dysplasia, spondyloepiphyseal dysplasia congenita and Stickler syndrome, and in dogs such as chondrodysplasia and disproportionate dwarfism in Labradors (Lachman 1998; Lachman et al. 2005; Couchouron and Masson 2011; Smit et al. 2011; Veeravagu et al. 2012; Frischknecht et al. 2013). However, our affected foal (Foal 1) showed no signs of dwarfism or ocular defects. Given that, in this case, the only abnormalities evident were located in the coxofemoral joints, osteochondral dysplasia of the coxofemoral joints may, for the time being at least, be the most plausible, phenotypical diagnosis.

In dogs, radiography is the most definitive technique for diagnosing coxofemoral joint disease (Ohlerth et al. 2003; Ginja et al. 2010; Verhoeven et al. 2012). Diagnosing coxofemoral joint disease in horses often requires radiographs. Principally, high-quality radiographs can only be obtained under general anaesthesia with the horse in dorsal recumbency (Kangstrom 1972; Butler et al. 2008). Nonetheless, under more practical, field conditions, techniques have been described to be used in the standing horse, such as standing lateral oblique pelvic radiography. The disadvantages of this procedure would include limited visibility of the pelvis, which is further reduced in larger horses with inability to assess right/left symmetry, and due to the longer exposure time increased exposure to radiation for personnel (Barrett et al. 2006; Geburek et al. 2009).

In the first 6–12 months of life of human children, ultrasonography is used to confirm coxofemoral joint disease (Alanay and Lachman 2011; Bracken and Ditchfield 2012). Once ossification has progressed and the complete acetabulum cannot be assessed accurately, pelvic radiography becomes the primary imaging modality. Ultrasonography can also be a useful technique to diagnose coxofemoral joint disease in horses under practical, field conditions, but it is limited to the detection of irregularities of bony surfaces and soft tissue changes on the outer parts of the coxofemoral joint only (Brenner and Whitcomb 2009; Geburek et al. 2009). Recently, a study of ultrasonographic examination of the coxofemoral joints of young foals yielded reliable images of the joint (Rottensteiner et al. 2012). However, in older foals and mature horses it is impossible to visualise the complete acetabulum (including the acetabular labrum);
only parts of the acetabular rim can be observed. In our affected foal (Foal 1), ultrasonography may have provided a presumptive diagnosis but the extent of the degenerative changes could not have been visualised.

A CT examination of the coxofemoral joints of young horses has not been described yet in the literature. The major advantage of CT examination is the lack of superposition of the adjacent tissues, which facilitates the detailed observation of bony structures. In addition, it is possible to create useful multiplanar reconstructions or 3D images of the coxofemoral joint and pelvic bones of young horses in which pelvic or femoral disorders are suspected [Fig 3]. Unfortunately, the pelvic area of large mature horses cannot be accommodated by CT equipment, due to the limitations of the size of the gantry. In our cases the choice was made to place the foals in lateral recumbency, as dorsal recumbency would have needed more elaborate, permanent hoisting and thus would have increased the anaesthetic risk [van Loon et al, 2010].

The only possible treatment option for the foal in this case would have been total hip arthroplasty, as described by Huggons et al. (2010). However, this was not an option in our foal, due to the presence of bilateral disease and the fact that the foal had not reached its maximal limb growth; this technique may only be successful in full grown, small equine cases (Huggons et al. 2010).

Concerning the genetic background of this disease, in man and dogs osteochondral dysplasia has been reported to be a hereditary disease (Lachman 1998; Lachman et al. 2005; Goldstein et al. 2010; Coucharon and Masson 2011; Smit et al. 2011; Shi et al. 2012; Veeravagu et al. 2012). These skeletal forms of osteochondral dysplasias seem to arise following mutations in genes that encode for collagen, which in dogs cause such conditions as short-limbed dwarfism and ocular defects [Goldstein et al. 2010; Frischknecht et al. 2013]. In Friesian horses, disproportional dwarfism is described as a congenital, genetic defect [Orr et al. 2010] and osteochondral dysplasia may be the generalised underlying cause (Back et al. 2008). Recently, a local, osteochondral dysplastic malformation of the petrosal bone and, as a result, narrowing of the jugular foramen, has been demonstrated to be the cause of hydrocephalus appearing in the same breed (Sipma et al. 2013). Given the fact that Friesian horses are the product of a relatively small population, it is likely that this or a similar manifestation of osteochondral dysplasia (in a local or a generalised form) might become diagnosed more often in this breed, and thus it may be shown that this disease also has strong genetic predisposing factors in horses.

In conclusion, when encountering a weight-shifting stance in the hindlimbs together with a kyphosis of the back and a shortened hindlimb gait, bilateral coxofemoral joint disease should be on the differential diagnosis list of possible causes including an initial, primary congenital osteochondral dysplasia and a secondary, deforming osteoarthritis. The pathological findings in the affected foal in this study might resemble a form of osteochondral dysplasia, as earlier described in Friesian horses and further illustrating a possible genetic background in this breed. Nonetheless, CT scanning appears to be a useful imaging technique in the detection of coxofemoral joint disease in small horses and foals and improves diagnostic imaging to recognise osteochondral dysplasia of the coxofemoral joints and secondary osteoarthritis.

Authors’ declaration of interests
No conflicts of interest have been declared.

Ethical considerations
We certify that the animals in the study were treated in accordance with all legal and ethical requirements. No procedures were performed other than those needed to treat the patients in this study.

Manufacturers’ addresses
1Boehringer Ingelheim Vetmedica GmbH, Germany.
2Philips Secura, Eindhoven, The Netherlands
3Orion Corporation, Espoo, Finland.
4Actavis, München, Germany.
5Vetoquinol S.A, Lure Cedex, France.
6Actavis, München, Germany.
7Eurovet Animal Health BV, Bladel, The Netherlands.

References

Continued on page 496
RUGGED
RELIABLE
UNBEATABLE
ENDURO™
RUGGEDIZED

THE ONLY DROP TEST GUARANTEE ON THE MARKET UNDER 10 LBS. TOTAL SYSTEM WEIGHT

THE ONLY 5 YR. COMPLETE SYSTEM WARRANTY INCLUDING SERVICE & CLOUD

www.vetel.com
1-800-458-8890
Case Report

Standing removal of the proximal aspect of an olecranon fracture in a mature horse

C. R. B. Elliott* and B. G. A. Middleton†

Randwick Equine Centre, Sydney, New South Wales, Australia; and †Blackdown Equine Clinic, Fernhurst, Surrey, UK.

*Corresponding author email: celliott@randwickequine.com.au

Keywords: horse; olecranon; fracture; standing surgery

Summary

A 12-year-old 450 kg Argentine polo mare presented with a dropped elbow and an unwillingness to bear weight after being kicked by another horse on the lateral aspect of the upper left forelimb. The mare was subsequently diagnosed with a displaced olecranon fracture that did not readily conform to the standard classification systems. Referral for surgical treatment involving open reduction and internal fixation was declined due to financial constraints. Due to the mare being unsuitable for breeding, and conservative treatment of displaced olecranon fractures being deemed to have an overall poor prognosis for return to full athletic performance, another treatment option was sought. Given the fracture configuration, standing surgical removal of the large proximal fragment was performed. The mare returned to full athletic performance 12 months post operatively without lameness. This case report describes an alternative treatment option for selected olecranon fractures.

Introduction

The olecranon acts as a lever allowing the triceps brachii muscle to extend the elbow. The triceps brachii consist of 3 heads – long, lateral and medial – all of which insert together on the olecranon tuberosity (Watson and Wilson 2007). Fractures of the olecranon in the horse are relatively common and often occur as a result of direct trauma; frequently a kick or a fall. Injured horses that have disruption of the triceps apparatus often have a ‘dropped elbow’ appearance and are unable to bear weight fully or extend the carpus (Denny et al. 1987; Watkins 2006).

Olecranon fracture configurations have been previously described and a commonly used classification system defines 6 categories: 1a, 1b, 2, 3, 4 and 5 (Donecker et al. 1984; Wilson and Riedesel 1985; Denny et al. 1987; Fackelmann 1999; Swor et al. 2003) (Table 1). Type 2 fractures are the most common type of olecranon fracture in the mature horse (Easley et al. 1982; Donecker et al. 1984; Denny et al. 1987). In comparison, juvenile horses more commonly sustain type 1b olecranon fractures (Swor et al. 2003; Watkins 2006).

A variety of surgical techniques have been documented for the correction of olecranon fractures. Open reduction and internal fixation with the use of cerclage wire or a dynamic compression plate applied to the caudal aspect of the ulna is the current common standard for repair (Martin et al. 1995; Murray et al. 1996; Hanson et al. 1997; Swor et al. 2003, 2006; Watkins 2006; Jackson et al. 2011). Surgical repair of olecranon fractures in mature horses has a good prognosis, with recent published success rates of 81.2% (Jackson et al. 2011) and 86% (Swor et al. 2003). Conservative management of olecranon fractures can be a viable treatment option in certain fracture configurations that are nonarticular and nondisplaced such as type 1b and type 5 (Wilson and Riedesel 1985). The degree of disruption of the triceps apparatus, extent of fracture displacement, distraction, comminution and instability, along with the animals’ ability to bear weight on the limb are all key factors involved in the choice of conservative management. Case background, economical constraints as well as the horse being viable if it cannot return to full athletic performance are other factors also involved. Despite some fracture configurations such as those that are non-articular involving the growth plate only (type 1b) and those involving the distal semilunar notch (type 5) having a favourable prognosis of 70% becoming sound after conservative management, the overall prognosis for return to full athletic performance is often poor. In a study of 43 cases managed nonsurgically, the overall rate of return to soundness was 33% (Wilson and Riedesel 1985).

We report the management of an olecranon fracture in which the proximal fragment was removed via standing surgery and the subsequent successful return of the mare to full athletic performance 12 months post operatively without lameness.

Case history

A 12-year-old 450 kg Argentine polo mare playing low to medium goal polo was seen to be kicked by another horse on the lateral aspect of the upper left forelimb. The mare was unwilling to bear weight on the limb immediately after the trauma.

Clinical findings and diagnosis

Palpation and manipulation of the point of the elbow induced marked pain and moderate crepitus. A vertical 6 cm skin wound was located approximately 10 cm cranial to the point of the elbow. The mare was sedated with 0.009 mg/kg bwt

Table 1: Olecranon fracture categories (Swor et al. 2003)

<table>
<thead>
<tr>
<th>Type 1a</th>
<th>Nonarticular fracture involving the growth plate only</th>
</tr>
</thead>
<tbody>
<tr>
<td>Type 1b</td>
<td>Articular or nonarticular fracture involving the physis and the proximal semilunar notch</td>
</tr>
<tr>
<td>Type 2</td>
<td>Articular fracture involving the semilunar notch</td>
</tr>
<tr>
<td>Type 3</td>
<td>Nonarticular fracture involving the metaphysis</td>
</tr>
<tr>
<td>Type 4</td>
<td>Comminuted fracture involving the semilunar notch and body of olecranon</td>
</tr>
<tr>
<td>Type 5</td>
<td>Articular or nonarticular fracture involving the ulnar shaft at the level of the radial physis and extending proximally to involve the distal semilunar notch</td>
</tr>
</tbody>
</table>

© 2015 EVJ Ltd
detomidine (Equimidine)$^1$ and 0.009 mg/kg bwt butorphanol (Torbugesic)$^1$ and a mediolateral radiograph of the elbow was taken using a portable digital radiography machine (Eklin Mark IIIG)$^2$. The radiograph revealed a displaced nonarticular complete short oblique fracture of the left proximal ulna with minimal cranial displacement of the large proximal fragment. Additional radiographic views were not taken due to financial constraints.

The fracture line propagated from the caudoproximal surface of the left olecranon tuberosity of the ulna to the craniodistal aspect of the proximal surface of the anconeal process. Relative to the distal ulna, the large proximal fragment was minimally displaced cranially (Fig 1). The fracture configuration did not readily conform to the standard classification systems (Fig 2). Surgical referral was offered to the owner but declined due to financial constraints.

An alternate treatment was sought in order to return the mare to full athletic function as she was deemed unsuitable to be preserved as a broodmare. The mare was confined to a box and treated with prophylactic antibiotics consisting of gentamicin (6.6 mg/kg bwt i.v. q. 24 h; Genta Equine 10%)$^3$ and procaine penicillin (22,000 iu/kg bwt i.m. q. 12 h; Duphapen)$^1$ as well as phenylbutazone (4.4 mg/kg bwt per os q. 24 h; Equipalazone)$^3$ for 3 days. After this time, the small skin wound had sealed over, swelling within the region had resolved and the mare, although unwilling, was able to bear weight on the limb and extend the elbow.

The authors believed that standing removal of the fragment would be viable at this stage as it was evident that there was still function of the triceps apparatus.

**Surgical treatment**

Preoperative antibiotics consisted of gentamicin and procaine penicillin along with phenylbutazone, all at previously mentioned dose rates. Prior to surgery, standing sedation was achieved with 0.013 mg/kg bwt detomidine (Equimidine)$^1$ and 0.013 mg/kg bwt butorphanol (Torbugesic)$^1$. Sedation was maintained with one additional dose of 0.009 mg/kg bwt detomidine (Equimidine)$^1$ mid-way through surgery. Surgery time was approximately one hour.

The region was aseptically prepared for standing surgery. Mepivacaine (Intra-Epicaine)$^1$ was injected subcutaneously in a vertical line over the lateral aspect of the elbow directly over the fracture line. Mepivacaine was also injected into the deeper muscle layers and around the fracture. A vertical skin incision was made centred over the fracture line and subcutaneous tissues were bluntly dissected to allow for direct palpation of the fracture. Approximately 60% of the tendinous insertion of the triceps brachii muscle was attached to the proximal fragment. This was detached by sharp dissection as close to the bone of the fragment as possible to allow for removal of the fragment (Fig 3). Several blood vessels were encountered during dissection of the fragment attachments. Haemorrhage was controlled by application of direct pressure and was not of significant concern.

The surgical site was thoroughly lavaged with sterile saline prior to the deeper tissue layers being closed with a monofilament absorbable size zero suture (poliglecaprone, Monocryl, size 0)$^4$ using a simple continuous pattern. A Penrose drain was placed subcutaneously and the skin then closed.
with a nonabsorbable monofilament suture (nylon, Ethilon, size 1)⁴ using a simple interrupted pattern. The distal 2 cm of the incision was left open to allow for egress of the Penrose drain.

The mare was confined to a box post operatively. Procaine penicillin, gentamicin and phenylbutazone were continued at the previously mentioned dose rates for a further 7 days. The mare was then treated with trimethoprim/sulfadiazine (30 mg/kg bwt per os q. 12 h; Norodine Granules)⁵ for another 10 days. After 7 days, the dose of phenylbutazone was reduced (2.2 mg/kg bwt per os q. 24 h; Equipalazone)⁶ and maintained for a further 14 days.

The Penrose drain was removed after one week. Sutures were removed 2 weeks post operatively, at which point the surgical incision had healed with a good cosmetic appearance.

One single lateral radiograph of the surgical site was taken 3 days post operatively. This radiograph revealed a small fragment that was not visible prior to surgery (Fig 4). The authors speculate that this fragment may have fractured off the larger fragment during surgery, or was potentially missed initially as only one radiograph of the fracture was taken. It was not deemed necessary to remove it as the fragment did not appear to be articular and was considered unlikely to cause ongoing lameness.

Outcome

The mare was confined to a box for 5 weeks prior to being turned out into a small paddock. At this point of time the mare was 2/5 lame at the trot (AAEP lameness grading scale – Anon 1999). The mare was re-examined again 8 weeks after surgery and found to be sound at the trot. A firm round smooth fibrous mass of a proximately 10 x 10 cm in size had developed on the lateral aspect of the elbow. The mass was not painful, nor did it hinder free movement of the limb. The cosmetic appearance of the leg was good (Fig 5). The mare was then turned out to a larger paddock for another 16 weeks prior to commencing a graduated ridden rehabilitation programme.

Twelve months post surgery the mare was back in full work and playing polo at the same level prior to injury without lameness. Follow-up radiographs were not taken due to financial limitations. The mare was sold to another polo player approximately 18 months post injury. A full 5 stage prepurchase examination was completed prior to sale.

