

# Medial patellofemoral ligament reconstruction with simultaneous osteochondral fracture fixation is an effective treatment for adolescent patellar dislocation with osteochondral fractures

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## Abstract

**Background:** Osteochondral fractures can occur during patellar dislocation and often require treatment. The purpose of this study is to determine the incidence of recurrent instability and second surgery following osteochondral fracture fixation with concomitant medial patellofemoral ligament reconstruction.

**Methods:** A retrospective review of a cohort of 365 medial patellofemoral ligament reconstructions by a single surgeon from 2008 to 2019 was performed to identify patients who underwent simultaneous osteochondral fracture fixation with bioabsorbable nails. Demographic data, surgical details, clinical follow-up, and subsequent procedures were collected.

**Results:** Forty medial patellofemoral ligament reconstructions with osteochondral fracture fixation were performed by a single surgeon from 2008 to 2019. The average age at surgery was 14.6 years (range 10.7–19.6 years). The average length of follow-up was 2.6 years (range 0.7–7.0 years). Eleven (28%) patients required a second surgery on the ipsilateral knee. One patient had recurrent instability and required revision medial patellofemoral ligament reconstruction and osteochondral allograft. The other 10 patients underwent a second surgery to address cartilage damage or debridement of nails. Of the four patients who required nail debridement, the average number of nails initially placed was  $7 \pm 1.7$ . This was significantly more than the patients who did not require second surgery related to nail debridement ( $4.1 \pm 1.6$ ,  $p < .05$ ).

**Conclusion:** 28% of patients required a second procedure, most of which involved debridement of unhealed portions of the osteochondral fracture. At 2.6-year follow-up, only 2% of patients had a failure of their osteochondral fracture fixation requiring a cartilage restoration procedure. Osteochondral fracture fixation in adolescents with patellofemoral instability can be effectively treated with fixation and simultaneous medial patellofemoral ligament reconstruction.

**Level of evidence:** level IV,

**Keywords:** Osteochondral fracture, knee, pediatrics, sports

## Introduction

Osteochondral fractures (OCFs) of the patellofemoral joint can occur after acute or recurrent patellar dislocations. The reported rates of OCF associated with a patella dislocation range widely from 5% to 76%.<sup>1</sup> When an OCF is present, early surgical intervention is recommended to optimize healing and reduce the risk of loss of articular cartilage and subsequent osteoarthritis.<sup>2,3</sup> Treatment of OCF commonly involves either removal of the fracture

piece and debridement, or open reduction and internal fixation. Both treatment options can be combined with

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stabilizing procedures in the setting of patellar instability. In the case of acute fractures that are larger than 1 cm in size, surgical repair with fixation is suggested to optimize clinical outcomes.<sup>4</sup> Long-term comparative studies have shown that fixation produces superior results compared with debridement in patient-reported outcome scores and rates of second surgery and subsequent instability.<sup>5</sup> However, the reported rates of second surgery and recurrent instability vary depending on the method of fixation used and whether a concomitant patellar stabilization surgery was performed.<sup>6</sup>

There is currently no consensus on the best method for OCF fixation. Various reported options for OCF fixation include fibrin glue, sutures, bioabsorbable screws, metal screws, and bioabsorbable nails.<sup>7–11</sup> While patients with recurrent patellar dislocations are commonly indicated for a patellar stabilizing surgery such as a medial patellofemoral ligament (MPFL) reconstruction, patients that experience a first-time dislocation tend to be treated non-operatively.<sup>12</sup> In the setting of an OCF, surgeons are presented with the option to simultaneously treat the patellofemoral instability and the OCF. There appears to be developing consensus that OCF secondary to patellofemoral instability should be treated with a simultaneous MPFL reconstruction to decrease recurrent patellofemoral instability and to help preserve articular cartilage.<sup>5,13</sup>

To date, there is a paucity of literature reporting outcomes of OCF fixation with bioabsorbable nails and concomitant MPFL reconstruction in a consecutive series of patients. The purpose of this study was to determine the incidence of second surgery and recurrent instability following OCF fixation with bioabsorbable nails and concomitant MPFL reconstruction.

