Treatment of hoof injuries in the horse

Introduction
- Heel bulb lacerations
- Waterproof foot bandage
- How to apply a foot cast
- Surgical management of P3 osteomyelitis
- Collateral cartilage sepsis
- Hoof crack management
- Hoof avulsion injuries
- Septic navicular bursa
- Tendon brace shoe

Heel bulb lacerations
- Pastern and heel bulb lacerations are common
- Wire or metal object
- Synovial structure involvement
  - Tendon sheath, DDFT, DIP
  - PIP, navicular bursa
- Subsequent hoof wall defect may limit soundness

TAMU retrospective study 100 cases
- Coffin joint -25%
- TS and pastern 10%
- 30% of lacerations were acute and sutured – rest secondary healing
- 30% had delayed primary closure
- 30% second intention healing

Dabareiner et al JAVMA, 2005
**Initial treatment**
- DP and lateral radiograph - looking for foreign body and boney lesions
- +/- Ultrasound exam to assess soft tissue involvement – deep flexor tendon damage

**Results**
- Majority had no radiographic lesions (86%)
- 9 - P3 lesions
- 5 - P2 lesions
- 1 - navicular bone

**Initial treatment**
- Cleansing and lavage of wound with chlorhexidine or betadine solution
- Abaxial nerve block
- Integrity of synovial structures assessed
  - Clip and prep area away from wound, tap joint
  - Cytology & culture
  - Injection and infusion of sterile LRS at a site remote from wound

**Initial treatment**
- Synovial structure involvement
- Standing sedation - 4 mg domosedan
- Lavaged with 1 to 2 liters of LRS
- Local infusion of 500 mg (2 mls of 250 mg/ml) Amikacin
- Broad spectrum antibiotics (KPen and Gentocin or Enrofloxacin)
**Initial treatment**
- Synovial structure involvement
- Daily regional limb perfusion

**Initial treatment**
- Increases local concentration of antibiotic 1000 fold to area below tourniquet compared to intravenous dosing

**Regional limb perfusion**
- 21 to 23 ga. butterfly catheter
- Into closest vein
- Sterile prep of vein

**Regional limb perfusion**
- Standing sedation
- Tourniquet above area to be perfused
- Slow perfusion of diluted antibiotic
- Leave tourniquet on for 20 minutes

Webster veterinary supply
Sterling, Mass.
1-800-225-7911 $19.50/box 50
Regional limb perfusion

- Can apply tourniquet top and bottom of area to be perfused, i.e., septic tarsal joint

- 1 gram (4 mls) amikacin diluted in 10 - 30 mls sterile water
- Clafloran 2 gms cephalexine in 20 mls

Initial treatment

- Synovial structure involvement
- Daily joint lavage and IA amikacin until synovial fluid cell count and TP are reasonable (usually 3-4 days)
- Daily regional limb perfusion continued for an additional 3-4 days
- Until synovial fluid cytology and/or clinical signs indicated structure no longer infected
- Systemic abx – 2 weeks past no clinical signs

- Acute and minimal contamination with no synovial structure involved = wounds sutured (#1 or 2 PDS) with tension relieving sutures and foot cast

- Vertical mattress sutures
TAMU study 100

- # 1 or # 2 polypropylene
- 30 not sutured
- 70 lacerations sutured

Initial treatment

- Chronic with granulation tissue or very contaminated = foot bandage for 7 to 10 days to self debride and granulate
- +/- foot cast to improve cosmetics or
- Debride and suture 5 to 7 days later

Waterproof foot bandage

- Large baby diaper
- Duct tape
- 4” x 6” roll cotton
- Vetwrap
- Elasticon

Foot bandage

- Telfa, cast padding and elasticon over wound
- Cotton padding on toe
Foot bandage

Diaper over cotton

Vet wrap over diaper

10” x 10” Duct tape square
Crisscrossing layers, cut corners

Waterproof foot bandage

Cut corners of square to
Conform to foot

Duct tape to
water proof
bandage

Elasticon
eliminate debris

Foot bandage

Will remain in place 3 to 4 days
Foot cast
- Telfa pad, cast padding, elasticon over laceration

Foot cast
- 3 inch Stockinette to above fetlock, rolled ends
- 1 inch felt pad just below fetlock

Foot cast
- 3 rolls of 3 inch fiberglass cast material
- Front limb held by assistant for first 2 rolls

