Transthecal Arthroscopy of the Palmar Distal Interphalangeal Joint in the Horse: A Cadaver Study

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Presented at ECVS Annual Scientific Meeting, Rome, Italy, July 2013 and ACVS Veterinary Symposium, San Antonio, TX, October 2013.

Abstract

Objective: To describe a transthecal approach to the palmar pouch of the distal interphalangeal joint (DIPJ) in horses and compare it with the conventional blind arthroscopic technique.

Study Design: *Ex vivo* study.

Sample Population: Cadaver forelimbs (n = 26 pairs) from mature horses.

Methods: One limb from each pair was randomly assigned to each arthroscopic approach (conventional or transthecal). The conventional arthroscopic approach was performed as previously described and the transthecal approach was performed through sharp dissection of the distal reflection of the digital flexor tendon sheath (DFTS). The proportion (0–100%) of the navicular bone, palmar aspect of the condyles of the 2nd phalanx, collateral sesamoidean ligaments, and palmar synovial pouches of the DIPJ visualized by each approach was estimated. Limbs were dissected and iatrogenic damage of relevant structures was assessed. Nondirectional Mann–Whitney *U*-test was used to compare groups. Significance was set at $P < .05$.

Results: The transthecal approach provided greater visualization of the navicular bone ($P < .001$), palmar aspect of the 2nd phalanx ($P < .001$), and palmar synovial pouches of the DIPJ ($P < .001$) than the conventional approach. There were no significant differences in iatrogenic damage between approaches.

Conclusion: The transthecal approach provides improved visualization of the palmar aspect of the DIPJ compared to the conventional blind approach and may be useful in nonseptic conditions of the DIPJ. However, because of the creation of communication with the DFTS, use of the transthecal approach for suspected synovial sepsis of the DIPJ may be contraindicated.

Dorsal and palmar/plantar approaches have previously been described for arthroscopic examination of the distal interphalangeal joint (DIPJ) in horses.[1] Indications for arthroscopy of the palmar/plantar aspect of the DIPJ include diagnostic inspection, fragment removal, debridement of cystic lesions at the proximal border of the navicular bone or the palmar aspect of the DIPJ, and debridement and joint lavage for synovial contamination and/or sepsis.[1-3] The first arthroscopic approach to the palmar pouch of the DIPJ was described using a blind approach after distention of the DIPJ joint.[2] Because of the confined and complex anatomy of the area, maneuverability of the arthroscope and instruments is limited and complications such as iatrogenic hemarthrosis and/or tissue damage as well as inadvertent intrusion into the closely associated navicular bursa or digital flexor tendon sheath (DFTS) can occur.[1, 2] A recently described lateral/medial approach to the palmar/plantar pouch of the DIPJ provided comparable visualization of the palmar pouch of the DIPJ to the conventional technique and was associated with decreased risk of inadvertent penetration of DFTS and/or navicular bursa.[4]

Similar anatomical and technical limitations are encountered during arthroscopic evaluation of the navicular bursa as described for the DIPJ. A transthecal approach to the navicular bursa via sharp penetration of the "T ligament" at the distal reflection of the digital flexor tendon sheath (DRFTS)[5, 6] allows a more comprehensive examination of the navicular bursa with less associated iatrogenic damage than the conventional blind approach to the navicular bursa.[7] A transthecal approach to the palmar pouch of the DIPJ via sharp penetration of the DRFTS has been described[5]; however, to the authors' knowledge, its clinical use and comparison with the conventional blind approach to the DIPJ have not been reported.

The objectives of our study were to describe the transthecal approach to the palmar pouch of the DIPJ in horses and compare visualization of and iatrogenic damage to related structures with the conventional blind arthroscopic technique. Our null hypothesis was that the transthecal approach would enable comparable visualization of the palmar pouch of the DIPJ through a single portal with a similar incidence of iatrogenic damage.