## Method

### Study cohort

After institutional review board approval, a retrospective review of a cohort of 365 MPFL reconstructions by a single surgeon from 2008 to 2019 was performed to identify patients who underwent simultaneous OCF fixation. Patients below 20 years old who underwent MPFL reconstruction and concomitant OCF fixation with bioabsorbable nails were eligible. Demographic data, surgical details, date of latest radiographic and clinical follow-up, and dates and details of subsequent surgical procedures were collected.

### Surgical technique

Procedures began with standard diagnostic arthroscopy to assess the knee joint for ligament or meniscal damage and chondromalacia, and to locate the OCF. Treatment of the OCF in all cases consisted of reduction and fixation with bioabsorbable polylactic acid (PLA) fixation nails

( $1.5 \times 16 \text{ mm}^2$  or  $1.5 \times 20 \text{ mm}^2$  SmartNail; ConMed Linvatec). OCF fragments were first identified and removed from the knee. After measuring, the fragment was debrided of any fibrous tissue and trimmed of any frayed edges. The parent bone was also debrided of any fibrous or frayed tissue and in cases where the location of the fracture showed a large area of exposed chondral bone, a 0.45 K-wire was used to drill the bed and promote healing. The OCF fragment was then placed into the parent bed and secured with the necessary number of bioabsorbable fixation nails to achieve stable and congruent reduction (Figures 1 and 2).

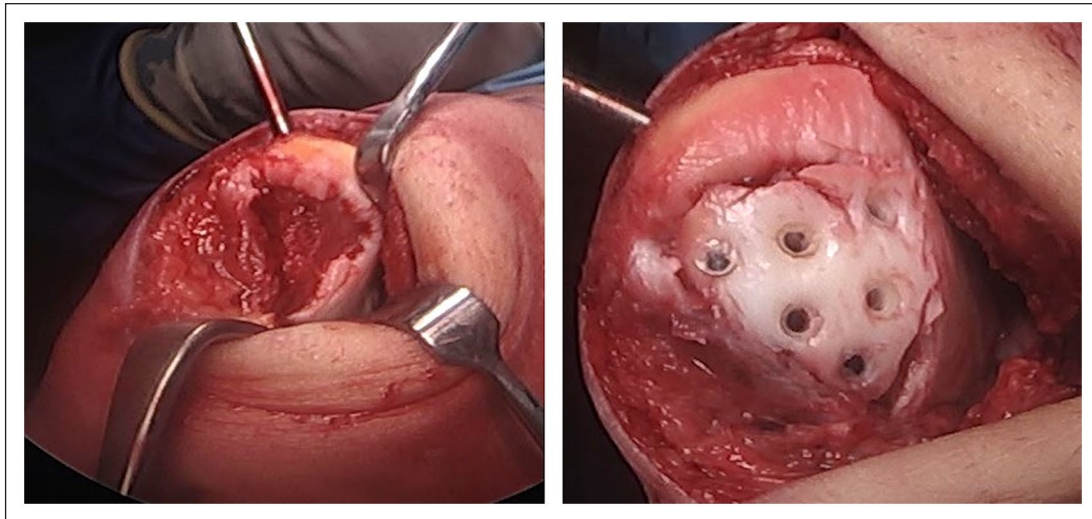
MPFL reconstructions were indicated in patients with concomitant patellar instability. MPFL reconstructions were performed using hamstring autografts and, in four cases, a hamstring allograft. Two 4.5 mm short sockets were made in the superior half of the patella and the free ends of the grafts were secured with PEEK anchors. The femoral socket was placed based on the radiographic parameter of Schlotter's point and the double end of the graft was secured in the socket using a screw. In the skeletally immature patients, the location of the femoral socket was placed just distal to the distal femoral physis as previously described.<sup>14</sup> The aperture location of the femoral socket was confirmed with fluoroscopy in all cases. The length of the graft was adjusted, and isometrics were checked prior to final fixation of the graft with the knee in 30° of flexion.

