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Summary

Background: There are numerous techniques for MPFL reconstruction, however, one single technique has not been proven to be superior to another. Suture anchor reconstruction has been shown to provide stable fixation while decreasing the risk of patellar fracture.

Purpose: The aim of the study was to compare the stiffness and clinical load to failure of two common MPFL reconstruction techniques. Our hypothesis was that there would be no significant difference in the stiffness and the clinical load to failure between the suture anchor and interference screw reconstructions.

Methods: Eight pairs of fresh frozen cadaveric knees were randomized into two groups undergoing MPFL reconstruction using either a suture anchor technique ($n = 8$) or an interference screw technique ($n = 8$). Testing was performed at 0, 30, 60, and 90 degrees of flexion for the native knee, transected medial structures, and reconstructed MPFL. Next, the reconstructed MPFL specimens were tested until failure in 0 degrees of flexion. *t*-Test, One-Way ANOVA, and repeated measures of ANOVA were used for statistical analysis, p values less than 0.05 were considered significant.

Results: The average stiffness for the suture anchor and interference screw reconstructions was 12.02 ± 3.96 N/mm and 14.21 ± 4.20 N/mm, respectively (*t*-test, $p = 0.27$), while average clinical load to failure was 256.57 ± 54.1 N and 237.81 ± 23.82 N, respectively (*t*-test, $p = 0.38$). There was no significant difference in stiffness between the suture anchor and interference screw techniques at 0, 30, and 60 degrees of flexion.

Conclusions: The suture anchor and interference screw reconstruction techniques produce comparable stiffness for sub-failure testing at 0 and 30 degrees of flexion. For testing to failure, the initial stiffness for both reconstruction techniques have been shown to be concordant with previously

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Comparison of suture anchor vs. interference screw technique for patellar fixation for medial patellofemoral ligament reconstruction

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Introduction

The medial patellofemoral ligament (MPFL) has been shown to be the primary soft tissue stabilizer to lateral displacement of the patella with knee in slight flexion [1,4,9,10,30]. Patellar dislocation frequently leads to rupture of the MPFL and subsequent patellar instability [6,8,10,32]. Primary patellar dislocation has an annual incidence of 5.8 per 100,000 people in the US, and this number is five-fold higher for adolescents [1,2,12,17]. In recent years, the utilization of medial patellofemoral ligament reconstruction for patellar instability has steadily increased with advancements in implant design and surgical technique. Numerous techniques and devices are used to reconstruct the MPFL; however, no single technique is proven to be superior to another [3–5]. The strength of the reconstructed MPFL has been tested in several biomechanical studies using various fixation methods and devices, both with and without comparison to native MPFL [4,9,10,13–15,20,24,27,30].

The purpose of this study was to compare the stiffness of two common MPFL reconstructions techniques: interference screw reconstruction and suture anchor reconstruction. In addition, clinical failure loads for the two reconstructions types were investigated. Our hypothesis was that there is no significant difference in stiffness and clinical failure load between the suture anchor and interference screw reconstructions

Methods

Testing protocol

Sixteen (eight pairs) of fresh frozen post-mortem human knees (6 male and 2 female) were used in this study. Mean specimen age was 62 years (range, 50–70 years). Physical inspections and review of medical summaries were completed prior to acceptance and specimens with a history of knee surgery, trauma, and osteoporosis were excluded. Knees were harvested from mid-femur to mid-tibia. All skin and subcutaneous tissues were removed from each of the specimens leaving the retinacular and ligamentous structures, capsule, patellar tendon and distal quadriceps mechanism intact [4]. The quadriceps tendons were whip-stitched with

published values for the native MPFL. Both reconstruction techniques provide greater ultimate failure loads than those reported for the native MPFL in previous studies. Suture anchor reconstruction described in our study provides another reliable option for the reconstruction of the medial patellofemoral ligament.
Clinical relevance: Our study provides biomechanical data that the suture anchor technique described in this study provides comparable fixation compared to interference screw fixation and has the potential of reducing fracture to patella particularly in the pediatric population with small patellae.