MATERIALS AND METHODS

Forelimbs (n = 26 pairs) from mature horses of a range of ages, light breeds, and genders were collected from submissions to the Department of Pathology, University of Pretoria. Details of signalment and reasons for euthanasia were unknown. Limbs were removed at the level of the mid-radius and stored at −40°C in pairs. The study was approved by the Animal Care Committee of the Faculty of Veterinary Science, University of Pretoria. Before performing arthroscopy, limbs were thawed at room temperature for ∼18 hours and 1 limb of each pair was randomly assigned to either the conventional or the transthecal approach with the opposite limb used for the other approach.

One board certified surgeon performed all arthroscopic approaches and examinations (L.M.R.-M.). Limbs were secured to a surgical table with the distal aspect of the limb directed to the side, simulating lateral recumbency. The distal limb was clipped and cleansed

using chlorhexidine gluconate scrub and water. The DIPJ was distended with 20–25 mL tap water using a 20 g, 3.81 cm hypodermic needle through a standard dorsal approach. Joint distention was palpable axial to the palmaroproximal end of the collateral cartilage.

Conventional Approach

The palmar pouch of the DIPJ was approached as previously described.[4] An approximately 1 cm skin incision was made with a #15 scalpel blade over the palpably distended palmar DIPJ pouch, axial to the lateral collateral cartilage of the distal phalanx, axial to the digital neurovascular bundle, and abaxial to the deep digital flexor tendon (DDFT). A deep incision into the joint was created with a #11 scalpel blade. The arthroscopic sheath (5 mm diameter) with the conical obturator was advanced into the joint parallel to the palmar aspect of the 2nd phalanx, aiming toward the apex of the frog. The conical obturator was replaced with a 4 mm 30° forward viewing arthroscope (Karl Storz GmbH & Co., Tuttlingen, Germany). Once the intra-articular location of the arthroscope was ascertained by visualization of intra-articular structures, arthroscopic evaluation of the palmar pouch of the DIPJ was performed while distention was maintained with tap water and an arthroscopic peristaltic pump (Continuous wave II Arthroscopy Pump, Arthrex, Inc, Naples, FL) at 100 mmHg of pressure.

Transthecal Approach

The DFTS was distended with 30 mL tap water using the approach at the base of the proximal sesamoid bone, between the palmar annular ligament and the proximal digital annular ligament.[8] A 5 mm skin incision was made with a #15 scalpel blade on the palmar aspect of the digit, immediately abaxial to the margin of the DDFT and axial to the palmar digital neurovascular bundle at the level of the proximal limit of the collateral cartilage directly over the palpably distended pouch of the DFTS. A deep incision into the sheath was created with a #11 scalpel blade. The arthroscopic sheath (5 mm diameter) with the conical obturator was placed dorsal to the DDFT and inserted into the distal aspect of the DFTS.[7] The obturator was replaced with the 4 mm 30° forward viewing arthroscope, and its intrathecal placement was confirmed by visualization of the deep digital flexor tendon within the DFTS. Distention of the DFTS was maintained with tap water and an arthroscopic peristaltic pump as described above, and a contralateral portal was made into the distal aspect of the DFTS in a similar manner and under endoscopic guidance. A Beaver mini blade (376700, Becton Dickinson and Company, Waltham, MA) attached to a Beaver handle (371395 Dynagrip, Becton Dickinson and Company) was introduced through the instrument portal. Sharp dissection was performed through the most dorsal aspect of the DRFTS and the palmar pouch of the DIPJ was penetrated through the dorsal aspect of the "T ligament." Dissection was continued as far laterally and medially as permitted by the maneuverability of the arthroscopic approach and the cannula with the arthroscope was then introduced into the palmar pouch of the DIPJ.

Arthroscopic Visualization of the Palmar Pouch of the DIPJ

Arthroscopies were recorded and videos were evaluated by 2 board certified equine surgeons (L.M.R.-M. and J.L.B.). Individual estimates of the proportion (0–100%) of the intra-articular structures amenable to examination from a single portal: navicular bone (NB; proximodorsal aspect of the navicular bone from its medial to lateral extent), 2nd phalanx (P2; palmar aspect of the condyles from their medial to lateral extent), collateral sesamoidean ligaments (ipsilateral [iCSL] and contralateral [cCSL] ligaments and an average of both estimates

[overall: oCSL]), and palmar synovial pouch of the DIPJ (ipsilateral [iSYN] and contralateral [cSYN] synovial pouches and average of both estimates [overall: oSYN]).

