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A limited surgical approach for pastern arthrodesis in horses with severe osteoarthritis

11 horses, 2000-2007

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Keywords

Pastern, arthrodesis, limited, surgical, approach

Summary

Osteoarthritis of the proximal interphalangeal joint (PIPJ) is a common cause of chronic lameness in the horse that requires surgical arthrodesis when medical management is no longer able to alleviate pain. Surgical principles for successful PIPJ arthrodesis include articular cartilage debridement and rigid fixation. To completely debride articular cartilage, the collateral ligaments and extensor tendon are transected, disarticulating the joint. The purpose of this study was to demonstrate that in chronically lame horses with periarticular new-bone formation and osteoarthritis, successful arthrodesis occurs without joint disarticulation and complete ar-

ticular cartilage debridement. We hypothesised that complete articular debridement is not necessary, thus allowing for a less invasive surgical approach that decreases surgical time and hospitalisation with comparable success rates to previous reports. Medical records from 2000–2007 were reviewed for PIPJ disease. Information regarding lameness, surgical time and hospitalisation were retrieved from 11 horses (12 limbs). Follow-up information was obtained via a telephone interview and a re-evaluation. Average hospital and surgery times were shorter than previous reports at 19 days and 111 minutes respectively. Lameness decreased at least one grade in 92% of limbs. 73% of owners would elect to operate again. The data suggests that successful arthrodesis occurs without joint disarticulation and complete articular cartilage debridement.

condition eventually producing a grossly visible deformation proximal to the coronary band (1, 4–6). Radiographic imaging confirms the diagnosis and often demonstrates excessive periarticular new bone formation and loss of joint space with joint collapse (3–6).

Historically, several therapeutic options have been explored in low motion joints. Most of these treatments, such as intra-articular steroids and more recently intra-articular alcohol injections, have focused on ameliorating clinical signs by providing pain relief (4–8). While medical therapy may provide short term benefits, it often fails to provide long-term analgesia sufficient enough to improve quality of life, or to return the animal to full performance (7). Therefore pastern arthrodesis becomes necessary to eliminate pain and restore usefulness in these horses.

Articular cartilage debridement followed by rigid internal fixation, are generally accepted surgical principles for successful PIPJ arthrodesis. In order to completely debride all articular cartilage, the joint must be disarticulated to provide adequate exposure. This requires a robust surgical approach, starting with the initially reported I-shaped or the currently advocated inverted T-shaped skin incision (1, 2). The extensor tendon is transected in an inverted Y or V fashion to reveal the PIPJ capsule. The joint capsule, collateral ligaments and other periarticular soft tissues must be transected to disarticulate the joint (1). In severe or chronic cases of PIPJ-OA, substantial periarticular 'new bone' formation may interfere with the transection of the joint capsule and other soft tissues, making exposure of the remaining articular cartilage challenging. Much of this 'new bone' must be removed to allow for disarticulation of the joint, which adds surgical time and

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Introduction

Osteoarthritis (OA) of the proximal interphalangeal joint (high ringbone), is a common cause of lameness in the horse (► Fig. 1 and 2). It has been suggested that horses performing disciplines which place excessive stress and torque on the lower limbs are at higher risk for OA of the proximal interphalangeal joint (PIPJ), but horses engaged in all disciplines can be affected. The average age of

affected horses varies, and a wide range has been reported (1, 2). The breed predilection appears to be dependent upon the local horse population of the hospital reporting the study.

Osteoarthritis can significantly reduce performance, quality of life, and can potentially lead to life threatening conditions such as overload laminitis of the contralateral limb in severe cases (3). Osteoarthritis of the PIPJ is often characterised by lameness, with the



Fig. 1 Lateromedial radiographic projection demonstrating severe osteoarthritis of the proximal interphalangeal joint from horse 8. The subchondral sclerosis and new bone proliferation were typical of most horses in this study.



Fig. 2 Dorsoplantar radiographic projection demonstrating osteoarthritis of the proximal interphalangeal joint from horse 8. Osteoarthritis was graded as severe with reduction of joint space, subchondral sclerosis and cyst-like lucencies.