Keywords
Medial patellofemoral ligament reconstruction– Suture anchor fixation– Interference screw fixation

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Vergleich von Fadenankern vs. Interferenzschraubentechnik für die patellare Fixation bei der medialen patellofemoralen Bandrekonstruktion

Zusammenfassung

Hintergrund: Es gibt viele Techniken für die MPFL-Rekonstruktion, allerdings hat sich keine einzelne Technik als überlegen gezeigt. Die Fadenankerrekonstruktion hat eine stabile Fixation bei verringertem Risiko einer Patellafraktur gezeigt.
Ziel: Das Ziel der Studie war es, die Steifheit und klinische Versagenslast von zwei gebräuchlichen MPFL-Rekonstruktionstechniken zu vergleichen. Unsere Hypothese war, dass es keine signifikanten Unterschiede in der Steifheit und klinischen Versagenslast zwischen Fadenanker-und Interferenzschrauben-Rekonstruktionen gibt.
Methoden: 8 Paare von frisch tiefgefrorenen Kadaverknien wurden in zwei Gruppen randomisiert, wobei entweder die Fadenankertechnik (n = 8) oder

No. 2 FiberWire (Arthrex Inc., Naples, Florida, USA) to provide an attachment from which a load was suspended over a pulley to simulate active contraction. A load of 166.09 N was used after calculating the resultant force acting on the patella through the single quadriceps tendon based on the study by Duchman et al. [9]. Semitendinosus tendon autograft was then harvested from each knee using a tendon stripper. Muscle tissue was removed from the proximal part of the harvested tendon. The tendon ends were then trimmed and tapered. No. 2 FiberWire (Arthrex Inc., Naples, Florida, USA) was used to whip-stitch approximately 20 mm of each tendon end. Each semitendinosus tendon graft was approximately 220 mm in length and was trimmed to fit a 7-mm sizing guide when doubled over. The proximal end of the femur was potted in a polymer resin (Bondo™, 3M Corporation, St. Paul, MN) to provide rigid fixation to the custom-built fixture which consisted of a restraining segment and mobile segment. The restraining segment was fixed to the table of the 8500 Instron (Instron Ltd., Buckinghamshire, England), securely fixing the knee in position. The femoral end was potted and rigidly fixed while the tibial end was free to assume natural rotation experienced during knee flexion. The restraining segment included a pulley system that facilitated the loading of the quadriceps through the suture. The mobile segment of the fixture was designed to allow for patellar mobility with a total of five-degrees-of-freedom. The segment fixed directly to the Instron provided freedom of motion in the sagittal plane: anterior–posterior and proximal–distal translations, plus flexion–extension rotation. The mobile segment was attached to the patella through a vertical rod with a 90-degree ball joint that was screwed directly into the geometric center of the patella which allowed natural tilt and rotation of the patella as the medial–lateral displacement was controlled (Fig. 1) [30]. Testing was performed on each of the knees at 0, 30, 60, and 90 degrees of flexion for the native anatomy with the

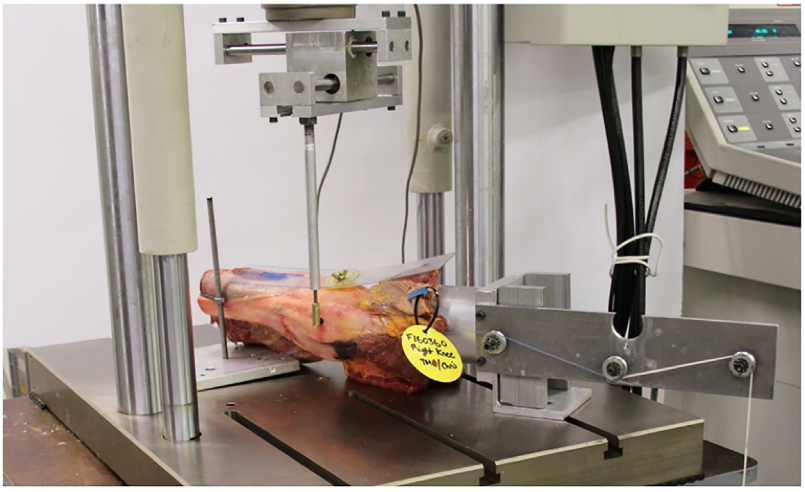

Figure 1
Demonstrating the testing setup with rigidly fixed femoral end, rotationally free tibial end, and 90-degree ball-joint patellar attachment with 166.09 N load applied to the quadriceps tendon.