### Statistical analysis

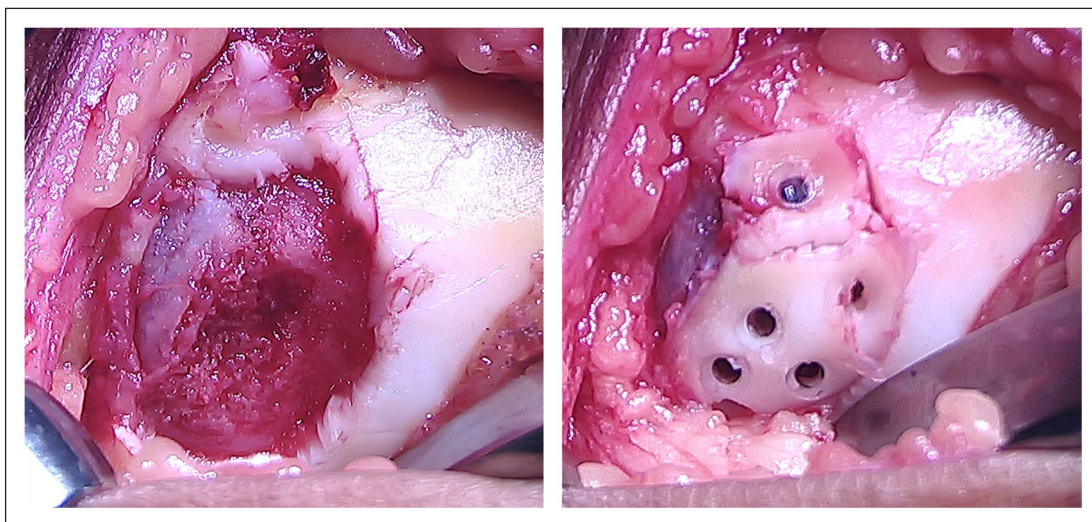
Statistical analysis was performed using Statistical Package for the Social Sciences (SPSS) version 22.0 (IBM Corp., Armonk, NY). Continuous variables were reported as means and standard deviations, and discrete variables were reported as frequencies and percentages. An unpaired Student's *t*-test was used to compare the number of bioabsorbable fixation nails implanted in patients that required subsequent nail debridement compared with the patients that retained the fixation nails. A *p*-value of  $\leq 0.05$  was used as the threshold of statistical significance, and all tests were two-tailed.

## Results

Of the 365 MPFL reconstructions performed by a single surgeon from 2008 to 2019, 40 knees underwent simultaneous OCF fixation for a rate of 11%. The average age at surgery was 14.6 years (range 10.7–19.6 years). The average length of clinical follow-up was 2.6 years (range 0.7–7.0 years). The average number of bioabsorbable fixation nails used was 4.4 (range: 2–8). All knees had OCFs that were greater than 1 cm in size, thus warranting fixation. A total of 30 fractures were fixed to the patella and 10 were fixed to either the lateral femoral condyle or trochlea (Table 1).



**Figure 1.** Intraoperative images of a 2 × 2.5 cm<sup>2</sup> medial facet defect (left). The osteochondral fracture was fixated with six bioabsorbable nails (right) prior to MPFL reconstruction.



**Figure 2.** Intraoperative images of a 2 × 2 cm<sup>2</sup> inferomedial patella defect (left). The two pieces of the osteochondral fracture were fixated with six bioabsorbable nails (right) prior to MPFL reconstruction.

Thirty-three knees had an available postoperative magnetic resonance imaging (MRI). Of those 33 knees, 31 (94%) showed good incorporation of the fracture fragment into the parent bone (Figures 3 and 4). Out of the 40 total knees, 11 (28%) knees required a second surgery related to the index procedure. One patient had recurrent instability and required revision MPFL reconstruction, tibial tubercle osteotomy (TTO), and osteochondral allograft. One patient suffered a lateral meniscal tear during fencing that was repaired at the time of chondroplasty. The other nine knees that required a second surgery underwent procedures to address residual cartilage damage or debridement of nails (Table 2). The procedure selected for these patients was based on their effusion at their latest follow-up appointment. If the patient appeared 6–18 months after the index procedure with a mild effusion that did not resolve with