Fig. 3 Photograph representing the final result of the surgical dissection of the proximal interphalangeal joint utilised in this study. The skin and extensor tendon are longitudinally incised and the joint is exposed with the assistance of self-retaining Gelpi retractors.

trauma. Recent studies challenge the idea that all articular cartilage must be removed for successful joint fusion to occur (9–11). Studies in rabbits have shown that depletion of synovial fluid and disruption of the bone-cartilage interface via a single drill pass leads to cartilage death and ultimate disappearance of articular cartilage (9–11). When these two techniques were combined, no viable articular cartilage matrix was present post-operatively at seven weeks in rabbits (10). More recently, arthrodesis of intertarsal joints in human beings is being accomplished with arthroscopic assisted cartilage removal and implant placement via stab incisions. (12)

These findings suggest that it is not necessary to completely remove articular cartilage for successful joint fusion to occur (9–11) and less invasive surgical approaches should be considered. Disruption of the periarticular new bone and disarticulation may not be required as part of the surgical approach to fusion of the equine PIPJ. It is plausible that leaving the periarticular new bone and collateral ligaments intact would allow for load sharing and provide a more rigid fixation than relying on the implants alone. Consequently, a single longitudinal skin incision followed by longitudinal splitting of the extensor tendon may provide adequate exposure to the PIPJ and be less invasive.

The purpose of this study was to describe a new approach for surgical fusion of the PIPJ, while demonstrating that in horses with naturally occurring OA of the PIPJ and significant periarticular 'new bone' formation, successful arthrodesis can be achieved without joint disarticulation and complete debridement of remaining articular cartilage. We hypothesised that without the need to remove all articular cartilage, a less invasive surgical approach via a longitudinal skin incision and splitting of the extensor tendon would decrease surgical time, shorten hospitalisation and result in comparable success rates to previous reports.

Materials and methods

Inclusion criteria

Medical records of horses presented to the Veterinary Medical Teaching Hospital from 2000–2007 for lameness localised to the PIPJ were reviewed. All horses with a radiographically confirmed diagnosis of OA that were treated with pastern arthrodesis using a limited surgical approach were included in this study. Subject details including duration and grade of lameness, use of the horse, surgical technique including implant type and closure, surgical time, duration of coaptation, and duration of hospitalisation were retrieved. Follow-up information was obtained by re-examination, including radiography and telephone interviews.

Surgical procedure

Horses were anaesthetised and positioned in lateral recumbency with the affected leg facing upwards. The limb was aseptically prepared and draped in standard fashion. A longitudinal skin incision was made on dorsal midline from 7 cm distal to the metacarpo/metatarsophalangeal joint to 1 cm proximal to the coronary band. The common / long digital extensor tendon was longitudinally incised and the dorsal surface of the PIPJ exposed with the aid of sharp dissection and retraction using Gelpi retractors (► Fig. 3). When a narrow dynamic compression plate (DCP) was applied, an osteotome was used to remove excess bony proliferation and create a

groove over the dorsal aspect of the joint. This allowed the contoured bone plate to be positioned in direct contact with the dorsal cortices of the proximal and middle phalanges. A 3.2 mm, 4.5 mm, or 5.5 mm drill bit was used in a dorsal to palmar / plantar orientation to drill across the joint space. Three passes were made using a fanning technique across both the lateral and medial condyle, and on mid-line to remove remaining articular cartilage and disrupt the subchondral bone, followed by internal fixation with 4.5 or 5.5 mm cortical transarticular lag screws alone, or in combination with a 3- or 4-hole DCP (► Supplementary Table 1, available online at www.vcot-online.com) using a previously described technique (1).

Seven limbs were treated with a 3-hole DCP placed on the dorsal surface bridging the proximal interphalangeal joint, with one transarticular lag screw placed on either side of the plate. In one limb, a 4-hole DCP and two abaxial transarticular lag screws were utilised. Three limbs had two transarticular screws (5.5 mm AO cortical) placed in lag fashion and one limb had three transarticular screws (two 4.5 mm cortical screws and one 6.5 mm cancellous screw due to stripping of the thread hole with the third 4.5 mm cortical screw) placed in lag fashion. Correct implant placement was controlled and confirmed by intra-operative digital radiography (► Fig. 4 and 5).

Closure

The longitudinally incised edges of the extensor tendon were re-apposed using 3.5 metric polyglactin 910^a in a cruciate pattern; the subcutaneous tissue was closed with an absorbable suture in a simple continuous pattern and the skin closed with 3.5 metric polypropylene^b in a vertical mattress pattern. The incision was covered with a sterile, non-adherent dressing and all horses had a half-limb fibreglass cast applied in normal weight bearing position. Horses were recovered from anaesthesia on an inflatable air mattress (13).