Discussion

To the authors’ knowledge this is the first case report describing the surgical removal of a fractured olecranon fragment in a standing horse. The prognosis for olecranon fractures with both surgical repair and conservative management is well documented (Donecker et al. 1984; Wilson and Riedesel 1985; Denny et al. 1987; Swor et al. 2003, 2006; Jackson et al. 2011). Recent published success rates for surgical management are 81.2% (Jackson et al. 2011) and 86% (Swor et al. 2003), whilst conservative management shows an overall return to soundness of all types of olecranon fractures collectively being 33% (Wilson and Riedesel 1985). An accepted method of classification for olecranon fractures (Swor et al. 2003), describes 6 types of fracture configuration. This classification method is useful for the most commonly seen fractures, but can be inflexible in its ability to describe fractures such as the one presented in this case study. Fractures in juvenile horses frequently involve the physis and usually result in predictable configurations. Fall-induced fractures also create predictable fracture configurations due to the pronounced tension forces associated with the olecranon caused by the triceps. By contrast, kick-induced fractures involve variable forces that are not all tension related, with the direction of the external force being able to originate from any angle. The variability of this external force can result in kick-induced olecranon fractures being less predictable and less able to conform to the standard classification method.

Veterinarians, when presented with a fractured olecranon, currently have 2 reasonable treatment options: conservative or surgical management. The current accepted standard of surgical repair of an olecranon fracture involves open reduction and internal fixation using dynamic compression plates to counteract the tension forces. The use of tension
band wires is a viable surgical option but is limited in relation to fracture fixation strength, as such is only recommended for horses under 250 kg (Martin et al. 1995). Internal fixation using orthopaedic plates results in the best prognosis for return to athletic performance (Donecker et al. 1984; Denny et al. 1987; Jackson et al. 2011). Persistent sinus formation, implant failure, contralateral limb break down and re-fracture during recovery from anaesthesia are all recognised complications of surgical repair (Donecker et al. 1984; Denny et al. 1987; Jackson et al. 2011). In a recent study (Jackson et al. 2011) of 12 type 2 fractures treated with locking compression plates, 4 horses experienced post operative complications. Two were subjected to euthanasia, another remained chronically lame, whilst the fourth required plate removal due to persistent sinus formation.

Financial limitations often dictate chosen diagnostic procedures and treatments in equine veterinary medicine and surgery. The case presented in this report was performed on a very strict budget. In order to remain within this budget, additional radiographic views at the time of initial examination, intraoperative radiographs, post operative radiographs and follow-up radiographs were not performed. The authors recognise that it was less than ideal and would certainly encourage others to obtain full radiographic series if presented with similar fractures. The challenges of financial limitations in equine veterinary medicine and surgery are well highlighted when presented with a horse that has an olecranon fracture. Based on our results, standing removal of the proximal aspect of the olecranon, in certain specific configurations of fractures, could potentially be a viable alternative to the currently available surgical techniques. It has the advantage of not requiring general anaesthesia or the use of implants, thus eliminating some of the inherent costs and complications.

It must be emphasised that this surgical technique is not suitable for all olecranon fracture configurations. In order for this technique to be a suitable option it is essential that there is a functional triceps apparatus. In our case, we assessed this by observing the mare being able to extend the elbow to a reasonable degree and although unwilling, the mare was able to bear weight fully on the leg. The authors recommend that surgery is delayed until the functionality of the triceps apparatus is absolutely confirmed.

This case demonstrates that with appropriate case selection and by careful retention of remaining triceps function during dissection, a mature horse can be successfully returned to athletic performance with this procedure.

Conclusion
This paper reports the successful removal of the proximal fragment of an olecranon fracture in a standing mare that resulted in return to full athletic performance. With conservative management it is unlikely that this could have been achieved. This paper may prove useful to other veterinary surgeons presented with similar fracture configurations where finances are limited.

Acknowledgement
The authors would like to acknowledge Dr Karon Hoffmann Dip ECVDI for her assistance in radiographically describing the fracture, and Dr Benjamin Ahern DipACVS for his assistance in preparing this manuscript.

Authors’ declaration of interests
No conflicts of interest have been declared.

Manufacturers’ addresses
1Pfizer Animal Health, Sandwich, Kent, UK.
2Sound-Eklin, Carlsbad, California, USA.
3Dechra Veterinary Products, Shrewsbury, Shropshire, UK.
4Johnson & Johnson Medical, Livingston, West Lothian, UK.
5Norbrook Laboratories, Newry, Down, UK.

References


Jackson, M., Kummer, M., Auer, J., Hagen, R. and Fuerst, A. (2011) Treatment of type 2 and 4 olecranon fractures with locking...


The Science of Protected

From the breeding barn to the show ring and everything in between, we have the vaccines you need to help protect your horse.

- Made with the exclusive Antigen Purification System (APS™)
- Contains the Havlogen® adjuvant veterinarians know and trust
- Delivers core vaccine coverage according to American Association of Equine Practitioners recommendations

Now that’s protected.

Ask your veterinarian for Prestige®, Encevac®, Prodigy® and EquiRab® brand vaccines. Visit us at GetVaccinatingRight.com to learn more about Merck Animal Health and the equine products and programs that help keep horses healthy.

Every vaccine purchased through Merck supports the plight of the unwanted horse through the Unwanted Horse Veterinary Relief Campaign.
Fast, affordable, and accurate equine testing.

You no longer have to compromise.

**IDEXX Reference Laboratories** is your leading resource for real-time PCR and other innovative tests and panels that help you diagnose and monitor the health of your equine patients. The broad range of equine diagnostics include the Foal Diarrhea/Enterocolitis RealPCR™ Panel, Strangles RealPCR™ Screen, equine reproductive health panels, and other new equine tests. For more information, call 1-800-621-8378 or visit [idexx.com/equine](http://idexx.com/equine).
Case Report

Traumatic coccygeal luxation and distal amputation of the tail of an Appaloosa mare

M. McMaster*, A. Munsterman and V. Albanese

Department of Clinical Sciences, College of Veterinary Medicine, Auburn University, Auburn, Alabama, USA.

*Corresponding author email: mam0094@auburn.edu

Keywords: horse; caudal vertebrae; amputation; luxation

Summary

A 17-year-old Appaloosa mare presented to the emergency service for acute, traumatic, partial amputation of the tail at the level of the ninth coccygeal vertebra. The patient did not have tail or anal tone and did not respond to sharp stimulation of skin in the perineal region. Two grade 1 rectal tears were found during rectal palpation. Radiographs revealed dislocation of the second (Cd2) and third (Cd3) caudal vertebrae. The patient was treated with antibiotics, an anti-inflammatory drug and stall confinement. The ninth caudal vertebra was surgically removed to facilitate closure of skin over the wound. When the mare was discharged after 7 days of hospitalisation, she had regained partial sensation of the perineum and partial function of the internal and external anal sphincters. At re-evaluation one year following injury, the mare was able to move her tail laterally and had regained sensation of her perineum and tail; however, she still was unable to lift her tail.

Introduction

Trauma of the sacrococcygeal spine of the horse is infrequently reported (Grant et al. 1998). Clinical signs of injury range from generalised back pain and hindlimb lameness to an inability to defaecate, micturate or lift the tail (Grant et al. 1998; Witte et al. 2007). These findings vary depending on the severity of the lesion present, as well as the extent of involvement of the caudal sacral, coccygeal and pudendal nerves (Grant et al. 1998). Treatment also varies depending on the type of trauma present. This report describes a case of coccygeal spine trauma involving amputation of the tail and dislocation of the cranial coccygeal spine in an adult Appaloosa mare.

Case description

A 17-year-old Appaloosa broodmare weighing 490 kg presented for traumatic amputation of the tail. The patient was found recumbent in her pasture the morning of presentation with the distal portion of her tail missing; the amputated segment was found hanging on a fence nearby. The horse was examined and treated by the referring veterinarian with flunixin meglumine, 1.1 mg/kg bwt intravenously (i.v.), procaine penicillin G, 22,000 iu/kg bwt intramuscularly (i.m.) and administered a prophylactic tetanus toxoid vaccine i.m. The horse arrived at the JT Vaughan Large Animal Teaching Hospital, Auburn University, 4 h after being seen by the referring veterinarian.

On presentation, the mare was quiet, alert and responsive. Physical examination revealed that the patient was tachycardic (52 beats/min). Other vital signs were within normal limits and the mare was sound at a walk. There was a significant amount of soft tissue swelling at the level of the tail-head and perineum, with moderate bruising of the skin at the base of the tail (Fig 1). The amputated 20 cm section of tail was brought by the owner (Fig 2). An exposed coccygeal vertebra could be seen at the distal aspect of the remaining tail. There was no significant haemorrhage from the wound; however, the owner had observed a large amount of blood in the paddock where the mare was found. Blood was collected for PCV and total solids which were measured at 35% and 58 g/l respectively. During neurological examination, the horse had no tail or anal tone and did not respond to sharp stimulation of the skin immediately surrounding the tail-head and perineum (Fig 3).

Radiographs obtained of the sacroiliac and remaining caudal spine revealed dislocation of Cd2 and Cd3. There was significant caudal and mild dorsal distraction of Cd3 with a 57 mm gap present between Cd2 and Cd3. There was a moderate to significant amount of soft tissue swelling and mottling of soft tissue surrounding the sacroiliac and caudal spine and at the base of the tail-head, consistent with subcutaneous emphysema (Fig 4). The distal portion of caudal vertebra 9 (Cd9) was exposed at the site of tail amputation (Fig 5). Mild degenerative changes could be observed...
between caudal vertebrae. A small, 2 mm round focal metallic radio-opacity could be observed at the level of Cd3. Because cutaneous wounds in this region could not be found, the foreign object was considered to be an incidental finding associated with a previous injury.

The mare was sedated with butorphanol tartrate (Torbugesic)\(^1\), 0.01 mg/kg bwt i.v and detomidine hydrochloride (Dormosedan)\(^2\), 0.01 mg/kg bwt i.v. During transrectal palpation of the abdomen, two grade 1 rectal tears in the dorsal rectal wall, 4 and 8 cm oral to the anal sphincter were felt. Although the patient did not have anal tone, peristaltic waves within the rectum were appreciated during palpation. No other abnormalities of the rectum or palpable abdominal organs were noted during palpation and during transabdominal ultrasound no abnormalities were observed.

Initial treatment included placement of a 14 gauge, 13 cm i.v. catheter (Milacath)\(^3\) in the right jugular vein. Antibiotic therapy was initiated using gentamicin sulfate (Gentamicin Sulfate)\(^4\) 6.6 mg/kg bwt i.v. q. 24 h, potassium penicillin (Penicillin G Potassium)\(^5\) 22,000 lu/kg bwt i.v. q. 6 h and metronidazole (Metronidazole Tablets USP)\(^6\) 15 mg/kg bwt administered orally (per os) q. 8 h, to prevent ascending infection from the wound site, subcutaneous emphysema, as well as due to the presence of the rectal tears. The mare was also administered flunixin meglumine, 1.1 mg/kg bwt per os q. 12 h (Banamine)\(^7\).

To close the wound, the tail stump was aseptically prepared for standing surgery. Epidural anaesthesia was not
administered because nerve injury caused by the trauma had desensitised the surgery site. An Esmarch tourniquet was applied to the tail to provide haemostasis during the surgical procedure. Beginning at the 15.00 and 21.00 h positions of the wound edge, two 6 cm skin incisions were made along the longitudinal axis of the distal end of the tail stump. Subcutaneous tissue surrounding partially exposed Cd9 was undermined using a pair of curved Mayo scissors. The Cd9 was removed by sharply transecting ligamentous attachments between the eighth caudal vertebra (Cd8) and Cd9. The subcutaneous tissue was apposed over Cd8 using No. 2-0 Monocryl® in a simple interrupted suture pattern. Overlying skin was closed using No. 0 polypropylene (Prolene)® in alternating vertical mattress and simple interrupted suture patterns. A topical antiseptic (Alu-Spray®) was applied to the sutured wound following the procedure and the Esmarch tourniquet, applied for approximately 45 min, was removed (Fig 6).

Post operatively, the horse was administered gentamicin, penicillin and metronidazole for 3 days. The mare was then administered trimethoprim-sulfamethoxazole10, 25 mg/kg bwt per os q. 12 h for an additional 7 days. The mare received additional doses of flunixin meglumine, 1.1 mg/kg bwt i.v. q. 12 h for 5 days after the injury. A diet of alfalfa leaves and equine senior mash mixed with mineral oil was fed to soften faeces post operatively.

The mare was observed defaecating and urinating normally throughout hospitalisation. A muted reaction to sharp stimulation of the perineum was obvious near the end of the 7 days of hospitalisation. At the time of discharge, the mare appeared to have regained partial function of the ventral aspect of the internal and external anal sphincters. In addition, swelling surrounding the perineum had significantly decreased and vulvar sensation was present. A lameness evaluation was not performed during hospitalisation because the mare appeared subjectively to be sound at a walk, with no evidence of proprioceptive defects or hindlimb weakness.

The mare was discharged after 7 days of hospitalisation. One year after discharge, the mare was re-examined. She was able to move her tail laterally; however, she was not able to lift her tail in a vertical plane. The mare had regained full sensation of her perineum and tail. There was notable atrophy of musculature of the tail-head (Fig 7). Due to the fact that the mare was unable to lift her tail, she had a moderate amount of faecal staining of her tail; her owner would clean her tail on a regular basis as a result. The owner stated she was pleased with the outcome of the procedure.

Discussion

The caudal spinal cord, known as the conus medullaris, ends at the level of the first to second sacral vertebrae in the horse (Budras et al. 2001). The filum terminale, a thin fibrous cord, extends from the caudal spinal cord to the fourth sacral segment (Budras et al. 2001). The conus medullaris, filum terminale and sacral and caudal spinal nerves in this region form the cauda equina (Budras et al. 2001). The cauda equina provides motor innervation to the hindlimbs, anal sphincter and tail tone, sensory innervation of the rump and perineal area and parasympathetic innervation of the bladder and distal bowel through innervation provided by the pudendal and pelvic nerves (Tutko et al. 2002). The coccygeal nerve gives rise to the dorsal and ventral caudal nerve plexuses. These plexuses are located between the muscles and bones of the tail, branching between vertebrae (Tutko et al. 2002).

Trauma of the caudal and sacral vertebrae in a horse may result in damage to the cauda equina. Depending on the location and degree of trauma, injury of the cauda equina may lead to tail weakness or paralysis, anal hypotonia or atonia, paralysis or weakness of the rectal sphincter, loss of bladder tone or function and paraparesis in the male (Tutko et al. 2002; Furr and Sampieri 2008). Other clinical signs of cauda equina injury include analgesia of the tail, anus and skin of the perineum and muscle atrophy of the coccygeal muscles. Occasionally, hindlimb weakness, ataxia or lameness can occur (Tutko et al. 2002; Witte et al. 2007). Less common signs of cauda equina injury are pelvic limb and gluteal muscle atrophy as well as reproductive dysfunction such as urospermia or impotence in males and urine pooling in mares (Tutko et al. 2002).

Injuries of the tail and sacrum in horses can result from backing-up into an object, sitting down suddenly, falling over backwards or landing on the tail (Tutko et al. 2002; Witte et al. 2007). Tail and sacral injuries may also be iatrogenic, most often due to lifting a patient by the tail when repositioning under general anaesthesia or caused by injection of an irritant substance around the tail-head (Grant et al. 1998). Injuries to the tail are infrequently described in horses. They are more often described in cats but rarely in dogs with sacrocaudal luxation following traffic injuries (Davies and Walmsley 2012).

Horses with injuries of the tail and sacrum typically have neurological deficits caused by fractures of the sacral or caudal vertebrae (Grant et al. 1998; Tutko et al. 2002). The exact cause of trauma in this particular case is unknown, although it is suspected that the patient caught her tail on a fence.

