Retrospective Case Series of 20 Horses (2002–2009) Sustaining Puncture Wounds to the Navicular Bursa With Maggot Debridement Therapy as an Adjunctive Treatment

Raul J. Bras, DVM; and Scott Morrison, DVM

This paper describes the use of maggot debridement therapy as an adjunctive treatment for puncture wounds of the navicular bursa. The ability of horses in this series to return to their previous level of work was better than previously reported for the street nail procedure and endoscopic techniques. Authors’ address: Rood and Riddle Equine Hospital, PO Box 12070, Lexington, Kentucky 40580-2070; e-mail: rbras@roodandriddle.com. © 2009 AAEP.

1. Introduction
Puncture wounds of the equine hoof are a common cause of equine lameness. Most superficial penetrating hoof injuries are readily treated with conservative management by simple exposure, drainage, and disinfection of the wound tract. Cases of deep puncture wounds may involve vital synovial structures. Infection of the navicular bursa, distal interphalangeal joint, deep digital flexor tendon, or tendon sheath can be difficult to overcome once established, sometimes leading to irreversible tissue damage. Deep puncture wounds involving the navicular bursa have a more guarded prognosis than puncture wounds of other parts of the foot. Knowledge of the anatomy of the equine foot is essential. The navicular bursa is a unique synovial structure within the foot. The main difference is the relatively isolated and protected location, which renders it difficult to reach and assess for potential contamination. Special attention should be paid to the lateral or medial and central sulci of the frog, because this is a common puncture site usually involving deeper structures such as the navicular bursa.

Puncture of the navicular bursa and the introduction of contamination with subsequent infection are generally considered to carry a poor prognosis. Septic navicular bursitis and the sequelae of septic deep digital flexor tendonitis and osteomyelitis of the navicular bone are considered to be the most frequent reasons for euthanasia of horses with deep puncture wounds of the foot. Identification of affected structures followed by early surgical debridement and the establishment of drainage is considered the treatment of choice when indicated. Traditionally, the “street nail” procedure has been used to open the palmar or plantar aspect of the navicular bursa for drainage, debridement, and lavage. Reviews of septic navicular bursitis have indicated a poor prognosis for success of the street nail procedure (31.6%). In contrast to the street nail
procedure, the arthroscopic approach for navicular bursa lavage and evaluation seems to offer an advantage in the treatment of contaminated or septic navicular bursa, with a significantly improved prognosis (63%).

However, some cases require continuous drainage for resolution of the septic process.

2. Materials and Methods

The medical records of 20 horses with puncture wounds of the navicular bursa that presented to the Podiatry Department of Rood and Riddle Equine Hospital were reviewed. The descriptions of the horses and case histories are shown in Table 1. The procedures performed, including diagnosis and treatments, final outcome, and therapeutic shoe used on each case, are shown in Table 2.

On admission, a complete physical examination and evaluation of the puncture wound consisting of plain radiographs, fistulograms, probing of the puncture tract, samples for bacterial culture and antimicrobial sensitivity, and synovial fluid aspirate collected were performed. All horses received light surgical debridement of the puncture tract, navicular bursa lavage, regional limb perfusion, intravenous antibiotics, anti-inflammatory, and therapeutic shoeing with heel elevation. Light surgical debridement only involved the most superficial structures, such as the necrotic infected tissues, and did not include the deeper vital synovial structures (Fig. 1). Navicular bursa lavage was performed using aseptic standard technique. An 18 gauge 3 inch spinal needle with stylet was utilized and inserted on the midline at the distal extent of the depression created by the junction of the collateral cartilages and the deep digital flexor tendon which is at the proximal extent of the digital cushion at a 10° downward angle proximal to the ground surface (Fig. 2). Distal limb intravenous regional perfusion using a butterfly catheter injected into the medial or lateral digital vein at the level of the pastern with a pneumatic tourniquet at the level of the proximal sesamoid bone was performed generally for 3 consecutive days and then every other day as needed. Initially 750 mg of amikacin sulfate diluted to a volume of 20 ml of isotonic solution for a period of 30 min was administered once daily. Antimicrobial selection was based on culture and susceptibility test results. Sterile medical maggot therapy was initiated on days 2 and 3 for non-traumatic debridement of necrotic tissue and bacteria after receiving initial treatment on admission. In maggot debridement therapy, disinfected green blow fly larvae are used to treat and manage puncture wounds. One vial of 500-1000 larvae embedded in gauze was applied to the external solar surface of the foot at the puncture site initially (Fig. 3). A stack of dry sterile gauze was gently bandaged over the larvae and wound to absorb any exudate, and a treatment plate was used for protection. Bandages were changed daily to remove any discharge/excretions created by the maggots and the suppurating wound. Each batch of maggots placed into the wound usually lasted 5–7 days before they become satiated. At this time, a second batch of maggots was added if needed. Repeated applications of maggots were kept in the wound until all necrotic tissue was debrided and a healthy bed of granulation tissues was evident. In 60% (12/20) of horses, a 0.25-in Penrose drain was fed through the entry tract directed just palmar/plantar to the deep digital flexor tendon and