Foot cast
- Last roll placed under heel with toe on board
- Conforms better
- Initial rolls for hindlimb
Foot cast

- Allow horse to stand and cast to “set” in weight bearing position
- Technovit bottom of cast
- Elasticon tape at top to keep debris out

Foot cast

- Very safe cast
- Send owner home
- Watch for increased lameness, sores or drainage
- Remove cast in 2 to 3 weeks

Surgical Diseases Associated With the Distal Phalanx

- Keratoma
- P3 infection - sequestration
Surgical Decision Making

When to operate

- P3 infection
  - Radiographic evidence of infection
  - Tracts that extend to bone

Instrumentation

Galt trephine
Dremel tool

Instrumentation

- Sharp hoof knife
- Sharp blade and thumb forceps

Instrumentation

- Half round hoof nippers
- Various size bone curettes
Lesion Location

Determined by:

✓ Triangulation
  ▪ BB’s taped to hoof wall
  ▪ BB’s in small dremel holes

Lesion Location

Determined by:

✓ Triangulation
  ▪ BB’s taped to hoof wall

Lesion Location

Determined by:

✓ Location of draining tracts associated with lesion

Lesion Location

Determined by:

✓ Defects in hoof wall architecture
  ▪ Nail holes
  ▪ Other definitive irregularities
Surgical Approaches

✓ Anesthesia
  - General
  - Regional
  - Most are done in the standing sedated horse
  - Financial reasons

✓ Hemostasis
  - Vetrap™
  - Esmarch
  - Twist vet wrap over the vascular bundle

P3 infection
  ✓ Access through sole
  ✓ Keratinized tissue
    - Hoof knife, Dremel®, trephine, curette

P3 infection
  ✓ Follow tract to bone
  ✓ Remove infected bone
    - Curette
  ✓ Remove infected soft tissue
    - Scalpel, curette
Surgical Approaches

**P3 infection**
- Follow tract to bone
- Remove infected bone
  - Curette
- Remove infected soft tissue
  - Scalpel, curette

**Keratoma**
- Access through sole and wall
- Keratinized tissue
  - Hoof knife, Dremel®, trephine, curette
Surgical Approaches

Keratoma
✓ Historical approach
✓ Possibly more invasive
  • Remove keratoma and soft tissues
  • Curette bone defect in P3

When Is Surgery Done?
P3 Infection or Keratoma
✓ Margins crisp & clean
✓ All discolored tissue removed
✓ Check with radiographs
✓ Sound of hard, healthy bone
Post-operative Care

**Initial care**
- Pack site with dry gauze sponges
- Waterproof bandage
- +/- antibiotics or regional limb perfusion
- NSAID’s

**Daily care (1st week)**
- Change bandage
- Inspect→debride devitalized tissue
- Loosely pack operative site

**Long-term care**
- Sole defects
  - Treatment plate
  - Plastic pad
- Wall defects
  - Duct tape
  - Elastikon
  - Hoof wall repair?

**Apply astringents** (thimersol, sugar-betadine paste) to granulation tissue once bone covered.
**Prognosis**

Excellent
- P3 infection – sequestration
  - Laminitis → guarded
- Keratoma
  - Wall regrowth
    6-12 months

**Septic Collateral Cartilages or “Quittor”**

**Anatomy**
- Cartilage bisected by coronary band
- Axial side in intimate contact with coffin joint
- Neurovascular bundle

**Surgical Diseases Associated With the Collateral Cartilages**

Infection/necrosis
- “Quittor”
  - Lacerations
  - Puncture wounds
  - Foot abscesses
  - Gravel
  - Hoof cracks
  - Blunt trauma → avascular necrosis
Surgical Diseases Associated With the Collateral Cartilages

Infection/necrosis

✓ “Quittor”
  • Lacerations
  • Puncture wounds
  • Foot abscesses
  • Gravel
  • Hoof cracks
  • Blunt trauma → avascular necrosis

Septic collateral cartilage vs. abscess

Draining tract higher vs at hoof coronary band junction

Surgical Decision Making

Clinical signs

✓ Lameness
✓ Tracts proximal to coronary band
✓ +/- drainage
✓ Marked swelling

Diagnosis

✓ Presence of draining tracts
  ▪ DDx → gravel
✓ Radiographs to assess tract depth
  ▪ Probe studies
  ▪ Contrast studies
Surgical Decision Making