^aVicryl, Ethicon, Somerville, NJ, USA.

^bProlene, Ethicon, Somerville, NJ, USA.



Fig. 4 Dorsoplantar radiographic projection demonstrating placement of implants in the proximal interphalangeal joint from horse 8.



Fig. 5 Lateromedial radiographic projection demonstrating placement of implants in the proximal interphalangeal joint from horse 8.

Drug therapy

Potassium penicillin (22,000 IU/kg IV, QID) and gentamicin (6.6mg/kg IV, SID) were administered preoperatively to all horses and continued for three to seven days. All horses received a tetanus toxoid injection intramuscularly as well as phenylbutazone (4.4mg/kg PO, SID) until two days post cast removal.

Post-operative care

The half-limb casts were removed after a mean of 13 days (range 9–21 days) post-operatively and sutures were removed the following day. Immediately following cast removal, a sterile dressing was placed over the incision followed by a cotton support bandage. The support bandage was changed the following day, and then changed every other day or as necessary for 30 days. Re-check examinations and radiographs were scheduled between 30–60 days post cast removal for all horses. Typical post-operative management consisted of stall rest for 60 days followed by small paddock turnout for 60 days followed by pasture turnout for an additional 60 days. Once the horses demonstrated improvement in lameness scores, they were gradually returned to their normal routine.

Follow-up

Follow-up information, including current lameness, current use of the horse, quality of life and cosmetic appearance was obtained via telephone interviews with the owners. Re-examination at the Veterinary Medical Teaching Hospital was performed by one of the authors (JDL, MD, PDJ, WB) and included lameness evaluation and radiography. Success was determined as a decrease in lameness of at least one grade and an increase in owner satisfaction.

Results

Pastern arthrodesis surgery was performed on 12 limbs in 11 horses. The average age was 12 years (range 3–22 years) and average duration of lameness was 14 months (range 16 days – 36 months) prior to presentation. Ten horses had unilateral and one horse had bilateral arthrodesis 6 months apart. The function of horses ranged from working athlete to companion animal. Additional details are summarised in ►Supplementary Table 1, available online at <http://www.vcot-online.com>.

Eight limbs affected were forelimbs while four had a hindlimb affected. Ten limbs had chronic OA which was assessed radiographically as severe, one had moderate OA, and one had moderate OA with a subchondral bone

cyst in the distal articulation of the first phalanx. Osteoarthritis was considered severe if there was excessive bony proliferation appreciated in all radiographic projections with or without loss of joint space. Osteoarthritis was considered moderate if the bony proliferation did not span the joint and the joint spaces appeared symmetric. Five limbs had collapse of one joint compartment (medial or lateral) of the PIPJ. Articular cartilage was removed from the PIPJ using a 4.5 mm drill bit in six limbs, a 3.2 mm drill bit in four limbs, and a 5.5 mm drill bit was used in one limb. A Hohmann retractor was used to distract the PIPJ, allowing curettage of the articular surfaces in one limb. The average surgery time was 111 minutes (range 100–130). Duration of coaptation averaged 13 days (range 9–21) with total hospital stay averaging 19 days (range 15–27).

Outcome

Follow-up information was obtained for all 11 horses. The mean follow-up time for the telephone interview with the owner or observation at the Veterinary Medical Teaching Hospital was 33 months (range 7–84 months). Ownership was maintained in nine of 11 horses. Prior to surgery, none of the horses could perform their intended function. Incidentally, four of 11 owners reported they would have euthanatized the horse based on pain, severity of the lameness or chronicity of the disease. Following surgery, ten of eleven horses, or eleven of twelve limbs, had a decrease in lameness of at least one grade with eight of eleven horses fulfilling the owners' expectations post-operatively, which ranged from comfortable companion animal to working athlete. While the authors recognised that many of the horses in this study were not high level athletes prior to surgery, we feel it is important to note that the two horses (horses 7 and 8) that were athletes and were treated with a plate-screw combination did return to their previous level of performance.