Table 1. Clinical Description: 17 Horses With Puncture Wounds of the Navicular Bursa

<table>
<thead>
<tr>
<th>Horse</th>
<th>Age</th>
<th>Breed</th>
<th>Gender</th>
<th>Limb</th>
<th>Time Delay From Injury to Referral (Days)</th>
</tr>
</thead>
<tbody>
<tr>
<td>1</td>
<td>4 yr</td>
<td>Thoroughbred</td>
<td>Female</td>
<td>LH</td>
<td>31</td>
</tr>
<tr>
<td>2</td>
<td>8 mo</td>
<td>Thoroughbred</td>
<td>Filly</td>
<td>LF</td>
<td>14</td>
</tr>
<tr>
<td>3</td>
<td>Unknown (adult)</td>
<td>Thoroughbred</td>
<td>Female</td>
<td>RF</td>
<td>Chronic—exact time unknown</td>
</tr>
<tr>
<td>4</td>
<td>6 mo</td>
<td>Thoroughbred</td>
<td>Female</td>
<td>LF</td>
<td>7</td>
</tr>
<tr>
<td>5</td>
<td>9 yr</td>
<td>Thoroughbred</td>
<td>Gelding</td>
<td>LF</td>
<td>8</td>
</tr>
<tr>
<td>6</td>
<td>8 yr</td>
<td>Saddlebred</td>
<td>Female</td>
<td>LH</td>
<td>21</td>
</tr>
<tr>
<td>7</td>
<td>5 yr</td>
<td>Thoroughbred</td>
<td>Female</td>
<td>LH</td>
<td>4</td>
</tr>
<tr>
<td>8</td>
<td>8 yr</td>
<td>Quarter Horse</td>
<td>Gelding</td>
<td>LH</td>
<td>3</td>
</tr>
<tr>
<td>9</td>
<td>5 mo</td>
<td>Thoroughbred</td>
<td>Female</td>
<td>LH</td>
<td>3</td>
</tr>
<tr>
<td>10</td>
<td>4 yr</td>
<td>Thoroughbred</td>
<td>Female</td>
<td>LH</td>
<td>7</td>
</tr>
<tr>
<td>11</td>
<td>14 yr</td>
<td>Quarter Horse/Thoroughbred</td>
<td>Gelding</td>
<td>LH</td>
<td>3</td>
</tr>
<tr>
<td>12</td>
<td>11 yr</td>
<td>Warmblood</td>
<td>Gelding</td>
<td>RF</td>
<td>3</td>
</tr>
<tr>
<td>13</td>
<td>Unknown (adult)</td>
<td>Thoroughbred</td>
<td>Female</td>
<td>LF</td>
<td>3</td>
</tr>
<tr>
<td>14</td>
<td>11 yr</td>
<td>Thoroughbred</td>
<td>Female</td>
<td>LF</td>
<td>21</td>
</tr>
<tr>
<td>15</td>
<td>5 yr</td>
<td>Thoroughbred</td>
<td>Female</td>
<td>RF</td>
<td>3</td>
</tr>
<tr>
<td>16</td>
<td>Unknown (adult)</td>
<td>Thoroughbred</td>
<td>Female</td>
<td>RF</td>
<td>7—but suspect older</td>
</tr>
<tr>
<td>17</td>
<td>5 yr</td>
<td>Thoroughbred</td>
<td>Male</td>
<td>LH</td>
<td>5</td>
</tr>
<tr>
<td>18</td>
<td>1 yr</td>
<td>Thoroughbred</td>
<td>Unknown</td>
<td>LH</td>
<td>3</td>
</tr>
<tr>
<td>19</td>
<td>Unknown (adult)</td>
<td>Thoroughbred</td>
<td>Female</td>
<td>LH</td>
<td>7</td>
</tr>
<tr>
<td>20</td>
<td>8 yr</td>
<td>Appaloosa</td>
<td>Gelding</td>
<td>LH</td>
<td>30</td>
</tr>
</tbody>
</table>