In cats, tail-pull injuries can result in variable trauma to the sacral spinal cord segments and cauda equina causing neurological deficits (Smeak and Omlstead 1985; Davies and Walmsley 2012). Paraparesis and loss of tail tone can occur, as well as anal sphincter and bladder dysfunction due to damage to the pudendal, pelvic and caudal nerves (Smeak and Omlstead 1985; Davies and Walmsley 2012). Depending on the degree of neurological dysfunction, cases can be managed
medically or surgically. Cage confinement and administration of an analgesic is often successful for treatment of cats with tail-pull injury when clinical signs are mild and neurological function is regained (Davies and Walmsley 2012). When loss of motor and sensory function to the tail appears to be permanent, amputation of the tail is recommended (Smeak and Omlstead 1985; Davies and Walmsley 2012). Amputation may improve comfort and prevent further traction and injury of the caudal nerve roots (Davies and Walmsley 2012). Other surgical treatments of tail-pull injury include decompression and internal stabilisation of sacral fractures if present, as well as preventing further nerve damage by stabilising fractures or luxations of the caudal vertebrae using suture or wire (Smeak and Omlstead 1985; Davies and Walmsley 2012).

Although this patient was able to urinate and defaecate, she did not have sensation of the tail and perineum, nor did she have anal sphincter or tail tone on presentation. The pudendal nerve, which originates from the ventral branches of the third and fourth sacral nerves, innervates the external anal and urogenital sphincters and provides motor and sensory innervation to the muscles and skin of the genitalia and perineum (Schumacher et al. 1985) (Fig 8). Damage to the deep perineal nerve, which is a branch of the pudendal nerve (Schumacher et al. 1985) that innervates the anal sphincter, could have been the cause of loss of anal sphincter tone. Damage to the caudal rectal nerve, which also originates from the ventral branches of the third and fourth sacral nerves (Schumacher et al. 1985), could have also caused a loss of anal sphincter tone and sensation of the perineum. There were no signs of incontinence or urine retention, indicating that the mare still had somatic control of the external urogenital sphincters and that the root of the pudendal nerve, as well as its branches that supply the external urogenital sphincters, were still intact.

Analgesia of the perineum, as well as loss of tail tone, could have also been the result of damage to the coccygeal nerve and associated nerve plexuses. No gait deficits were noted at the walk; however, an extensive lameness evaluation was not performed during hospitalisation due to the fact that the

© 2015 EVJ Ltd
Patient was a broodmare and future athletic performance was not a concern. Because the injury was too acute and hospitalisation too short to observe for neurogenic muscle atrophy, the full degree of nerve damage was not known at that time. Because the mare regained partial function of her anal sphincter, as well as partial sensation of her perineum prior to discharge, neuropraxia or axonotmesis of the coccygeal, pudendal and caudal rectal nerves from possible stretching or surrounding oedema and/or haemorrhage were suspected rather than nerve transection.

Initial evaluation of coccygeal trauma should include a complete physical examination, paying special attention for abnormalities in the region of the sacrum and coccygeal vertebrae. Findings suggestive of trauma in this region include abnormal conformation with possible muscle atrophy, paresis of the tail, pain on palpation of the sacrum and coccygeal area, positive response to hindlimb flexion, lack of anal tone and unusual pelvic enlargements found during rectal palpation (Furr and Sampieri 2008). If there is damage to the pudendal, pelvic or hypogastric nerves, retained faeces in the rectum as well as an enlarged bladder may be identified on rectal palpation (Grant et al. 2007; Davies and Walmsley 2012). A unique finding in this case was two grade 1 rectal tears identified during initial evaluation at presentation. Rectal palpation was not performed on the patient prior to presentation and the rectal tears were not caused during initial evaluation at presentation. It was presumed that the tears occurred at the same time as traumatic luxation of the caudal vertebrae and amputation of the tail as a result of a large amount of force applied to this region at the time of injury.

Radiographs should be obtained of the caudal pelvis, sacrum and coccygeal vertebrae if a lesion of the sacral and/or coccygeal regions is suspected. An epidural contrast study can be performed after baseline radiographs are taken, which may reveal spinal cord compression at the area of a lesion. Nuclear scintigraphy can also be performed, which may show increased radiopharmaceutical uptake in areas compatible with clinical signs. Electromyography could be used to determine neuromuscular function but results may not be conclusive, especially in the standing patient. If a patient presents with signs of lameness and back pain, infiltration of the intervertebral spaces with local anaesthetic may aid in localising a source of pain originating from the caudal vertebrae (Witte et al. 2007). It is important to remember that clinical findings must correlate with radiographic and nuclear scintigraphic findings. Mild changes observed through the use of these diagnostics may be consistent with normal variations between patients. In this case, clinical findings agreed with the lesions identified on radiographs.

Treatment for trauma of the cauda equina in horses includes surgical decompression of fractured vertebrae, epidural corticosteroids and physical therapy (Grant et al. 1998; Tutko et al. 2002; Witte et al. 2007). The choice of therapy is dependent on the clinical signs of the patient; surgery is typically reserved for patients unable to defaecate or micturate due to compression of the spinal canal from a vertebral fracture (Grant et al. 1998). Epidural corticosteroids are administered to horses with trauma of the cauda equina with signs of lameness and chronic back pain (Grant et al. 1998). Physical therapy was used for conservative management of one horse through the use of a crupper from a Standardbred racehorse harness to stabilise and encourage the tail-head to heal in a more dorsal position (Grant et al. 1998).

In this case, there were no signs of vertebral fracture. Luxation of the first 2 caudal vertebrae was more comparable to clinical signs associated with sacrocaudal luxation seen in cats. Therefore, surgical decompression at this site was not warranted. Due to the fact that the patient was regaining function of the anal sphincter and sensation of the perineum during hospitalisation, the elected treatment was conservative, with administration of analgesics and stall rest. The goal of conservative treatment was a fibrous scar at the site of luxation to promote stability and return sensation to the perineum and function of the anal sphincter and tail. However, peripheral nerve damage may be irreversible, especially if the area of luxation remained unstable, causing repeated nerve trauma (Grant et al. 1998).

Trauma to the sacrum and caudal vertebrae is infrequently reported in horses. These cases most often present as fractures to the sacral or caudal vertebrae, with secondary neurological deficits. This case is unique in that the lesions sustained by the patient were more consistent with sacrocaudal luxation seen in cats. Previously reported cases of sacral and coccygeal trauma in horses have been treated...
with surgical reduction of vertebral fractures, epidural corticosteroids in cases with chronic pain or lameness or physical therapy. Due to the fact that the patient sustained a luxation of the coccygeal vertebrae as opposed to vertebral fracture and responded well to conservative therapy, surgical treatment with internal fixation was not warranted.

Authors’ declaration of interests
No competing interests have been declared.

Acknowledgements
The authors wish to acknowledge Jack McMaster for his artistic contribution of Figure 8 and Drs Ray Wilhite and Eleanor Josephson for their assistance with this paper.

Manufacturers’ addresses
1Fort Dodge Animal Health, Fort Dodge, Iowa, USA.
2Pfizer Animal Health, New York, New York, USA.
3Mila International Inc., Erlanger, Kentucky, USA.
4Vet One, Boise, Idaho, USA.
5WG Critical Care LLC, Paramus, New Jersey, USA.
6Watson Pharma Private Limited, Corona, California, USA.
7Schering-Plough Animal Health Corp., Union, New Jersey, USA.
8Ethicon, LLC, Guaynabo, Puerto Rico.

References
IMPORTANT SAFETY INFORMATION: The safety of LEGEND has not been evaluated in breeding stallions or in breeding, pregnant or lactating mares. The following adverse reactions have been reported following use of LEGEND Injectable Solution: Following intravenous use: occasional depression, lethargy, and fever. Following intra-articular (LEGEND Injectable Solution — 2 mL only) use: lameness, joint effusion, joint or injection site swelling, and joint pain.

LEGEND® (hyaluronate sodium) Injectable Solution

Everyday training and competing takes its toll. Before joint dysfunction sidelines your clients, attack it with LEGEND. LEGEND delivers the same effective therapy lasting 45 days whether delivered via IV with three once-weekly doses or IA — making it the perfect fit for your clients’ training and competition schedules as well as your clinic.1,2 Treat them like LEGENDs.

www.equineLEGEND.com

(1) LEGEND product label and FOI summary.

LEGEND is a registered trademark and the Horse Logo and TMMAX are trademarks, of Merial. ©2016 Merial, Inc., Duluth, GA. All rights reserved.
Animals speak louder than words.
If there’s greatness on the inside, it shows on the outside.
purinamills.com/horse-feed
Clinical Commentary

Traumatic coccygeal luxation and distal amputation of the tail of a mare

B. Grant

Private Practice, Bonsall, California, USA.
Corresponding author email: barriegrant@earthlink.net

McMaster et al. (2016) should be complimented on a very well written paper with an excellent discussion on the relevant literature, especially regarding the complex neuroanatomy of this area. The clinical approach and technique was appropriate and the illustrations of excellent quality and would serve any clinician well if presented with such a case.

The outcome was certainly more than satisfactory, especially with a dedicated owner to provide daily cleaning of the perianal region.

The authors did not have any method to predict the long-term function of the remaining tail, especially regarding neuromuscular control at the time of the repair. They did not feel internal fixation was indicated as there were no fractures and certainly trying plating or external fixation at the time of original repair would have greatly increased the expense and chances of infection of any implant.

If the client had chosen to consider any additional treatment that might reduce faecal soiling then waiting for primary healing to occur was indicated. Although not attempted by this author, an intramedullary pin with a screw tip placed retrograde, starting at about the body of the 4th or 5th coccygeal vertebra, may have been a consideration in an attempt to realign the luxated vertebra and effect a fusion of the joint. This could possibly be achieved with an epidural and using a stab incision along with manual and radiographic monitoring. Keeping the horse in a tail crouper to maintain the tail in an elevated position while the healing/fusion process was maturing (Grant et al. 1998) would help reduce excessive force on the implant during the initial post operative period. Preoperative radiographs would be indicated to see if actual movement of the luxated coccygeal area was possible.

This horse appears to have an adequate length of tail, even for an Appaloosa (which have short tails supposedly to allow them to run through dense brush without getting their tails caught) but it did not help in this case. The lateral movement of the tail was also a benefit for the horse in allowing more ectoparasite control.

Figure 1 is a radiographic image of an infected melanoma of the approximate 4th and 5th coccygeal vertebra. The horse had been an outstanding Quarter Horse race mare and a producer of high quality runners, producing several embryos each year for transplantation into recipient mares. The tail was amputated and all visible melanotic tissue removed. In addition, several large baseball size perianal masses were removed and the spaces left open and treated with cryosurgery every 2 weeks for several months. The amputation site healed slowly and the perianal spaces also granulated in. The remaining tail hairs provided the horse with some relief (along with a fly sheet) during the warm months of the year.

Figure 1: Radiograph of the tail of a grey Quarter Horse mare presented with a necrotic draining area of the proximal tail. The exudate was dark grey and histopathology showed it to be a melanosarcoma. The distal tail was amputated proximal to the involved articulation so that all melanotic tissue was removed. Arrows show the bone and joint necrosis caused by the melanoma.

Amputation of the tail has been performed on a number of breeds of horses mainly as a cosmetic procedure for breed registration. This practice may have originated not because of any health concerns, such as fly strike in long-tailed sheep, or safety reasons (getting the tail caught in the harness and evoking a violent response) as most graduates of the last 5 decades have learned as conventional wisdom. Rather, the practice was most likely a method to avoid taxation in past centuries when taxes were levied on prized animals and owners would cut off the tail from a prized animal leaving them to the mercy of external parasites during the warm months of the year.

Fortunately this practice of tail altering amongst certain breeds is declining. The American Association of Equine Practitioners (AAEP) took a stand on alterations to the tail in 2011 and this statement can be seen in the annual membership guide on equine welfare (Anon 2011). The American Association of Equine Practitioners are opposed to the alteration of the tail of the horse for cosmetic or competitive purposes. This includes, but is not limited to, docking, nicking (i.e. cutting) and blocking. When the tail of a horse becomes injured or diseased and requires medical or surgical intervention for the health of the horse, it should be performed by a licensed veterinarian.

The AAEP encourages all breed associations and disciplines to establish and enforce guidelines to eliminate these practices. Members of AAEP should educate their clients about the potential health risks and welfare concerns involving these procedures.
I am unaware if this action by the AAEP has yet made a difference in this practice of cosmetic alterations.

**Author’s declaration of interests**

No conflicts of interest have been declared.

**Source of funding**

None.

**References**


---

Continued from page 484


American Eventer
Clark Montgomery

Proud sponsor of:
NUTRITION THAT GIVES YOU THE WINNING EDGE

Standlee
PREMIUM WESTERN FORAGE
www.standleeforage.com

PREMIUM PERFORMANCE DEMANDS
PREMIUM FORAGE

Proud sponsor of:
He’s more than just a horse.
To your clients, he’s Family.

Give him the best COSEQUIN®
Joint Health Supplements

THE MOST ADVANCED COSEQUIN FORMULA!
Contains proprietary, trademarked ingredients NOT available in other brands.

Active Ingredients:
• FCHG49® Glucosamine (GLU)
• TRH122® Chondroitin Sulfate (CS)
• NMX1000® Avocado/Soybean Unsaponifiables (ASU)
• Green Tea Extract (EGCG)
• Hyaluronic Acid (HA)
• Methylsulfonylmethane (MSM)

HOW COSEQUIN WORKS

HA/ASU/GLU/CS\(^1\) and ASU/EGCG\(^2\)
• Reduce COX-2 activity
• Reduce PGE\(_2\) production
• Inhibit NF-\(\kappa\)B nuclear translocation

*Source: Survey conducted in February 2016 of equine veterinarians who recommended oral joint health supplements.


Case Report

Successful surgical management of abdominal abscession secondary to Strongylus edentatus migration

R. P. Bell*, S. K. Reed and N. T. Messer, IV

Department of Clinical Sciences, College of Veterinary Medicine, University of Missouri, Columbia, USA.

*Corresponding author email: bellrh@missouri.edu

Keywords: horse; Strongylus edentatus; abdominal abscess; exploratory celiotomy

Summary

This report describes the successful surgical management of abdominal abscession secondary to Strongylus edentatus migration. Abdominal abscesses are a relatively common source of recurrent fever in the horse and are primarily managed with long-term antimicrobial administration. However, identification of the definitive cause, extent of the abscesses and successful resolution in this case were not possible without an exploratory celiotomy to facilitate surgical resection.

Introduction

The migration of strongylines, i.e. Strongylus edentatus, S. equinus and S. vulgaris, is extensive through various organs before settling in the caecum and colon (McCraw and Slocombe 1974). Of these, S. vulgaris has received the majority of attention within the veterinary literature due to its ability to produce ischaemic colic generally refractory to treatment and is considered uniformly fatal.

Pathology in the horse secondary to S. edentatus infection has been reported rarely in the literature and has included eosinophilic gastroenteritis (Cohen et al. 1992) and subconjunctival phlegmon and granuloma formation (Walde and Prosl 1976). All commercially available anthelmintics have consistently maintained antiparasitic efficacy against strongylines (Slocombe and McCraw 1975; Klei and Tarbert 1980; Craig and Kunde 1981; Klei et al. 2001). This continued efficacy presumably precludes infections from manifesting clinically in treated horses. In experimentally infected ponies, third stage larvae have been demonstrated to penetrate the wall of the intestine, predominantly the caecum and right ventral colon, before reaching the liver via the portal system. Moulting to fourth stage larvae occurs by Day 2 of infection. Moulting to fourth stage larvae occurs by Day 15 and active migration, presumably via the hepatorenal ligament, provides access to the intestine at the base of the caecum. Massive granulomata of the caecum and right ventral colon can be evident one month after infection and severe disruption of omental architecture as well as adhesions involving the intestine occurred experimentally after several weeks of S. edentatus infection (McCraw and Slocombe 1974). As early as 40 weeks post infection, eggs can be encountered in the contents of both the caecum and colon (McCraw and Slocombe 1978). Although migration of S. edentatus has not been explicitly or consistently associated with colic, post mortem examination of infected horses frequently reveals intense local inflammation surrounding migrating larvae that ultimately may result in fibrin deposits and fibrous adhesions on the surface of various abdominal organs (Reinemeyer and Nielsen 2009). In untreated control ponies infected experimentally, clinicopathological observations have included an increase in circulating eosinophils, 5–8 mm red nodules on the caecum and right ventral colon, an altered omental architecture, and intestinal lymphadenopathy. The nodules on the caecum and right ventral colon of these untreated ponies had central cores of necrotic eosinophils that often enclosed dead larvae (Slocombe and McCraw 1975).