Interferenzschraubentechnik (n = 8) zur MPFL-Rekonstruktion verwendet wurde. Getestet wurden die nativen Knie mit durchtrenntem MPFL und rekonstruiertem MPFL bei 0, 30, 60 und 90° Knieflexion. Anschließend wurden die MPFL-Präparate in 0° Knieflexion bis zum Versagen getestet. Der t-Test, One-Way Anova und repeated measures ANOVA wurden für die statistische Analyse verwendet, wobei ein p-Wert kleiner als 0,05 als statistisch signifikant gewertet wurde.

Ergebnisse: Die mittlere Steifheit für die Fadenanker und Interferenzschraubenrekonstruktion war 12.02 ± 3.96 N/mm beziehungsweise 14.21 ± 4.20 N/mm (t-Test, p = 0,27), während die mittlere klinische Versagenslast 256.57 ± 54.1 N beziehungsweise 237.81 ± 23.82 N betrug (t-Test, p = 0,38). Es zeigte sich kein signifikanter Unterschied in der Steifheit zwischen Fadenanker und Interferenzschraubentechnik in 0, 30 und 60° Flexion.

Schlussfolgerungen: Die Fadenanker und Interferenzschraubentechniken führen zu vergleichbarer Steifheit während submaximaler Testung bei 0 und 30° Knieflexion. Bei maximaler Versagenslast zeigte sich die initiale Steifheit für beide Rekonstruktionen vergleichbar mit früheren publizierten Werten. Beide Rekonstruktionen erreichen höhere maximale Versagenslasten als für das native MPFL berichtet. Die in unserer Studie beschriebene Fadenankerrekonstruktion stellt eine weitere verlässliche Option zur Rekonstruktion des medialen patellofemoralen Ligamentes dar.

Klinische Relevanz: Unsere Studie zeigt biomechanische Daten, wonach die Fadenankertechnik eine vergleichbare Fixation wie die Interferenzschraubentechnik ermöglicht und gleichzeitig das Potential der Reduktion von Patellafrakturen, besonders bei Kindern mit kleinen Patellae, ermöglicht.

Schlüsselwörter
Rekonstruktion des medialen patellofemoralen Ligamentes – Fadenankerfixation – Interferenzschraubenfixation

intact MPFL. The medial capsuloretinacular tissue and the MPFL were transected and testing was repeated. Next, testing was performed for both MPFL reconstruction techniques. Based on previous biomechanical MPFL studies, the patella was distracted laterally 10 mm at a rate of 0.08 Hz using the vertical actuator of the 8500 Instron (Instron Ltd., Buckinghamshire, England) [4,9]. The testing consisted of three preconditioning trials followed by a fourth testing that was ultimately used in the data analysis. Measurements of the following were measured and analyzed: (a) the stiffness of the native MPFL, transacted MPFL and the 2 reconstruction techniques at various degrees of flexion, (b) The lateral restraining force at 10 mm displacement of the patella and (c) the load to clinical failure defined as below.

The average stiffness of the two repair techniques was compared using a Student's *t*-test. Finally, the reconstructed MPFL specimens were tested until clinical failure in 0 degrees of flexion. The load at 26 mm was considered the maximum load to clinical failure. Previous studies have indicated that MPFL rupture occurs around 26 mm of displacement [1,8]. This threshold was used to define the limit for clinical failure for the two reconstruction techniques. Although the construct may be biologically intact at this amount of displacement, it corresponds to approximately 2 quadrant laxity for a normal patella and the displacement at which the native ligament fails. In other words, it is likely that the patient would not be satisfied with the outcome if the patella continues to have significant laxity after reconstruction. The specimens were visually inspected at 26 mm displacement and all were found to have intact reconstruction. The average failure loads of the two repair techniques were compared using a Student's *t*-test.

