Arthroscopic Removal of Large Extensor Process Fragments in 18 Friesian Horses: Long-Term Clinical Outcome and Radiological Follow-Up of the Distal Interphalangeal Joint

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Objective: Report long-term clinical and radiological follow-up in horses after removal of large extensor process fragments occupying >25% of the joint surface of the distal interphalangeal joint (DIJ).
Study Design: Retrospective case series.
Animals: Friesian horses (n=18) that underwent arthroscopic removal of a large extensor process fragment.
Methods: Arthroscopic examination of the DIJ was performed in dorsal recumbency with the affected foot in extension using routine portals. Visualization of the fragment was improved using motorized synovial resectors. A dissection plane between the common digital extensor tendon and the extensor process fragment was created using sharp lever instruments, in some cases aided by motorized burrs and radiofrequency ligament dissection. The fragment was removed piecemeal using Ferris-Smith rongeurs. Medical records, preoperative and postoperative radiographs, and owner surveys were reviewed for case details and outcome.
Results: The technique described allowed removal of the large fragment in all 18 horses. Of the 17 horses where long-term clinical follow-up was available, 14 were used as intended and 3 kept some degree of lameness. The angle between the remodeled extensor process and the dorsal surface of the distal phalanx was increased and subchondral bone remodeling at the fragment bed was noted on postoperative lateromedial radiographs.
Conclusion: Arthroscopic removal is a good treatment option for horses with large extensor process fragmentation with a good long-term outcome. Remodeling of the remaining extensor process and the subchondral new bone formation in the fragment bed can occur with functional recovery.

Fragments of the extensor process of the distal phalanx are uncommon in horses and their cause remains speculative.[1–5] They seem to have multiple known etiologies: trauma because of hyperextension, avulsion by the extensor tendon, a separate center of ossification and osteochondrosis (OC).[1–5] The size of fragmentation can vary from small OC fragments with little articular involvement to large fragments that can involve a large portion of the articular surface.[1–5] These large fragments particularly appear more often in Friesian horses.[6–8]

Depending on the fragment size and chronicity of the condition, horses can be presented with a variable degree of lameness and eventually concurrent arthrosis of the distal interphalangeal joint (DIJ). Some horses, mainly young horses, show no clinical signs, and the presence of a fragment of the extensor process is found incidentally.[4,7] Lameness may not develop until the horse is in full work when the presence of the fragment induces synovitis.[5] Lameness may be sudden in onset, particularly in horses with large fragments, although radiological abnormalities often appear chronic at that time. In these cases, a strong fibrous union may maintain stability of the fragment until trauma causes minor fragment loosening.[5] When discovered in a limb exhibiting lameness, their clinical significance can be determined with intra-articular anesthesia of the DIJ, although this is not always very specific.[5,8]

The treatment advised for this condition differs with the size of the fragment and chronicity of the fragmentation.[2,4,5] In acute cases, conservative treatment is usually applied initially. For large fragments, insertion of screws in lag fashion has been described, but with a positive outcome only in some individual cases.[9–12] In horses with a chronic, recurrent lameness, despite the conservative treatment given, surgical removal of the fragment is recommended.[4] Some references also state that all extensor process fragments, independent of

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size, should be removed prophylactically, in order to prevent intra-articular disease of the DIJ.[5,13]

Arthroscopy of the DIJ, like in other joints, has fully replaced arthrotomy for removal of small OC fragments.[2–5,9,13] However, there is still no consensus about the optimal treatment for the removal of large fragments (>25% of the joint surface of the DIJ) of the extensor process.[2,4,5]

Removal of large extensor process fragments by arthrotomy resulted in only 57% (8/14) return to function rate.[1] Arthroscopic removal of these large extensor process fragments has already been described as a preliminary, promising technique, but only in 4 cases.[7] Therefore, the purpose of this article is to describe the clinical long-term outcome and radiological changes in the DIJ after arthroscopic removal of large extensor process fragments in a larger number of Friesian horses.