Iatrogenic Damage

Gross examination of the palmar pouch of the DIPJ was accomplished by careful dissection of the soft tissues of the palmar aspect of each pair of limbs after DIPJ arthroscopy. The size, depth, and location of iatrogenic lesions to the NB cartilage, the articular surface of the palmar aspect of P2, and the DDFT were measured and recorded by 1 individual unaware of the specific details of the surgical approaches used. Lesion severity was scored for articular cartilage and tendon damage (0–3)[7]: articular cartilage lesions (NB and P2): 0 (no apparent iatrogenic damage), 1 (partial thickness scoring only), 2 (partial thickness fibrillation or flap), and 3 (full thickness damage); DDFT lesions: 0 (no apparent iatrogenic damage), 1 (superficial tears [≤2 in number and/or ≤5 mm in length]), 2 (superficial tears [>2 in number and/or >5 mm in length]), and 3 (tendon tear with associated fibrillation or flap that would require surgical debridement).

Statistical Analysis

All study variables for each approach were analyzed descriptively (Microsoft Excel 2010, Microsoft Corporation, Redmond, WA). Iatrogenic damage and visualization variables for each approach and each surgeon were compared statistically using Mann–Whitney *U*-test (SAS Institute, Inc, version 9.2, Cary, NC). The average results from both surgeons for each visualization variable were estimated and compared using the same tests as described above. Significance was set at $P \leq .05$.

RESULTS

The transthecal approach allowed greater visualization of the NB, P2, iSYN, and oSYN ($P \leq .05$) compared to the conventional approach when scores were compared for each surgeon separately and when the averaged values for both surgeons were compared (Figs 1–4; Table 1). When visualization was compared between surgeons for each approach, few significant differences were found. For the conventional approach Surgeon 1 recorded higher visualization scores (median [range]; Surgeon 1; Surgeon 2) for the NB (95.0 [80.0–100]; 85.0 [50.0–100]; $P < .001$) and P2 (95.0 [75.0–100]; 85.0 [50.0–100]; $P = .005$), and a lower visualization score for iSYN (0.0 [0.0–90.0]; 25 [0.0–90.0]; $P = .002$). For the transthecal approach Surgeon 1 reported lower visualization scores for iSYN only (50 [0.0–100.0]; 80 [0.0–100.0]; $P = .034$). There were no significant differences in iatrogenic damage between the 2 arthroscopic approaches to the palmar pouch of the DIPJ regardless of whether the 2 surgeons were compared to each or when averaged for both surgeons (Table 2).