This report describes a clinical case of abdominal abscession within the wall of the caecum, right ventral colon and body wall secondary to migration of S. edentatus resulting in fever, depression and inappetence that was managed surgically in conjunction with prolonged medical therapy. Although a previous report has described a case of abdominal abscession secondary to Parasarcis equorum infection in a foal (DiPietro et al. 1983), to the authors’ knowledge, a similar association has not been made with regard to S. edentatus.

Case history

A 5-year-old Arabian gelding presented with a fever of unknown origin, decreased appetite, and mild depression of approximately 10 days’ duration. Prior to admission, the gelding was intermittently administered flunixin meglumine and a trimethoprim/sulfadiazine antibacterial. Significant straining and subsequent detection of mucosal haemorrhage hindered a complete rectal examination. Initial haematological evaluation performed by the first opinion veterinarian revealed a leucocytosis. Rectal temperature was determined to be 38.3°C (reference range [rr] 37–38°C).

Clinical findings

On presentation, the gelding was bright, alert, and responsive to his environment. His heart rate was 48 beats/min (rr 36–44 beats/min) and respiratory rate 20 breaths/min (rr 8–16 Vf). Rectal temperature was 36.7°C. Mucous membrane colour and capillary refill time were both within normal clinical limits. Gastrointestinal sounds were within normal clinical limits in all quadrants. Initial haematological evaluation at the hospital revealed mild anaemia (total red blood cell count 6.51 × 10¹² cells/l, rr 6.8–12.9 × 10¹² cells/l) and mild elevation of immature granulocytes (0.42 × 10⁹ cells/l, rr 0–0.1 × 10⁹ cells/l). A biochemical profile revealed hyperfibrinogenaemia (7.0 g/l, rr 1–4 g/l) and hyperproteinenaemia (95 g/l, rr 63–81 g/l) characterised by an albumin concentration of 28 g/l (rr 35–44 g/l) and globulin concentration of 67 g/l (rr 24–41 g/l).
The gelding was admitted to the hospital and feed withheld in anticipation of gastroscopy followed by thoracic and abdominal ultrasonography the following day. No elevation in rectal temperature was noted overnight.

**Initial diagnostics**

Gastroscopy, thoracic ultrasonography and thoracic radiography on the second day of hospitalisation failed to reveal any abnormal findings. On abdominal ultrasonography in the right ventral quadrant, a focal thickening of a loop of bowel consistent with a mass or abscess was noted. The horse reacted negatively to having this area imaged and struck with his hindlimbs and demonstrated generalised muscle fasiculations. An attempted abdominocentesis failed to yield sufficient fluid for evaluation. The gelding was returned to feed in order to assess the repeatability of the ultrasonographic findings with more normal bowel contents. Overnight, no increase in rectal temperature was noted, although the gelding was mildly depressed compared with admission and failed to demonstrate a normal appetite for mixed grass hay. On Day 3 of hospitalisation, the previously identified abdominal mass was again encountered in the right ventral abdomen. At this time, an exploratory celiotomy to investigate the abnormal ultrasound findings further was suggested to and accepted by the owner.

**Surgical findings and treatment**

The gelding was induced using xylazine (1.1 mg/kg bwt i.v.)\(^1\), ketamine (2.2 mg/kg bwt i.v.)\(^2\) and diazepam (0.5 mg/kg bwt i.v.)\(^3\). General anaesthesia was maintained with isoflurane\(^4\) and oxygen. Upon exploration of the abdominal contents via a ventral midline celiotomy, an approximately 7 cm diameter, firm mass was encountered that was adhered to the right body wall, involving the omentum, caecum, caecocolic ligament and the right ventral colon. The mass was bluntly and sharply dissected away from the body wall ([Fig 1](#)) leaving a defect within the muscle layers that was not amenable to closure. The adhered omentum was ligated with 0 polydioxanone (PDS II)\(^5\) and then removed. Within the excised omentum was a mass that upon dissection contained a 3.5 cm parasitic organism. The affected bowel and primary mass were isolated from the remainder of the abdomen using laparotomy sponges. Aspiration of the remaining mass yielded a purulent fluid that was submitted for culture and susceptibility testing. Haemostasis of the generous vasculature supplying the mass was achieved by a combination of electrocautery, ligation with circumferential ligatures (2-0 polydioxanone), and a ligate-and-divide surgical stapling device (LDS)\(^6\) where appropriate. 3–4 cm of the wall of the base of the caecum was resected with the mass and the caecal lumen was closed in 2 layers – a simple continuous pattern oversewn with a continuous Cushing pattern – with 2-0 polydioxanone on a tapered needle. A large portion of the mass was intimately associated with the wall of the right ventral colon. Doyen forceps were placed across the mass, stay sutures were placed in the colon and sharp dissection was continued circumferentially around the mass, creating an approximately 10 cm full thickness incision in the bowel wall. Upon entering the lumen of the right ventral colon, large numbers of small strongyles were noted. The defect in the right ventral colon was closed in 3 layers – a simple continuous pattern twice oversewn with a continuous Cushing pattern – with 2-0 polydioxanone suture on a tapered needle. The caecocolic ligament was noted to be freely movable and wider than that of a horse of comparable size, thus it was sutured over the caecum and right ventral colon surgical sites utilising a continuous Cushing pattern with 2-0 polydioxanone suture on a tapered needle ([Fig 2](#)). The ileum was subsequently noted to have maintained its proper orientation and remained freely movable. All contaminated surgical instrumentation and attire were discarded and replaced. No further abnormalities were detected upon complete evaluation of the remainder of the abdominal contents. The abdomen was thoroughly lavaged with 10 l of 0.9% saline\(^7\) and 2 l of an antibiotic flush (gentamicin\(^8\) 1 g and potassium

---

**Fig 1:** The exterior surface of the abdominal abscess after it has been dissected away from the patient’s abdominal wall. A = Right ventral colon; B = caecocolic ligament; C = caecum.

**Fig 2:** Site of removal of the abscess post closure. A = Caecum; B = right ventral colon.
GastroGard, 2 mg/kg bwt i.v., every 6 h for 10 days, gentamicin 6.6 mg/kg bwt i.v. every 24 h for 6 days, a tapering dose of a nonsteroidal anti-inflammatory drug (flunixin meglumine 1.1 mg/kg bwt i.v. every 12 h for 5 days, then 0.5 mg/kg bwt i.v. every 12 h for 2 days, then 0.5 mg/kg bwt i.v. every 24 h for 2 days), and intravenous crystalloid fluid therapy (lactated Ringer’s solution, 50 ml/kg bwt/day for 2 days, then decreased to 25 ml/kg bwt/day for an additional 2 days). A lidocaine constant rate i.v. infusion was maintained (0.05 μg/kg bwt/min for 2 days) following surgery. Feed was initially withheld for 24 h following surgery then gradually reintroduced. When the gelding was initially reluctant to return to consuming feed, omeprazole (GastroGard, 2 mg/kg bwt per os every 24 h for 9 days) was added to the treatment protocol on Day 2 post operation. Following identification of the parasite as S. edentatus, fenbendazole (Panacur) was administered at a dose of 10 mg/kg bwt per os every 24 h for 5 days. Repeat haematological assessment 5 days following surgery revealed a fibrinogen level within normal clinical limits (3.0 g/l, rr 1–4 g/l) and a mild total hyperproteinaemia of 88 g/l (rr 58–87 g/l). The gelding was discharged from the hospital 9 days following surgery with recommendations to administer trimethoprim/sulphadiazine (Tucoprim, 13 mg/kg bwt per os every 12 h for 12 days) and to continue stall confinement with daily handwalking for an additional 3 weeks, followed by small paddock turnout for 4 weeks, then 4 weeks of large paddock turnout, before resuming regular riding activity. In addition, a 6-month course of 1.06% pyrantel tartrate (Strongid C) was recommended with ivermectin administered every 8 weeks. Following this, it was recommended that he be administered an anthelmintic every 8 weeks rotating between fenbendazole, pyrantel and ivermectin, and once a year praziquantel. Faecal egg counts were recommended every 4 months. The horse returned to its intended use and was considered healthy by the owner via telephone follow-up 5 years following discharge.

Additional diagnostics

Impression smears of the mass were submitted for cytological assessment. The specimens were moderately to highly cellular and inflammatory cells were predominantly eosinophils, suggestive of a parasitic granuloma. Histopathological assessment was consistent with an eosinophilic abscess with serositis of the surrounding colon wall. The worm specimen was examined via dissecting and compound microscopes and was consistent with a female S. edentatus due to size (3.3 cm) and morphological features of the buccal capsule. Culture of the aspirate of the mass produced a Gram-positive anaerobic rods: Bacteroides fragilis and Propionibacterium spp.

Additional therapy and discharge recommendations

The gelding was maintained on intravenous broad spectrum antimicrobial therapy following the collection of material for culture and sensitivity testing (potassium penicillin 22,000 iu/kg bwt i.v. every 6 h for one day then 44,000 iu/kg bwt i.v. every 6 h for 10 days, gentamicin 6.6 mg/kg bwt i.v. every 24 h for 6 days), a tapering dose of a nonsteroidal anti-inflammatory drug (flunixin meglumine 1.1 mg/kg bwt i.v. every 12 h for 5 days, then 0.5 mg/kg bwt i.v. every 12 h for 2 days, then 0.5 mg/kg bwt i.v. every 24 h for 2 days), and intravenous crystalloid fluid therapy (lactated Ringer’s solution, 50 ml/kg bwt/day for 2 days, then decreased to 25 ml/kg bwt/day for an additional 2 days). A lidocaine constant rate i.v. infusion was maintained (0.05 μg/kg bwt/min for 2 days) following surgery. Feed was initially withheld for 24 h following surgery then gradually reintroduced. When the gelding was initially reluctant to return to consuming feed, omeprazole (GastroGard, 2 mg/kg bwt per os every 24 h for 9 days) was added to the treatment protocol on Day 2 post operation. Following identification of the parasite as S. edentatus, fenbendazole (Panacur) was administered at a dose of 10 mg/kg bwt per os every 24 h for 5 days. Repeat haematological assessment 5 days following surgery revealed a fibrinogen level within normal clinical limits (3.0 g/l, rr 1–4 g/l) and a mild total hyperproteinaemia of 88 g/l (rr 58–87 g/l). The gelding was discharged from the hospital 9 days following surgery with recommendations to administer trimethoprim/sulphadiazine (Tucoprim, 13 mg/kg bwt per os every 12 h for 12 days) and to continue stall confinement with daily handwalking for an additional 3 weeks, followed by small paddock turnout for 4 weeks, then 4 weeks of large paddock turnout, before resuming regular riding activity. In addition, a 6-month course of 1.06% pyrantel tartrate (Strongid C) was recommended with ivermectin administered every 8 weeks. Following this, it was recommended that he be administered an anthelmintic every 8 weeks rotating between fenbendazole, pyrantel and ivermectin, and once a year praziquantel. Faecal egg counts were recommended every 4 months. The horse returned to its intended use and was considered healthy by the owner via telephone follow-up 5 years following discharge.

Discussion

This report describes an unusual and previously unreported source of abdominal abscessation resulting in fever, depression and inappetence in a horse. Abdominal abscessation was initially considered a likely source of the historical clinical signs as fever, colic, signs of depression, inappetence and weight loss generally accompany this condition (Rumibaugh et al. 1978). The clinicopathological data were also supportive of this diagnosis as neutrophilia, hyperproteininaemia, hyperfibrinogenaemia, hyperglobulinaemia and hypoalbuminaemia have been previously associated with abdominal abscesses (Zicker et al. 1990; Pratt et al. 2005: Arnold and Chaffin 2012). A rigorous diagnostic plan was enacted to either exclude other potential differential diagnoses or discover an abscess. Of the selected diagnostic examinations, percutaneous abdominal ultrasonography was included because abdominal abscesses have a characteristic sonographic appearance of a well-marginated structure with a mixed or complex echo pattern (Reuss et al. 2011). Although the sonographic findings in this case were highly suggestive of an abscess in the right ventral abdominal quadrant, definitive ante mortem confirmation required an exploratory celiotomy in the estimation of the attending clinicians. Although radiolabelling of leucocytes to image an abdominal abscess via nuclear scintigraphy has been reported (Koblik et al. 1985), a complete exploratory laparotomy would also afford a more accurate assessment as to the size and number of abscesses present, as this is often underestimated via ultrasonography (Reuss et al. 2011). Furthermore, exploratory laparotomy has been suggested to be employed to reveal the extent of adhesion formation secondary to peritonitis and to provide for a more accurate prognosis (Arnold and Chaffin 2012).

Long-term antimicrobial therapy has been considered the first-line therapy in cases of abdominal abscesses; however, surgical resection has been suggested as an option when possible (Taylor et al. 1981; Arnold and Chaffin 2012). Other treatment options that have been reported include marsupialisation via the ventral midline (Prades et al. 1989) and surgical drainage and post operative lavage (Mair and Sherlock 2011) in cases where the size of the abscess and location within the abdomen would not allow for complete removal. Given the small size (7 cm diameter) and location of the abscess in a segment of the intestine that could be visualised in this case, surgical resection was considered the treatment with the greatest chance for successful resolution.

Despite the massive and routine use of anthelmintics currently available, high efficacies have been consistently reported against large strongyles (Comer et al. 2006; Bonneau et al. 2009; Larsen et al. 2011). However, a recent report highlighted the importance of manufacturing issues of quality and/or formulation in the efficacy of commercially available avermectins. In their study, a generic drug produced by a small pharmaceutical laboratory was found to be inefficacious against S. edentatus, S. equinus and S. vulgaris (Toscan et al. 2012). The role that this information may have had in the present case is uncertain, although the horse was administered a commercially available anthelmintic by the owner approximately every 4 months, rotating between ivermectin, pyrantel and fenbendazole products. The gelding last received an anthelmintic approximately 5 months prior to presentation.
Fenbendazole was administered at a dose of 10 mg/kg bwt per os every 24 h for 5 days with the goal of eliminating large strongyles and encysted, third stage cyathostominis (DiPietro et al. 1997; Duncan et al. 1998); however, in subsequent studies (Chandler et al. 2000; Chandler and Love 2002; Lyons and Tolleriv 2003) the efficacy against all stages of cyathosmins was significantly reduced. Resistance of cyathosmins to benzimidazoles has consequently been documented in a wide geographic distribution (Kaplan et al. 2004). Furthermore, investigation of the degree of inflammation induced by administration of either fenbendazole at a dose of 7.5 mg/kg bwt every 24 h for 5 days or ivermectin at a dose of 0.4 mg/kg bwt per os found that the latter elicited a significantly milder inflammatory reaction within the large intestine, although both were found to be efficacious. Thus, based on the available information, ivermectin would have been another and perhaps better option for initial treatment in our case. Recommendations to administer a 6-month course of 1.06% pyrantel tartrate was based on the work of Monahan et al. (1998) which found a strong protective effect that was derived from daily treatment with the compound in terms of parasites recoverable at necropsy. The subsequent recommendation to administer an anthelmintic every 8 weeks rotating between fenbendazole, pyrantel and ivermectin, and once a year praziquantel with frequent [q. 4 months] faecal egg counts should not be interpreted as generalised advice for parasite control in all equids; however, it was the opinion of the clinicians that this plan would serve to provide the best chance for avoiding a repetition of the case history in this individual.

Recommendations to the owner included an additional course of antimicrobial therapy to be completed during the horse’s convalescence at the owner’s property. Trimethoprim/sulfadiazine was selected on the basis of its wide spectrum of activity, clinical efficacy, low price and ease of administration by the owner (Van Duijkeren and van Miert 1994). When administered at a combined dose of 30 mg/kg bwt per os every 12 h, this drug combination results in persistent plasma and tissue chamber fluid concentrations of both agents that exceed minimum inhibitory concentrations for susceptible organisms (van Duijkeren et al. 2002). The decision to continue systemic antibiotics beyond the period of hospitalisation was made in consideration of the mild degree of peritoneal contamination that occurred at surgery and due to the possibility for the presence of smaller abdominal abscesses not identifiable at the time of surgery. The recommended dose of 30 mg/kg bwt has since been routinely adopted by the surgeon involved in this case.