LH, left hind; LF, left front; RH, right hind; RF, right front.
<table>
<thead>
<tr>
<th>Horse</th>
<th>Diagnostic Tests</th>
<th>Procedure</th>
<th>Outcome</th>
<th>Therapeutic Shoes</th>
</tr>
</thead>
<tbody>
<tr>
<td>1</td>
<td>Fistulogram</td>
<td>Surgical debridement; lavaged</td>
<td>Returned to previous use (broodmare)</td>
<td>Steel keg shoe with treatment plate; Sigafoos (series II) with wedge (4°)</td>
</tr>
<tr>
<td>2</td>
<td>Fistulogram arthrocentesis (tendon sheath coffin joint)</td>
<td>Street nail procedure (NB sequestrum); lavaged</td>
<td>Returned to previous use (training)</td>
<td>Sigafoos (series II) with wedge (4°)</td>
</tr>
<tr>
<td>3</td>
<td>Fistulogram arthrocentesis (navicular bursa, coffin joint)</td>
<td>Street nail procedure; arthroscopy; Penrose drain</td>
<td>Returned to previous use (broodmare)</td>
<td>Rail shoe (4°) with treatment plate. Foot cast Sigafoos (series II wedge 2–3°)</td>
</tr>
<tr>
<td>4</td>
<td>Fistulogram arthrocentesis (coffin joint)</td>
<td>Lavaged (coffin joint); Penrose drain</td>
<td>Returned to previous use (training)</td>
<td>Sigafoos (series II wedge 2–3°) with treatment plate</td>
</tr>
<tr>
<td>5</td>
<td>Arthrocentesis (navicular bursa, coffin joint)</td>
<td>Arthroscopy; Penrose drain</td>
<td>Returned to previous use (riding)</td>
<td>Patten shoe with treatment plate (adjustable wedge)</td>
</tr>
<tr>
<td>6</td>
<td>Fistulogram</td>
<td>Surgical debridement; Penrose drain</td>
<td>Returned to previous use (broodmare)</td>
<td>Patten shoe with treatment plate (adjustable wedge)</td>
</tr>
<tr>
<td>7</td>
<td>Fistulogram arthrocentesis (navicular bursa)</td>
<td>Lavaged</td>
<td>Returned to previous use (racing)</td>
<td>Sigafoos (series II wedge 2–3°) with treatment plate</td>
</tr>
<tr>
<td>8</td>
<td>Fistulogram arthrocentesis (navicular bursa)</td>
<td>Lavaged; surgical debridement; Penrose drain</td>
<td>Returned to previous use (riding)</td>
<td>Patten shoe with treatment plate (adjustable wedge)</td>
</tr>
<tr>
<td>9</td>
<td>Fistulogram arthrocentesis (coffin joint)</td>
<td>Lavaged (tendon sheath); Penrose drain</td>
<td>Returned to previous use (training)</td>
<td>Rail shoe (4°) with treatment plate; Patten shoe (adjustable wedge)</td>
</tr>
<tr>
<td>10</td>
<td>Fistulogram</td>
<td>Lavaged; Penrose drain</td>
<td>Returned to previous use (training)</td>
<td>Patten shoe with treatment plate (adjustable wedge)</td>
</tr>
<tr>
<td>11</td>
<td>Fistulogram arthrocentesis (coffin joint)</td>
<td>Lavaged; Penrose drain</td>
<td>Returned to previous use (riding); bilateral neurectomy (2 yr after)</td>
<td>Patten shoe with treatment plate (adjustable wedge)</td>
</tr>
<tr>
<td>12</td>
<td>Arthrocentesis (coffin joint)</td>
<td>Surgical debridement; lavaged</td>
<td>Neurectomy (5 mo after)</td>
<td>Aluminum bar shoe with treatment plate</td>