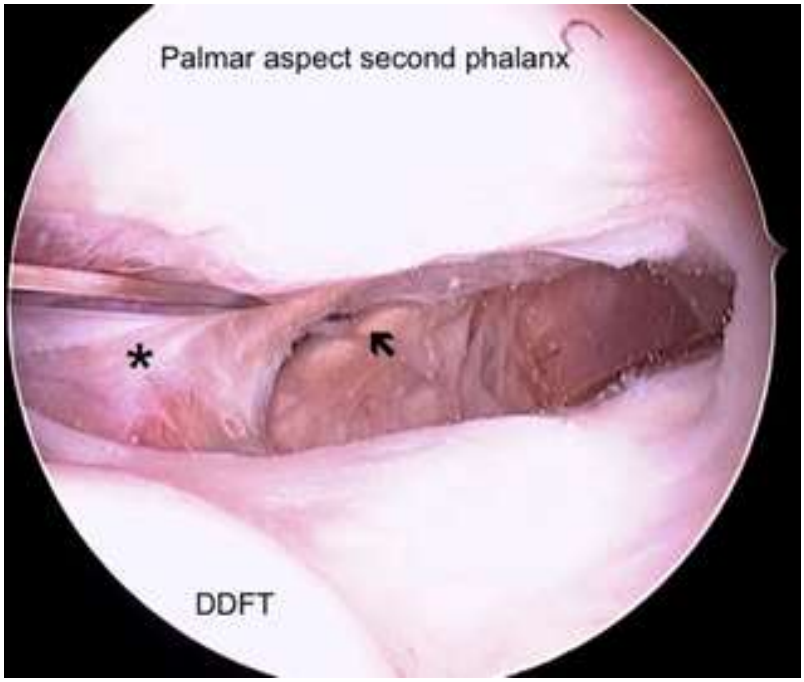

Figure 1. Arthroscopic view of the palmar pouch of the distal interphalangeal joint using the transthecal approach (top of the image is dorsal; right is lateral). The arthroscope is located in the distal aspect of the digital flexor tendon sheath (DFTS) looking distally. A Beaver blade is being used to dissect through the distal reflection of the DFTS (*). Arrow indicates the lateral collateral sesamoidean ligament. DDFT = deep digital flexor tendon.

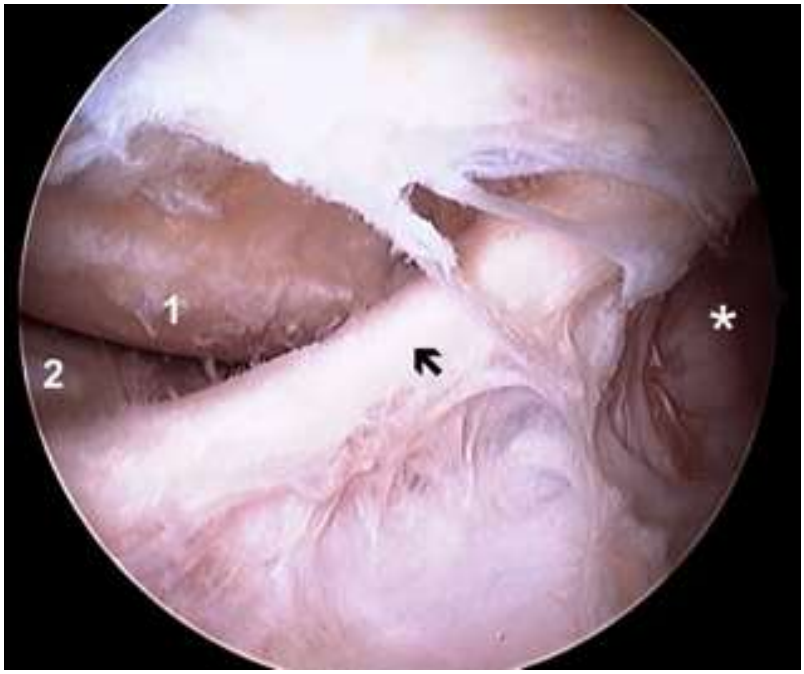

Figure 2. Arthroscopic view of the lateral aspect of the palmar DIPJ using the transthecal approach (top is dorsal; right is lateral). 1 = lateral palmar condyle of the second phalanx, 2 = proximolateral aspect of navicular bone, arrow indicates lateral collateral sesamoidean ligament, * = lateral pouch of the palmar aspect of the DIPJ.