Surgical technique

Suture anchor group (*n* = 8): A 30 mm longitudinal incision along the proximal two-thirds of the medial patellar border was used to transect the capsuloretinacular tissue and the MPFL after completion of native testing. This process was performed to ensure a complete transection of the broad patellar insertion of the MPFL. A 30-mm longitudinal bony trough was created with a depth of 3 mm and width of 5 mm using a fine tip rongeur along the proximal two-thirds of the medial patellar border. A crown tip drill guide was placed at the most proximal point of the medial patella bony trough perpendicular to the bone. A 1.7 mm SutureFix Ultra drill bit (Smith & Nephew Inc., London, UK) was drilled 18 mm into the patella and a 1.7 mm SutureFix Ultra anchor was then seated into bone with light taps until it bottomed out against the drill guide. The suture anchor was then deployed. Tension was applied to the suture to confirm adequate seating in the bone. Two additional anchors were then placed 15 mm apart for a total of three suture anchors. The semitendinosus graft was then secured in the trough with the sutures from the anchors. Next, the femoral insertion of the native ligament was determined with direct visualization and palpation of the medial femoral structures and landmarks, medial collateral ligament at the medial epicondyle, and adductor magnus tendon insertion on the adductor tubercle; all of which were easily palpable once the soft tissues were removed. A point approximately 2 mm anterior and 4 mm distal to the adductor tubercle, the sulcus between the medial epicondyle and the adductor tubercle, was used for

guide pin placement [19,23,33]. A 2.4 mm guide pin with suture eyelet was then driven across the femur in a slightly anterior and proximal direction exiting proximal to the lateral epicondyle. A soft tissue tunnel was then created from the medial border of the patella to the site of the 2.4 mm guide pin. Care was taken to stay superficial to the synovial capsule and deep to the medial retinacular layer and fascia, effectively staying between layers 2 and 3 of the knee [7]. A suture passer was then used to shuttle the looped end of the graft through the soft tissue tunnel and deliver it to the site of the MPFL insertion where the 2.4 mm guide pin was previously placed. The most isometric position of the pin was checked by wrapping the two looped graft limbs around the pin and assessing for excursion of the tendon around the pin as the knee was moved through a full range of motion. If needed, the position of the pin was adjusted until we observed the least change in graft excursion around the pin during flexion from 0 to 60 degrees [23,34]. A 1 cm longitudinal incision was made around the pin and soft tissue was cleared. An 8-mm reamer was used to drill the femoral socket until the lateral cortex was reached but not penetrated. Soft tissue was cleared around the socket to aid in graft passage. Graft suture ends were then fed through the eyelet of the 2.4 mm guide pin, and delivered through the lateral femur and soft tissues. While maintaining equal tension on both graft bundles, the graft was pulled into the femoral socket. A 1.1 mm nitinol guidewire was then placed into the socket to facilitate insertion of the interference screw (Fig. 2). In order to achieve adequate MPFL tension, the knee was flexed to 30 degrees and the lateral patellar facet was held flush against the lateral trochlear of the femur while tension was applied to the quadriceps mechanism [23]. The tension was assessed by pushing the patella laterally and confirming that there was at least 1 quadrant of excursion but not more than two and by allowing approximately 1 cm of lateral patellar translation with the knee in extension with a firm endpoint [8,18,26]. This was followed by placement of 7 × 25 mm Biosuture HA Screw (Smith & Nephew Inc., London, UK) while maintaining graft tension. After final fixation, appropriate MPFL tension was reassessed using the abovementioned methods.

