Original Article

A Landmark-Based Technique for Determining an Isometric Femoral Attachment Site for Lateral Extraarticular Tenodesis is Inaccurate

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Purpose: To evaluate the reliability and accuracy of a method of placing the femoral fixation location for lateral extra-articular tenodesis (LET) within a safe isometric area using anatomic landmarks. **Methods:** Using a pilot cadaveric specimen, the center of the radiographic safe isometric area for femoral fixation of LET, defined as a 1 cm (proximal-distal) area located proximal to the metaphyseal flare and posterior to the posterior cortical extension line (PCEL), was located using fluoroscopy and found to be 20 mm directly proximal to the center of the fibular collateral ligament (FCL) origin. Using 10 additional specimens, the center of the FCL origin and a location 20 mm directly proximal was identified. K-wires were placed at each location. A lateral radiograph was obtained, and distances of the proximal K-wire relative to the PCEL and metaphyseal flare were measured. The location of the proximal K-wire relative to the radiographic safe isometric area was assessed by 2 independent observers. Intrarater and inter-rater reliability was calculated for all measurements using intraclass coefficients (ICCs). **Results:** There was excellent intrarater and inter-rater reliability for all radiographic measurements (.908 to .975 and .968 to .988, respectively). In 5/10 specimens, the proximal K-wire was outside of the radiographic safe isometric area, with 4/5 anterior to the PCEL. Overall, the mean distance from the PCEL was 1 mm ± 4 mm (anterior), and the mean distance from the metaphyseal flare was 7.4 mm ± 2.9 mm (proximal). **Conclusion:** A landmark-based technique referencing the FCL origin was inaccurate in the placement of femoral fixation within a radiographic safe isometric area for LET. Therefore intraoperative imaging should be considered to ensure accurate placement. **Clinical Relevance:** These findings may help to decrease the likelihood of misplacement of femoral fixation during LET by showing that landmark-based methods without intraoperative image guidance may be unreliable.

The addition of lateral extra-articular reconstructions, including lateral extra-articular tenodesis (LET) and anterolateral ligament reconstruction to an anterior cruciate ligament reconstruction (ACLR) can improve rotational laxity and reduce graft failure.[1] Numerous techniques for LET have been described.[2-6] One of the most commonly used techniques was originally described by Lemaire[4] and since been modified, using a 1 cm wide strip of the iliotibial band (ITB) left attached distally at Gerdy's tubercle, which is then passed beneath the fibular collateral ligament (FCL) and fixed to the femur.[2] Various other techniques that also rely on fixation of the ITB or a free tendon graft to the femur have also

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The authors report the following potential conflicts of interest or sources of funding: J.W.X. reports personal fees from Arthrex and Trice Medical. J.D.L reports personal fees from Arthrex. G.D.M. reports grants from the National Institutes of Health/NIAMS Grants U01AR067997, R01 AR070474, R01AR055563, R01AR076153, R01 AR077248; personal fees from Q30 Innovations, LLC, El Minda, Ltd., Human Kinetics, and Wolters Kluwer. Full ICMJE author disclosure forms are available for this article online, as supplementary material.

Received July 2, 2022; accepted November 9, 2022.

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2666-061X/22830

https://doi.org/10.1016/j.asmr.2022.11.017

been described with both biomechanical and clinical outcomes studies to support their use.[5,6] However, the specific location on the femur at which femoral fixation should be performed relative to identifiable anatomic and radiographic landmarks remains poorly defined.[7]