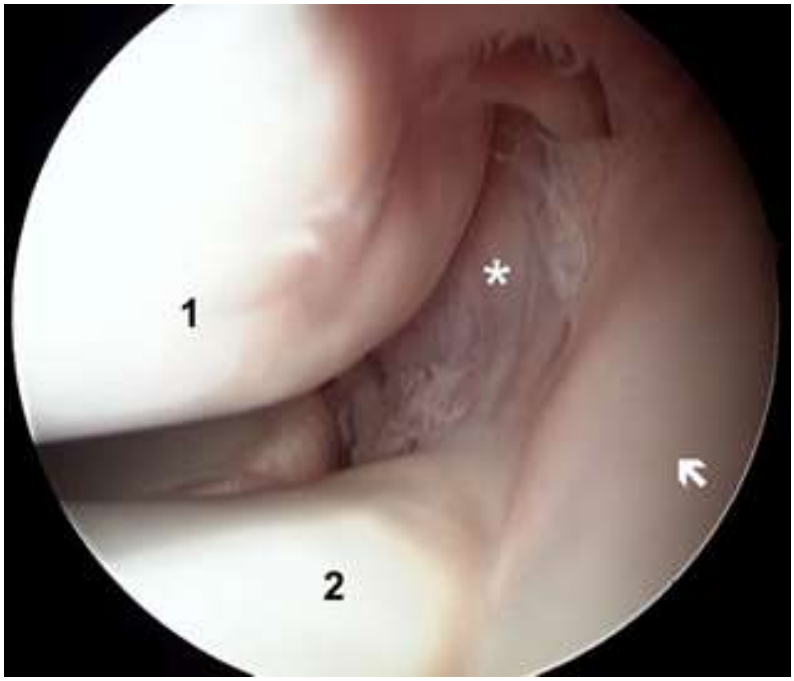

Figure 3. Arthroscopic view of the lateral pouch of the palmar DIPJ using the transthecal approach (top is dorsal; right is lateral). The arthroscope has been advanced to the level of the lateral collateral sesamoidean ligament (arrow). 1 = lateral palmar condyle of the second phalanx, 2 = lateral aspect of navicular bone, * = joint capsule.

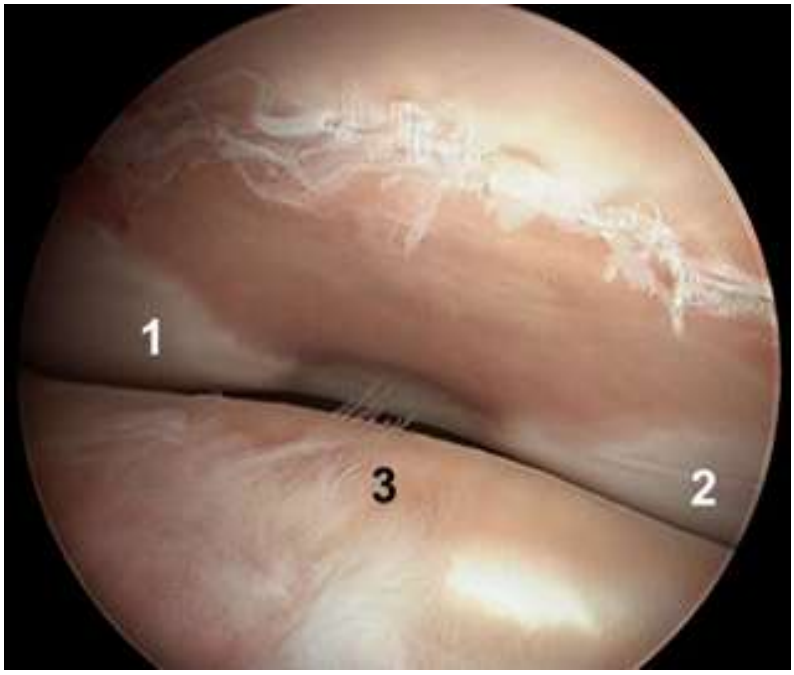

Figure 4. Arthroscopic view of the central (axial) aspect of the palmar DIPJ using the transthecal approach (top is dorsal; right is lateral). 1 = medial and 2 = lateral palmar condyles of the 2nd phalanx, 3 = proximodorsal aspect of the navicular bone.

Table 1. Percent Visualization of Anatomical Structures Using Conventional and Transthecal Approaches to the Palmar Aspect of the Distal Interphalangeal Joint

Structure	Conventional Approach	Transthecal Approach	*P*
Navicular bone	91.2 [72.5–100]	100 [89.0–100]	<.001
2nd phalanx	89.5 [72.5–100]	98.2 [86.5–100]	<.001
Collateral ligament			
Ipsilateral	60.0 [10.0–97.5]	70.0 [10.0–100]	0.197
Contralateral	100 [0.0–100]	100 [50.0–100]	0.846
Overall	76.2 [5.0–98.7]	81.8 [46.2–100]	0.126
Synovial pouch			
Ipsilateral	15.0 [0.0–85]	62.5 [0.0–95.0]	<.001
Contralateral	96.2 [0.0–100]	100 [15.0–100]	0.098
Overall	55.0 [5.0–92.5]	80.6 [12.5–97.5]	<.001