To the authors’ knowledge, the case described here is the first documented clinical case of abdominal abscessation secondary to S. edentatus migration in the horse. Complete surgical resection of the abscess was considered critical in achieving a positive outcome.

Authors’ declaration of interests
No conflicts of interests have been declared.

Manufacturers’ addresses
1Lloyd Laboratories, Shenandoah, Iowa, USA.
2Fort Dodge Animal Health, Fort Dodge, Iowa, USA.
3Hospira, Lake Forest, Illinois, USA.
4Baxter Healthcare Corp., Deerfield, Illinois, USA.
5Ethicon, Cincinnati, Ohio, USA.
6Covidien, Mansfield, Massachusetts, USA.
7Abbott Laboratories, North Chicago, Illinois, USA.
8Vedco Inc., St Joseph, Missouri, USA.
9Shering Plough Animal Health, Union, New Jersey, USA.
10Merial LLC, Duluth, Georgia, USA.
11Intervet Inc., Millsboro, Delaware, USA.
12Pfizer, New York, New York, USA.
13Zoetis, Florham Park, New Jersey, USA.

References

Continued on page 511
Tina is one of my favorite horses I’ve ever trained because she always wants to do the right thing. Her strength is that she reads a cow so well, like a horse that has a lot more experience. It’s like she has an old soul. When she gets a hold of a cow, she lets it all hang out. That’s the difference between being a good horse, and being a great one. She is such a big, strong mare, I am particular about her diet so she stays in shape, and is able to be as athletic as she needs to be. Platinum gives her so many important nutrients in just one scoop, and she loves the taste of it.

Lindy Burch
NCHA Open Futurity Champion & NCHA Open World Champion, Platinum Performance® Client since 1999

Lindy Burch is a sponsored endorsee and actual client.

This is **My Platinum**

**Platinum Performance® CJ Supports:**
- Joint Health
- Hoof Health
- Skin & Coat Health
- Performance & Recovery
- Digestive Health
- Bone & Tendon Health

**Platinum Bar EQ® Supports** Equine Wellness & Performance

Lindy also uses Platinum Performance® products for people, to help keep her feeling her best.

877-586-3362
www.PlatinumPerformance.com

To find the right Platinum Performance® solution, and to learn about the science behind the supplements, call or visit our website, or speak with your equine veterinarian.

© 2016 PLATINUM PERFORMANCE, INC.
Clinical Commentary

Abdominal abscesses in horses

F. Tóth

College of Veterinary Medicine, University of Minnesota, St Paul, USA.
Corresponding author email: ftoth@umn.edu

The accompanying case report presented by Bell et al. (2016) describes the successful surgical management of a horse with an abdominal abscess believed to be caused by migration of Strongylus edentatus larvae. Abdominal abscesses occur uncommonly in horses and are divided into 2 groups (Arnold and Chaffin 2012). A primary abscess originates from a systemic bacterial infection and is often caused by Corynebacterium sp., Streptococcus equi, Rhodococcus equi or Escherichia coli (Elce 2006; Arnold and Chaffin 2012; Berlin et al. 2013). A secondary abscess is one that develops usually after (surgical) trauma, perforation of the gastrointestinal or urogenital tracts or, as in the case reported by Bell et al. (2016), from parasitic larval migration.

Clinical signs displayed by a horse with an abdominal abscess are usually nonspecific and may include inappetence, lethargy, weight-loss, recurrent colic, and fever. Likewise, findings of clinical pathological examination are also aspecific but consistent with the presence of inflammation, and include hyperfibrinogenaemia, hyperglobulinaemia, neutrophilia and, occasionally, hyperproteinenaemia (Elce 2006; Pusterla et al. 2007; Arnold and Chaffin 2012; Berlin et al. 2013).

Definitively diagnosing the presence of an abdominal abscess is usually difficult and often requires an extensive investigation. A history of a respiratory infection with Streptococcus equi or Rhodococcus equi should heighten the suspicion of the presence of an abdominal abscess. Palpation of the abdomen per rectum may be helpful in obtaining a diagnosis if the abscess is localised to the caudal aspect of the abdomen, and it can provide further information if supplemented with ultrasonographic examination of the abdomen per rectum (Arnold and Chaffin 2012; Berlin et al. 2013). Identification of a thick-walled structure containing fluid of mixed echogenicity during percutaneous ultrasonographic evaluation of the abdominal organs is also suggestive of an abdominal abscess (Pusterla et al. 2007; Arnold and Chaffin 2012). If a lesion is identified adjacent to the abdominal wall, fine-needle aspiration and cytological evaluation of its contents are likely to yield a definitive diagnosis. Fluid obtained by abdominoenteresis from a horse with an abdominal abscess, is often characterised by an elevated white blood cell count and increased concentrations of total protein and fibrinogen. Intracellular bacteria may or may not be seen (Arnold and Chaffin 2012; Berlin et al. 2013).

If the above-mentioned diagnostic techniques yield no positive findings, surgical exploration of the abdomen, through a ventral midline celiotomy or laparoscopically with the horse anaesthetised or standing and sedated, should be considered. Although laparoscopic exploration performed with the horse standing is usually the less expensive approach, it rarely provides an opportunity for definitive treatment (Mair and Sherlock 2011). Nevertheless, it can be helpful in identifying lesions severe enough to warrant euthanasia, or situations where standing flank approach might provide effective treatment.

Treatment options for a horse with an abdominal abscess include prolonged systemic antimicrobial therapy alone or in combination with surgery. Selection of antimicrobial drug(s) for the treatment of a horse with an abdominal abscess is often difficult. Although Berlin et al. (2013) successfully treated 4 of 4 horses for an abdominal abscess by prolonged administration (32–50 days) of penicillin, a history of strangles directed the antimicrobial treatment of choice for all 4 of those horses. In a study by Pusterla et al. (2007), 8 horses determined to have an abdominal abscess initially received various combinations of injectable (and sometimes oral) antimicrobial drugs (i.e. ceftriox and gentamicin; gentamicin and penicillin; gentamicin and ampicillin; gentamicin, ampicillin and rifampin; ceftriox and rifampin) for up to 46 days, which was followed by a prolonged course (up to 120 days) of orally administered antimicrobials (rifampin or trimethoprim-sulfamethoxazole or chloramphenicol or the combination of trimethoprim-sulfamethoxazole and rifampin). Two of 8 horses were lost to follow-up, 4 survived long-term and 2 died due to complications associated with the abdominal abscess. More recently, bacterial cultures obtained from 42 horses affected with an abdominal abscess yielded a single pathogen in only 10 of 40 positive cultures; the remaining 30 positive cultures had multiple pathogens emphasising the difficulty of selecting proper antimicrobial therapy (Arnold and Chaffin 2012). Authors of publications detailing their experiences of treating horses for an abdominal abscess, however, uniformly agree that antimicrobial therapy should be continued until physical, clinicopathological, and ultrasonographic or laparoscopic findings confirm that the abscess has resolved completely (Elce 2006; Pusterla et al. 2007; Arnold and Chaffin 2012; Berlin et al. 2013).

If the horse remains unresponsive to prolonged antimicrobial treatment, surgical exploration of the abdomen is warranted because it is likely to provide additional information about the true extent of the disease. Surgical exploration may reveal additional disease (e.g. intestinal adhesions) and may allow definitive treatment, as illustrated by the report from Bell et al. (2016) in the accompanying article. Depending on the location of the abscess and involvement of various abdominal organs, complete resection of the abscess (and perhaps adhered intestine), surgical drainage and lavage, or marsupialisation can be attempted (Elce 2006; Mair and Sherlock 2011). If intestinal resection is necessary to completely excise the abscess, intraoperative evacuation of the intestinal contents is warranted to decrease contamination. Successful drainage or resection of the abdominal abscess is also likely to allow shortening of the...
period of antimicrobial administration (Blot and De Waele 2005). Indeed, with prompt surgical treatment and complete resection of the abscess, antimicrobial therapy beyond 5–7 days is rarely indicated for human patients treated for an abdominal abscess (Blot and De Waele 2005). Thorough lavage of the abdominal cavity immediately before closing the celiotomy and afterwards using an abdominal drain is warranted to prevent the formation of intestinal adhesions (Hague et al. 1998). A sterile polyionic solution is adequate for abdominal lavage. Adding iodine to the irrigating solution seems to be supported by scientific evidence (Schneider et al. 1988; Qadan et al. 2010).

Accurate prognosis for a horse with an abdominal abscess is difficult to provide, and the reported long-term survival rate ranges from 19.6 to 100% (Arnold and Chaffin 2012; Berlin et al. 2013). Arnold and Chaffin (2012) speculated that the low incidence of survival found in their study might be explained in part by the high proportion of horses with a secondary abscess that typically had multiple bacterial pathogens, making antimicrobial treatment more difficult. A large number of horses with septic peritonitis that subsequently developed intestinal adhesions may have also contributed to the low incidence of survival. Nevertheless, the validity of these conclusions is limited by the relatively large number of horses subjected to euthanasia without further treatment in that study. Conversely, Berlin et al. (2013) found that horses with a primary abdominal abscess up to 25 cm in diameter not accompanied by intestinal adhesions had an excellent outcome using prolonged treatment with penicillin.

Author’s declaration of interests
No conflicts of interest have been declared.

References
Primary closure of equine laryngotomy incisions: Healing characteristics and complications of 180 cases

C. Lindegaard*, L. Karlsson†, C. T. Ekstrøm‡ and J. Fjeldborg†

Evidensia Equine Specialist Hospital, Helsingborg, Sweden; †Faculty of Health and Medical Sciences, Department of Large Animal Sciences, University of Copenhagen, Taastrup; and ‡Department of Public Health, Section of Biostatistics, University of Copenhagen, Denmark.

*Corresponding author email: Casper.lindegaard@evidensia.se
Dr Karlsson’ present address: Flyinge District Veterinarians, Swedish Board of Agriculture, Flyinge, Sweden.

Keywords: horse; laryngotomy; recurrent laryngeal neuropathy; ventriculocordectomy; laryngeal hemiplegia

Summary
The objective was to report healing characteristics and complications after primary closure of equine laryngotomies and analyse factors potentially associated with complications. This retrospective case series of the medical records of horses (n = 180) undergoing laryngoplasty and laryngotomy incision between January 1995 and June 2012 were reviewed. Horses with a laryngotomy incision closed in three layers for primary healing were included. Descriptive data on healing characteristics and complications of laryngotomy wounds were collected from the medical records and via follow-up questionnaires sent to the owners. During hospitalisation 6.1% of the laryngotomy wounds became infected. In addition, 3.3% had oedema around the wound and 3.3% had subcutaneous emphysema after surgery. Neither oedema nor emphysema required additional treatment. No signs of respiratory distress, need of a tracheotomy or need for a reopening of the laryngotomy was observed in any horse. Infection of the laryngoplasty wound occurred in one horse. A total of 96 questionnaires were answered. Prolonged healing of the incision after discharge from the hospital was reported in four horses (4.2%). Laryngotomy infections were confined to the subcutaneous tissues; none led to complete dehiscence and all healed within 4 weeks. Regression analysis showed that closure of the skin with suture carried signifi-

Introduction
Due to the high risk of contamination with food-material and/or saliva, a laryngotomy wound is considered a clean-contaminated wound and therefore it is generally recommended to leave a laryngotomy incision open for second intention healing (Turner and McIlwraith 1982; Haynes 1984; Ducharme 2012; Fulton et al. 2012). Full 3 layer primary closure of laryngotomy incisions after ventriculectomy (VE)/ventriculocordectomy (VCE) has been reported with discouraging results (Boulton et al. 1995). In that study, incisional complications were reported in 22/42 horses, of which eight required further treatment, including one or more of the following: prolonged antibiosis, opening of the entire or part of the incision and/or flushing of the wound. Furthermore, there is an assumption that excessive post operative swelling, as reported in cases left to heal by second intention, might occur after primary closure and lead to obstruction of the laryngeal lumen (Tetens et al. 1996; Cramp et al. 2009). These experiences with both primary and second intention healing, as well as the classification of the wound as clean-contaminated, have probably led to the common impression that primary closure of the laryngotomy incision will lead to infection and ‘increase morbidity unnecessarily’ (Ducharme 2012).

However, second intention wound healing is slower and inevitably leads to increased wound inflammation with increased risk of scar formation, as well as decreased owner satisfaction because of the aesthetically unpleasing wound that requires daily or twice daily cleaning. Modern recommendations regarding wound healing have therefore moved towards primary wound healing strategies, even in wounds that are not clean (Stashak 2008).

When wounds are closed primarily, several factors, including choice of suture material and pattern, might affect the occurrence of various post operative complications including infection.

The primary aim of the present study was to report outcome and complications in laryngotomy incisions subjected to primary closure in a retrospective series of horses. In addition, we analysed pre-, intra- and post operative factors potentially associated with complications. Our hypothesis was that primary closure of a laryngotomy incision carries a low risk of complications, minimal aftercare and short duration of hospitalisation. Further hypotheses were that the risk of complications was associated with the use of certain suture materials in the cricothyroid ligament and skin.

Materials and methods
Case selection
Medical records of the Large Animal Hospital, University of Copenhagen (former Royal Veterinary and Agricultural University) from January 1995 to June 2012 were reviewed and all horses that underwent laryngoplasty in combination with either VE or VCE through a laryngotomy incision were included. Only horses in which the laryngotomy incision was closed for primary healing in three layers were included.

Surgical procedure
The surgical procedure was performed as originally described by Marks et al. (1970) with modifications as described by...
Fulton et al. (2012). Briefly, the laryngoplasty surgery was performed in lateral recumbency and after placing the prosthetic suture, antibiotics were deposited in the wound (see results section for specifications). Thereafter, the skin incision was closed in one of two ways; either with simple interrupted skin sutures or later in the study period with simple continuous suture in the subcutis followed by skin staplers in the cutis. After the laryngoplasty procedure, the horse was turned to dorsal recumbency followed by a new antiseptic preparation and draping of the ventral laryngeal surgical area. The VE or VCE was then performed through a midline laryngotomy initiated by a 6-8 cm skin incision followed by sharply dividing the paired sternohyoid and omohyoid muscles in the muscle septum while continuously spreading these by use of a Weitlaner retractor and finally incising the cricothyroid membrane and underlying laryngeal mucosa. The VE or VCE was performed using a laryngeal burr for the initial retraction of laryngeal ventricular mucosa followed by grasping and full exteriorisation with Ochsner forceps and final transection with Metzenbaum scissors. After performing the VE/VCE, the laryngotomy was closed for primary intention healing in the following way: first the cricothyroid ligament and laryngeal mucosa was sutured together with absorbable suture material USP No. 0 or 2-0 in a simple interrupted pattern with sutures interspersed approximately 5 mm or using a simple continuous pattern with similar bite size (Figs 1 and 2). Particular attention was paid to including both the ligament and laryngeal mucosa in the same closure. Closure of the ligament and mucosa was followed by flushing with sterile saline and local deposition of antibiotics. Antibiotics deposited in the wound were either benzylpenicillin sodium (1 g diluted in 3-5 ml of sterile water) or ampicillin sodium (1 g diluted in 5 ml of sterile water). One dose of the antibiotic was used in the laryngoplasty wound and one dose in the laryngotomy wound.

Thereafter gloves and instruments were changed and the incision between the paired sternohyoid and omohyoid muscles sutured with an absorbable suture material No. 0 in a simple continuous pattern (Fig 3). Finally, the skin was closed by use of an absorbable suture material No. 0 or 2-0 in a simple interrupted pattern, or by use of stainless steel skin staples. After spraying with a sterile water resistant protective film (Kruuse Wound plast spray) (Fig 4) and depending on the preference of the surgeon, the wound was covered by a stent bandage consisting of sterile gauze swabs attached with differing types of monofilament suture material. At the end of anaesthesia, the cuff of the nasotracheal tube was deflated approximately 50% and the tube removed with any blood and/or secretion collected in the trachea or larynx during the surgical procedure. The same surgeon performed the majority of the surgeries. The owner or referring veterinarian removed skin sutures or staples 10 days post operatively.