Although there remains a lack of consensus regarding a specific location for femoral fixation during lateral extra-articular reconstruction procedures, recent biomechanical studies have provided insights that may guide these techniques. In a cadaveric study, length changes of several combinations of tibiofemoral points for lateral reconstructions were investigated, finding that reconstructions with a femoral insertion located proximal and posterior to the lateral femoral epicondyle (LFE), with grafts passed deep to the FCL, displayed similar length change patterns with one another and less total strain compared with those located anterior to the LFE.[8] These positions on the femur approached isometry, with slight length increases during knee extension, characteristics considered favorable for a lateral extra-articular reconstruction (i.e., longer/tighter in extension). Using these findings, an isometric attachment area (IAA) for lateral extra-articular reconstructions was defined.[8] The IAA extends from the femoral attachment position of the Lemaire reconstruction which is approximately 4 mm posterior and 8 mm proximal to the LFE[9] to the femoral attachment position of the MacIntosh reconstruction, which is located on the posterior femoral cortex at the distal aspect of the intermuscular septum where the Kaplan fibers attach.[10] A subsequent study used these findings to describe radiographic landmarks in an effort to facilitate more reliable and accurate determination of the location of femoral fixation for lateral extra-articular reconstruction during surgery.[7] A radiographic safe isometric femoral attachment area for lateral extra-articular reconstruction that lies within the IAA was described using radiographic lines that were originally described by Schöttle et al.[11] for guiding isometric femoral fixation during medial patellofemoral ligament (MPFL) reconstruction. The radiographic safe isometric area for lateral extra-articular reconstruction was described as an area located on or posterior to the posterior cortical extension line (PCEL) and proximal to the proximal femoral condylar line, a line perpendicular to the PCEL where the posterior femoral condyle intersects the posterior femoral cortex.[7] Although identification of the IAA may be difficult during surgery using either palpation or radiographic techniques, the radiographic safe isometric area has been reliably shown to lie within the IAA and is easily identified using familiar radiographic lines used commonly during patellar instability surgery.[11]

There remains debate regarding surgeons' ability to reproducibly determine the femoral attachment site during lateral extra-articular reconstruction without intraoperative fluoroscopy or ultrasound scanning.[12,13] Avoiding the use of fluoroscopy could decrease operating room times, decrease radiation to the patient and operating room staff, and allow for less equipment in the operating room. However, without the use of intraoperative imaging, there can be concern for a misplaced femoral tunnel or fixation point, which may lead to anisometric graft placement and potentially inferior clinical outcomes. A previous study evaluated the placement of a femoral tunnel for lateral extra-articular reconstruction using palpation techniques, finding significant variability in tunnel placement and therefore recommending the use of fluoroscopy.[13] However, the anatomic landmarks that were used to guide femoral tunnel placement were not well detailed, and as such the observed variability is not unexpected. Another recent study demonstrated that intraoperative ultrasound scanning was more accurate than palpation methods without imaging.[12]

The purpose of this study was to evaluate the reliability and accuracy of a method of placing the femoral fixation location for LET within a safe isometric area using anatomic landmarks. We hypothesized that referencing the central aspect of the FCL femoral insertion would consistently place the femoral attachment for LET within a safe isometric femoral attachment area.

Methods

In this controlled laboratory study, 11 fresh frozen cadaver legs (70% male; mean age 80.3; range, 66-86) were dissected free of all skin and subcutaneous tissues.

Pilot Specimen

A single specimen was used to pilot the methods that would later be used for landmark guided LET femoral attachment site determination. The FCL was palpated, and the overlying soft tissues including the ITB were excised (Fig 1A). The FCL, including its femoral origin, was outlined with a marking pen. A 0.045″ Kirschner wire (K-wire) was inserted into the center of the FCL origin, and this location was corroborated by 2 sports medicine fellowship–trained orthopaedic surgeons (M.L.J. and J.D.L.) and verified on radiograph as previously described.[14] Briefly, a true lateral radiograph was obtained such that the posterior and proximal portions of the lateral and medial femoral condyles were superimposed onto one another, and the location of this K-wire relative to the Blumensaat line was determined. A previous study demonstrated that the Blumensaat line is closely associated with the FCL origin on a lateral radiograph.[14] A metallic guide rod was placed in line with the long axis of the femoral shaft, and a ruler was used to measure 15 mm directly proximal along the long axis of the femur from the center of the FCL origin. A second 0.045″ K-wire was