**Table 1.** Demographic data and descriptive statistics.

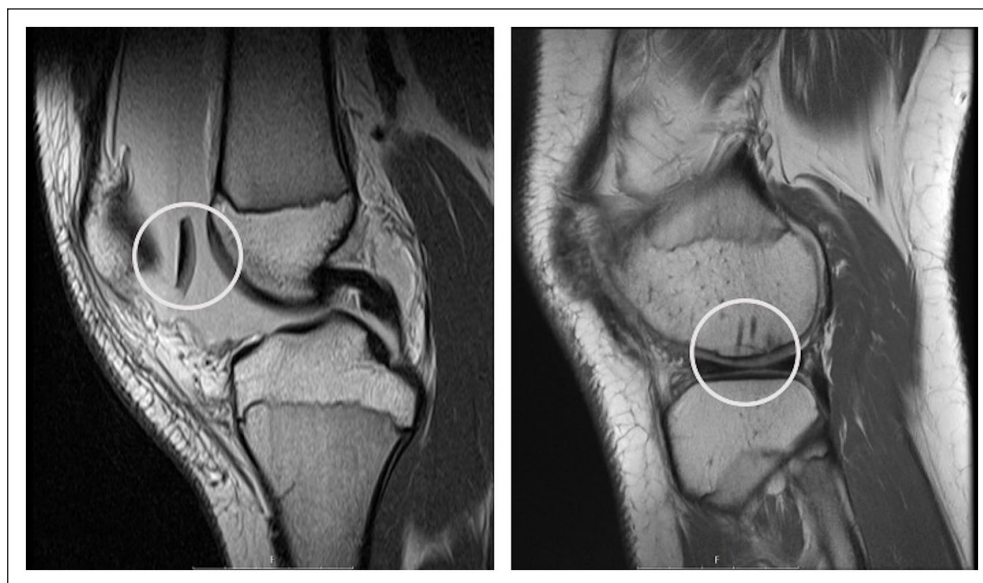
	N = 40
Age (years)	14.6 ± 2.1
Sex	
Male	20 (50%)
Female	20 (50%)
BMI (kg/m <sup>2</sup> )	22.7 ± 6.4
Laterality	
Right	17 (43%)
Left	23 (57%)
Location of OCF	
Patella	30 (75%)
Lateral femoral condyle	7 (18%)
Lateral trochlea	3 (7%)
Number of fixation nails used	4.4 ± 1.9

BMI: body mass index; OCF: osteochondral fracture.





**Figure 3.** (a) Preoperative sagittal and (b) axial MRI images of an osteochondral fracture of the patella after patellar dislocation. 1-year postoperative (c) sagittal and (d) axial MRI images showing MPFL reconstruction and healed patellar OCF fixed with bioabsorbable nails.



**Figure 4.** Preoperative sagittal MRI image of a loose OCF fragment originating from the lateral femoral condyle (left). Six-month postoperative sagittal MRI image showing healed lateral femoral condyle OCF (right).

**Table 2.** Details of second surgeries performed on the ipsilateral knee.

	N = 11
Length of time between index and second surgery	8.4 months
Length of follow-up since second surgery	2.7 years
Location of initial OCF	
Patella	8 (73%)
Lateral femoral condyle	2 (18%)
Lateral trochlea	1 (9%)
Second surgeries performed	
Chondroplasty	11
(+) Debridement of biodegradable nails	4
(+) Lateral meniscus repair	1
(+) Revision MPFLR with TTO and osteochondral allograft	1

OCF: osteochondral fracture; MPFLR: medial patellofemoral ligament reconstruction; TTO: tibial tubercle osteotomy.

1 month of rest and non-steroidal anti-inflammatory drugs, then arthroscopic chondroplasty with or without debridement of biodegradable nails was recommended. There were two reports (5%) of recurrent instability at the latest follow-up. One case was managed non-operatively. The single case of both poor OCF healing and subsequent instability occurred in the same patient. This patient has juvenile idiopathic arthritis and underwent a total of three ipsilateral knee surgeries after the initial MPFL procedure, including a revision MPFL reconstruction, TTO, and an osteochondral allograft.

The mean time to second surgery was 8.4 months (range 2.5–15.6 months). Of the four knees that required debridement of nails, the average number of nails initially placed was  $7 \pm 1.7$ . This was significantly more than the number placed in the knees that did not require second surgery related to debridement of the biodegradable nails ( $4.1 \pm 1.6$ ,  $p < .05$ ).

## Discussion

This study is the first report of a consecutive series of patients, all of whom had OCF fixated with bioabsorbable nails and underwent a concomitant MPFL reconstruction. The most important finding of this study is that in patients with an OCF from a patellar dislocation episode, MPFL reconstruction and simultaneous OCF fixation with bioabsorbable nails can be performed safely with good healing of the OCF and low incidence of recurrent instability. All but one knee showed successful bony and cartilaginous incorporation of the fracture fragment on available MRIs and there were only two reports (5%) of subsequent instability.