Diagnosis
- Presence of draining tracts
  - DDx → gravel
- Radiographs to assess tract depth
  - Probe studies
  - Contrast studies

Treatment
- Surgical excision of “affected” portions of cartilage
  - Avoid adjacent “vital” structures
- Establish ventral drainage

Surgical Approach
- General anesthesia
- Lateral recumbency
- Tourniquet → RP → hemostasis
- Extend foot → tenses joint capsule
- Avoid DIP joint

Surgical Approach
- Curved incision – based proximally
- All diseased proximal cartilage removed
Surgical Approach

Proximal cartilage
- Curved incision – based proximally
- All diseased proximal cartilage removed

Distend DIP joint to avoid it
Surgical Approach

Proximal cartilage
- Curved incision – based proximally
- All diseased proximal cartilage removed

Distal cartilage
- Removed via trephine hole
  - Provides ventral drainage

Distal cartilage
- Removed via trephine hole
  - Provides ventral drainage
Surgical Approach

Ancillary consideration

Arthrocentesis
- Coffin joint
- Aseptically!!

Postoperative Care

- Pull gauze day after sx
- Bandage until skin incision healed (2 weeks)
- Protect trephine hole (tape)
  - Apply astringents to granulation tissue
- Hoof wall repair?
Postoperative Care

- Systemic antibiotics
  - Usually unnecessary
- Regional perfusion
  - 2 to 3x
  - Claforan, amikacin etc.

Prognosis

- Good with complete removal of infected tissue
- Re-operation of septic foci sometimes necessary

Surgical Diseases Associated With the Navicular Bursa and Navicular Bone

- Septic navicular bursitis
- Navicular bone osteomyelitis
**Diagnosis of septic navicular bursa**
- Usually reluctant to put heel on ground
- Swelling between heel bulbs/palmar pastern
- Arthrocentesis

**Surgical Decision Making**

**When to operate:**
- Identification of penetrating foreign body
- Cytology or culture of bursal fluid indicating sepsis

**Caution with probe studies**
- Sedation and local nerve block
- Radiographic evidence of bursal or bone involvement
  - *Probe studies*
  - Contrast studies

**Preferred method**
- Radiographic evidence of bursal or bone involvement
  - Probe studies
  - *Contrast studies*
Radiology
- Foreign body
- Lateral and flexor views most helpful
- Look closely at flexor cortex surface

Sometimes diagnosis is obvious

- Repeat radiographs at weekly intervals
- Again several months after resolution of sepsis for long term soundness prognosis

Considerations:
- Penetration or sepsis of distal interphalangeal joint
- Penetration or sepsis of digital tendon sheath
**Treatment Options**

**Primary aggressive Medical**

- Adjunct to surgery
- Systemic antibiotics
- Local debridement
- Regional limb perfusion
- Percutaneous lavage

**Indications for Surgery**

- Should be considered in every case
- Not always needed
  - No $$$
  - If Acute sepsis → aggressive medical mgmt 24-48 hrs – Surgery **Not Recommended initially**
  - Chronic osteomyelitis and mature adhesions in bursa can’t visualize

**Aggressive medical Rx**

- Septic navicular bursa aggressive medical therapy
- Horse is under IV anesthesia
- Daily lavage – 1 needle ingress/egress lavage, local antibiotic and RP for 3 to 5 days, 2 or more weeks systemic abx
- Wedges shoe which is gradually lowered over time (2 degrees q 6 weeks)

**Surgical Options**

- Endoscopy of the navicular bursa
- “Streetnail” procedure
Endoscopy of Bursa

- Surgical procedure of choice
  - Less invasive
  - Simplified post-op care
  - Acute infections of bursa and bone
- Challenging!!

Endoscopy of Bursa

Surgical approach

- Dorsal or lateral recumbency
- Fluoroscopy or radiography useful to confirm placement
  - Arthroscope portal
  - Instrument portal

“Streetnail” Procedure

- Lateral recumbency
- Tourniquet →
  - Regional perfusion
  - Enhanced visualization
- Sterile probe in tract
- Excise frog, digital cushion, DDFT
- Culture, lavage, curette

Streetnail procedure
Intraoperative Considerations

- Distend DIPJ & tendon sheath
- Pack open → 2nd intention healing
- Sterile bandage
- Bone graft → ??