MATERIALS AND METHODS

The medical records of horses in which an arthroscopy of the DIJ was performed at the Equine Department of Veterinary Clinic Emmeloord were collected for the period between January 1999 and December 2014. Only Friesian horses from which a large extensor process fragment had been removed arthroscopically were included. Information obtained from medical records included signalment, affected limb, severity and duration of lameness, radiographic findings, surgical treatment and, postoperative outcome. Lameness was graded according to a 0–10 scale, with 0 = not lame to 10 = nonweight bearing.[14]

An indicator of the relative size of the extensor process fragments was calculated from the lateromedial radiographs of the foot centered on the distal interphalangeal articulation. The size of the fragment was measured as a percentage of the total joint surface of the DIJ. The latter consisted of the articular surface of the distal phalanx and navicular bone combined. Using this method an attempt was made to control for the effect of image magnification and variation in patient size. In this study, large extensor fragments were defined as fragments occupying more than 25% of the joint surface of the DIJ (Fig 1).

Surgical Approach

The affected foot was trimmed and cleaned by a farrier 1 day before surgery and put in a wet, disinfecting bandage with diluted povidone–iodine solution overnight. Premedication included benzylpenicillin (20,000 IU/kg IV) and flunixine meglumine (1.1 mg/kg IV).

Surgery was performed with horses under general anesthesia and positioned in dorsal recumbency with the affected DIJ in extension (Fig 2). This extension was maintained by fixation of the affected foot in a sling. The degree of subsequent flexion of the carpus (obtained with an adhesive bandage) defined the degree of extension of the DIJ. The DIJ was distended with 50 mL of sterile saline using a 19 gauge hypodermic needle lateral or medial to the common digital extensor tendon (CDET). A standard arthroscopic approach was used, with the arthroscope portal dorsolateral and the instrument portal dorsomedial.[14,15] Resection of proliferative syno-

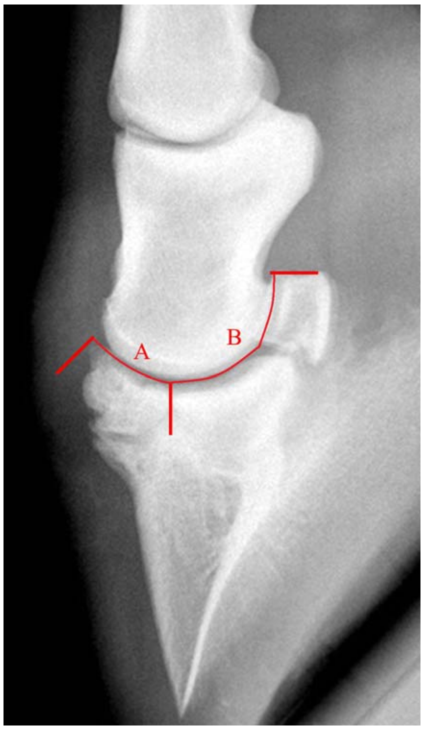

Figure 1 Lateromedial radiograph of the left forefoot centered on the distal interphalangeal articulation with a representative large extensor process fragment involving 35% of the articular surface of the distal interphalangeal joint. The relative fragment size is calculated by the formula: [A/(A+B)] × 100.

viae with a motorized synovial resector (4.5 mm Arthronet® Shaver System, Burscheid, Germany) was necessary in all 19 DIJ to obtain a clear overview of the dorsal part of the DIJ and clearly visualize the extensor process fragmentation. Once the fragment was clearly visualized, it was palpated using an arthroscopic hook probe in order to determine the edges and a possible dissection plane. In the first 5 DIJ, debridement of the proximal aspect of the fragment was performed using motorized burrs (arthroburr with a round tip of 4.0 mm, Notch Blaster, Smith & Nephew, Andover, MA or 5.5 mm, Stone Cutter, Smith & Nephew, Andover, MA) with subsequent sharp dissection to create a dissection plane between the fragment, joint capsule, and adjacent CDET. In later cases, only manual dissection was applied using sharp lever instruments, such as different sizes of spoon curettes (straight and angled) and different arthroscopic dissection knives (Cat # 64146F, Karl Störz, Germany). In 5 DIJ, a radiofrequency probe (Mitek VAPR®, DePuy-Synthes, Amersfoort, The Netherlands) was also used for dorsal dissection between the CDET and the fragment. These fragment mobilization techniques were followed by piecemeal fragment removal using different sizes of spoon curettes (straight and angled) to break up the fragment into smaller pieces and Ferris-Smith rongeurs to remove the pieces from the DIJ. In all cases, it was not necessary to enlarge the egress portal to make fragment removal possible, because the large fragment was taken out in smaller pieces. Egress portals were never made