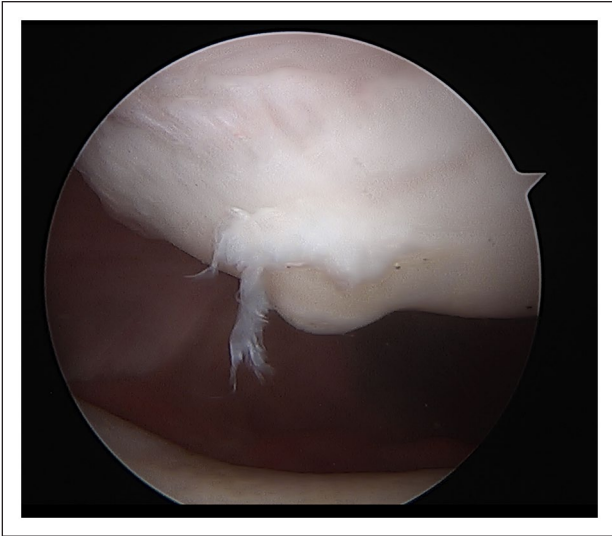
The previous literature shows high rates of OCF healing, regardless of the method of fixation used. In a study of 18 patients who experienced an OCF after a traumatic patellar dislocation, fractures fixed with bioabsorbable

pins showed 94% successful bone consolidation at 34 months.<sup>15</sup> A similar study using unspecified bioabsorbable implants found a fracture healing rate of 91% at 6.5 years of follow-up.<sup>16</sup> Li et al.<sup>17</sup> used absorbable sutures for OCF fixation and reported a 100% union rate at 36-month follow-up. In our series, we found a rate of radiographic fracture healing of 94%. While not all patients had a postoperative MRI available to assess bone consolidation, our results are similar to the existing literature and show that bioabsorbable nails are a viable implant option for OCF fixation.

Our rate of second surgery related to patellofemoral joint pathology was 28% at an average of 2.6 years follow-up. This is similar to the rate of 25% at 30 months follow-up reported by Lee et al.,<sup>6</sup> in a retrospective review of patients who underwent simultaneous MPFL reconstruction and OCF fixation with either bioabsorbable pins or headless metal screws. However, the incidence of second surgery can vary based on the length of follow-up. A study with only 8 months follow-up reported the rate of second surgery at 6%, while a different study with an average of 4.1 years follow-up found a rate of 46%.<sup>13,18</sup> Further long-term follow-up studies should be conducted to determine a more accurate rate of secondary intervention necessary in these cases.

In contrast to the similar rate of healing and second surgery, our rate of recurrent instability is drastically less than some of the currently reported numbers. Studies that investigate subsequent instability after OCF fixation without performing a concomitant MPFL reconstruction report higher rates of subsequent instability. Gesslein et al.<sup>5</sup> found a redislocation rate of 43% in a series of 53 patients who underwent isolated OCF treatment. A recent study by Pedowitz et al.<sup>13</sup> reported an overall subsequent instability rate of 61% after OCF treatment without an MPFL reconstruction, with no significant difference in instability rates whether or not an MPFL repair was performed. These findings could be due to the fact that studies have found that non-operative treatment and MPFL repairs have high failure rates and are less effective than MPFL reconstructions in preventing recurrent instability.<sup>19–21</sup> In a follow-up study, Gurusamy et al.<sup>22</sup> showed that patients with a loose body after dislocation had significantly less instability when treated with MPFL reconstruction versus repair or no MPFL treatment (10.0% vs. 58.7%); however, only 24% of the patients in this study underwent fixation of their loose body. Other studies in which an MPFL reconstruction was performed alongside an alternate method of OCF fixation show rates of redislocation ranging widely from 0 to 50%.<sup>6,17,18</sup> While further investigation is required, our finding of a 5% instability rate after MPFL reconstruction and OCF fixation suggests that this treatment approach with bioabsorbable nails may be a superior option for preventing recurrent instability.