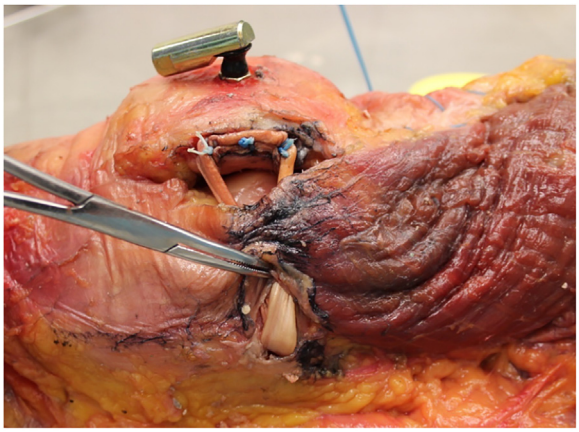

Figure 2
Demonstrating the suture anchor reconstruction using semitendinosus autograft.

Interference screw group (*n* = 8): A 30-mm longitudinal incision along the proximal two-thirds of the medial patellar border was used to transect the medial capsuloretinacular tissue and the MPFL after completion of native testing. A 30-mm longitudinal bony trough was created with a depth of 3 mm and width of 5 mm using a fine tip rongeur along the proximal two-thirds of the medial patellar border. Although this was not essential to the technique of screw fixation, it was done to limit the geometric variables between the reconstruction techniques. A 2.4 mm drill tip guide pin was drilled in a transverse fashion at the proximal apex of the trough to a depth of 30 mm and left in place. A second 2.4 mm drill tip guide pin was drilled in a transverse fashion, 25 mm distal and parallel to the first. A 4.5 mm cannulated reamer was used to over-drill the two pins in the medial patella to a depth of 25 mm; both guide pins were then removed. Free fiber wire tails (Arthrex Inc., Naples, Florida, USA) from the graft were placed through the eyelet of a 4.75 mm Biocomposite SwiveLock (Arthrex Inc., Naples, Florida, USA) interference screw. The free ends of the graft were then placed into each tunnel and secured by advancing the interference screw until it was fully seated. The process of graft passage, tensioning, and securing to the femur was then repeated as previously described for the suture anchor group (Fig. 3).

Statistical analysis

SPSS software (IBM, Version 22) was used for statistical analysis. For the comparisons between two groups, *t*-tests were performed to determine the statistical difference. When *p* value was greater than 0.05, power analysis was performed to estimate a number of larger sample size required for a statistical difference. To determine the effects of surgical procedures on stiffness, One-Way

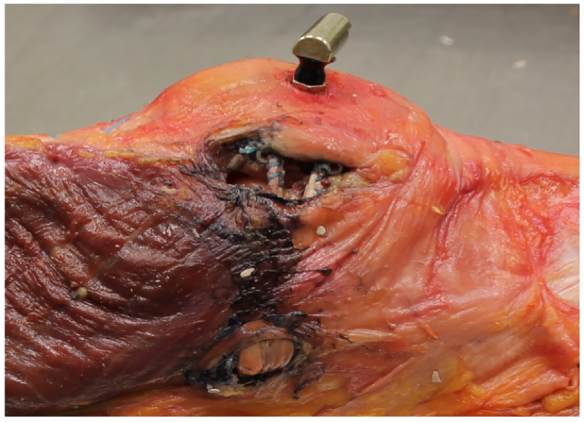

Figure 3
Demonstrating the interference screw reconstruction using semitendinosus autograft.

analysis of variance (One-Way ANOVA, PostHoc LSD) was performed for each degree of knee flexion (Table 2). To compare suture anchor vs. interference screw reconstruction with native group, repeated measures of ANOVA (RMANOVA) (PostHoc Bonferroni) were performed. p value smaller than 0.05 was considered as a statistically significant level.

Results

Stiffness (N/mm) of the MPFL for each testing condition with respect to knee flexion angle is shown in Fig. 4. The average force required to laterally displace the patella by 10 mm for each testing condition is presented in Table 1. Transecting the MPFL decreased the amount of force required to laterally displace the patella compared to the intact MPFL and reconstructed knees at all four angles of flexion. There was no significant difference found between the lateral restraining forces of the native knee and either reconstruction technique at 0 degrees of flexion (One Way ANOVA, PostHoc LSD, $p = 0.915$ and 0.373) (Table 2). There were no significant differences on restraining force at difference knee flexion angles of 0, 30, 60 degrees between interference screw and suture repair techniques (One Way ANOVA, PostHoc LSD, $p > 0.2$) except knee flexion of 90 degree, interference screw technique resulted in greater result (One Way ANOVA, PostHoc LSD, $p = 0.046$) (Table 2).