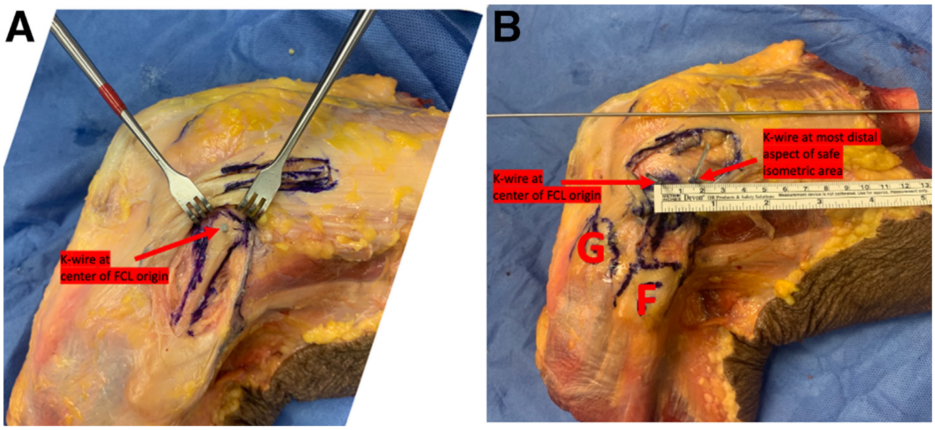

Fig 1. Pilot cadaveric specimen for determining center of safe isometric femoral attachment area during lateral extra-articular tenodesis (LET). (A) Fibular collateral ligament (FCL) outlined on left knee with purple marking pen. Central aspect of femoral insertion visualized and palpated, and 0.045″ K-wire placed at that location (red arrow and label). (B) For pilot specimen, second 0.045″ K-wire placed 15 mm directly proximal along the long axis of the femur into lateral femur. Metal wire placed along femoral shaft to guide placement of proximal K-wire. G, Gerdy's tubercle; F, Fibular head.

placed at this location (Fig 1B). A cortical button (Tightrope RT; Arthrex, Naples, FL) with dimensions of 12.0 mm long × 2.4 mm wide was passed over the more proximal of the 2 K-wires down to the level of the femoral cortex for radiographic visualization purposes, because the length of the button approximated the length of the radiographic safe isometric area for LET previously described.[7] Briefly, the radiographic safe isometric area for femoral attachment during lateral extra-articular reconstruction is described as a 10-mm distance on or proximal to the proximal femoral condylar line and on or posterior to the PCEL (Fig 2).[7] A true lateral radiograph was then obtained.[14] The radiograph was then uploaded into ImageJ (National Institutes of Health, Bethesda, MD), and measurements were performed demonstrating that a location 20 mm directly proximal to the center of the FCL origin was at the center of the radiographic safe isometric area in the pilot specimen.[7]

Experimental Specimens

Understanding that anatomic variability exists between specimens, we decided to pilot a single specimen, and with the remaining specimens assess if the 20 mm distance from the FCL origin could reliably result in a location for LET femoral fixation within the radiographic safe isometric area. Each specimen was dissected free of skin and soft tissues to the level of the ITB. A 1-cm wide and 8-cm long central strip of ITB was harvested as previously described for modified Lemaire LET, leaving its distal attachment to Gerdy's tubercle intact.[15,16] The course of the FCL was palpated, and a 0.045″ K-wire was placed at the central aspect of its femoral origin as described above. A ruler was used to measure 20 mm directly proximal to the center of the FCL origin along the long axis of the femur, and a second 0.045″ K-wire placed in this location. The tip of a small, curved hemostat was placed on each of the 0.045″ K-wires before obtaining a true lateral radiograph using a mini C-arm (General Electric, Boston, MA).

Data Analysis

Fluoroscopic radiographs from the 10 experimental cadaveric specimens were downloaded into ImageJ (National Institutes of Health). A line was drawn along the Blumensaat line extending from the anterior aspect to the posterior aspect of the femoral condyle as previously described.[14] The distance of the more distal of the 2 K-wires along the Blumensaat line was measured and recorded, with the anterior/distal aspect of the line

