Assessing wounds surrounding synovial structures or suspected synovial infections in adult horses.

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Introduction

Despite a wealth of literature and review articles describing septic synovial infections in adult horses, it is not uncommon that their initial assessment and management is less than ideal. The following notes describe appropriate early assessment and management of synovial cavities (bursae, tendon sheaths or joints) suspected to be affected by wounds or infection. Wounds are the most common cause of synovial infection in adult horses, other causes include the iatrogenic introduction of bacteria via either synovial cavity injections or surgery. Less common again are the so called ‘idiopathic infections’ that are thought to occur secondary to haematogenous localisation within joints similar to those seen in foals with septic synovitis/osteomyelitis. Clinical findings, diagnostic work up and treatment plan can vary with each of the categories of synovial infection.

Wounds near or involving synovial structures

A thorough understanding of the anatomical extents of joints, tendon sheaths and bursae is essential knowledge when assessing the likelihood that a wound may communicate with synovial structures. The clinical presentation of a horse with a wound directly involving a synovial structure can be broad, from trotting sound to non-weight bearing lame. The degree of lameness seen is an honest indicator of the inflammatory response and level of tissue damage within the joint and surrounding structures. In the early phase, provided there is minimal structural damage to the joint and even with bacterial contamination, infection can take hours to become established and this may be even longer in joints that are freely draining. Horses with either of these scenarios often show no, or minimal evidence of lameness as a result. Early identification and treatment of such contaminated or early infected joints improves not only prognosis but significantly reduces the likely ongoing treatment costs compared with cases where infection has become more established.

Once infection has taken hold the bacteria and their enzymes combined with the hosts immune response causes a severe generalised arthritis/synovitis. In affected joints the fluid becomes a soup of degradative enzymes which in conjunction with a loss of the normal flow of nutrients and oxygen results in progressive chondrocyte death. This inflammatory reaction causes the typical moderate to severe lameness associated with most synovial infections. Obviously the accumulation of this inflammatory soup is more rapid when there is limited or no drainage via the wound. Assessing wounds for potential synovial involvement should be at the top of the list of when they are close to synovial structures.

Planned work up of a wound with possible synovial involvement:

- **History** duration of wound and how it occurred along with any treatments the horse has received.
- **Lameness exam** while this may be brief, an assessment of the horse’s baseline lameness at the walk and if possible the trot is essential diagnostic and prognostic information. Also assess synovial structures around the wound for joint effusion.
- **Physical exam** (TPR) often overlooked but is an essential part of a work up particularly rectal temperature.

Once this part of the exam is completed the horse may need restraint and sedation to proceed quickly and efficiently through the next steps of the examination.
• **Examination of the wound:** Careful evaluation of the wound with a sterile gloved hand and headlamp or good natural light. This should include flexion and extension of the joint, sheath or bursa (many joint wounds occur at the extremes of their range of motion). Obviously if the joint is freely draining through the wound no effusion will be present.

At this stage determine if the joint is or is not likely involved to decide what logical further investigation is required.

• **Radiography** is essential if synovial structure involvement is suspected. Radiographic evidence that a synovial structure has been breached include intrathecal air, damage to bone surfaces and foreign radiopaque material within the wound extending into the synovial structure. The initial radiographs are ideally performed prior to synoviocentesis to avoid gas artefacts. In cases with a deep penetrating foreign body, films are ideally taken prior to removal of the foreign body. Fistulous or deep penetrating tracts may be an indication for a contrast study.

• **Ultrasound** while not indicated in all cases, can be useful to assess the level of joint effusion, wound tracts and may aid planning sites for synoviocentesis. Ultrasound guided needle centesis may assist in difficult to access sites (biceps bursae, tarsal sheath, coxofemoral joint etc.) and can aid remote needle placement into a joint devoid of fluid. Ultrasound is indicated in tendon sheath and bursa wounds to assess the level of tendon pathology.