Two of three horses that did not meet the owners' expectations were surgically fused using only transarticular lag screws. One horse was implanted with two transarticular lag screws and suffered implant failure 60 days after surgery. This horse was turned out

to pasture against recommendations one month post-operatively. The owners elected not to have the broken implant removed. In the second horse, fusion was attempted with three transarticular lag screws. This horse had no radiographical evidence of complications; however the lameness failed to improve. The owners declined further investigation and sold the horse at auction. One horse treated with a 3-hole DCP and two transarticular lag screws did not meet the owner's expectation because of a small chronic draining tract at the proximal end of the surgical scar, yet the lameness score was improved. Radiographs confirmed progressive fusion and the implants were removed 12 months after the initial surgery due to presumptive low-grade implant infection. One month after implant removal the draining tract had healed, the lameness improved another grade and the horse was back in work.

Three horses had mild sores upon cast removal; all resolved with minimal wound care and bandaging. Two horses developed a mild incisional infection after cast removal which resolved in three to five days with local antibiotic therapy. At the time of follow-up, no additional complications were reported in these two horses.

Post-operative radiographs (lateromedial and dorsopalmar / plantar) were available in all 11 horses at an average of 86 days (range 13–395 days), with eight of twelve limbs imaged at least 30 days post-operative. All eight limbs imaged after 30 days demonstrated progressive bony fusion, periarticular new bone formation and a decrease in joint space from pre-operative radiographs. In one limb, the distal plate screw loosened creating excessive dorsal bony proliferation recognised 18 weeks after surgery. The implant was not removed and the horse became sound after 12 months.

Eight of eleven owners believed that their horse's quality of life had improved, based on a voluntary increase in activity level and a decrease in lameness. Cosmetically, nine owners stated that the surgical limb did not look different following the procedure. The two limbs that appeared grossly different after surgery were those in which significant periosteal new bone was not radiographically apparent prior to surgery. A successful outcome was obtained in nine horses and ten limbs. Nine owners would elect to have the procedure performed again if offered a favorable prognosis.

Discussion

This report demonstrates that in cases of severe OA of the PIPJ, successful arthrodesis can be achieved using a limited surgical approach, drilling of the articular surface, internal fixation and short-term cast immobilisation. It has traditionally been accepted that during surgical arthrodesis, residual cartilage must be removed for bony fusion to occur (10, 11). Documented methods of cartilage removal include curettage and drilling (14, 15). It has been suggested that passing a drill bit through the PIPJ would create undesirable incongruity between bones, leading to early implant loosening and potential failure (15). In this report, 92% of operated limbs demonstrated decreased lameness, with only one limb suffering implant failure. Therefore, the results of this study would suggest that any incongruity caused by passing an orthopaedic drill bit across the joint surface may be offset by leaving the periarticular supporting soft tissues intact. Nevertheless, the fact that two of only three failures in this study were associated with transarticular screw fixation alone would suggest that the plate-screw combination may be a more appropriate fixation type when utilizing this surgical approach. If cases with screw fixation alone are excluded, our success rate was 89%.

Ideal conditions for bony fusion are obtained when two cancellous bone surfaces are aligned, compressed and rigidly immobilised (9). Therefore, the surgical approach to the PIPJ has routinely consisted of a large flapped skin incision and transection of the common/long digital extensor tendon and collateral ligaments to allow for disarticulation and exposure of the articular surface (14). In cases of chronic OA, periarticular new bone is intimately attached to the joint capsule (1, 3, 16) which can make complete disarticulation of the joint difficult and time consuming. Once the joint is disarticulated, proper anatomic alignment must be reestablished and maintained for proper implant placement as studies have shown the PIPJ contributes significantly to the flexion/extension of the digit (17). The surgical technique reported here avoids these additional steps, which likely accounts for our shorter surgical time of 111 minutes, compared to 144 minutes reported previously (1).