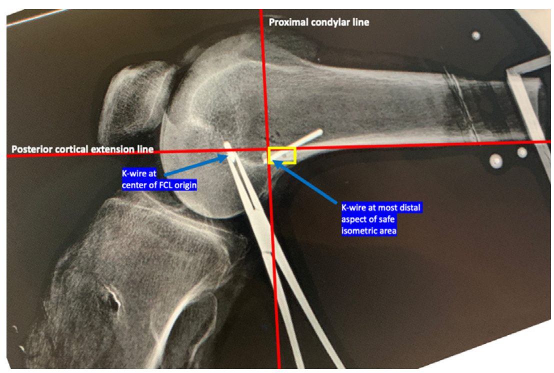

Fig 2. Lateral radiograph of pilot cadaveric specimen for confirmation of safe isometric area of femoral attachment site during lateral extra-articular tenodesis (LET). Posterior cortical extension line (PCEL) labeled on left knee. Proximal condylar line drawn perpendicular to the PCEL where the posterior femoral condyle intersects the posterior femoral cortex. Yellow box indicates radiographic safe isometric area as described by Jaecker et al.,[11] an area 1 cm from distal to proximal that is located on or posterior to the PCEL and on or proximal to the proximal condylar line. A K-wire was placed at the center of the FCL origin on the femur. A second K-wire was placed 15 mm directly proximal along the long axis of the femur and was located at the distal aspect of the radiographic safe isometric area.

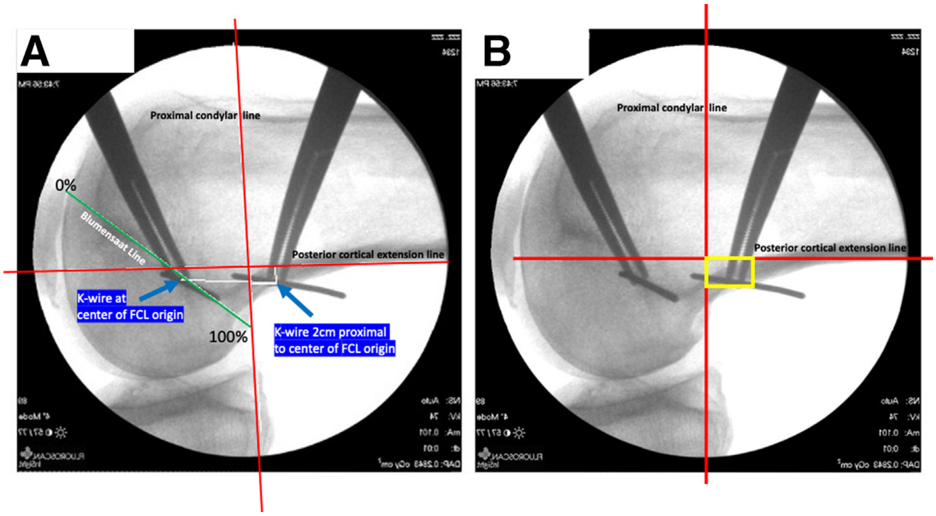

Fig 3. Experimental specimen radiographic measurements. (A) Green line indicates the Blumensaat line (labeled) on left knee. Red lines indicate posterior cortical extension line (PCEL) and proximal condylar line (both labeled). K-wires are clamped at the level of the lateral femoral cortex. Distance between K-wires is 20 mm in all specimens. The distance along the Blumensaat line, from the anterior aspect of the femoral condyle to the posterior aspect of the femoral condyle, as well as the distance proximal or distal to the Blumensaat line, was measured. The distance from the PCEL to the proximal K-wire was measured. The distance from the proximal condylar line to the proximal K-wire was measured. (B) Yellow box indicates radiographic safe isometric area for femoral fixation during lateral extra-articular tenodesis (LET). In this specimen, the proximal K-wire is located within this safe isometric area.

considered 0% and the posterior/proximal aspect of the line considered 100% (Fig 3A). The distance of the K-wire proximal to or distal to the Blumensaat line at this location was also measured and recorded. Next, an extension of the posterior femoral cortex was drawn as previously described (PCEL).[7,11] A second line was drawn perpendicular to the first line where the posterior femoral condyle intersects the posterior femoral cortex (proximal condylar line). These lines were originally described by Schöttle et al.[11] for determining radiographic landmarks for isometric femoral fixation during MPFL reconstruction. The distance from the proximal K-wire to each of these lines was then measured and recorded.

