How to Perform Ultrasound-Guided Injection of Corticosteroids Into Subchondral Bone Cysts of the Medial Femoral Condyle in the Standing Horse

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1. Introduction

The most common location for subchondral bone cysts (SBCs) in the horse is the medial femoral condyle (MFC). SBCs are often bilateral and are thought to arise either as a manifestation of osteochondrosis or as a consequence of local trauma. Horses are generally presented for evaluation and treatment of MFC SBCs in one of two scenarios:

1. The horse is lame and the lameness has been localized to the medial femorotibial joint by intra-articular analgesia, with subsequent radiologic identification of a SBC
2. A young horse is presented following prepurchase or survey radiographs, which identified a SBC in a horse, which may not be lame

In either situation, radiographic confirmation typically remains the mainstay for diagnosis of MFC SBCs. The use of ultrasound for the diagnosis of medial condyle SBCs has, however, been described in the standing horse. This modality has the advantage of allowing rapid assessment of joint, ligament, meniscus, and other soft tissues, which, in addition to evaluation of the SBC, are prognostically important. Ultrasound of the equine stifle can be easily performed using widely available portable ultrasound equipment and a linear probe. Concurrent radiographic and ultrasonographic examination in cases of MFC SBCs is often recommended.

Several conservative treatment options have been proposed for treating MFC SBCs including restricted exercise and intra-articular steroid injection. Other techniques, which are more invasive and require general anesthesia and surgical facilities include: arthroscopic enucleation and forage, and cancellous bone grafting. Such procedures can, however, lead to medial meniscal injuries, possible postoperative enlargement of the cyst, and disruption to the articulator surface. Additionally, debridement of lesions greater than 15 mm wide is associated with a poor prognosis.
Other studies have focused on reconstruction of the SBC using platelet-rich-plasma (PRP) and/or cultured stem cells\textsuperscript{14} or the use of transcondylar lag screws.\textsuperscript{15} The aforementioned techniques require general anesthesia in a surgical facility.

Arthroscopic-guided injection of corticosteroids directly into the fibrous cyst lining has been recommended\textsuperscript{13} to attenuate the inflammatory process associated with cytokines within the cystic lining.\textsuperscript{16} The cytokine production is thought to contribute to lameness and bone resorption. It is hypothesized that reduction in the production of such inflammatory mediators may aid resolution of the SBC. Treatment via direct infiltration with corticosteroids yielded a success rate of 77\%.\textsuperscript{1} The procedure resulted in faster recovery times and similar or improved results over surgical intervention. However, arthroscopic-guided injection of SBCs requires a surgical facility, general anesthesia, expensive arthroscopic equipment, and may represent considerable expense to the client.

A less invasive ultrasound-guided injection of corticosteroids directly into the fibrous cyst lining under general anesthesia has been used with success to alleviate lameness arising from SBCs.\textsuperscript{1,14} However, the materials and methods of the technique have not been reported. Additionally, application of this technique in standing horses has not been described in the literature. Ultrasound-guided injection of corticosteroid into MFC SBCs in the standing patient may represent advantages over existing treatment methods including: rapid treatment time, avoidance of general anesthesia, reduced cost, and ability to treat patients on the farm. The widespread availability of ultrasound equipment and the relatively simple ultrasonographic anatomy make this technique a useful alternative for treatment of SBCs in the MFC in appropriately selected cases.

The purpose of this paper is to describe the technique used to identify and treat femoral SBCs in the standing horse using ultrasound guidance.

2. Materials and Methods

Evaluation of the MFC and SBC

A standard series of stifle radiographs should be obtained\textsuperscript{17} prior to ultrasonographic evaluation and treatment, with the caudo 20 lateral-craniomedial oblique, flexed lateromedial and caudocranial views being of particular importance (Fig. 1). These lesions are often bilateral, so images of both stifles should be obtained.

Following sedation, a wide area around the medial femorotibial joint should be clipped with a #40 blade as the overlying skin will move considerably when the limb is flexed. A routine ultrasonographic examination of the stifle should be performed to identify associated soft tissue injuries.\textsuperscript{6} Most SBCs are present on the weight-bearing surface of the cranial aspect of the MFC.\textsuperscript{18} Ultrasonographic evaluation and treatment of the MFC lesion must be performed with the stifle flexed. Care should be taken when imaging the MFC with the limb flexed in fractious horses; appropriate sedation is recommended as is the help of a capable assistant to maintain the limb in the flexed position. To evaluate the MFC SBC, the hindlimb is lifted to maintain stifle flexion at 90°. The foot can either be placed on a wedge block or placed on a hoof jack (Fig. 2). In this position,
The MFC becomes more superficial and can be easily evaluated using standard linear transducers (Fig. 3). To obtain a parasagittal image, the transducer is placed in long axis, proximal to the tibial crest and axial to the middle patellar ligament. The ultrasound transducer is directed approximately 45° in a craniodistal to caudoproximal direction to image the medial condyle and SBC. The probe is then rotated 90° to obtain transverse images of the condyle and the SBC. The femoral condyle is more rounded in the transverse plane than the parasagittal plane. In a normal MFC, the articular margin is a smooth, convex bone surface with a thin layer of overlying anechoic cartilage. The SBC is often a concave disruption of this smooth contour and may be associated with thickening of the cartilage layer around the cloaca (Fig. 4). By obtaining images in 2 planes, it is possible to judge the contour and size of the cloaca and articular surface. This allows the formation of a plan for needle trajectory, saving valuable time in the surgically prepared patient.
Patient Preparation