Figure 2 Preoperative photo of a horse under general anesthesia in dorsal recumbency with the affected left fore distal interphalangeal joint maintained in extension by fixation of the affected foot to a sling. The degree of subsequent flexion of the carpus (obtained with an adhesive bandage) defined the degree of extension of the distal interphalangeal joint.

larger than 10 mm. After the removal of all parts of the fragment, the fragment bed was debrided using curettes and Ferris-Smith rongeurs. A synovial resector was used to remove any fibrillation from the edges of the fragment bed. The joint was lavaged with sterile saline and checked for remaining debris through careful arthroscopic examination. The portals were routinely closed with simple interrupted sutures using 2-0 poliglecaprone and an adhesive one layer bandage was applied. Recovery was assisted by head and tail ropes.

Perioperative Management

Postoperative lateromedial radiographs of the foot were taken the day after surgery and a new one layer adhesive bandage was applied. This bandage was maintained until suture removal 10 days after surgery. Horses were stall-rested for 14 days followed by stall rest and hand walking exercise for 1 month (hand walking 2×/day for 10 minutes). After 6 weeks, horses returned to the clinic for follow-up examination consisting of evaluation of the horse at walk and trot on a hard surface, straight line, and circle. Distention of the DIJ and the gait of the horse were evaluated. Subsequently, repeat lateromedial radiographs of the foot were taken. Further rehabilitation was adjusted to the individual clinical progress, and free turnout, in most cases, was possible 3 months after surgery.

Outcome

The arthroscopic videos and preoperative and postoperative radiographs of all cases included were reviewed for this retrospective study. The angle between the remodeled extensor process and the dorsal surface of the distal phalanx was measured and compared on the available preoperative, directly postoperative, and long-term follow-up lateromedial radiographs (>3 months) of the foot. Additionally, the immediately postoperative and long-term follow-up lateromedial radiographs were subjectively evaluated by 2 of the authors (EC and NdH) by consensus for subchondral bone remodeling at the fragment site. Radiographic evidence of osteoarthritis of the affected DIJ was scored on the preoperative and long-term postoperative lateromedial radiographs of the foot. The observed changes were subjectively divided in 4 groups: no changes, minor changes, moderate changes, and severe changes. Long-term follow-up information of the horses was obtained by telephone interview with the owner and/or referring veterinarian using a standardized protocol. The correlation between fragment size, age of the horse, increase in angle of the extensor process, and outcome was tested using a Mann-Whitney test (IBM SPSS 22.0 software, IBM, Armonk, NY). The correlation between sex and outcome was tested using a Fisher exact test (IBM SPSS 22.0 software).

RESULTS

The study included 19 DIJ in 18 Friesian horses. One horse underwent surgery on both forelimbs in 2 different surgeries 10 months apart, resulting in a total of 19 cases in 18 horses. Another horse had bilateral extensor process fragmentation, but only 1 limb was treated surgically. The age ranged from 1 to 19 years (median 3 years). Of the 18 horses, 11 had surgery before the age of 4 years. Sex distribution was 7 stallions, 6 geldings, and 5 mares. The condition was only found in forelimbs. The affected foot was the left front in 10 cases and the right front in 9 cases. Lameness grading could be obtained from the medical records in 13/19 cases; 11 were lame and 2 were sound at presentation. The 2 horses that were sound at presentation were young horses (3 and 5 years old) that were not yet in training. The 2 horses that had a bilateral problem had a unilateral lameness. The lameness grade in the lame horses ranged from 1 to 8 out of 10 (median 2/10). Lameness duration ranged from 3 weeks to 12 months and none of the horses showed an acute lameness. Perineural anesthesia of the foot was performed using an abaxial sesamoidean nerve block in 4 horses and intra-articular anesthesia of the DIJ was performed in 2 horses. In the other cases, which were mainly referred cases, details about the lameness exam were not recorded in the horse's record.