Post operative clinical examination
Post operatively and on a daily basis, temperature, heart and respiratory rates were noted in the records. Horses were examined clinically with visual inspection and manual palpation of the surgical areas. Based on these examinations, swelling, heat, sensitivity to palpation, discharge and emphysema were noted in the record. The term ‘post operative oedema in excess of what was expected’ was based on the surgeon’s experience with this type of surgery where swelling is generally minimal. ‘Oedema in excess of what is expected’ would for instance include pitting oedema.
Surgical wounds of their horses (Supplementary Item 1)

rates were computed using exact binomial methods to

A total of 95% confidence intervals (95% CI) for the incidence

Discharge and aftercare
Horses were discharged at 5 days post operatively if there were no signs of wound complications. Owners were instructed not to clean the wound if it was dry and to remove skin staples or sutures 10 days after surgery. Owners were instructed to contact a veterinarian if the wound was swollen or secreting any material. Further convalescence after discharge was routine.

Data obtained from the hospital records
Information obtained from the medical records included breed, gender, weight and age, suture material and pattern used for the different layers, pre-, intra- and post operative administration of antibiotics and analgesics, days of hospital stay and year of surgery. Clinical observations of the laryngotomy wound, with regards to swelling, heat, pain and discharge were recorded.

A retrospective analysis of these observations grouped them into three types of complications: infection, oedema and emphysema. If any uncertainty regarding the classification arose, the wound was classified as infected.

Classification as a surgical site infection (SSI) was based on commonly used criteria with the three different types of SSI: superficial incisional, deep incisional and organ/space (Ahern and Richardson 2012).

Follow-up questionnaires
Owners and trainers of horses were contacted by letter and asked to fill in a questionnaire regarding healing of the surgical wounds of their horses (Supplementary Item 1). Questionnaires included descriptions and questions regarding healing and potential complications, type of complication and whether any further treatment was performed and if so, what type of treatment had been necessary after discharge from the hospital.

Statistical analysis
A total of 95% confidence intervals (95% CI) for the incidence rates were computed using exact binomial methods to ensure proper coverage. A multiple logistic regression model that allowed for over-dispersion was used to model the odds of infection or complications as outcome and the initial model included cricothyroid membrane and mucosa suture (monofilament or braided), skin suture (suture or staples) and year of surgery as possible predictors. We investigated the linearity of the potential trend of operation year, but found that a linear effect of year described the data as well as a more complicated nonlinear effect (i.e. we initially allowed for a quadratic effect of year but found that it was not significant).

When analysing emphysema as an outcome we used the same initial model as described above, except that skin suture was discarded as a potential predictor since emphysema is considered only to arise from air exiting from the respiratory tract into the tissues. Model simplifications were undertaken using likelihood ratio tests at a 5% significance level. In the situations where the statistical model could be reduced to contain a single categorical predictor we used Fisher’s exact test to obtain exact P values for that final predictor. Otherwise, the results from the multiple logistic regression model were reported.

In addition, we wished to investigate if any of the predictors appeared to be associated to whether an observation was missing (lost to follow-up). This was done using a multiple logistic regression model where missing status was the response and the variables mentioned above were included as potential predictors. Difference in length of hospital stay between infected and noninfected horses was tested with an exact Wilcoxon rank sum test.

Descriptive data are reported as mean ± s.d. or median and range.

The study was approved by the University of Copenhagen internal research committee. Due to the retrospective nature of the study, neither were owner consent nor animal research licenses applied for nor given.

Results
Signalment data
During the study period 180 horses met the inclusion criteria. Breeds included were 100 Danish Warmbloods, nine Oldenburg, six Standardbred trotters, five Trakehners, four Holsteins, three Russian Warmbloods, three Thoroughbreds, one Quarter Horse, one Pinto, one Hanoverian, one Frederiksborg, two mixed breed riding horses and 44 of unrecorded breed. A total of 105 were geldings, 17 stallions, 32 mares and 26 were of unrecorded gender. Age was recorded in 158 horses, ranging from 1.5–17 years (mean 6.2 years). Left-sided laryngeal neuropathy was seen in 98.3% (n = 177) of the horses and 1.7% (n = 3) had right-sided laryngeal neuropathy.

Medications
All horses routinely received antibiotics preoperatively, intraoperatively locally in the laryngotomy wound after closure of the cricothyroid ligament (see Materials and Methods) and post operatively along with pre- and post operative nonsteroidal anti-inflammatories (NSAIDs) until discharge from the hospital at 5 days post operatively. Some horses were treated for a shorter period since they left the hospital earlier for logistic reasons. The peri- and post operative antibiotics administered were benzylpenicillin

Fig 4: The laryngotomy and laryngoplasty wounds immediately after closure.
Dexon, braided polyglycolic acid; Vicryl, braided polyglactin 910; Biosyn, monofilament synthetic polyester.

Suture materials and variations of surgical technique

During the 17 year study period, sutures used for all three layers has varied between braided polyglycolic acid (Dexon), braided polyglactin 910 (Vicryl) and monofilament synthetic polyester (Biosyn). In addition, skin has been apposed by use of stainless steel skin staples (Appose single use skin stapler). The distribution of suture material used for the different layers sorted by horses that got infected and horses that did not get infected are shown in Table 1.

Short-term results and complications

During hospitalisation, 11 horses (6.1% [3.1–10.7%]) displayed signs of infection including secretion, suppuration and/or fever, 6 (3.3% [1.2–7.1%]) had oedema in excess of what was expected but without any secretions and/or fever and 6 (3.3% [1.2–7.1%]) showed some degree of subcutaneous emphysema. The remaining 157 horses (87.2%) did not show any signs of wound complications. Only four of the infected horses had a bacterial culture performed and this revealed a mixed flora in two horses (one dominated by E. coli sp.) and beta haemolytic Staphylococcus sp. in the other two cases. Treatment for surgical site infection was removal of a few to all skin sutures or staples (Appose single use skin stapler). The distribution of suture material used for the hospital differed significantly between infected and noninfected (P = 0.0151). In none of the horses with post operative emphysema or post operative oedema in excess of what was expected was treatment with antibiotics and/or NSAIDs extended and all were discharged from the hospital as planned. Follow-up information was available for eight of the 12 (66.7%) horses with emphysema or oedema in excess of what was expected and none of these reported any signs of wound healing problems after discharge from the hospital.

Long-term results and complications of the laryngotomy wound

Follow-up data from a total of 96 answered questionnaires were available (53.5% return rate). Follow-up time ranged from 3 to 120 months (median 28.5 months). A total of 90 (93.8%) of these horses were reported to have no complications with laryngotomy wound healing after discharge. A total of four horses (4.2% [1.2–10.5%]) that did not show any signs of infection at discharge from the hospital were reported to have prolonged healing of the wound (i.e. some degree of discharge and swelling of the wound and/or not healed primarily at suture/staple removal). These horses were treated by the referring veterinarian with either removal of some skin sutures/staples and/or an increased period of antibiotic treatment. In addition, two horses (2.1% [0.5–7.3%]) discharged from the hospital with an already diagnosed wound infection also reported prolonged healing (as defined above). None of these required any further treatment after discharge from the hospital. None of the infected wounds included the deep muscles or cricothyroid ligament and all infected wounds closed between 2 and 4 weeks after surgery. None of the wounds were cultured.

Logistic regression analysis of outcome until discharge (infection, infection + oedema and emphysema) did not show any significant association with any of the explanatory variables (year of surgery, skin suture and cricothyroid ligament suture material). For the analysis regarding follow-up combined with data until discharge regression analysis showed an association between the overall occurrence of infection and choice of skin closure (P = 0.032), with sutures having an OR for infection of 7.93 (95% CI: 2.55–24.67) compared with staples. For the follow-up data, the analysis showed that only ‘year’ was associated with success for follow-up retrieval (P=0.0001), with increasing success for retrieving a follow-up response the later the horse was operated upon. The occurrence of post operative complications of the laryngotomy wound.
complications was not associated with success for retrieval of follow-up data.

Discussion
The present study demonstrated that equine laryngotomies closed for primary intention healing had an infection rate of 6.1% and a total complication rate of 12.8% until discharge from the hospital. There was no need for a tracheotomy in any of the horses and none of the complications led to a complete reopening of the laryngotomy incision. Hospitalisation time was significantly longer for infected than noninfected horses. Closure of the skin with suture carried a significantly higher risk of infection than closure of the skin with staples. In contrast to previous reports, the results demonstrate that laryngotomies in horses can be sutured for primary intention healing without jeopardising the health of the horse.

It is generally recommended to leave laryngotomies open for second intention healing for several reasons; one is the concern of development of post operative swelling that may become so severe that acute placement of a laryngotomy tube is necessary to restore adequate airflow (Haynes 1984; Tetens et al. 1996), a complication reported to occur in up to 6.6% of horses with a laryngotomy left to heal by second intention (Cramp et al. 2009). However, as this complication reported during healing of wounds by second intention was not observed in any of the 180 horses included in the present study, the argument seems to be of minor significance (Figs 5a-f). The difference in amount of post operative swelling observed between laryngotomies healing primarily or by second intention could be related to differences in perioperative antibiotic and NSAID treatments; in the present study, horses received antibiotics and NSAIDs for 5 days, compared with 1–3 days in the studies by Tetens et al. (1996) and Cramp et al. (2009).

Due to the potential risk of contamination of the laryngotomy, many surgeons may classify surgery of the larynx as contaminated surgery carrying a high risk of infection if closed for primary intention healing. Consequently, the general recommendation is to leave equine laryngotomies open for healing by second intention (Marks

Fig 5: The laryngotomy after closure of the cricothyroid membrane viewed from the laryngeal lumen. (a) Immediately after surgery (OBS other horse than b–f), (b) Day 1, (c) Day 2, (d) Day 3, (e) Day 4 and (f) Day 5 post operatively.
The tissues and consequently, other contaminated material emphysema is present, air escapes from the larynx and into the laryngeal lumen and laryngotomy wound; if contamination, air

Surgery of the paranasal sinuses in 1970; Turner and Mcllwraith 1982; Haynes 1984; Boulton et al. 1995). However, the correct classification for surgery of the upper respiratory tract, including the larynx, is clean-contaminated (Ahern and Richardson 2012) and primary closure is generally recommended for clean or clean-contaminated wounds since it has many advantages over healing by second intention. Primary closure successfully apposes the wound edges, reduces the risk of further contamination and reduces the healing time, aftercare and scar tissue formation (Stashak 2008). Primary closure is also the recommended choice for laryngotomies in dogs, with one study reporting only 2.3% wound complications (seromas) (Zikes and McCarthy 2012). Surgery of the paranasal sinuses in horses is another example of a procedure where contamination, airflow and the amount of soft tissue available for primary closure is similar to the laryngotomy. Despite these surgeries often being performed in contaminated or infected tissue, post operative healing has been reported as excellent or good in 92% of the cases (Dixon et al. 2012).

Boulton et al. (1995) reported on the application of primary closure of laryngotomies in 42 horses after various intralaryngeal or intrapharyngeal procedures. The incidence of post operative complications was 52% and the types of complications reported were similar to those reported in the present study, including oedema, emphysema and infection. However, further treatment/intervention of the complications was necessary in 19% of all horses in the study by Boulton et al. (1995) compared with only 2.8% in the present study. The primary reason for the differences between the study by Boulton et al. (1995) and the present study might be differences in surgical technique. Haynes (1984) regarded surgical technique to be a very important factor for the risk of post operative infection and considered that the complications encountered after primary closure of the laryngotomy were mainly caused by the difficulties of obtaining an air- and water-tight closure of the cricothyroid ligament. In the study by Boulton et al. (1995), 26% of the horses had emphysema, compared with only 3.3% in the present study. This difference might help explain the different results of the two studies since the occurrence of subcutaneous emphysema might be a measure of the surgeon’s ability to achieve a tight seal between the laryngeal lumen and laryngotomy wound; if emphysema is present, air escapes from the larynx and into the tissues and consequently, other contaminated material like saliva may also continue to contaminate the tissues of the incision. One of the major reasons for this difference might be the suture pattern applied to the cricothyroid ligament; in the study by Boulton et al. (1995) 29/35 horses (the rest not accounted for) were sutured with a simple continuous pattern, whereas more than 97% of the horses in the present study were closed with simple interrupted sutures. Closure of the cricothyroid ligament creates moderate to strong tension and we believe that this tension might be better managed by use of simple interrupted sutures spaced closely together (approx 5 mm) compared with a simple continuous suture pattern. However, the difference between simple interrupted and continuous closure was not analysed statistically in the present study as the number of horses in each group was too small. Another important point of the surgical technique is the anatomy of the ‘cricothyroid membrane’. This ‘membrane’ consists of two layers; the ligament proper and internal laryngeal mucosa and we consider it of utmost importance to meticulously include both the laryngeal mucosa and ligament proper when closing the first layer of the laryngotomy.

A third important reason for the different complication rates observed between the present study and the study by Boulton et al. (1995) might be differences in antibiotic treatment regimens: in the present study all horses received antibiotics preoperatively. Furthermore, we used antibiotics routinely locally in the incision intraoperatively and systemically for 5 days post operatively compared with no local antibiotics and only 1–2 days of post operative systemic administration in the study by Boulton et al. (1995). Although controversial, local deposition of antibiotics has been reported to be an effective means of reducing the risk of post operative infections (Lindsey et al. 1982; Beroza 1994). Local deposition of antibiotics is performed solely to reduce the amount of contaminating bacteria present when the incisions between the sterno- and omohyoid muscles are sutured and it is not probable that local deposition of antibiotics will prevent infection if continuous leakage of air and/or saliva is present.

In the present study, the use of skin staples was associated with a significantly reduced risk of infection compared with sutures. This is in opposition to the results of a study of factors associated with infection of celiotomy wounds where staples have been associated with a higher risk of wound infection than skin sutures (Torfs et al. 2010). However, Iavazzo et al. (2011) conducted a meta-analysis on this subject in human medicine and concluded that the use of staples is associated with a significantly lower risk for post operative infections than the application of skin sutures. Method for closure of the skin is not specified in the study by Boulton et al. (1995).

The results of the present study also compare favourably with previous studies with ‘partial’ second intention healing of laryngotomies (Dixon et al. 2003), or complete second intention healing (Taylor et al. 2006). In these studies, 7 and 15% of the horses, respectively, had discharge from the wound that lasted 2–4 weeks post operatively and 2–3% had discharge from the wound lasting more than 4 weeks post operatively. In the present study, only 4.2% of the owners or trainers declared that there had been disturbances such as swelling of, or discharge from, the laryngotomy after the horse left the hospital and all healed within 4 weeks. Consequently, primary closure reduces the need for
aftercare of the wound (Fig 6). Even if the secretion encountered in horses with partial closure or second intention healing is mild and does not need further treatment, it does require aftercare, such as cleansing of the wound for an extended period of time. The reduced need for aftercare after primary closure also reduces the duration of hospitalisation; in the present study, horses were hospitalised for a median of 5 days compared with a minimum of 6 days in other studies with second intention healing of laryngotomies (Dixon et al. 2003; Taylor et al. 2006).

It has been reported that the presence of an adjacent, infected laryngotomy wound (from concurrent VE or VCE) significantly increases the risk of laryngoplasty incisional complications (Dixon et al. 2003; Ahern and Richardson 2012). In the present study, only 1/180 horses had infection of the laryngoplasty and the successful primary closure of the laryngotomy incision may be the reason for the very low infection rate of the laryngoplasty demonstrated in the present study. Consequently, fewer complications benefit not only the horses by reduction of pain and discomfort, but also the owners, both economically through reduced hospitalisation time, a reduced need for aftercare and a reduced risk of concomitant infection of the laryngoplasty and hence reduced risk of potential failure of the entire procedure.

An increasing number of VCs or VCEs are now performed with laser surgery through a transendoscopic approach, gradually reducing the number of laryngotomies performed. However, many clinics still do not have the possibility to perform transendoscopic laser VE and VCE. Furthermore, laryngotomies are still indicated for a variety of other intralaryngeal or intrapharyngeal procedures, such as larger subepiglottic cysts, arytenoidectomy and epiglottic entrapment with adhesions amongst others. Application of primary intention healing wound principles is therefore still relevant as the technique may contribute to faster healing with fewer complications.