If the K-wire entered the lateral femoral cortex within the posterosuperior quadrant of these 2 lines (on or posterior to posterior to the PCEL and on or proximal to the proximal condylar line) within 10 mm of the proximal condylar line, then the location was determined to be within the radiographic safe isometric area (Fig 3B). This area (yellow box in Fig 3B) corresponds to the radiographic safe isometric area[11] based on the findings of a biomechanical study by Kittl et al.[8] If the K-wire overlapped 1 or both lines, then it was deemed to be located within the safe isometric area. Radiographs for each specimen were reviewed separately and measured by a board-certified sports medicine fellowship—trained orthopaedic surgeon (J.D.L.; rater 1; 2 sets of measurements performed 1 week apart to evaluate intrarater reliability) and a board-certified fellowship-trained musculoskeletal radiologist (J.D.L. and F.G; rater 2; inter-rater reliability) to determine whether fixation location was acceptable based on the above criteria. In total, 5 radiographic measurements were evaluated for reliability: condylar width (mm), distance of FCL origin along the Blumensaat line

Table 1. Radiographic Measurements for Palpated FCL Origin and LET Femoral Attachment Site

	Mean	Standard Deviation
Condylar width (mm)	46.3	3.74
Distance of FCL origin along the Blumensaat line (%)	56.7	9.3
Distance of FCL origin from the Blumensaat line (mm)*	1.76	2.68
Distance from LET femoral attachment site to PCEL (mm)†	1	4
Distance from LET femoral attachment site to proximal condylar line (mm)*	7.4	2.9

FCL, fibular collateral ligament; LET, lateral extra-articular tenodesis.
*Positive value indicates proximal to reference line.
†Positive value indicates anterior to reference line.

Table 2. Intrarater Reliability for Radiographic Measurements

Radiographic Measurement	ICC (95% CI)*	*F* Test With True Value 0			
		Value	*df*1	*df*2	*P* Value
Condylar width	.908 (.691-.976)	20.710	9.000	10.000	<.001
Distance of FCL origin along the Blumensaat line	.975 (.908-.994)	78.706	9.000	10.000	<.001
Distance of FCL origin from the Blumensaat line	.969 (.889-.992)	64.167	9.000	10.000	<.001
Distance from posterior cortical extension line to LET femoral attachment site	.972 (.898-.993)	70.178	9.000	10.000	<.001
Distance from proximal condylar line to LET femoral attachment site	.971 (.895-.993)	67.958	9.000	10.000	<.001

ICC, Intraclass correlation coefficient; CI, confidence interval; FCL, fibular collateral ligament; LET, lateral extra-articular tenodesis.
*Separate 1-way random, single-measure ICCs (1, 1) were computed for each radiographic measurement.

(calculated as a percentage), distance of FCL origin from the Blumensaat line (mm) at that location measured perpendicular to the Blumensaat line, distance from PCEL (mm), and distance from proximal condylar line (mm). To estimate intrarater reliability (i.e., test-retest reliability of rater 1), we computed 1-way random, single measure intraclass correlation coefficients (ICCs; 1, 1) for each radiographic measurement. To estimate the inter-rater reliability (i.e., reliability of rater 1 compared to rater 2), we computed 2-way mixed, average measures intraclass correlation coefficients with absolute agreement (3, k) for each radiographic measurement. Statistical significance was set a priori at $P < .05$ and 95% confidence intervals were reported. ICC values were interpreted as excellent >.75, good between .59 and .75, fair between .40 and .58, and poor if <.40.[17] All data analysis was performed using SPSS Version 28.0 (IBM, Armonk, NY).

Results

A summary of findings can be seen in Table 1. Intrarater and inter-rater reliability was excellent for all measurements (.908 to .975 [Table 2] and .968 to .988 [Table 3], respectively; all *P*s < .001). On the pilot specimen, the FCL origin was 61.3% along the width of the condyle and 1.5 mm distal to the Blumensaat line. For experimental specimens, the FCL origin was 56.6% ± 9.3% across the width of the condyle and 1.8 ± 2.7 mm proximal to the Blumensaat line.

Of the 10 experimental specimens, 5 of the proximal K-wires missed the radiographic safe isometric area.[7] In 4 of these specimens, the K-wire was anterior to the PCEL by an average of 5.2 ± 2.1 mm (range, 1.0-8.0 mm). In 2 specimens, the K-wire was proximal to the radiographic safe isometric area by 2.5 mm and 2.8 mm, respectively. In one specimen, the K-wire was both excessively anterior and proximal to the radiographic safe isometric area (Fig 4). There were no disagreements between raters in terms of which K-wires fell within or outside of the radiographic safe isometric area.