Preoperative lateromedial radiographs of the foot were available for retrospective analysis in 16/19 cases and additional dorsopalmar and oblique views of the distal phalanx were present in some cases. Preoperative radiographs of 3 horses were no longer available, although medical records indicated that they revealed large fragments of the extensor process that were typical of those detected in the other 16 joints. All 19 joints showed only 1 large fragment on radiographs. The relative size of the fragments, as a percentage of the total articular surface of the DIJ, ranged from 27–38% (median 32%). Radiographic signs of the chronic duration of the fragmentation were noticed in all horses for which preoperative radiographs were available. All fracture margins were widened and irregularly marginated, and extensive enthesophyte formation at the insertion of the CDET on the distal phalanx were present, most likely reflecting chronic changes of the traction forces of the CDET on the extensor process, in all 16 joints.[5] Radiographic evidence of preoperative osteoarthritis was present in 10/19 DIJ. Seven of these 10 DIJ were classified as having minor osteoarthrotic changes, consisting of small periarticular osteophytes on the middle and distal phalanx. Moderate changes were recorded in 3 cases, consisting of medium size periarticular osteophytes on the middle and distal phalanx. No evidence of osteoarthritis was present in 8/19 DIJ and in 1 case the radiographs were neither available nor described in the medical record. None of the DIJ that underwent surgery showed severe osteoarthrotic changes on the preoperative lateromedial radiographs of the foot.

In the first 5 cases an arthroburr with a round tip was used for fragment debridement. In all 19 cases, a 4.5 mm synovial resector helped improve visualization of the fragment and debridement of fibrillation at the margins of the fragment bed. In 5 DIJ, a radiofrequency probe was used for dorsal dissection between the fragment and the CDET. The large fragment was removed from all 19 DIJ and all 18 horses made an uneventful recovery from anesthesia. Surgery time ranged from 2 hours to 3 hours 5 minutes (median 2 hours 40 minutes).

Removal of the large fragment was confirmed by postoperative radiographs. In 4 cases, these radiographs were no longer available, but the results of fragment removal were listed in the medical record. Out of the 15 postoperative radiographs reviewed, small densities dorsal in the DIJ in the area of the CDET were visible in 11 cases. The radiographs were without any remarks in 4 cases.

Follow-up information was present in 18/19 DIJ in 17/18 horses that underwent surgery. The follow-up period ranged from 6 to 96 months (median 38 months). Successful outcome was present in 14 of 17 horses available for follow-up (82%). A total of 6/17 horses with long-term follow-up were already in training before the surgery and 5 of these 6 (83%) returned to their previous level of activity. The other 11 horses were not yet in training before the surgery; however, 9 of these 11 (82%) could be used as intended after the rehabilitation period. Activities for horses with successful outcome included dressage (low to medium level), driving, and pleasure riding. Three horses experienced an unsuccessful outcome and remained lame. One was a 19 year old horse that remained 1/10 lame at the treated limb for 9 months after surgery. This horse had a bilateral problem that, combined with the advanced age of the horse, made the owner decide not to proceed with further treatment. The horse was humanly euthanatized. The second horse that remained persistently lame was diagnosed years after surgery with extensive osteoarthritic new bone formation at the dorsal part of the condyles of the middle phalanx and 2 rounded densities in the soft tissues of the dorsal DIJ, not visible on preoperative and immediately postoperative radiographs. The third horse, although successfully treated for severe lameness because of wound complications, did not return to intended use because of persistent lameness. Follow-up radiographs 3 years after surgery showed extensive osteoarthritic new bone formation on the dorsal part of the condyles of the middle phalanx. This horse was kept by the owner as a companion animal.

Median recovery period for return to previous use was 10 months (range 6–18 months). Postoperative complications consisted of minor serous discharge from 1 arthroscopic portal in 3 cases. Two of these horses were treated with oral broad spectrum antibiotics (trimethoprim/sulfadoxine 30 mg/kg orally twice daily for 2 weeks) and recovered uneventfully. The third horse developed a nonweight bearing lameness of the treated limb 15 days after surgery with drainage from both arthroscopic portals at that time. Arthrocentesis was performed and revealed a minor elevation in white blood cell count (12,500/μL). No further cytology or bacterial culture tests were performed at that time. The horse was treated with broad spectrum antibiotics (procain penicillin, 20 mg/kg, IM once daily and gentamicin 6.6 mg/kg IV once daily for 14 days) and repeated articular lavage of the DIJ using sterile saline on the standing, sedated horse once a day for 3 days. After treatment, clinical signs resolved completely and the horse was discharged from the hospital.