</tr>
<tr>
<td>13</td>
<td>Arthrocentesis (coffin joint)</td>
<td>Street nail procedure; lavaged (coffin joint); surgical debridement (2 wk after)</td>
<td>Neurectomy (2 mo after)</td>
<td>Patten shoe with treatment plate (adjustable wedge)</td>
</tr>
<tr>
<td>14</td>
<td>Fistulogram arthrocentesis (navicular bursa)</td>
<td>Lavaged; Penrose drain</td>
<td>Contralateral laminitis (1 mo after); neurectomy (1 yr after)</td>
<td>Rail shoe (4°)</td>
</tr>
<tr>
<td>15</td>
<td>Fistulogram arthrocentesis (tendon sheath)</td>
<td>Surgical debridement; lavaged; Penrose drain; street nail procedure (1 mo after)</td>
<td>Contralateral laminitis (3 mo after); neurectomy (4 mo after); euthanized (5 mo after)</td>
<td>Patten shoe with treatment plate (adjustable wedge)</td>
</tr>
<tr>
<td>16</td>
<td>Fistulogram arthrocentesis (tendon sheath)</td>
<td>Surgical debridement; lavaged; Penrose drain</td>
<td>Euthanized (by farm)</td>
<td>Patten shoe with treatment plate (adjustable wedge)</td>
</tr>
<tr>
<td>17</td>
<td>Fistulogram arthrocentesis (coffin joint)</td>
<td>Lavaged (bursa and coffin joint); surgical debridement; Penrose drain</td>
<td>Euthanized (1 mo after)</td>
<td>Patten shoe with treatment plate (adjustable wedge)</td>
</tr>
<tr>
<td>18</td>
<td>Fistulogram arthrocentesis (tendon sheath)</td>
<td>Lavaged (bursa and tendon sheath); surgical debridement</td>
<td>Return to previous use (sound)</td>
<td>Patten shoe with treatment plate (adjustable wedge); splint cast</td>
</tr>
<tr>
<td>19</td>
<td>MRI and arthrocentesis (navicular bursa, coffin joint)</td>
<td>Lavaged (bursa and coffin joint); surgical debridement</td>
<td>Return to previous use (broodmare/sound)</td>
<td>Patten shoe with treatment plate (adjustable wedge)</td>
</tr>
<tr>
<td>20</td>
<td>Digital radiographs</td>
<td>Street nail procedure (NB osteomyelitis); Penrose drain</td>
<td>Return to previous use (endurance riding)</td>
<td>Patten shoe with treatment plate (adjustable wedge)</td>
</tr>
</tbody>
</table>
secured to the skin at the palmar/plantar aspect of the pastern to maintain an open tract for continuous drainage and to allow the maggots to maintain access to the diseased tissue (Fig. 4). After 10–14 days, the drain was removed. Adjunctively, in 10% (2/20) of the horses, endoscopic lavage and debridement was used, and in 25% (5/20), the street nail procedure was performed before maggot debridement. All horses were treated with therapeutic shoes with heel elevations such as adjustable Patton shoes, wedge shoes, and rail shoes, with treatment plates for support and protection (Fig. 5). Long-term follow-up of all the cases to this date was done by routine re-evaluations, direct contact with colleagues or referral veterinarians, and over-the-phone conversations with the current owners of the surviving horses.