Following a thorough ultrasonographic examination of the stifle, the area from the base of the patella to the tibial crest is surgically prepared with the horse fully weight-bearing on all 4 limbs. The patient should be resedated if necessary to ensure complete compliance.

With the horse weight-bearing, a subcutaneous line block using mepivicaine should be placed at the level of the base of the proximal patella. This should be sufficiently proximal to avoid gas artifact appearing in the ultrasound image.

The limb is then lifted and the foot placed on the hoof jack and stabilized throughout the procedure by an assistant. In this position, the final surgical scrub is applied, and the area copiously doused in alcohol as an ultrasound coupling agent.

A 7.5 to 10 Mhz linear or curvilinear probe is placed inside a sterile sleeve with sterile lube between the transducer and the glove.

The probe is placed over the medial condyle in both parasagittal and transverse planes to determine the best needle trajectory.

A 3.5 inch 18 G spinal needle is placed through the skin adjacent to the transducer and advanced, in the ultrasound beam, towards the SBC. It is preferable to perform this freehand, rather than with a biopsy guide. The needle will appear as a hypoechoic line, which may cast an acoustic shadow (Fig. 5). The needle should be advanced into the far wall of the cyst, which may not be visible on ultrasound if the cyst is wider than the cloacal opening.

The needle should contact bone and be fairly firmly placed prior to removal of the stylette and injection of 10 to 15 mg of sterile triamcinolone acetonide. It has been recommended that injection in multiple sites within the cyst lining may be beneficial, and this can be attempted with ultrasound depending on patient compliance. The total dose of triamcinolone should not exceed 18 mg.

In less cooperative horses, the technique can be performed under general anesthesia. Following premedication with xylazine (0.8mg/kg bwt i.v.) and butorphanol (0.04 mg/kg bwt i.v.), anesthesia is induced with diazepam (0.05 mg/kg bwt i.v.) and ketamine (2.2 mg/kg bwt i.v.). The horse is then placed in dorsal recumbency, a sterile rectal sleeve placed over the foot on the affected limb, and the limb flexed to allow evaluation of the medial condyle. The surgical technique is similar to that described in the standing patient, with the stifle held in a 90° flexed position by the assistant (Fig. 6). An adhesive bandage strip should be placed to prevent contamination during recovery from anesthesia. This procedure can be performed under short acting intravenous general anesthesia of 20-minutes duration.

Following the procedure, the patient should be stall rested for several days, provided with systemic anti-inflammatory medications, and observed for any negative sequelae to joint injection.

3. Results

The authors have successfully performed this technique in over 45 horses (2011–2013). For the purposes of this manuscript, however, case selection was limited to juvenile Thoroughbred horses in race training presenting with sudden-onset unilateral hindlimb lameness within the first 6 months of commencement of training. The source of lameness being localized to the medial femorotibial joint by a positive response to intra-articular anesthesia of the medial femorotibial joint with radiologic confirmation of a MFC SBC with no additional ultrasonographic abnormalities. Twelve cases met...
the selection criteria for inclusion in this study. Twenty horses were identified from our medical records to comprise a retrospective control group. Controls were Thoroughbred horses of the same age and stage of training as case horses with a known history of lameness resulting from a unilateral MFC SBC. All horses had been subjected to ultrasonographic evaluation of the stifle with the SBC confirmed as the only significant pathological finding. Controls had been treated with intra-articular triamcinolone acetonide injection and were, thus, considered to have been treated conservatively. For both groups, treatment was considered a success if the horse returned to training and remained free from stifle lameness for at least 1 year. This was assessed by direct observation by the authors over the first 6 months and then by detailed trainer/owner follow-up conversations. Long-term follow-up was assessed by the ability to start a race. Comparison of outcome variables between groups was performed using Fishers Exact Test (P < 0.05). The number of days from treatment to resumption of training was compared using analysis of variance (ANOVA). The number of repeat injections and changes in radiographic SBC appearance were also compared between groups.