Long-term radiological follow-up of >3 months was available in 13 cases. The time between pre-operative and long-term follow-up measurements was 5–45 months (median 19 months). An increase in the shallow angle between the remodeled extensor process proximally and the dorsal surface of the distal phalanx distally was noted on lateromedial radiographs of the foot centered on the distal interphalangeal articulation. This angle was measured and compared on preoperative and long-term follow-up lateromedial radiographs of the foot (Figs 3A,B). The increase in angulation was 0–20° (median 10°) in 12 horses and remained unchanged in 1 horse. A second observation on long-term follow-up radiographs was subchondral bone remodeling at the previous fragment site. Comparison of the immediate postoperative and long-term follow-up lateromedial radiographs showed subchondral new bone formation present in the former fragment bed in 10/13 cases for which long-term follow-up radiographs were present. In 10/13 cases, the osteoarthritic changes of the affected DIJ worsened over time and in 3 cases it remained unchanged.

There was no significant correlation between the size of fragments (P=.60), age of the horse (P=.824), and increase in angle of the extensor process after surgery (P=.641) and successful outcome. There was no significant correlation between sex and outcome (P=.31).

DISCUSSION

Large extensor process fragments are uncommon in horses in general[1,3] but are relatively frequently seen in Friesian horses in our clinic. It has been reported that Friesians might be predisposed to develop large extensor process fragments because of generalized flexor tendon laxity leading to a more extended fetlock position and resulting in a more horizontal position of the pastern bone.[6,16,17] The majority (11/18) of treated horses in our study were <4 years old, consistent with previous

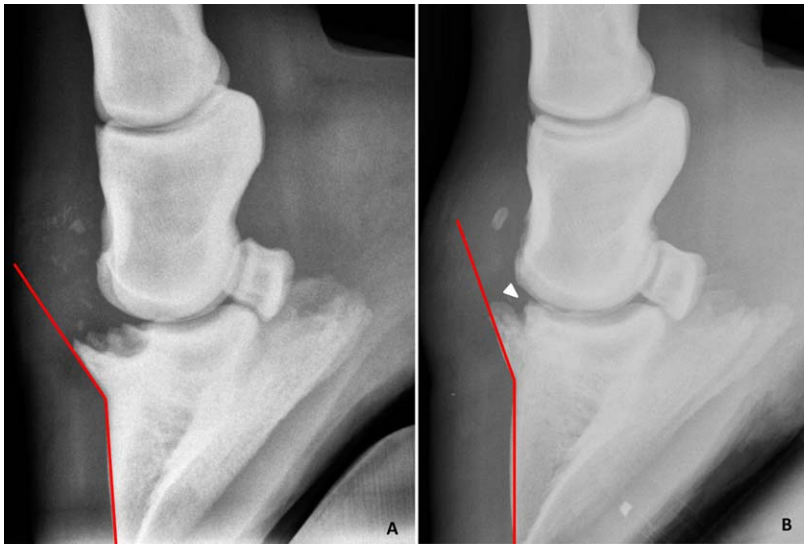

Figure 3 Lateromedial radiographs of the right forefoot centered on the distal interphalangeal articulation (A) directly postoperatively and (B) at long-term follow-up after 47 months. The angle between the remodeled extensor process and the dorsal surface of the distal phalanx was measured as indicated. The change in angle in this case was 10°. Subchondral new bone formation (arrowhead) is present at the previous fragment site on the long-term follow-up radiograph.

studies.[1,7] Male horses were over-represented compared to females, which is also consistent with other studies in which a sex predisposition has been suggested.[1,3,7] Previous reports of large extensor process fragments occurring primarily in forelimbs is consistent with our findings.[1–3,7,13]

The size of the extensor process fragmentation was reported relative to the total articular surface of the DIJ, including the articular surface of the navicular bone. Dechant used a different method to measure these fragments, describing the size relative to only the articular surface of the distal phalanx.[1] When comparing results between studies, this means that the actual size of the fragments in our cases was considerably larger than in the Dechant study.[1] As dorsopalmar preoperative radiographs were only available in a few cases, no information about the fragment size in the lateral to medial dimension could be obtained. No correlation between relative fragment size and outcome was found, as in previous reports.[1,3] This result may be influenced by the relatively small variation in fragment size in our study and previous studies.[1,3] On the other hand, it could also reflect a poor correlation between fragment size and severity of DIJ disease, as suggested in a previous report.[3]