**Conclusion**

The present study demonstrates that primary closure of laryngotomy incisions can be performed with a rate of post operative infection well below 6%. The study thereby concludes that primary closure of laryngotomy incisions in horses can be performed safely without unacceptable morbidity or the final result of the surgical procedure performed. The few complications observed are considered to be of minor severity and importance to the horse than those reported after healing by second intention. Positive effects of primary closure include low degree of inflammation in a delicate area, minimal aftercare, fast healing, better aesthetics and reduced hospitalisation time. We consider that the protocol described in the present paper can be amended safely if care is taken to adhere to the surgical technique, particularly regarding closure of the cricothyroid ligament.

**Authors’ declaration of interests**

No conflicts of interest have been declared.

**Ethical animal research**

This is a retrospective case series and hence ethical permission was not sought nor given.

**Source of funding**

None.

**Acknowledgements**

We sincerely wish to thank all staff of the University of Copenhagen, Large Animal Hospital (former Royal Veterinary and Agricultural University) involved in the diagnosis, treatment and handling of the included horses.

**Antimicrobial stewardship policy**

None of the horses in the present study were treated with quinolones, 3rd or 4th generation cephalosporines or macrolides.

**Authorship**

J. Fjeldborg, L. Karlsson and C. Lindegaard planned the study and C. Ekström performed the statistics. All authors were involved in manuscript preparation.

**Manufacturers’ addresses**

- aKruuse, Marslev, Denmark.
- bBoehringer Ingelheim Vetmedica, Ingelheim, Germany.
- cFamaco AB, Sweden.
- dIntervet/MSD Animal Health, Copenhagen, Denmark
- eZoetis, UK.
- fCoviden, Dublin, Ireland.
- gEthicon, Johnson & Johnson, Somerville, New Jersey, USA.

**References**


Supporting information

Additional Supporting Information may be found in the online version of this article at the publisher’s website:

Supplementary Item 1: Questionnaire.
Review Article

Basics of equine dermatology

M. M. Sloet van Oldruitenborgh-Oosterbaan* and G. C. M. Grinwis†

*Department of Equine Sciences, Faculty of Veterinary Medicine, Utrecht University, The Netherlands; and †Department of Pathobiology, Utrecht University, The Netherlands.

*Corresponding author email: m.sloet@uu.nl

Keywords: horse; dermatology; anamnesis; anatomy; skin reaction patterns

Summary
This is the first article in a series of equine dermatology. The anatomy, reaction pattern of the skin, anamnesis, clinical examination and terminology of lesions are discussed.

Introduction
The skin is the largest organ in the body and dermatological problems are a frequent occurrence in equine practice. A great advantage of skin disorders is that they are readily visible and that the skin is easily accessible when specimens need to be taken. The disadvantage is that many skin disorders resemble one another. The combination of case background, thorough anamnesis and thorough physical examination generally enable the clinician to make a (tentative) diagnosis, which can be confirmed with appropriate additional examination. Skin disorders also have the great advantage that gross lesions can easily be photographed digitally. Digital images, together with the case history, extensive anamnesis and thorough physical examination, can then be discussed with colleagues.

Anatomy of the skin

Macroscopy of the skin
The skin of a horse is largely covered with hairs. The skin beneath the haired areas may or may not be pigmented. The skin around the nose, the udders and the genitalia (be it pigmented or not) is hairless. Tactile hairs are situated around the nose and the eyes (Fig 1). They are much larger and longer than ordinary hairs, have an adapted blood and nerve supply, and serve as mechanoreceptors.

The hair follicles grow at an angle to the skin, and in a direction that is particular to the body part concerned. As a result, an overall pattern emerges, ensuring that rainwater 'runs off' efficiently. Sometimes hairs grow in a different direction in a certain place, referred to as a 'whorl' (Fig 2). Body hairs grow to a length, the maximum of which is genetically determined for the particular breed and under certain conditions. Equine hairs grow in cycles comprising three major stages:

Anagen
The growth stage in which hair is produced by mitosis of the cells in the hair bulb and the dermal papilla supplies nourishment to the hair bulb. At the start of this stage a new hair is formed that presses out the old hair. The new hair progressively elongates and emerges above the surface of the skin.

Catagen
The hair has reached maximum length, growth stops and the hair loosens from the hair matrix.

Fig 1: Tactile hairs around the nose of a horse.

Fig 2: The hairs in a whorl or crown have a different alignment from the other body hairs.
Telogen
This is the quiescent stage and there is no hair growth.

In conditions that prevail in Western Europe, horses shed in the spring and autumn. Growth of the mane, tail and fetlock hair is continuous and so these hairs are not shed.

The horned structures of the skin are the hoof, chestnut and ergot. The ergots are small callosities in the fetlock, which are sometimes only palpable. Chestnuts are possibly vestigial toes; a horse has a chestnut on the medial side of each leg. Zebra have a chestnut on the forelimbs only (Fig 3). Hooves, chestnuts and ergots grow continuously. Excess horn breaks off at the ergots and chestnuts (Fig 4) or wears down in the hooves.

Wear of the hoof, as would occur in natural circumstances, is generally insufficient, or by contrast, too great, in the currently prevailing living conditions of horses and ponies (Figs 5 and 6) and so a farrier is required for hoof care.

Fig 3: A zebra only has a chestnut on the front limb.

Fig 4: Chestnuts grow slowly but steadily and excess horn breaks off.

Fig 5: Although this horse suffering from colic had been shod, the front hooves have worn down in the course of a few days.

Fig 6: A badly neglected foot of a draft horse.
The skin, when viewed under a microscope, consists of the epidermis (top layer), the dermis and the subcutis (= hypodermis; Figs 7–10).

Microscopy of the skin
The skin, when viewed under a microscope, consists of the epidermis (top layer), the dermis and the subcutis (= hypodermis; Figs 7–10).

The epidermis is a multilayered, squamous, keratinised epithelium. Ninety-five percent of the epidermis is made up of keratinocytes, plus melanocytes, Langerhans and Merkel cells. Langerhans cells, which play a part in the immunity of the skin, and Merkel cells, which contribute to the sensory experience of touch, are not visible in standard haematoxylin and eosin stained sections. The melanocytes, which are responsible for pigmentation, protection from solar radiation and stabilisation of free radicals, are sometimes visible. However, when skin sections are made, melanocytes lose their normal appearance with long cytoplasmic extensions (dendrites) as a result of artifactual cytoplasmic shrinkage during tissue processing. There are four layers in the epidermis of the horse: the stratum basale (a single layer of proliferating basal cells with mitoses and melanin granules), stratum spinosum (several layers thick with a great many desmosomes and tonofilaments for the skin’s mechanical strength and elasticity), stratum granulosum (3–5 cellular layers with keratohyaline granules for ‘waterproofing’ the skin,
and for considerable apoptosis in the upper layer), and stratum corneum (sharply demarcated from the stratum granulosum, no nuclei and no cell organelles, splits between the cells filled with material from keratinosomes). In horses, the basement membrane is also generally easily distinguishable in haematoxylin and eosin sections (Fig 11).

The dermis consists mainly of collagen and elastin fibres in a ground substance chiefly made up of glycosaminoglycans and proteoglycans. Cells occur here and there in the dermis; they are primarily fibroblasts (producing ground substance) and dermal dendrocytes (part of the dermal immune system). However, in the normal skin of a horse, mast cells (particularly in the superficial dermis around the blood vessels), lymphocytes (around blood vessels), histiocytes (around blood vessels) and eosinophilic granulocytes (around blood vessels) can be found.

Also embedded in the dermis are hair follicles with hairs, sebaceous glands, hair muscles (Musculi arrectores pilorum), sweat glands, blood vessels, lymphatic vessels and nerve fibres.

Horses have one hair per hair follicle. Each hair has its own Musculus arrector pili, a smooth muscle running from the hair root to the skin surface. They play a role in erection of the hairs and emptying of the sebaceous glands. These skin muscles are not very well developed in the horse. A hair grows out of a hair bulb (Fig 12). Hair follicles are divided into three parts. The infundibulum runs from the surface of the epidermis to the opening of the sebaceous gland, the isthmus runs from the opening of the sebaceous gland to the attachment of the M. arrector pilorum, and the inferior segment running from the attachment of the M. arrector pilorum to the dermal hair papilla.

The sebaceous glands are holocrine glands, which empty via a drainage channel in the hair follicle (Fig 13). Sebaceous glands mostly occur around the mucocutaneous junctions, the upper eyelid, the mane, the udder and the coronary band. The production of these glands is primarily regulated hormonally. Sebum keeps the skin supple and ensures adequate moisture balance of the skin. Androgen hormones stimulate production, whereas oestrogens and corticosteroids curb it.

The sweat glands are apocrine glands situated like curved tubules in the skin. Sweat glands are responsible for thermoregulation, for excretion of some residues and for production of aromatic products (pheromones). Sweat glands are found in the haired skin and are located somewhat deeper than the sebaceous glands. Sweat glands have their own drainage channel to the surface of the epidermis. The way in which they are controlled is only partially known; it is based on a complex interaction of neurogenic and humoral factors.

The cutaneous blood vessels in the skin consist of arterioles, arterial and venous capillaries and venules, and form a complex system that is important for the metabolism of the skin, but also for thermoregulation. Moreover, the cutaneous blood vessels play an important part in the skin’s defence mechanisms. They form three intercommunicating plexuses: a superficial plexus just below the epidermis (serving the epidermis and the upper part of the hair follicles, amongst other things), a middle plexus at the level of the sebaceous glands (serving, for example, the sebaceous glands, Musculi arrectores pilorum), and a deep plexus.
located at the junction between deep dermis and subcutis (serving the deep parts of the hair follicles, sweat glands and subcutis). These three plexuses are interconnected.

The lymphatic system of the skin is organised in a subcutaneous lymphatic plexus. The lymph vessels are essential for feeding the skin, because they control the flow of fluid in the skin.

The cutaneous nervous system comprises small cutaneous nerve fibres, which mainly follow the blood vessels. These fibres have multiple functions, including touch, vascular tone and regulation of the secretion of the glands. The skin of the face is innervated by branches of the trigeminal nerve, the rest of the body skin by nerves emerging from the spine. The area innervated by the branches of one nerve emerging from the spine is called a dermatome. The nerve supply comprises afferent sensory nerve fibres and efferent autonomic nerve fibres.

The subcutis, also known as the hypodermis or panniculus, is mainly made up of adipose tissue, collagen and elastin fibres. In most areas of the body the skin is connected to the underlying muscle tissue, fascia or bone by means of the subcutis. However, that is not the case everywhere: in the lips, eyelids, ear and anus, for example, the skin is in direct contact with the underlying muscle tissue or fascia.

The top layer of the subcutis lies in folds (papilla adiposae) between the hair follicles and the sweat glands. The functions of the subcutis are protection by shock absorption (prevention of trauma), storage of energy reserves, thermoregulation and insulation, and maintenance of surface contours. The muscle fibres in the adipose tissue enable the skin to move, for instance to dislodge insects. Fat storage in the subcutis can sometimes assume pathological forms, as with very overweight horses and ponies. Fat redistribution can also occur with pituitary pars intermedia dysfunction (formerly also known as Cushing’s disease).

**Reaction pattern of the skin**

The skin has only a limited number of possible reaction patterns. They can be divided into epidermal and dermal changes.

**Epidermal changes**

The main changes that can occur in the epidermis relate to epidermal growth and/or differentiation, changes in epidermal cell adhesion, inflammatory changes in the epidermis, and changes in its pigmentation.

Changes in epidermal growth and/or differentiation include hyperkeratosis, pseudocarcinomatous hyperplasia, necrosis, apoptosis and neoplasia. Examples of changes in epidermal cell adhesion are oedema and acantholysis.

Inflammatory changes affecting the epidermis comprise exocytosis, microabscesses and pustules, and crusts. Hyperpigmentation, hypopigmentation, pigmentary incontinence, leucotrichia and leucoderma are examples of pigmentation changes.

**Dermal changes**

The foremost changes that can occur in the dermis relate to its inflammation or degeneration with deposition of certain substances in the dermis. Examples of inflammatory changes of the dermis are hyperaemia, oedema, perivascular and periadnexal infiltrates of leucocytes and the formation of granulomas. The description of cellular infiltrates in the dermis is generally based on the type of infiltrating cells and the pattern in which they occur and can give direction towards a specific skin disease. Degenerative dermal deposits are found mainly in the form of amyloidosis or calcinosis. Degenerative changes may also involve collagen degeneration and atrophy.

With some skin conditions these basic changes are found in various combinations. Very few skin conditions entail entirely distinct pathognomonic histological changes. Thus a diagnosis can usually only be made when the anamnesis, the clinical examination and the histological changes are jointly assessed. Good collaboration between clinician and pathologist is, therefore, essential if a reliable diagnosis is to be reached.

**Changes in the subcutis**

The main change that can affect the subcutis and, in particular, the fat cells in the subcutis, is inflammation which may cause panniculitis or steatitis. In addition, neoplasia of fat tissue can occur.

**Clinical examination**

There is a more or less set protocol for examining patients with skin disorders. It proceeds as follows:

- Case background
- Anamnesis
- Clinical examination
- Further examination

Clinical examination is in two parts: general clinical examination and clinical examination of the skin. If required, closer clinical examination can take place: on the one hand addressing organ systems other than the skin, and on the other hand further examination of the skin, for example a parasitological, bacteriological or mycological examination.

**Fig 14:** Chronic progressive lymphoedema in a 15-year-old Friesian, formerly also known as condylomatous greasy heel.
**Case background**

Age, breed and sex are important data for differential diagnosis. For instance, some breeds are predisposed to certain skin conditions, like the predisposition of Friesians and cold-blooded horses for chronic progressive lymphoedema (CPL), formerly often known as condylomatous greasy heel (Fig 14). In addition, some conditions are age-related, such as papillomas in young animals (Fig 15) or to a particular colour, such as melanoma in greys (Fig 16).

**Anamnesis**

Adequate time should be taken for the anamnesis (history). It is often better to speak to the person who looks after the horse on a daily basis (not always the owner). A reliable, comprehensive anamnesis is very important to understand the aetiology and development of the disorder and environmental factors that might have played a part in its commencement and continuation.

Important questions that need to be asked with anamnesis of skin disorders are:

1. **The nature, type and development of the change in the skin.**
   - What is the problem and how long has it been present?
   - How did the problem start and where on the body?
   - How old was the animal when the problem started?
   - What did the changes in the skin (lesions) look like initially?
   - Did the lesions come about suddenly or gradually?
   - What changes have taken place over time?
   - What course has the disorder taken (season-related, stationary, improved or worsened)?

2. **Behaviour and presentation of the case.**
   - Is there itching (scratching, biting, rubbing, stamping) and, if so, where?
   - Is the itch slight, moderate or severe?
   - Does itching lead to lesions?
   - Is itching season-related?
   - Is there evidence of reduced performance?
   - Is there evidence of a behaviour change or restlessness?
   - Are there other clinical signs besides itching?

3. **The case’s environment in the widest sense.**
   - What feed does the patient get?
   - What kind of ground cover is there in the stall/stable?
   - Are there, apart from the patient, other horses or ponies in the patient’s surroundings with problems?
   - Does the disorder also occur in other animal species?
   - Prior to the onset of the disorder, were new animals introduced in the surroundings?
   - How is the horse/pony housed (nature and type of stable, pasture)?
   - Is there contact with other horses or other species?
   - Has the animal been out of the country?

4. **Medication in the form of injections, tablets, ointments or washes.**
   - Are medicines being used for the skin disorder or washes performed (or have they been) – and what is/was the effect?
   - Is the case receiving medication for other conditions (side effects)?

5. **Zoonotic aspects.**
   - Are there people in the surroundings who also have skin complaints (owner, carer, family members)?
   - If so, what are the skin (or other) complaints?

When the anamnesis is conducted it is important to remember that an owner has often already tried ‘everything’ before consulting the veterinarian and that the owner or
caretaker will only recount the whole process after further probing. It is worth repeating several questions, formulated somewhat differently, in order to check the answers.

**General and dermatological examinations**

The clinical examination of the skin case is twofold: a general clinical examination and the clinical examination of the skin (dermatological examination). The main objective of the former is to find indications for a possible disorder other than just the skin complaint for which the animal has been submitted. For instance, a horse with chronic skin problems, as well as serious weight loss and greatly enlarged lymph nodes, could have lymphoma (Fig 17). During general clinical examination, respiration, pulse, body temperature, mucosa and lymph nodes are observed. In addition, a (short) examination is made of the skin, coat and horny structures. If necessary, examination of the organ systems – lungs or heart – follows.