Discussion

The most important finding in this study is that a landmark-based method based on a measurement from the palpated FCL origin was inaccurate to locate the previously described radiographic safe isometric area for femoral fixation during LET.[7] Our hypothesis was not fully supported—a location measured 20 mm proximal to the central aspect of the FCL origin resulted in an excessively anterior femoral attachment position relative to the radiographic safe isometric area.[7] These findings indicate that intraoperative imaging (fluoroscopy or ultrasound scanning) may be warranted to ensure that the femoral LET attachment site is within the intended safe isometric area. If using fluoroscopy to guide placement of the femoral LET attachment site, familiar radiographic lines on a true lateral radiograph previously described by Schöttle et al.[11] for MPFL reconstruction, namely the PCEL and a line perpendicular to the PCEL where the posterior femoral condyle intersects the posterior femoral cortex, can be used to ensure an isometric femoral attachment site for LET. If not using fluoroscopy, care should be taken to

Table 3. Inter-Rater Reliability for Radiographic Measurements

Radiographic Measurement	ICC (95% CI)*	*F* Test With True Value 0			
		Value	*df*1	*df*2	*P* Value
Condylar width	.968 (.872-.992)	35.289	9.000	10.000	<.001
Distance of FCL origin along the Blumensaat line	.984 (.938-.996)	58.639	9.000	10.000	<.001
Distance of FCL origin from the Blumensaat line	.966 (.868-.992)	27.622	9.000	10.000	<.001
Distance from posterior cortical extension line to LET femoral attachment site	.988 (.951-.997)	74.381	9.000	10.000	<.001
Distance from proximal condylar line to LET femoral attachment site	.985 (.940-.996)	77.111	9.000	10.000	<.001

ICC, Intraclass correlation coefficient; CI, confidence interval; FCL, fibular collateral ligament; LET, lateral extra-articular tenodesis.
*Separate 2-way mixed, average-measures ICCs with absolute agreement (3, k) were computed for each radiographic measurement.

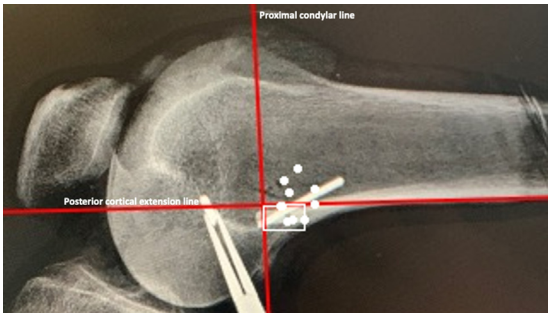

Fig 4. Schematic radiograph containing a point cloud of tunnel positions for all 10 specimens relative to radiographic safe isometric area. The white box indicates the safe isometric area posterior to the posterior cortical extension line (PCEL) and proximal to the proximal condylar line. Five of 10 (50%) specimens fell within the radiographic safe isometric area.

avoid an excessively anterior femoral attachment position, the most common error using the landmark-based method in this study.

The location of femoral fixation during LET is often based on a reference point palpated on the lateral femur, most commonly the LFE.[2,8,16,18] A previous cadaveric study suggested that the femoral attachment of the FCL is, on average, 1.4 mm proximal and 3.1 mm posterior to the LFE.[19] In a cadaveric study, Jaecker et al.[7] dissected specimens and marked the apex of the LFE and distal Kaplan fiber attachments on the distal femur, obtained true lateral radiographs, and determined the relative location of these anatomic landmarks to the radiographic reference lines used in the present study (PCEL and posterior condylar line). The authors concluded that LET femoral attachment on or posterior to the PCEL and on or proximal to the posterior condylar line within a 10 mm distance ensures that the femoral tunnel is located within an isometric position that can be easily and reproducibly visualized radiographically. Those previous studies formed the basis for the methods in the present study and, to our knowledge, comprise the best available evidence guiding femoral fixation location during LET.