Table 2. Scores for Iatrogenic Lesions Observed by Gross Examination of Articular Structures After Palmar Arthroscopy of the Distal Interphalangeal Joint

Structure	Conventional Approach	Transthecal Approach
Navicular bone cartilage	0 [0–2]	0 [0–1]
2nd phalanx cartilage	0 [0–2]	0 [0–1]
Deep digital flexor tendon	0 [0–1]	0 [0–1]

Median [range].

DISCUSSION

The modified transthecal arthroscopic approach evaluated in our study enabled more extensive visualization of the palmar pouch of the DIPJ than the conventional approach and would therefore be a good alternative for evaluation of conditions involving the NB, P2, iSYN, and oSYN. Maneuverability of the arthroscope was increased during the transthecal compared to the conventional blind approach, which could be the reason for the increased arthroscopic visualization observed with the transthecal approach. Increased maneuverability may be the result of the wide lateral/medial sharp dissection through the DRFTS compared with the single narrow tract created during the conventional approach.

Increased visualization from a single portal may also provide other advantages such as decreasing the need for switching arthroscopic and instrument portals or creating extra instrument portals. Switching or creating new portals can be challenging to perform in the DIPJ, increases the risk of losing synovial distention, decreases visualization, and potentially adds surgical time. One of the authors (L.M.R.-M.) has used the transthecal approach in 2 clinical cases (unpublished data). In 1 case with a NB fracture, a single transthecal approach permitted examination of both synovial margins of the proximal aspect of the NB by creating dorsal and plantar sharp dissections through the DRFTS into the plantar pouch of the DIPJ and the navicular bursa, respectively. The transthecal approach was also used in a horse with a penetrating foreign body into the proximal aspect of the navicular bursa, DDFT, and DIPJ with involvement of the DFTS. In this case, the transthecal approach enabled controlled exploration and foreign body removal with no apparent iatrogenic damage to the DIPJ, navicular bursa, and related structures. In both these cases, the transthecal approach was

performed without complications; however, further use of the transthecal approach on clinical cases is warranted before more definitive conclusions can be drawn.

During arthroscopic surgery the arthroscope portal is usually placed distal to the area to be evaluated whereas the instrument portal is located near the area to be assessed. Insertion of the arthroscope at the more proximal location in the DFTS may allow placement of a more distal ipsilateral instrument portal, which could be beneficial in some clinical situations. Although not applied on clinical cases, the authors have placed an ipsilateral instrument portal in cadaver limbs when using the transthecal approach to the palmar pouch of the DIPJ. Placement of the instrument portal using the more lateral/medially located arthroscope portal described by Fowlie et al. may facilitate the technique.[4]

A previous study evaluating the transthecal approach to the navicular bursa in horses revealed that the risk of iatrogenic damage was decreased compared with the conventional approach.[7] In our study, the risk for iatrogenic damage was similar between conventional and transthecal approaches. The use of a scalpel blade to enter the previously distended DIPJ followed by the use of a blunt conical obturator in the conventional approach may have decreased the risk of iatrogenic damage to the joint compared with the use of a sharp obturator as initially described by Vacek et al.[2] In our study, the most common iatrogenic lesion was traumatic erosion of the articular cartilage/tendon with the arthroscope sheath/obturator at the time of insertion into the synovial structure. There is also a risk of causing sharp damage to cartilage or the collateral sesamoidean ligament with the Beaver blade. The authors find that the risk of sharp damage is comparable to the transthecal approach to the navicular bursa and that it rapidly decreases as the surgeon gains experience with the technique. Sharp dissection through the DRFTS was performed as extensively as possible from the medial to lateral aspects of the DFTS. None of the cadaver limbs in the study showed evidence of neurovascular bundle damage with the transthecal approach.