3. Results

The septic process resolved in 90% (18/20) of the horses after treatment, with 70% (14/20) returning to intended or previous level of use with no complications. All horses were admitted in the chronic stage of the disease (after 72 h), with 8/20 (40%) horses before 5 days, 5/20 (25%) horses between 5 and 10 days, and 7/20 (35%) horses after 10 days from injury to referral. Endoscopic lavage and debridement of the navicular bursa was performed on 2/20 (10%) horses (cases 3 and 5), with evidence of a moderate amount of fibrin within the bursa, injury to the deep digital flexor tendon, and full-thickness damage to the cartilage at the palmar surface of the navicular bone. Both horses returned to their pre-

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Fig. 1. (A) Examination of the puncture wound tract on the medial sulcus of the frog with evidence of a serosanguineous discharge. (B) Surgical debridement only involved the most superficial structures such as necrotic infected tissues and did not include deeper vital synovial structures.

Fig. 2. A) Navicular bursa lavage was performed using aseptic technique with an 18 gauge 3 inch spinal needle with stylet. B) Lavage was also performed from the puncture site entry tract.
vious level of use. In addition to the navicular bursa, synovial structures were also involved and also infected in five (25%) horses. Two cases (cases 9 and 18) had tendon sheath involvement, and the other three cases (cases 4, 13, and 17) involved the coffin joint. The synovial structures were lavaged and treated; a successful outcome was found in three horses (cases 4, 9, and 18) who returned to their previous level of use. A second debridement procedure was required for case 13, with neurectomy 2 mo after. Street nail surgery was performed on five (25%) horses (cases 2, 3, 13, 15, and 20) because of a navicular bone sequestrum and osteomyelitis. Adjunctive endoscopic lavage was also performed together with street nail surgery in one case (case 3). These three horses (2, 3, 20) returned to their intended use. The remaining two (cases 13 and 15) horses required surgery 1 mo after presentation because of lack of response to treatment. These two horses were euthanized, but it must be noted that one (case 13) was because of unrelated factors (infertility) and the other (case 15) was because of contralateral laminitis complications. One other horse (case 12) required neurectomy because of persistent lameness. It must be noted that case 11 returned to previous level of use (riding) until it required bilateral neurectomy 2 yr later because of lameness unrelated to the puncture wound. The remaining two (10%) horses in the study (cases 16 and 17) were euthanized humanely. Case 16 was euthanized by the farm after opting to not proceed with treatment because of no improvement and further complications, and case 17 was euthanized 1 mo later because of lack of response to treatment.

In 90% (18/20) of the horses, the infectious process resolved with the presented methods, with 70% (14/20) returning to their previous level of use.

4. Discussion

An accurate medical history is essential in determining the source and duration of the injury. Lameness will be variable in severity, depending largely on the duration of the infection. Initially lameness may be mild, rapidly progressing to severe and non-weight bearing on the affected limb. The history is usually typical of sepsis and lameness of increasing severity, developing over several hours or days. Any information regarding the location, direction, and depth of the puncture is valuable. If the location, direction, and depth of the foot penetration are known, it is easier to ascertain which structures are likely to be involved. If a horse is presented with a foreign body in situ, radiographs should be carried out before removal of the foreign body to identify the structures involved. A thorough examination and careful inspection of the foot for a puncture tract is essential if a foreign body is not present. Trimming the solar surface of the foot and paring away superficial exfoliating layers of horn tissue will usually show a puncture tract. For puncture wounds involving the frog and its sulci, the cornified tissue overlaying this area and adjacent bar must be removed. Foreign body penetration can be difficult to identify if the object is no longer in situ, because the relatively elastic horn of the frog tends to seal over once the object is removed. Placement of a blunt-ended, malleable metal probe into the tract helps in defining the depth and direction of the penetration (Fig. 6). Positive contrast radiography has great potential in assisting the determination of the extent of the puncture tract. The resulting fistulogram can provide useful information as to the depth and direction of the penetrating tract and whether or not it communicates with the suspected synovial compartment (Fig. 7).
Diographs can also show other abnormalities such as navicular bone osteomyelitis and presence of debris. The evaluation of any secondary tissue damage that has occurred as a consequence of sepsis is particularly important in cases where there has been a delay in the identification of the foreign body. Obtaining a synovial fluid sample is important in all cases of potential synovial penetration, because synovial fluid analysis can aid in the diagnosis of sepsis. Also, obtaining a sample swab of the puncture wound for culture and sensitivity can help to provide a therapeutic plan and monitoring response to treatment.

The aim in treating septic bursitis is eradication of bacterial load, removal of any foreign material, debridement of necrotic tissue, elimination of inflammatory mediators and free radicals, pain relief, and restoration of the normal synovial environment to promote tissue healing. These objectives are achieved by appropriate administration of antimicrobial and anti-inflammatory drugs, lavage, and surgical debridement for rapid elimination of the infection to minimize structural damage and fibrous adhesion formation. In general, puncture wounds with <48-h duration of injury can be treated with lavage and drainage, systemic antibiotics, anti-inflammatories, and regional perfusion. On the other hand, puncture wounds with >48- to 72-hour duration of injury require some form of debridement of the affected tissue. Factors that determine treatment of septic bursitis include duration of the infection, contamination of the puncture wound, other structures involved, expectation of outcome, and financial capabilities of owners.