It can be useful at this stage to consider regional anaesthesia if no major fracture or mechanical disruption was identified on imaging. It is particularly useful in cases of lower limb injury and allows a better assessment of the joint visually in difficult patients and also facilitates synoviocentesis.

• **Synoviocentesis** ‘If any joint fluid is obtained and joint is suspected infected or open and contaminated then it should be submitted for culture and sensitivity.’

Synoviocentesis in obviously infected joints is discussed later. In open joints more commonly no fluid is obtained, in which case distending the joint with a balanced polyionic fluid is recommended. This process is made easier in a regionally anaesthetised horse. An extension set can be of benefit as it allows multiple syringes to be run into a joint and makes movement less of an issue than a syringe/needle interface. If no fluid expresses freely from the wound once the synovial structure is distended then remove the needle and run the adjacent joint though its full range of motion. Occasionally structures will hold pressure in weight bearing position but they may decompress through range of motion. If the joint is not obviously involved then decompress the synovial structure. If communication of the wound is identified and it is freely draining then a needle flush is a worthwhile consideration at this stage. This can be done with an extension set and syringes or a giving set and pressure bag. Instilling intra articular antimicrobial after flush or decompression (Gentamicin or Amikacin) should be considered if available.

The key is to have pre-thought and organised yourself so that this process can be performed quickly and conveniently. Prior to embarking on the above assessment ensure the owner understands the ‘gravity’ of the process and is prepared for the likely management plan if the wound is found to communicate with a synovial structure. If at any stage of the investigation process, the likelihood of synovial infection goes from suspect to likely then ideally institute either plan A, referral for surgical evaluation, or plan B, local treatment. This may be expedited in cases with visually obvious joint involvement combined with heavy contamination, or in horses or facilities not suited to safe standing assessment. Chronic wounds involving synovial structures are often difficult to assess as they tend to be complicated by a cellulitis and severe discomfort surrounding the joint making standing
assessment difficult. In these scenarios wound exploration and synoviocentesis may require general anaesthesia.

**Post Joint Injection Sepsis**

Synovial infection post joint injection is a relatively rare complication and has an incidence of less than 1 in 1000 joint injections. Recent data supports this with a USA based study of greater than 14,000 joints documenting the risk of septic arthritis post injection to be 0.092% while a similar Australian study of greater than 16,000 joints showed a risk of 0.078%.1,2 There appeared to be a significantly increased risk within the US study for injections of PSGAGs combined with corticosteroids compared to other substances.

Typically, joint infections do not manifest until around a week post injection, but may become evident as early as 3 days or alternately as long as 3 weeks or more post injection. Corticosteroids can delay the onset of clinical signs. Another complication of joint injections is post injection flares where there is an immune response to the injected material without the presence of bacteria. These tend to occur rapidly being first identified within 24-48 hours in the majority of cases and can range from mild to severe with accompanying synovitis and lameness. Flares are most commonly seen after injection of corticosteroids and some of the newer available biologics (PRP, IRAP and stem cell injections), they are rare after diagnostic anaesthesia. They tend to rapidly respond clinically to NSAIDs and local therapy (wrapping and icing) alone.

**Post-surgery Joint Sepsis**

Post arthroscopy joint sepsis is also uncommon with published reports ranging between 0.4-1.3% of horses undergoing arthroscopy.3 Experience would suggest it is likely lower than this in Thoroughbred racehorses and yearlings. Typically draft breeds and tarsocural joints seem to present a higher risk in studies that have looked at risk factors.3 Perioperative antimicrobials are suggested to provide no benefit in elective clean arthroscopy in human patients and in horses this appears similar where arthroscopy without antimicrobials have reported infection rates of 0.5% operated joints or 0.7% horses.4 Regardless of this fact perioperative antimicrobials are commonly given aimed at both the surgical site and horse’s airways with many horses having shipped distances to surgical facilities. When used, ideally perioperative antibiotics are utilised on the day of surgery only.