Prognosis

Endoscopy
- 62% return to soundness
- Shortens convalescence
- Medical = very good outcome in 9/10 (90%) cases

“Streetnail”
- 20% return to soundness
- Extended post-op care
- $$$
- No longer recommended

Hoof Wall Removal

- White Line Disease
- Hoof Wall Cracks
- Hoof Wall Avulsion injuries
White Line Disease

- Separation
- Deterioration
- Fungal?
- Bacterial?
- Common in hot, humid environments

White line disease

- Separation of hoof wall from laminae
- Bacteria, fungi, yeast
- Hot, humid climates
- Travels from ground to coronary band
- Severe cases need hoof wall removal

White Line Disease

- Variable Appearance
- Gray/white Sawdust
- Hoof Wall Distortion
- Minor defects can be treated with tincture iodine and cotton packing

White line disease

- Mild cases can pack with cotton-iodine and cover with shoe-dry foot
- Severe cases require resection of undermined hoof wall
White line disease

- Dremel tool or half-round nippers are useful for debridement
- Exposed laminae dry, dead, and necrotic

Therapy

- Debridement
- Exposure to Air
- Apply daily topical astringents
- Sugar-betadine mix
- Thimerosol

White line disease

- Large area of hoof wall loss

White line disease

- Full support bar shoe to increase surface contact with ground
- Bears weight on remaining healthy part of foot
- Replaces voided hoof wall
**White line disease**

- 10 days open
- Methiolate applied daily to sterilize
- Foot kept dry
- Acrylic when area is dry and bacteria free (50% abscess)
- Return to work

**Hoof cracks**

- Usually ML imbalance
- Excessive moisture
- Long shoeing period
- Fulcrum LT-LH
Hoof crack

- Debride crack
- “Float” or unweight hoof wall behind crack

Hoof crack

- Usually compresses under load
- Stabilization of crack
- Hose clamp

Hoof crack

- Usually compresses under load
- Stabilization of crack
- Small plate

Hoof crack

- Full support bar shoe
- Egg bar with frog plate
- Contact during load-not pressure
- Stabilize hoof capsule while new horn is grown
Hoof crack

- Usually compresses under load
- Stabilization of crack
- Glue-on patch

Questions?

Flexor tendon lacerations

- Common injury in horses
- Prognosis 20-70% return to soundness
- Can be costly and labor intensive
- Tendon brace shoe as a treatment option

Tendon Structure

- Poor intrinsic blood supply
- Heals by paratendon (fascia) blood supply
- Tendon injuries within tendon sheath heal slower due to more distant blood supply
Digital tendon sheath
- Extends from about 4 to 7 cm proximal fetlock joint to heel bulb area
- “Windpuff”
- Sterile structure
- Important in pastern lacerations
- Poor blood supply
- Mid cannon heal faster

Clinical signs relate to where tendon attaches to boney column
- SDFT to distal P1 and P2
- DDFT to P3
- DSL to proximal P2

Clinical presentation - SDFT only
Fetlock drops but not to ground

Clinical presentation - DDFT only
Both SDFT and DDFT toe up/ fetlock drops
Toe comes up
Clinical presentation - All

- SDFT, DDFT, suspensory then toe comes up and fetlock on ground

Inflammatory stage

- Hematoma
- Invasion of cells
- Granulation tissue
- Very weak and requires rigid fixation until it remodels into tendon fibers

Remodeling phase

- 6-8 weeks following injury type 3 (weak)
- ↑ type 1 collagen
- 0 to 2 mos = weakest
- 2 to 4 mos. 2-3x inc strength
- > 6 mos. Still not as strong as normal
- 6 to 12 months to heal completely

Treatment

- Acute, clean wounds can be sutured
- > 12 hrs or contaminated = no suture
- Or no suture
- Immobilization
- NSAIDS
- Stall rest
**Healing**
- 2 to 4 months or > Period of immobility
- Some mobility is critical
- Physical therapy
- Decreases amount of scar tissue and adhesions which limits elasticity and causes re-injury
- Increases tensile strength of the new tissue.