Limitations of our study include the subjectivity of the visualization assessment and the fact that evaluators could not be completely blinded to the procedure as sharp dissection through the DRFTS was evident in most videos. In previous studies, visualization scoring systems have categorized arthroscopic visualization as complete or incomplete[4] or by assigning individual scores to visible articular structures.[7] In our study, individual visualization of different intra-articular structures was performed in an attempt to improve objective assessment. In fact, some differences were observed between surgeons and these differences were more common in the conventional than the transthecal approach (3 vs. 1 variable). These differences did not have an effect when visualization was compared between approaches but may indicate that the transthecal approach allowed more standardized visualization of the palmar pouch of the DIPJ than the conventional blind approach.

One of the indications for arthroscopic examination of the palmar pouch of the DIPJ is penetrating injuries and septic processes. In these cases, an arthroscopic portal that decreases the chances of iatrogenic penetration of the DFTS would be preferred. The transthecal approach creates a direct communication between the DFTS and DIPJ and has the potential to create inadvertent iatrogenic penetration of neighboring synovial structures such as the navicular bursa. However, iatrogenic penetration of neighboring synovial structures was not evaluated in our study for either approach. It is therefore unknown whether the navicular bursa was penetrated during the transthecal approach or the DFTS was penetrated during the conventional approach to the DIPJ. Penetration of the navicular bursa and DFTS after the conventional approach was recently reported to occur in 50% and 60% of cases,

respectively.[4] The transthecal approach is therefore not recommended when synovial sepsis of the DIPJ is suspected and the medial/lateral approach as described by Fowlie et al. is preferred in these cases to decrease the risk of inadvertent synovial penetration.[4]

In conclusion, our study demonstrates that the transthecal approach provides greater visualization of the palmar pouch of the DIPJ than the conventional blind approach without causing more iatrogenic damage. The transthecal approach may be preferable to the conventional technique when performing palmar DIPJ arthroscopy in horses with nonseptic conditions of the DIPJ; however, in cases where synovial sepsis is suspected, the conventional approach may be preferable.

ACKNOWLEDGMENTS

The authors thank Karl Storz (South Africa) for its support by providing arthroscopic instrumentation to perform this study.

DISCLOSURE STATEMENT

The authors declare no conflicts of interest related to this report.

REFERENCES

1. McIlwraith CW, Nixon AJ, Wright IM, et al: Arthroscopic surgery of the distal and proximal interphalangeal joints, in McIlwraith CW, Nixon AJ, Wright IM (eds): *Diagnostic and surgical arthroscopy in the horse* (ed 3). St. Louis, Mosby, Elsevier, 2005, pp 347–364.

2. Vacek JR, Welch RD, Honnas CM: Arthroscopic approach and intra-articular anatomy of the palmaroproximal or plantaroproximal aspect of distal interphalangeal joints. *Vet Surg* 1992; 21:257–260.

3. Zierz J, Schad D, Heess D, et al: Chirurgische Moeglichkeiten zur Versorgung von Strahlbeinzysten sowie Strukturdefekten im Strahlbein. *Pferdeheilk* 2000; 16:171–176.

4. Fowlie JG, O'Neill HD, Bladon BM, et al: Comparison of conventional and alternative arthroscopic approaches to the palmar/plantar pouch of the equine distal interphalangeal joint. *Equine Vet J* 2011; 43:265–269.

5. McIlwraith CW, Nixon AJ, Wright IM, et al: Bursoscopy, in McIlwraith CW, Nixon AJ, Wright IM (eds): *Diagnostic and surgical arthroscopy in the horse* (ed 4). St. Louis, Mosby, Elsevier, 2014, pp 387–406.

6. Smith MR, Wright IM, Smith RK: Endoscopic assessment and treatment of lesions of the deep digital flexor tendon in the navicular bursae of 20 lame horses. *Equine Vet J* 2007; 39:18–24.

7. Haupt JL, Caron JP: Navicular bursoscopy in the horse: a comparative study. *Vet Surg* 2010; 39:742–747.

8. Bassage LH, Ross MW: Diagnostic analgesia, in Ross MW, Dyson SJ (eds): *Diagnosis and management of lameness in the horse*. St. Louis, Elsevier Saunders, 2003, pp 93–124.