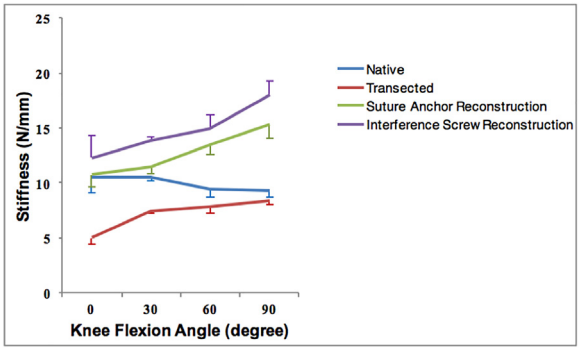

Figure 4
Shows the stiffness of MPFL under four different testing conditions (Mean ± SEM). Suture anchor technique provided results more closely related to the native MPFL in terms of stiffness than interference screw technique.

Specimens repaired using the suture anchor technique had an average stiffness of 12.02 ± 3.96 N/mm occurring at an average displacement of 11.80–22.46 mm. Specimens repaired with the interference screw technique had an average stiffness of 14.21 ± 4.20 N/mm occurring at an average displacement of 12.38–20.99 mm. The average stiffness of the two repair techniques was compared using a Student's t-test. No statistical difference was determined between the two groups (t-test, $p = 0.27$) (Fig. 4).

The average clinical failure loads of the two repair techniques were compared using a Student's t-test. No statistical difference was determined between the two groups (t-test, $p = 0.38$). Suture anchor reconstruction group had an average load to clinical failure of 256.57 ± 54.1 N. Interference screw reconstruction group had an average load to clinical failure of 237.81 ± 23.82 N (Fig. 5).

Transecting the MPFL also caused significant reductions in the majority of the tests, however the difference between the native MPFL and the transected MPFL was not significant at angles of 60 and 90 degrees of flexion (One Way ANOVA, PostHoc LSD, $p > 0.05$, Table 2). Both the suture anchor and the interference screw techniques resulted in lateral restraining forces being higher than those of the native condition when knee flexion angles were 60 and 90 degrees (One-Way ANOVA, PostHoc LSD, $p < 0.01$) (Table 2). The interference screw

Table 1. Force in Newtons (N) (mean ± SD) required to displace the patella laterally by 1 cm.

Condition	Knee flexion angle, deg			
	0	30	60	90
Native	105.57 ± 55.89	104.58 ± 42.38	94.33 ± 30.72	92.81 ± 23.77
Transected	49.78 ± 22.06	74.45 ± 26.46	78.13 ± 22.05	84.08 ± 16.21
Suture anchor reconstruction	107.60 ± 32.07	114.87 ± 17.85	134.98 ± 27.15	153.23 ± 34.09
Interference screw reconstruction	122.66 ± 57.70	137.94 ± 49.75	149.62 ± 33.11	179.77 ± 35.82

Table 2. One-Way ANOVA of stiffness at different knee flexion angle.

p value	Surgical groups	0 degree Sig.	30 degree Sig.	60 degree Sig.	90 degree Sig.
Native	Transected	0.001	0.022	0.108	0.346
	Suture anchor repair	0.915	0.512	0.002	0.00
	Interference screw repair	0.373	0.038	0.00	0.00
Suture anchor repair	Interference screw repair	0.496	0.207	0.3	0.046