Effective dermatological examination consists of a systematic inspection of the patient as a whole. Examination of the skin focuses on the general aspect of the coat and recording the changes in any skin (lesions). In addition, the thickness of the coat, possible changes in coat colour, alignment and sheen of the hairs, loose or broken hairs, grooming condition and the presence of chafed or hairless patches.

An inspection is also made for lice eggs (nits) or bot fly eggs, and whether ectoparasites are visible (lice can certainly be detected with the naked eye, as ‘moving matter’) and whether skin lesions occur. A magnifying glass with a small light (Fig 18) can be extremely useful in that respect. The inspection is not only aimed at seeing where the lesions are located, but also the type of lesions and the configuration in which they occur. Lesions can be symmetrical, generalised or localised. The localisation of skin lesions is important for a correct differential diagnosis and it is important to record them.

When a disorder occurs, the skin may exhibit a number of changes, which are clearly discernible macroscopically. With respect to the reaction pattern of the skin, these are changes, which on the whole occur at the level of the epidermis, the hair follicles, the dermoepidermal interface and the subcutis. Aetiological diagnosis based on visible changes is often not always possible. Characteristics such as breed, age and localisation of the lesions are also important in diagnostics. Elementary changes in the skin, which occur in various skin disorders, can be divided into primary and secondary lesions. Primary lesions occur spontaneously and directly reflect the underlying disorder. Secondary lesions result from trauma (scratching, rubbing), but may also be induced by treatment with chemical products such as medication. It is important to try to distinguish between the two types of lesions, by looking at the skin closely and describing the lesions carefully. Some lesions belong in both groups. They are either primary or secondary, depending on the nature of the disorder. Primary lesions can be disguised by secondary infections and trauma resulting from itching. When a disorder occurs, the skin may exhibit a number of changes, which are clearly discernible macroscopically. With respect to the reaction pattern of the skin, these are

![Fig 17: A 19-year-old Royal Warmblood Studbook of the Netherlands mare with weight loss and, within 3–4 months, increasingly large lumps over the entire body which, with histological examination, proved to be lymphoma (courtesy Huub van Wijk).](image)

![Fig 18: A magnifying glass with a small light is very useful when inspecting details.](image)

**Primary lesions**

Macula: This is a circumscribed, flat discoloration of the skin. With haired skin, the discolorations are often difficult or impossible to see. There are:

- Red maculae resulting from hyperaemia (erythema) or haemorrhages in the dermis. They can also be bluish in colour.
- Brown to black maculae resulting from a local build-up of pigment in the basal part of the epidermis; pigment
changes can also be the consequence of modified production of melanin.

• White maculae caused by local depigmentation, possibly occurring following inflammation, for example an interface dermatitis or pressure from articles of tack (Fig 19).

Papule, plaque: A papule is a circumscribed, firm elevation of the skin measuring less than 2.5 cm. The papule’s colour is usually red (though often not visible on account of hair growth). Papules that coalesce are called plaques: flat elevations which can also stem from a tumour. Depending on the morphogenesis, two types of papule are distinguishable:

• The epidermal papule comprising a thickening of the epidermis due to hyperplasia, for instance, inflammation or oedema.

• The subepidermal papule, which is formed by a thickening of the dermis due to a cell increase (inflammation or tumour).

Nodule or node: Nodules are small, precisely circumscribed dermal elevations (lumps), which penetrate into the deep dermis. They are the result of accumulations of cells due to neoplasia or inflammation. Lesions smaller than 1 cm are called nodules, whilst the larger ones are called nodes.

Urtica or wheal: An urtica is a circumscribed elevation with a flat surface; it is caused by oedema in the dermis. Urticae, which can suddenly appear and disappear, often accompany an allergic reaction. When they occur in generalised areas, this is referred to as urticaria (Fig 20), so called after the reaction to contact with the cells of the Urtica dioica (stinging nettle).

Vesicles and bullae: A vesicle is a small blister filled with fluid (oedema, blood). Blisters often have a thin wall, meaning they can burst easily. These can be divided into:

• Intraepithelial vesicles, for instance resulting from extensive intercellular (spongiosis) and intracellular (hydropic degeneration) oedema and degeneration of desmosomes (acantholysis).

• Subepidermal vesicles, in which blister-formation has brought about a separation between epidermis and dermis. Blisters with a diameter of more than 5 ml are called bullae.

Pustules: A pustule is a small, circumscribed elevation of the skin resulting from an accumulation of pus in and/or under the epidermis (abscess formation). With intraepidermal localisation, it is also referred to as impetigo. Pustules can be a secondary development from vesicles.

New formation: A tumour (swelling) can either be neoplastic or reactive (inflammation) of nature. Generally the term tumour is used for neoplasms.

Secondary lesions

Squamae or scales: Squamae are loose scales or flakes of horn that are found between the hairs (Fig 21). They can be caused by an inflammation of the skin. Scales may occur as primary lesions, for example primary seborrhoea. The underlying disturbance can be increased production (hyperkeratosis) or impaired exfoliation (dyskeratosis).

Crusts: Crusts (scabs) are attached to the skin. They are mainly made up of dried serum, pus or blood, plus horn and/or sebum.

Collarettes: Collarettes occur after a pustule or vesicle has burst. The upper layer of the stratum corneum (the ‘roof’) has become detached. What remains is a circular rim of epidermal tissue.

Erythema: This is a red discolouration of the skin that is not sharply defined. It usually results from licking, though vasodilation can be a cause (in that case, the erythema can be considered a primary lesion).
Alopecia: This is hair loss. The patch may be sharply circumscribed, but can also be diffuse. Alopecia may result from trauma as caused by rubbing, or from a serious disorder that occurred several weeks earlier, whereby the hairs have all entered the telogen phase. Alopecia also occurs as a primary lesion, for example with an immune-mediated disorder (Fig 22) and can be idiopathic as well. Therefore, in such cases, a primary lesion exists.

Excoriations or erosions: These apply to superficial defects in which the epidermis is damaged and the basement membrane is intact. They can be caused by rubbing.

Ulcers: An ulcer is a deep epidermal defect that extends into the dermis and entails damage of the basement membrane. If the ulcer is linear it is termed a fissure. Scars often occur once the ulcer has healed.

Lichenification: Lichenification refers to an extensive thickening of the skin with a pronounced accentuation of the skin’s surface relief. It results from repeated trauma, such as scratching (Fig 23).

Hyperpigmentation: The skin has a dark colour due to increased production of melanin. Hyperpigmentation is often accompanied by lichenification. Hyperpigmentation can also be congenital or idiopathic.

Comedo: A comedo (‘blackhead’) consists of a dilated hair follicle filled with keratin and sebum. The plural of ‘comedo’ is ‘comedones’.

List of problems and differential diagnosis
The results of the clinical examination are recorded, possibly using a diagram to show the localisation of certain major defects (Fig 24) or preferrably digital photos.

With all the data from the initial clinical examination, a list of problems is drawn up, as well as a list of the most probable differential diagnoses. It is worth noting them in the patient’s dossier and then systematically going through the list. The owner’s wishes will also determine whether further examination is carried out and expenses may play a significant role here.

Authors’ declarations of interests
No conflicts of interest have been declared.
Fig 24: Diagram on which to indicate the localisation of changes in the skin and skin lesions.

Ethical animal research
Ethical review not applicable for this review article.

Source of funding
None.

Authorships
Both authors contributed to writing this review article.
PARTNERS MAKE THE DIFFERENCE

LASTING PARTNERSHIPS PRODUCE ENDURING FRIENDSHIPS

AAEP’s Educational and Media Partners create opportunities for the AAEP and its members to help bridge the difference between the ordinary and the extraordinary. Together with their support, we can continue to advance the health and welfare of our patients and profession.

Educational Partners

Boehringer Ingelheim
Dechra
Luitpold Animal Health
Merial
Nutramax Laboratories
Platinum Performance
Purina
Zoetis

Media Partners

EquiManagement
Equus
The Horse

American Association of Equine Practitioners

aaep.org
Rood & Riddle
EQUINE HOSPITAL

With hospitals in Lexington, Saratoga and Wellington, Rood & Riddle is a worldwide leader in equine health care.

OFFERING SERVICES IN:
- Ambulatory
- Diagnostic Imaging
- Internal Medicine
- Laboratory
- Podiatry
- Reproduction
- Sport Horse
- Surgery

Lexington, KY • Saratoga Springs, NY • Wellington, FL
WWW.ROODANDRIDDLE.COM

EDS
Equine Diagnostic Solutions

Laboratory Testing Service
Specializing in
Equine Infectious Diseases

- Respiratory → S. equi, EHV 1, EHV 4, Influenza. R. equi
- Neurologic → EPM, EHV 1, WNV
- Biosurveillance → S. equi, Salmonella, EHV 1, Influenza

EQUINE DIAGNOSTIC SOLUTIONS, LLC
University of Kentucky Coldstream Research Campus
1501 Bull Lea Rd., Suite 104
Lexington, KY 40511
Tel: (859)288-5255 • Fax: (859)288-5250

Because a horse’s success starts on the inside

KindredBio
Best Medicines for our Best Friends

First of its kind in the veterinary market, a mineral based sunblock with ingredients to soothe, aid with healing, antimicrobial action and a natural bug repellent all in a creamy easy to apply base. Not just for noses but also easy to apply on white legs & patterns.

EquiShield SB contains Zinc Oxide to protect against UVA and UVB rays and also includes Citronella 1%, Chlorhexidine 1% and Aloe Vera.
Recognize Equine Problems Early

Catalog no. K21836
October 2014, 880 pp.
ISBN: 978-1-4822-2191-6
$149.95 / £99.00

Catalog no. K22261
ISBN: 978-1-4822-2191-6
$129.95 / £79.00

CRC Press has expanded into the field of veterinary medicine. Visit us online to see our complete collection of titles.

www.CRCPRESS.com

Order online at www.crcpress.com
with discount code GMQ60 at checkout and SAVE 20%

Task Force Horse presents:

Equine Eye Case Days
Work up real cases with the instructors and improve your skills!
With Brian Gilger, Thomas Launois and Richard McMillan
Müggenhausen, Germany, February 18 to 20, 2017

Equine Reproduction Days
— Embryo Transfer —
Hands-on clinical skill training on ET, OPU and ICSI!
With Anthony Colas, Peter Doels and Carolina Herrera
Lüsche, Germany, February 24 to 26, 2017

For detailed information and other events please check our website or contact Dr. Anne Lüder - contact@agpferd.de - phone +49 2461 340-430

www.agpferd.com

From the patient. For the patient.
Produces Autologous Conditioned Serum (ACS) containing anti-inflammatory cytokines.

Orthokine® vet irap 60
Orthokine® vet irap 60 vs. Arthrex IRAP II System:
✓ Higher serum yield
✓ Less hemolysis
✓ Closed system
✓ Sold thru distribution!

Orthokine® vet irap 10
✓ Single dose injection
✓ No special centrifuge needed
✓ Processed and injected same day

For Technical Support or information, contact Dechra Veterinary Products at: 866-933-2472 or www.dechra-us.com
Dechra Veterinary Products US and the Dechra D logo are registered trademarks of Dechra Pharmaceuticals PLC.
RegenerEQ™ has been scientifically formulated to promote...

- Appetite and weight gain
- A healthy gastro-intestinal environment

Therefore improving behavior and performance

RegenerEQ Plus™ Paste
Available in a 4 dose travel syringe.

"I have included RegenerEQ in my treatment regime in horses with inflammatory bowel disease and gastrointestinal disorders. I have been very impressed with the results."

Meg Miller Turpin. DVM.
DACVIM, (Diplomate ACVIM)

Call 386-868-0618
www.equitransound.com

THE BEST IN THE WORLD RELY ON GEL
PATENTED EQUINE COMFORT BOOTS & GEL ORTHOTICS

TRANSPORTING • STALLING • RECOVERY

- Soft-Ride's achieve maximum performance
- Protects and discomfort to decrease fatigue
- Provides support, stability and shock absorption
- Gel orthotic improves circulation to provide relief and foster recovery

ICE SPA THERAPY 21
- For extended Therapeutic Cooling
- Laminitic Prevention
- Post Surgery - Colic
- Performance Recovery

ICE SPA RECOVERY 28
- Athletic Performance Iceing
- Immobilization of knees and Hocks

CHANNELED GEL ORTHOTIC
- Circulated cold under sole

FOR THE ULTIMATE IN SPA BENEFITS PORTABLE AERATION AND MINERAL SALT TREATMENT OPTIONS

855-763-7431 • 281-334-2576 • www.SoftRideBoots.com

SHIPPED WORLDWIDE FROM MFG PLANT 626 GRAND AVE, BAGLIFE TX 77518 OR ASK YOUR VETERINARIAN
AAEP Show Special
As low as $6.63/chip!!!!!!

- ISO Compliant 134.2 kHz frequency
- Readable by ANY Universal Scanner
- No Registration Fees – EVER!

Sales: 818-445-3055
911PetChip.com
FreePetChipRegistry.com
You can rely on us for all your equine veterinary practice needs.

Breeding & Obsterics
C.H.I.C.E. Diagnostics
Equipment & Supplies
Pharmaceuticals
Parasiticides
Vaccine Biologicals

Call to Order Today:
(855) HSIN-ED1 (472-4371) | www.henryscheinvet.com

Trust Equiplas for life.

Equiplas® R
The ONLY USDA licensed combination plasma on the market for Rhodococcus Equi and Failure of Passive Transfer

FOR MORE INFORMATION VISIT plasvaccusa.com

Advanced Monitors Corporation

Tele-View® USB Endoscope/Gastroscope

- Display on Computers or Tablets*
- High Resolution with Super Bright LED’s
- No Processor or Light Processor Needed

“...The Tele-View 3M Gastroscope has been an excellent tool for our practice. In fact, the Gastroscope works so well, we’ve scoped 70 horses in the first three months!”

- Maia Arosaj DVM, Neil H Gray DVM, PC., Burbank, CA

Tele-View Articulating Dynamic Endoscope

- The Gold Standard for Diagnosing Upper Airway Breathing Pathology
- Quick and Easy to Use: Results in 30 Minutes

Call About Upcoming Trade Show Specials

877-838-8367 x105 | 858-536-8237 x105
www.admon.com | sales@admon.com
THE EVOLUTION OF EQUINE IMAGING IS HERE

NEXT
Equine DR™
The 1st Stand Up Portable Digital Radiography System

- 10” x 12” Cesium Panel
- MUSICA™ Image Processing
- SMART DR Workflow
- Wireless Auto-sense

- 18” Removable Tablet
- Multiple View Positions
- Multiple View Heights
- Wireless Freedom

Durable Shell Case
- Integrated Battery Charger
- Integrated Power System
- Monitor Elevator System

GE Healthcare

Ultrasound
Get advanced imaging, precision tools, easy usability and robust data management in a compact ultrasound that will grow with your practice.

- High resolution PDI
- Evolved image quality
- Faster performance
- Newly designed transducers
- Enhanced visualization
- Cutting edge technology
- Scan assist
- Ability to track patients
- Streamlined workflow

Sounds a Company

Experience The Evolution 800.268.5354 | www.soundvet.com
We’re shaping the future of equine health.

We don’t just bring more products to the market than any other company, we also bring up-to-date research and unique treatments to our customers. At Boehringer Ingelheim Vetmedica, Inc., our commitment to animal health begins with innovation.

Visit healthyhorses.com and learn how your needs can take shape with ours.

BY THE MAKERS OF:

VETERA vaccines

Prascend pirogallol mesylate

Hyvisc (hyaluronate sodium)
The Original - The Proven
Autologous treatment
of joints, tendons
and the back

Orthokine® vet
irap 60
Orthokine irap 60:
- A completely closed system
to reduce contamination
- Higher Serum yield and
less hemolysis than other
ACS kits on the market
- Sold through distribution

Orthokine irap 10:
- Collect blood, process
and deliver to the patient
in the same day!
- No specialized centrifuge or
rotor required (smaller syringe
fits in a standard 12mL rotor)
- Kit includes everything needed
for processing

For Technical Support or information, contact:
Dechra Veterinary Products at 866-933-2472 or www.dechra-us.com