Bacterial multiplication and the establishment of infection into the navicular bursa have a poor prognosis for survival and return to function without aggressive treatment. Bacteria together with the harmful products of inflammation destroy the fibrocartilage of the flexor surface of the navicular bone, leading to thinning and erosion. Areas of subchondral bone become exposed and likewise undergo destructive change, leading to septic osteitis and osteomyelitis. Simultaneous with the development

Fig. 4. A 0.25-in Penrose drain was fed through the entry tract using a malleable probe (A) directed just palmar/plantar to the deep digital flexor tendon (B) and secured to the skin at the palmar/plantar aspect of the pastern to maintain an open tract for continuous drainage and to allow the maggots to maintain access to the diseased tissue (C).
Fig. 5. Therapeutic shoes with heel elevations such as adjustable Patten shoes (A and B), wedge shoes, and rail shoes (C).

Fig. 6. Placement of a blunt-ended, malleable metal probe (A) into the tract helps in defining the depth and direction of the penetration on radiographs (B).
of septic bursitis, the proximal and distal navicular suspensory ligaments become damaged, and the normal anatomic barriers they form between the navicular bursa, coffin joint, and the digital flexor tendon sheath breaks down. Infection is free to extend between these synovial structures, leading to further tissue destruction.

Identification of the causative organism(s) is important in the management of synovial infections. In general, infections that occur as a result of puncture wounds generally tend to be polymicrobial because of environmental contaminates. Although an appropriate antibiotic regimen can be implemented based on the results of culture and sensitivity testing of an organism, antibiotic therapy should not be delayed while awaiting results. The most commonly used drugs are broad-spectrum antibiotics such as combinations of β-lactam agent (potassium penicillin) and aminoglycosides (gentamicin sulfate, amikacin sulfate). Other antimicrobials that have been clinically effective or have been shown to enter the synovial fluid at therapeutic concentrations in clinically normal joints include oxy-tetracycline, trimethoprim-sulfonamide combinations, metronidazole, ticarcillin-clavulanate, ceftiofur sodium, and vancomycin hydrochloride. Enrofloxacin is used for horses with refractory septic arthritis and osteomyelitis or when long-term administration of antimicrobials is required. It must be noted that the bacteria involved in the septic process must be susceptible to the antimicrobial chosen. The antibiotic regimen is modified as indicated by bacteriological culture and antibiotic sensitivity results. Combinations of systemic and local administration are recommended for the treatment of horses with septic synovitis and osteomyelitis. Oral antimicrobial administration is generally preferred when long-term administration is needed. Regional perfusion can be used to achieve high local concentrations of antimicrobials in the selected region of the limb. This suggests that administration of concentration-dependent antimicrobials, such as aminoglycosides, by regional perfusion should have an excellent bactericidal effect and should improve treatment efficacy. Imipenem-cilastin administered by slow regional intravenous infusion achieves antimicrobial concentrations that are also effective for susceptible pathogens. Significantly higher concentrations of antimicrobials can be achieved with intra-articular administration than those obtained with regional intravenous or intraosseous perfusion. Therefore, intra-articular administration of antimicrobials may be more effective for the treatment of septic synovitis. Although antibiotic treatment is useful, early effective surgical lavage and drainage is of paramount importance in these cases.

Physical removal of infected tissue, debris, and establishment of drainage is essential in horses with puncture wounds of the hoof. The goals of surgical lavage and drainage are to eliminate infection, remove debris and foreign material, debride contaminated or devitalized tissue, prevent damage to articular cartilage, reduce the formation of fibrous adhesions, and eliminate inflammatory mediators. Techniques most commonly used include lavage under arthroscopy guidance, through-and-through lavage, and open drainage with or without drains. Arthroscopy offers several advantages, including improved visibility, lavage of a larger area of the synovial structure, identification and removal of foreign material, fibrin, and devitalized tissue. The decision to use any of these techniques is directly related to the severity, duration, and the location of the infection.