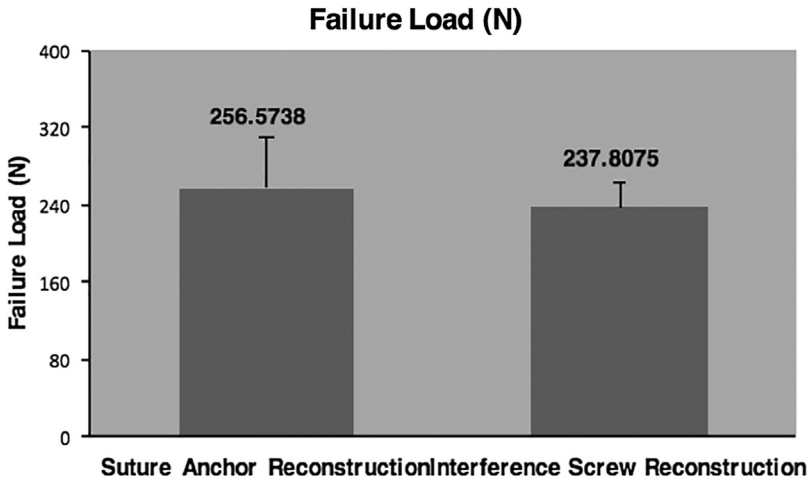

Figure 5
Average loads at 26 mm of lateral displacement,considered as clinical failure (Mean ± SD).

technique also resulted in higher restraining force than native restraining forces at 30 degree of flexion (One Way ANOVA, PostHoc LSD, $p < 0.05$) (Table 2).
Upon completion of maximal lateral displacement, typically around 60 mm in our set-up, we were able to examine the specimens and note likely failure modes. In the majority of specimens, we observed "cheese wiring" of the graft through the medial femur, which was the most common mode of failure in previous studies of MPFL reconstruction [21,24,25,31,32]. Less frequently, we noted graft slippage on the femoral side, graft slippage on the patellar side, interference screw pullout, suture anchor pullout, and suture anchor knot loosening.

Discussion

Our study investigated the biomechanical properties of two different MPFL reconstruction techniques and compared them to that of the native MPFL. This study compares biomechanical properties of two MPFL reconstruction techniques to that of the native MPFL at four different flexion angles while maintaining all native fascial, tendinous, and capsuloligamentous structures of the knee, physiologically loading the quadriceps, and allowing natural motion of patella and knee during testing. Prior MPFL biomechanical studies have demonstrated that a number of different MPFL reconstruction techniques experience failure at a force greater than or equal to that of the native MPFL [14,15,20,21,27]. Few studies have looked at stiffness of the MPFL

reconstruction [4,15,21,22,28]. Multiple studies have demonstrated that MPFL is the primary soft tissue restraint at 0–30 degrees of knee flexion [1,4,9,11,30]. This is reinforced by the findings of our study in which transection of the MPFL decreased the amount of force required to laterally displace the patella compared to the native knee at all flexion angles. Both suture anchor and interference screw techniques effectively restored the ability of the patella to resist laterally directed force while providing load to failure greater than the native MPFL.

The primary finding of our study were that there was no significant difference in stiffness between the suture anchor and interference screw techniques at 0, 30, and 60 degrees of flexion (Table 2). Suture anchor fixation provided nearly identical stiffness to native MPFL at 0 degrees of flexion and was close to that of native MPFL at 30 degrees of flexion. This suggests that the suture anchor reconstruction did not over constrain the patella at these flexion angles. When compared to interference screw fixation, suture anchor fixation provided stiffness more closely related to that of native MPFL at all flexion angles. The study by Russ et al demonstrated that the suture anchor group had significantly lower stiffness compared with the interference screw group [27]. The mean stiffness for the suture anchor group at 20.60 $\pm$ 6.78 N/mm in their study was higher than ours at 12.02 $\pm$ 3.96 N/mm. This is possibly related to the difference in the setup for testing. In their study, the patella was completely removed from the specimen and mounted on to methyl methacrylate. This creates a more rigid construct than our set up where we tried to replicate the clinical scenario. In a recent study by Hinckel et al., the stiffness noted for MPFL was between 4.2 and 10.1 N/mm, with a mean of 8.0 $\pm$ 1.9 N/mm, closely resembling our study [16].