In all our cases, large fragments could be removed by arthroscopy using 2 portals of standard size and position. A motorized synovial resector was used to improve visualization of the extensor process fragment. In the first 5 cases, a motorized burr was used to remove the fragment piecemeal; however, this technique failed to create a clean dissection plane between the fragment and the CDET. The result was small remnants of the fragment in the tendon, which were visible radiographically. Therefore, the initial motorized burr technique was abandoned. The clinical significance of these remnants can be debated as they are embedded in soft tissues and the clinical outcome of these horses was comparable to the general outcome in our study.

In the later cases, only manual dissection using sharp lever instruments was used to create a clean dissection plane between the fragment and the CDET. This appeared to reduce the residual densities found on postoperative radiographs. In the 5 cases between 2004 and 2009, a radiofrequency probe was used for dorsal dissection between the CDET and the fragment. The surgeon decided not to proceed with this method after personal communication about possible iatrogenic damage to synovial structures as a result of this technique, which was later described in literature.[18] Evaluating the clinical outcome of this group, results did not differ from the outcome of the entire study population.

Our successful outcome of 82% is good compared to removal by arthrotomy, in which a successful outcome of 57% (8/14 cases) was reported.[1] Our results may be influenced by the fact that most Friesian horses are used for pleasure riding or low-level competition (dressage and driving) where unsuccessful outcome was noted in 3/17 horses (18%) with long-term follow-up. All 3 of these horses had different additional problems complicating their recovery, including advanced age and bilateral problem, extensive osteoarthritis development during rehabilitation, and wound complications. No correlation between age, sex, and fragment size could be proven, so no preoperative factors are for the moment available to predict outcome. Our median recovery period of 10 months for return to previous use was longer than previously described.[1] This is influenced by the fact that many of our horses were immature ($\leq$3 years). Friesian horses are generally not started in training before the age of 3 years and reach their performing age at 4 years. Some horses were also bred during the recovery period. Early mobilization was, nevertheless, possible in our cases where hand-walking exercise could be initiated at 2 weeks postoperatively and the majority of horses could be turned out freely at 3 months after surgery.

Of the 3 horses with wound healing complications, 2 recovered uneventfully without extensive treatment and the third stayed persistently lame. The 1 case that developed a nonweight bearing lameness of the operated limb 15 days after surgery with drainage from the portals was treated more intensively to prevent further infection of the DIJ. After this treatment, the horse principally recovered and was discharged from the hospital; however, it stayed persistently lame in the treated limb in the long term. Although arthroscopy is known for its low incidence of wound complications,[3,9,13] Friesian horses have lower limbs with a relatively thick, hypertrophic skin that could be predisposed to impaired wound healing and increased risk of postoperative infection of the DIJ.[6]

Lateromedial long-term follow-up radiographs of the foot showed remodeling of the extensive enthesophyte formation at the insertion of the CDET on the remaining extensor process. The angle between the remodeled extensor process and the dorsal surface of the distal phalanx increased on average 10°. This could be because of the change in tension of the CDET applied on this bony proliferation with the removal of the large extensor process fragment. There was no correlation between the change in angle and outcome. Remodeling of the subchondral bone at the previous fragment site was present in 10/13 cases for which long-term follow-up radiographs were present. This remodeling is probably a reaction to restore normal anatomy and increase the weight bearing articular surface.

The osteoarthritic changes of the affected DIJ were categorized, based on pre-operative radiographs as none, minor or moderate. None of the DIJ was ranged as severe. This is probably because we did not perform surgery on these horses because of the expected poor prognosis. Of the 13 cases for which long-term radiographic follow up was available, 10 showed an increase in osteoarthritis between the immediate postoperative and long-term follow-up radiographs. The other 3 cases remained unchanged.

Our study supports arthroscopic removal as a good treatment option for Friesian horses with large extensor process fragmentation. The 82% long-term success rate is good compared with other techniques, such as removal by arthrotomy. Remodeling of the remaining extensor process and subchondral bone at the site of the removed fragment can occur in horses achieving functional recovery.

DISCLOSURE

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

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