Boyer 2005, James 2007

**Methods of Immobilization**
- Distal limb cast
  - **Advantages**
    - Reliable and rigid
  - **Disadvantages**
    - No movement
    - Requires hospitalization
    - Changes every 3 to 4 weeks
    - Duration of casting = 60 to 90 days

Boyer 2005, James 2007

**Disadvantages of casting**
- Maintenance may be difficult
- Frequent change
- Sores/cast breakage
- General anesthesia often required
- $$$

Bertino et al 1990

**Kimzey**
- Good Immobilization
- Bandage change every week
- Minimal movement
- Often get dorsal cannon bone sores
- Cost $400-500 plus bandage material
- Owner can manage at home if limb doesn’t touch ground while changing

Kimzey

Good option
Brace shoes

- Rarely reported in literature
- Greater degree of loading than cast or Kimsey splint
- Usually mentioned for use following cast removal

Roberts Shoe Erector, 1946

Tendon brace shoe

- 15 cases at TAMU last 3 years
- Hospitalization not required
- Easy for owner to manage at home
- Good external support
- Early mobility
- Good quality of healing despite lack of tendon suture
- Less sores – low cost

Don Sustaire CJF

Tendon brace shoe

- Foot is trimmed and flat steel shoe applied with ¼” to 1” extended heels
- 0.75 “ hollow steel pipe welded across the heels to raise heels for DDFT healing
- Allows brace attachment to foot

Don Sustaire CJF
Tendon brace shoe

- 4 foot length of 0.5” steel rod is heated and shaped in a “U”
- 5 to 10 cm distal carpus/tarsus proximal aspect bent to 90 degrees for proximal caudal support

Arms of brace should be slightly wider than horse’s limb
- Approx 12” distally at horse’s fetlock rod is bent to approximately 135 degrees to match contour of fetlock

- 1 ‘ from distal aspect of brace the ends are heated and bent at 90 degrees
- The ends insert into hollow pipe attached to the shoe

Tendon brace shoe

- Two steel eyelets placed on each side of brace (4 total)
  - (1 x 0.5”)
  - Proximal aspect
  - Another just proximal to fetlock
  - Distal ends slide in hollow pipe attached to hoof
Two dorsally placed leather straps (dog collars) run through the eyelets to attach brace to the limb.

- Proximal caudal aspect padded
- PVC pipe cut and padded to protect from dorsal cannon bone pressure sores
- Inner tube is slid over arms of brace to support fetlock and tendons

Distal limb bandaged with thick cotton, vet wrap, and topped with elasticon to keep debris out of brace. Inner tube slides over back of brace for support.

Best for hindlimb application, won’t interfere.
**Cost-Shoe**
- Mean 4 days in hospital after presentation
- ~$480 for initial brace
- Re-set every 6-8 weeks
- $100/re-set
- 63-143 days mean 106 days (3 to 4 months)
- No hospitalization
- Total cost $600 to $800

**Cost- Distal limb casting**
- IV anesthesia ($150) and materials ($300) to $450-500 per cast
- Reset q 3-4 weeks
- Duration 3 months
- DIH 45 to 90 days vs 4.2 days for brace
- Hospitalization $1650
- Materials/anes $1500
- Total = $3200

**Potential benefits of brace**
- Elevated heel for DDFT
- Good support for tendon healing
- Early motion/physical therapy
- Decreased cost
- Few complications
- Acceptable results
- Easy owner management

**Disadvantages**
- Not as rigid
- Sores possible
- Duration of brace/treatment a little longer than casting
- Interference from rear limb if its on a front limb
Retrospective study at TAMU
Whitfield – Dabareiner 2009

- 15 horses (mean age 5.8 yr)
- Duration of wound avg = 5.1 days
- Lame 4 to 5 of 5
- 8/15 dropped fetlock + raised toe
- Minimal treatment
- 13/15 hind limbs

Classification of wounds

- 5 - Complete transection of DDFT & SDFT
- 5 – SDFT and partial DDFT
- 4 – partial DDFT & SDFT
- 1 – DDFT and partial SDFT

Follow-up outcome on 11/15

- 10/11 owner’s very satisfied
- 100% owners said management was easy
- 5/11 thick limb
- 2/11 small scar
- 4/11 no scar

Follow-up Lameness

- 2 to 3 years after injury and tendon brace shoe
- 5 returned to previous use (3 performance, 2 trail horse), 4 sound but not in work (2 breeding, 2 ranch horses)
- 2 remained lame
### Disadvantages

- Not always indicated
  - Macerated tendons
  - Active infection
  - Large gaps in tendon ends
- General anesthesia and expensive
- Gaps still occur even with suturing

*Easley 1990, Boyer 2005*

### Problems

- Small case number
- Job of horse
- Follow-up
- Remainder of 15
- Promising results
- Euth on presentation?