In the study by Lenschow et al., they compared fixation strength of five different techniques. Porcine knees were used and the fixation was tested for patellar side only [20]. The load to biomechanical failure was 416 $\pm$ 101.7 N for the interference screw group and 401.5 $\pm$ 96.1 N for the 2-suture anchor group. Although the numbers cannot be directly compared with human cadaveric knees like in our study, it is interesting to note there was no statistical difference between the failure loads for both techniques.

Additionally, there was no significant difference between the suture anchor and interference screw reconstruction for clinical load to failure. The clinical failure load for the suture anchor technique at 256.57 $\pm$ 54.1 N and interference screw technique at 237.81 $\pm$ 23.82 N exceeded the 208 N load to failure of native MPFL determined in prior studies [20,24]. In one study, suture anchor fixation was determined to be inferior to interference screw fixation [27]. They noted that the mean failure load for the suture anchor group was 201.54 $\pm$ 63.14 N and that of the interference screw group was 299.25 $\pm$ 99.87 N. They noted in their limitations that this was the worst-case scenario as they performed linear testing with no other soft tissue attachments and without taking into account patellofemoral joint forces. It is likely that the mean failure load in clinical scenario is higher. In a recent study that compared all suture anchors, like the ones used in our study, with solid anchors, they found the ultimate failure load to be 228.5 $\pm$ 53.1 N for the former and 156.2 $\pm$ 84.9 N for the latter [29]. We used three (3) all-suture anchors in our study and had a slightly higher mean clinical failure load than what was shown in their study.

When compared to native MPFL, no significant difference in restraining force was observed at 0 and 30 degrees of flexion for the suture anchor reconstruction technique. In this study, the suture anchor technique closely matched stiffness of native MPFL at 0 and 30 degrees of flexion (Fig. 4). These values are similar to those in a study by Duchman et al. [9].

We believe that the suture anchor technique offers advantages when compared to the interference screw technique. Our tests demonstrated that suture anchor technique restores native MPFL stiffness more closely than interference screw technique at 30 and 90 degrees of flexion. Amis et al. described a broad patellar attachment of MPFL measuring 20 mm in width and possibly attaching to the entire medial patellar border [1]. The suture anchor technique described in our study is able to recreate a large contact area between graft and patellar bone, and closely restore the anatomic MPFL footprint. Also, using three (3) 1.7 mm non-absorbable polyester all-suture with a small diameter and relatively shallow depth of suture anchors (18 mm depth) decreases the chance of iatrogenic patellar fracture, cortical or subchondral penetration, and symptomatic hardware as well as providing a larger footprint of fixation on the patella. This is especially important when working with small patellae seen in pediatric and adolescent population. Furthermore, recurrent patellar instability and need for revision remains a concern with dislocation rates after MPFL reconstruction

reported to be between 12% and 31% [25,32]. Small diameter anchors used in our technique could be advantageous should the need for revision of patellar fixation arise.
There are limitations of this study. First, we did not test the ultimate load to failure as this was difficult using the specimens with intact attachments on both femoral and patellar side for both reconstructions. However, our knee specimens were setup so as to replicate patellofemoral joint forces which we believe would most likely represent clinical scenario. We defined failure as the load that is likely to cause clinical failure which would be presumably lower than biomechanical failure as noted in several studies. Previous studies have indicated that MPFL rupture occurs at around 26 mm of displacement [1,8]. Therefore, while testing reconstructed specimens to failure, maximum load of the construct was recorded at 26 mm of lateral patellar displacement and slope of the linear portion of the force vs. displacement graph prior to 26 mm was used to calculate stiffness. Second, with a mean age of 62, bone quality in our specimens could have influenced strength and stiffness of the construct, however, the specimens were randomly paired to the type of fixation to account for this difference [3].

Conclusion

The two most commonly used reconstruction techniques for MPFL reconstruction provide adequate medial patellar restraint that is comparable to values established for the native MPFL. The suture anchor reconstruction technique produces equivalent stiffness to the interference screw reconstruction technique for subfailure testing at most angles. Both reconstruction techniques provide greater ultimate failure loads than native MPFL.

Conflict of Interest

There is no conflict of interest.

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