A non-traumatic method for removal of necrotic tissue and bacteria is beneficial for the most optimal outcome. Maggot debridement therapy is a non-traumatic, minimally invasive method to remove necrotic tissue from an extensive foot infection (Fig. 8). Maggot debridement therapy (MDT) is the medical use of specially selected disinfected green blow fly larvae (maggots) for cleaning non-healing wounds. Medicinal maggots have been found to
have four principle actions: (1) debride wounds by
dissolving the necrotic, infected tissue; (2) disinfect
the wound by killing bacteria; (3) stimulate wound
healing; and (4) break down and inhibit the forma-
tion of biofilm. In the 1940s, before the introduc-
tion of antibiotics, maggots were routinely used to
clean infected wounds. William Baer, at Johns
Hopkins University in Baltimore, MD, was the first
physician (an orthopedic surgeon, actually) in the
United States to actively promote maggot therapy in
the 1930s. In 1989, the University of California
Irvine and Veterans Affairs Medical Center began
using maggot therapy in early stages of wound heal-
ing. In 2003, medical maggots (disinfected Phaeni-
cicia sericata larvae) were approved by the FDA for
maggot debridement therapy. Proteolytic enzymes
seem to be responsible for the debriding or liquefy-
ing action of the maggots on the necrotic tissue,
while the maggot-derived proteins do indeed kill
bacteria and promote wound healing. Maggot
therapy is believed to not only debride necrotic tis-
sue, but also to stimulate fibroblast activity and
angiogenesis. Larval therapy can be useful in de-
briding residual necrotic tissue after surgical de-
bridement. This combination of treatment is an
effective way to debride diseased tissue without
disturbing the normal architecture of the foot.
Regional limb perfusions and systemic antibiotics
are used along with maggot therapy and seem to
have no harmful effects on the larvae within the
wound.

For the purpose of comparison with the series of
cases reported by Wright et al. and Richardson et
al., many factors should be taken into consider-
atation. Tissue damage from the infection and ex-
tensive surgical debridement can cause structural
damage to the foot, permanent lameness, and pro-
longed healing time can be expected. The street
nail surgical technique described by Richardson et
al. and Steckel et al. is an extensive debridement
procedure in which a window is cut through the
deep digital flexor tendon and navicular bursa,
leaving a large, open wound requiring intensive
care and healing time in which complications can
be expected secondary to the disturbance of the
anatomical structure during surgical debride-
ment. MDT is believed to not only debride ne-
crotic tissue, but also to stimulate fibroblast
activity and angiogenesis, therefore decreasing
healing time significantly and resulting in shorter
periods of hospitalization. In contrast to the
street nail procedure, endoscopic treatment is less
invasive, and post-operative care is less intricate.
Maggot debridement therapy is non-traumatic
and less invasive than both procedures and is an
effective way to debride diseased tissue without
disturbing the normal architecture of the foot. The
street nail procedure and endoscopic treatment
requires the horse to be placed under general an-
esthesia, which always carries the risk for compli-
cations and increased costs. With the use of
maggot therapy, necrotic tissue debridement is a
continuous process while the maggots remain in
the puncture site. On the other hand, debride-
ment of necrotic tissue with the street nail proce-
dure and endoscopic lavage is achieved only
during the actual procedure, and it is not contin-
uous. Additionally performance-limiting adhe-
sions caused by infected tissue and damage during
surgery may be reduced with the use of elevated
heel therapeutic shoeing, a treatment not men-
tioned in previous studies. Prognosis for septic
navicular bursitis is significantly improved by
early therapeutic intervention. All cases re-
ported in MDT were admitted in the chronic stage
of the disease (after 72 hours); while 5 out of 16
cases reported in the series by Wright et al. (1999)
were admitted in the acute stage (before 72 hours).
The use of MDT as an adjunctive treatment with
the use of contemporary techniques appears to offer
an advantage over the other methods in the treat-
ment of contaminated and septic navicular bursitis
based on our results and success rate (90% septic
process resolved, with 70% of the horses returning to

Fig. 8. Sterile medical maggot therapy was initiated on days 2 and for non-traumatic debridement of necrotic tissue and bacteria.
Therapeutic shoes with treatment plates were used for support and protection.
This success rate was found to be better than that for the street nail procedure in the series of cases reported by Richardson et al.1 (31.5%; 12/38 horses) and the endoscopic technique in the series of cases reported by Wright et al.5 (75%; 12/16 horses with infectious process resolved, and 63%; 10/16 horses that returned to athletic performance).

References