Beyond the direct surgical team and facility, the key to post-operative management include fastidious sterile bandaging to maintain a clean environment over the incision and the skin sutures, that are very closely apposed in the subcutaneous tissues with the synovial cavity. Optimally timed sterile removal of skin sutures to avoid suture sinus formation or seeding suture tracts with bacteria is advised. Any drainage of an arthroscopic portal beyond 12 hours post-surgery should be treated as a potential problem and the surgeon contacted immediately for advice.

**Idiopathic Synovial infections**

Haematogenous localisation of bacteria is infrequently identified in adult horses and typically involves only one joint. The literature documents sporadic cases of idiopathic synovial sepsis but there are no large case studies. In my practice setting we see occasional cases of idiopathic synovial sepsis in Thoroughbred racehorses. Generally, these horses are in training and present with a per-acute synovial infection without any recent history of wound, surgery or intra-synovial injection. Between 2005-2015 at Randwick equine centre 14 cases of idiopathic synovial infection were identified (Byrne et al 2018, unpublished data). Sporadic cases of idiopathic synovial and orthopaedic infections are also seen in horses between 6-18 months of age associated with Kingella sp. This bacterial group is an upper respiratory pathogen that can cause septic arthritis in human infants (pers.comm. B Hudson).
Post injection, post-surgery and idiopathic joint infections present similarly with a distended joint and a variable but in most cases severe lameness.

**Planned work up of suspected joint infection without wound:**  
While similar to wounds overlying synovial structures the work up has some differences:

- **History** any history of recent illness, wounds, joint injections, surgery or foot related lameness.
- **Lameness exam** similar to wounds.
- **Physical exam** similar to wounds.

Once this part of the exam is completed the horse may need restraint and sedation to proceed quickly and efficiently through the next steps of the examination.

- **Radiography** of joint and surrounding bone structures in the case of a bursa or tendon sheath. The study acts to rule out a major joint surface or bone injury. It also provides an important baseline for later in the process particularly if the joint infection progresses to an osteomyelitis. A baseline radiograph of the foot on the contralateral support limb can be useful as support limb laminitis is not uncommon in severely lame or protracted cases.
- **Ultrasound** can be useful in joints to determine the level of fibrin formation and the amount of synovial fluid present. It is essential imaging in tendon sheaths and bursae to rule in or out primary tendon damage or sepsis.

In difficult patients consider regional anaesthesia.

- **Synoviocentesis; If sufficient joint fluid can be obtained then submit for both fluid analysis and culture/sensitivity.** Ensure you have an appropriate sterile container as an accurate culture is the primary goal and if insufficient fluid is obtained then submit for culture and use the drop left in the hub for total protein with the remainder placed on a slide to make a cytology smear squash and rapidly air dried. If obviously infected, then consider needle flush at this point followed by instillation of an intra articular antimicrobial (Gentamicin or Amikacin).

**Synovial fluid analysis**

While clinical suspicion of a septic or contaminated joint is usually the driver of management and decision making. Synovial fluid analysis provides an additional guide to the likelihood of sepsis. Subsequent culture is usually not available for 4-5 days to confirm a septic joint.