In low motion joints other than the PIPJ, such as the distal intertarsal and tarsometatarsal, ideal conditions for successful arthrodesis can not be met because aggressive surgical approaches can lead to unacceptable morbidity or failure (7, 18, 19). Accepted techniques for fusion of these joints include surgical drilling, injection with monosodium iodoacetate and either neodymium: yttrium aluminum garnet (Nd:YAG) or diode laser (18). Monosodium iodoacetate injection cannot be advocated for arthrodesis of the PIPJ due to the high risk of injection site necrosis, septic arthritis, and necrotic tendonitis (20). Recently, diode laser therapy has been applied for cartilage removal of the PIPJ in the horse (21). In this study, five limbs of four horses were subjected to diode laser therapy through 14 gauge needles into the PIPJ (21). Following laser therapy, 3 parallel trans-articular 5.5 mm cortical screws were placed through minimally invasive stab incisions (21). All horses were sound at a walk after surgery and follow up, which ranged from 2–8 months, and demonstrated radiographic bony fusion after this time frame (21). These observations suggest that arthrodesis of the PIPJ can be achieved with a more limited surgical approach and does not require complete cartilage debridement.

The technique described here utilised surgical drilling with an orthopaedic drill bit to remove articular cartilage and disrupt the subchondral bone plate to allow for vascular ingrowth and promote bony fusion. While it is highly unlikely that all cartilage was removed using this technique, this is not necessary as OA induces degradation of articular cartilage by chemical mediators such as proteolytic enzymes (metalloproteinases) and pro-inflammatory cytokines (22). Horses in this study did show radiographic evidence of progressive bony fusion as well as clinical improvement in lameness scores which may be explained by the fact that all horses in this study had evidence of advanced joint disease and bony bridging prior to surgery.

Normal hyaline cartilage has limited regenerative capabilities and receives the oxygen and nutrients necessary for life from the synovial fluid. Any disruption in synovial fluid production or content can negatively impact cartilage health (9, 23). A reduction of synovial fluid can be achieved simply by im-

mobilising the joint (24), which not only leads to erosions of the joint surface (24), but can also lead to complete disappearance of cartilage matrix histologically (10). The same report demonstrated that synovial fluid depletion (plus rigid immobilisation) utilising drill passage through the bone-cartilage junction caused complete disappearance of all cartilage matrix histologically after seven weeks (10). These data were confirmed in additional studies (9–11). In light of these data, minimal surgical manipulation of diseased articular cartilage may accelerate the loss of joint space, leading to bony fusion.

While following the trend for less invasive procedures, this technique may not be applicable in all cases that require arthrodesis of the PIPJ. One example is fracture of the second phalanx. In these cases, since the subchondral bone and articular cartilage are healthy without pre-existing bony callus, a more aggressive approach, including disarticulation, thorough cartilage debridement and osteostixis is likely indicated.

Finally, minimising the size of the skin incision has been a general trend with orthopaedic surgery in order to reduce the chance of implant infection (25). Recently, another minimally invasive technique has been described for PIPJ arthrodesis. Here plate placement was achieved through a small incision followed by creation of a subtendinous tunnel which resulted in a decrease in surgery time and infection rate (25). However, the creation of a subtendinous tunnel for placement of the plate over the first phalanx would not be possible in the severe osteoarthritic joint due to the excess bony proliferation over the dorsal aspect of the PIPJ.

Three horses within this study experienced incisional complications at the proximal end of the incision. While the incision through the skin overlaps the incision through the extensor tendon in this location, this portion of the dissection is similar to the currently accepted dissection where the skin incision overlaps the inverted Y-tendon incision. Therefore we can not conclude that the proposed surgical incision predisposes the horse to incisional complications or implant infection.

Our average hospitalisation time was 19 days, which is shorter than the recently reported average of 24.8 days (1). We attribute this finding to an excellent comfort level of

patients after cast removal and few immediate postoperative complications. We view this as a major advantage of the technique, because although cost was not evaluated in this study, shorter hospitalisation time can be expected to translate directly into cost savings for the owner. While most horses were promptly discharged from the hospital, four horses remained hospitalised for greater than six days post cast removal. One of these horses had the chronic draining tract, while the other three horses remained due to owner request.

Data from this study suggests that in cases of severe OA, arthrodesis of the PIPJ can be performed without disarticulation of the joint and complete articular cartilage debridement. This approach allows for proper placement of the implants through a smaller, less invasive incision. The extensor tendon and the collateral ligaments are not transected, maintaining the inherent stability of the joint. This allows for quicker, easier and more accurate anatomic reduction of the PIPJ which assists proper implant placement. This less invasive surgical approach resulted in shorter surgical times, shorter hospitalisation times and comparable success rates to previous reports. Therefore, we believe that a smaller, less invasive surgical approach to the PIPJ is adequate for the chronically lame horse with significant periarticular new bone formation and OA.

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