Eleven (91.7%) cases required only a single ultrasound-guided injection of the fibrous cyst lining to achieve soundness. Ten (83.3%) resumed training without lameness, and 9 (75%) successfully started a race. Only 11 (55%) conservatively treated control horses became sound following a single intra-articular injection with 14 (70%) returning to training. Eleven (55%) subsequently started a race. Although there was no statistically significant difference in likelihood of a positive outcome between the methods, cases treated with ultrasound-guided SBC injection were significantly more likely to require...
only one treatment than controls ($P = 0.05$ two sided Fishers Exact Test) with an average time from diagnosis to return to training of $50.8$ (95% confidence interval [CI] 15.2) days in case horses compared to 65 (95% CI 15.2) days in control horses. The radiographic appearance of the SBCs did not differ between groups and was not a useful predictor of a successful outcome. The results are summarized in Table 1.

### Table 1. Summary of Results

<table>
<thead>
<tr>
<th></th>
<th>U/S guided cases</th>
<th>Intra-articular controls</th>
<th>$P$</th>
</tr>
</thead>
<tbody>
<tr>
<td>Number of horses</td>
<td>12</td>
<td>20</td>
<td></td>
</tr>
<tr>
<td>1 treatment required</td>
<td>11 (91.7%)</td>
<td>11 (55%)</td>
<td>$P = 0.05$</td>
</tr>
<tr>
<td>&gt;1 treatment required</td>
<td>1 (8.3%)</td>
<td>9 (45%)</td>
<td></td>
</tr>
<tr>
<td>Returned to training</td>
<td>10 (83.3%)</td>
<td>14 (70%)</td>
<td></td>
</tr>
<tr>
<td>Started a race</td>
<td>9 (75%)</td>
<td>11 (55%)</td>
<td></td>
</tr>
<tr>
<td>Average days from initial treatment to return to training</td>
<td>50.8</td>
<td>65.1</td>
<td>$P = 0.04$</td>
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</tbody>
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4. Discussion

This is the first time that ultrasound-guided injection of SBCs has been compared to conservatively treated controls from a similar population. Ultrasound-guided injection of corticosteroids into the fibrous lining of MFC SBCs is a viable method to alleviate lameness caused by the subchondral bone cysts and appears to have similar success rates to several surgical treatment options. With practice, it is technically easy to perform using readily available equipment and obviates many of the shortcomings of existing surgical methods such as the requirement for general anesthesia and transport of the patient to a surgical facility. It also offers cost benefits to the client while achieving similar results to previously documented treatment methods. If the treatment is unsuccessful, arthroscopic investigation can be subsequently performed.

Proponents of arthroscopic-guided injection as an alternative to ultrasound-guided injection contend that arthroscopy is preferable, as it allows debridement of cartilage defects. However, less than 10% of cases may actually require debridement. One potential benefit of arthroscopic injection is the ability to observe the “bulging” of the cyst lining during injection. This direct visualization is not possible using ultrasound guidance. The reported outcomes appear to be comparable between the techniques.

It should be noted that the procedure is not without risk to the operator and the horse, especially if the patient were to move or become uncooperative during the procedure. However, with appropriate case selection, competent assistants, adequate restraint, and skin anesthesia, the authors have encountered no negative outcomes using this method. The authors have not found it necessary to place anesthetic solution into the medial femorotibial joint when undertaking the procedure as has been reported in standingarthroscopic evaluation of the stifle. Additionally, many potential risks can be reduced by performing the technique under intravenous general anesthesia if the above precautionary prerequisites cannot be achieved.

This study included only juvenile Thoroughbred racehorses with lameness originating from a single SBC in a single limb. Moreover, ultrasonographic examination was used to ensure no significant soft tissue pathology was visible in any of the horses used in this study. The usefulness of this technique on older horses, different breeds, or in the presence of coexisting soft tissue pathology is, therefore, unknown and should be considered prior to undertaking this procedure in such cases. The authors have performed the technique in horses of different breeds and ages but have not objectively evaluated the outcome. It is possible that the successful outcome in the cases reported here was due to lack of concurrent pathology associated with an immature cyst in a young horse.

As has been reported in previous studies, radiologic resolution of the SBC was not a useful predictor of treatment success. Using the ability to start a race as an objective outcome variable is a widely accepted method for assessing treatment success in racehorse studies, but care should be taken when interpreting results of the current study for several reasons: the study population was small, which has the potential to over or underestimate significance of results. Also, the class or ability of race was not investigated. It is possible that horses that raced may have done so at a lower level than if they had not suffered from the disease. It is not appropriate to comment on the significance of this in small groups such as in the current manuscript. Future studies with larger populations should further investigate this novel technique.

No negative sequelaes were observed in this study, but care should be taken throughout this procedure to ensure maintenance of a sterile environment during needle placement and injection, as the needle has to enter the medial femorotibial joint during this procedure.

In summary, ultrasound-guided injection of corticosteroid into the lining of subchondral bone cysts of the equine MFC is easy to perform and offers similar success rates to previously reported surgical treat-
ments in this group of young Thoroughbreds and may offer advantages to both owner and patient in appropriately selected cases.

Acknowledgments

Conflict of Interest
The Authors declare no conflicts of interest.

References