Obtaining sufficient synovial fluid can be a challenge and having small volume EDTA containers facilitates a more accurate assessment of these often small volumes. Excess EDTA in a 5 ml blood tube artificially increases refractometer measured protein and dilutes cytology of small volumes. Some chronic joint infections have sparse fluid due to the massive inflammatory process within the joint and fibrin clot formation. Often preferred arthrocentesis sites may be complicated by a nearby wound or cellulitis in these cases knowledge of alternate sites is essential and ultrasound guided arthrocentesis can also be a valuable tool. Normal synovial fluid reference values are a WCC <1 x 10⁹/L in which large mononuclear cells predominate and neutrophils make up less than 10%. The total protein values are typically less than 20g/L. Synovial fluid reacts quickly to inflammatory insults and there are no hard and fast rigid diagnostic criteria as values will often be influenced by timing of sampling after an inflammatory insult. Injection of common medications and even arthrocentesis alone are capable of significant cytological changes with increases in WCC in the range of 1-20 x 10⁹/L, differential of cells up to 50% Neutrophils and the TP up to 40g/L. Blood contamination will also influence cytology the most accurate assessment of haemarthrosis versus blood contamination can be made by the collecting clinician. Comparing PCV of synovial fluid and peripheral blood can allow a rough estimate as to the influence of blood contamination on sample cytology.
In cases of confirmed septic joints a range of cytology has been reported and is influenced by timing from inoculation, numbers of bacteria and their virulence. Reports of septic synovial structures confirmed by positive culture can have values lower than WCC 5 x 10⁹/L, differential of cells as low as 33% Neutrophils and the TP as low as 22 g/L. The majority of joints have significant cytological changes within the first 12-24 hours after inoculation with bacteria. A well referenced and frequently quoted general guide for joint sepsis is WCC >30 x 10⁹/L, >80% Neutrophils and TP > 40g/L. This does leave a large so-called 'grey zone' where synovial infection is not confirmed by the cytology but cannot be ruled out. In these cases clinical intuition should take over and determine if the joint is considered 'likely infected'. Sepsis after or involving corticosteroid injections can delay the onset of clinical signs and also the cytological changes associated with joint infection. Follow up synoviocentesis is useful in cases where cytology is only inflammatory and sepsis is suspected clinically. Septic synovial structures are generally determined by a combination of laboratory testing and clinical intuition and when determined as likely infected should undergo immediate treatment. Serial synovial sampling is useful for ongoing monitoring of treatment.

Additional testing such as pH, lactate and glucose difference with serum while reported are not typically utilised by the author. Recently synovial Serum Amyloid A (SAA) has been investigated as a useful additional tool alone and possibly more so when combined with a paired serum SAA particularly to determine the difference between acute synovitis versus early onset septic synovitis. Variety of different techniques are in development that may provide further improvements on this imprecise system. The major driver of research in this area are the difficulties faced investigating prosthetic implant infections in people. These techniques include using biomarkers typically cytokines and multiplex PCRs (Septifast or similar) that may provide a rapid assessment for horses in the so called grey zone.

The greatest impediment for an accurate diagnosis in most cases is a lack of rapid laboratory analysis for assessment. The gross appearance of the fluid is useful and this combined with a patient side refractometer is often sufficient. A cloudy sample with an elevated total protein can be suggestive enough that fluid should be submitted immediately for culture.

**Synovial fluid culture**

Without the aid of enrichment media typically only 50% of septic joints will yield a positive culture. This can be further increased in the range of 55-79% with the use of enrichment media such as cooked meat enrichment broth or commercial blood culture media. A positive culture of the bacteria involved in joint sepsis not only confirms the diagnosis but also aids treatment with an appropriate antimicrobial plan. It is probably the most overlooked but important part of the initial assessment of a septic joint.

Results often take 4-10 days or occasionally longer so a rational treatment plan is required based on knowledge of the likely bacteria involved determined primarily by the method with which the joint was inoculated. A gram stain is also a worthwhile if sufficient synovial fluid is obtained, providing guidance in approx. 25% of cases and can aid decision making with regard to antimicrobials.

**Treatment**

Principals of treatment are twofold firstly to remove the bacteria and the soup of inflammatory mediators, debris and fibrin present within the joint. Secondly, providing an appropriate antimicrobial at effective levels within the joint.

**Joint Drainage and Debridement**

- **Thru and thru needle flush**

Through and through needle flush can achieve a reasonable result and can be successful when applied in appropriate cases. In my opinion needle flushing is only indicated when...
there is a combination of a compliant patient with a peracute (<6-12 hour) synovial infection and the absence of significant joint fibrin on ultrasound. It is not ideal as the primary method of treatment in cases of more advanced synovial infection as fibrin forms within the joint acting as a reservoir for bacteria and impacting effectiveness of the flush. It can form a useful adjunct if referral is likely to be delayed to a surgical facility and may also delay the onset of infection in cases of open joint injury.