Finally, the significantly larger number of bioabsorbable nails used in patients who underwent subsequent nail



**Figure 5.** Intraoperative arthroscopic image of OCF taken during a second surgery. The image shows a protruding biodegradable nail and frayed cartilage that subsequently underwent debridement.

debridement could be useful in surgical decision-making and patient education. In this study, the four patients requiring second surgery in relation to debridement of nails had an average of 7.1 nails, which was significantly more than the patients who did not require nail debridement. This raises the possibility that an increased number of nails could be associated with the need for a second surgery; thus surgeons should attempt to use only the number of nails necessary to obtain proper reduction and fixation of the OCF. The bioabsorbable nails used in this study are a first-generation implant composed of PLA that has previously been shown to cause reactive synovitis and inflammation with reabsorption. Debridement of the exposed portion (Figure 5) of the biodegradable nail is indicated when a patient has pain and an effusion that persists after a trial of rest and non-steroidal anti-inflammatory drugs. Patients with larger fractures that will require more fixation nails might be informed preoperatively about the potentially increased risk of a second surgery for debridement of nails. This increased risk is likely due to the amplified mechanical irritation and the inflammatory reaction that is augmented by the presence of a greater number of bioabsorbable PLA nails. The senior author (DWG) implemented the use of bioabsorbable fixation nails into practice in place of bioabsorbable screws for OCF fixation, which are larger in diameter and have a known risk of intraarticular damage with breakage as they dissolve.<sup>23–26</sup> More recent literature by Mittal et al.<sup>27</sup> has shown positive outcomes after using headless biocompression screws to fix larger OCFs (20 mm × 18 mm). However, we believe that the smaller 1.5-mm diameter PLA nails

used in this study provide a low risk to intraarticular damage due to their smaller size. Other options for OCF fixation include small low-profile metal screws; however, these typically require a second staged surgery for removal.

This study contains limitations. This is a single surgeon study and the results may not be generalizable to all surgeons. The data are based on a consecutive series of available patients, resulting in a small sample size with a large range in follow-up times. Our low rate of recurrent instability that differs from the current literature may be confounded by patients with limited follow-up. Previous research found that the dislocation rates after operative treatment for primary patellar dislocation increase with time from treatment.<sup>28</sup> However, all 11 patients who underwent a second surgery did so less than 2 years after the initial operation. Furthermore, when including only the 25 patients who had a minimum of 2 years follow-up, the rate of recurrent instability is 2/25 (8%), which is still substantially lower than that in the previous literature. Another limitation was that not all patients had a postoperative MRI available for review. Obtaining a postoperative MRI in patients at either the 6-month or 1-year mark is standard for our institution in order to assess healing. However, some completely asymptomatic patients chose to not undergo a repeat MRI or were not scheduled due to restrictions during the peak of the COVID19 pandemic. Due to the study's retrospective nature, investigators did not assess patient-reported outcomes, nor were they able to ensure a uniform postoperative course for all patients. The baseline activity level and return to sport of the patients was not reported due to the small sample size and variability between patients. In addition, this study did not perform a radiographic assessment of anatomic risk for patellar dislocation. The results of this study should be corroborated in the future by larger multi-surgeon prospective studies. Nevertheless, this study shows promising clinical outcomes after MPFL reconstruction and OCF fixation with bioabsorbable fixation nails. Surgeons should consider this treatment option for patients with patellar instability and OCF.

## Conclusion

MPFL reconstruction and simultaneous OCF fixation with bioabsorbable fixation nails is a viable method of treating OCF produced by patellar instability. Thirty-eight of the 40 (95%) knees that underwent MPFL reconstruction and OCF fixation with bioabsorbable nails showed patellar stability without the need for cartilage restoration procedure at an average of 2.6 years follow-up. A total of 11 out of 40 (28%) knees went on to require a second surgery to address patellofemoral pathology. The most common second surgery involved debridement of an unhealed portion of the cartilage.



## Authors' Note

Investigation performed at Hospital for Special Surgery, New York, NY, USA.

## Author contributions

Our study is a product of the collaboration of four authors, each of whom contributed equally to the production of the study and article. D.W.G. created the study design and significantly edited the article for publication. A.H.A., S.H.P., and L.M.S. completed the data gathering at the direction of the authors, analyzed the data, and drafted the article. We strongly feel that each author was essential to the quality of the work produced.

## Declaration of conflicting interests

The author(s) declared the following potential conflicts of interest with respect to the research, authorship, and/or publication of this article: A.H.A., S.H.P., and L.M.S. have nothing to disclose. D.W.G. is a consultant for Arthrex Inc. and receives royalties from Arthrex Inc. and Pega Medical.

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