- **Arthroscopic assessment, flush and debridement**

Arthroscopy, tenoscopy or bursoscopy are the gold standard treatments for drainage and debridement of septic synovial structures. In my opinion, it is the ultimate cost benefit tool when treating a septic synovial structure. Not only providing excellent drainage and debridement, but also optimal diagnostic and prognostic assessment of the joint itself and is associated with a low morbidity. Synovial wounds can be assessed for bone, joint surfaces, tendon or ligament damage which may not be detectable with ultrasound or radiographic assessment. It also allows assessment of the wound tract, removal of foreign material and decision making for the need of ongoing drainage. In the author’s experience foreign material or joint surface damage not identified on prior imaging is present in the majority of wounded synovial structures. One study of endoscopically treated infected and contaminated synovial structures found 43% of synovial cavities following injury had foreign material contamination and osteochondral injuries were only predicted on prior imaging in approximately half of the cases.\(^\text{11}\)

In severe cases the small endoscopic access can either be left open for ongoing flushing or converted to arthrotomy, tenosynotomy or bursotomy for enhanced drainage. The duration of treatment, prognosis and outcome are heavily influenced by the chronicity, bacteria involved and the presence of either osteochondral or tendon damage. Generally, most cases managed surgically have a good prognosis for survival and return to performance. Most require at least 3 months of rehabilitation post sepsis.

**Antimicrobial therapy**

While there are multiple ways to deliver antimicrobials to achieve appropriate MICs within infected synovial cavities, parenteral antimicrobials are the mainstay of any treatment approach. The key is a logical first choice prior to culture and sensitivity results being available. Once bacteria are identified and sensitivity results available then therapy can be tailored specifically on a case by case basis. Antimicrobial planning prior to culture results should be based around the typical bacteria expected depending on the cause of the septic joint. Wounds involving joints, bursae and tendon sheaths generally are inoculated with multiple bacteria with Enterobacteriaceae and anaerobes typically isolated. Therefore, initial therapy with penicillin, gentamicin, and metronidazole is a good first choice from a spectrum, cost and safety standpoint.

In the rarer presenting cases of post injection or surgical joint infections *Staphylococcus* sp. are more common and therapeutic choices need to consider cost, complications and efficacy. Some reasonable choices that are usually readily available to consider in the short term until sensitivity is available includes ceftiofur and amikacin. While I am opposed to the use of fluoroquinolones without appropriate sensitivity data, if the weight of evidence is suggestive of a *staphylococcus* sp and I consider the infection life threatening I will use a combination of enrofloxacin and rifampin initially prior to culture results. It is still entirely reasonable to commence these horses on penicillin and gentamicin initially and use local administration techniques to provide more expensive or systemically risky antibiotics to the joint locally.
Other modes of antimicrobial delivery include:

- **Intra articular or intra-synovial** antibiotics an effective management tool for treatment of synovial infections. This is useful in the field as a first choice after initial sampling while the needle is still in the structure. Typically aminoglycosides are chosen due to their concentration based killing profile. Amikacin a good first choice as an intra-articular (250-500 mg) antimicrobial, especially when *Staphylococcus* sp. are suspected. Alternately and as an initial therapy that is more cost effective gentamicin (250-500 mg) can also be used but has a poorer spectrum against *Staphylococcus* sp.

- **Intravenous regional limb perfusion** similarly is effective for management of synovial infections however is more easily applied once at an appropriate referral facility and is more difficult and generally not indicated prior to referral.

**Conclusion**

Rapid referral to a surgical facility is the optimal treatment plan for horses with synovial wounds or infections. Successful outcome is aided by appropriate joint drainage and debridement combined with the appropriate antimicrobial regime. Planning an effective and expedient work up allows cases to commence treatment or be identified as surgical candidates prior to referral. Culture should be attempted in all cases where synovial fluid is obtained.

**Further reading regarding septic arthritis in foals:**


**References:**