In a related but distinct study, Jaecker et al.[13] used palpation to determine femoral tunnel placement during LET, finding a large variance of up to 23 mm, concluding that palpation should not be used in place of fluoroscopy if reproducible isometric tunnel placement is desired. However, in that study, femoral tunnel position was determined by 2 knee surgeons following their typical intraoperative protocol without specific mention of how the location of the LFE was determined or how far proximal or posterior the intended femoral tunnel was positioned relative to the LFE. As such, the variance observed in that study is not unexpected. In the present study, we clearly defined the methods by which the center of the FCL origin was determined and specified the direction and distance from that reference landmark to the femoral attachment site for LET. Although we found that our methods resulted in an LET femoral attachment site within the radiographic safe isometric area in only half of the specimens, this area is smaller than the true IAA.[8] As one moves proximal to the proximal condylar line, the IAA moves anteriorly. As such, an isometric femoral attachment site can be located anterior to the PCEL. In the present study, only one specimen had a femoral attachment that was more than 5.0 mm anterior to the PCEL and fell well outside of the IAA.[7,8] However, radiographic landmarks describing the IAA, namely an accurate radiographic location of the distal posterior Kaplan fibers, are not well understood. As such, we were unable to determine whether any K-wires were outside of the radiographic safe isometric area but fell within the IAA. Altogether, while our proposed methods seem to facilitate placement of an isometric or near-isometric femoral attachment site in most cases, the senior authors (J.D.L. and M.L.J.) routinely use fluoroscopy to verify the location of LET femoral fixation due to increased reliability and a decreased likelihood of an outlier that may occur without image verification.

In a cadaveric radiographic study, the Blumensaat line was closely associated with the FCL femoral insertion on lateral radiograph, 58% ± 5.7% across the width of the condyle along the Blumensaat line (from anterior-inferior to posterior-superior) and 2.3 mm ± 2.3 mm distal to the Blumensaat line at this location, with all specimens having less than 5 mm of variance from the mean.[14] In the present study, the femoral insertion of the FCL was identified on the pilot specimen using similar methods and fell within these previously described values.[14] Similarly, in the experimental specimens, the mean location of the FCL origin along the Blumensaat line fell within the previously described values,[14] and only 2 specimens fell outside of the 5 mm of variance from the mean (5.8 mm and 6.7 mm, respectively). However, the palpated location of the FCL origin in the experimental specimens was, on average, *proximal* to the Blumensaat line, with 4 of 10 specimens falling outside of the 5 mm variance.[14] These findings indicate that the anterior-posterior location of the FCL origin may be more accurately assessed by inspection and palpation than its proximal-distal location. Because the midsubstance of the FCL is a structure that is relatively easy to visualize and palpate, and its anterior and posterior borders must be delineated when performing a modified Lemaire LET or any other lateral reconstruction in which the ITB or a free graft is passed beneath the FCL,[5,18] it is not surprising that the anteroposterior midpoint was accurately and reproducibly determined in the present study.

The proximal/distal midpoint of the FCL origin was less reliable in our study as evidenced by our deviations from the values previously reported.[14] As this location was used as the reference point by which to determine the location of femoral fixation during LET, an excessively proximal location of the FCL origin resulted in a femoral fixation point that was anterior to the PCEL and therefore outside of the previously described radiographic safe isometric area.[7,8] For surgeons that choose not utilize intraoperative imaging to guide or verify placement of the femoral attachment site during lateral extra-articular reconstruction, based on the findings of this study in which the error was consistently excessively anterior on the femur, we recommend the following steps: (1) Clearly delineate the anterior and posterior borders of the FCL before passing the ITB or free graft beneath the FCL. (2) Follow the central aspect of the FCL to its femoral origin and mark this location. Palpate the LFE, and ensure that this marked location is posterior and proximal to the LFE (on average, 1.4 mm proximal and 3.1 mm posterior to LFE).[19] (3) Measure 20 mm directly proximal along the long axis of the femur to the intended location for placement of the femoral attachment site, taking care to avoid inadvertently measuring proximal and anterior rather than directly proximal. The convexity of the posterolateral femur may require a slightly posterior to anterior trajectory of implant or tunnel placement during femoral fixation, and this may confirm a sufficiently posterior location on the femur.

There is limited evidence on the clinical implications of nonisometric femoral fixation during lateral extra-articular reconstruction. However, it is possible that deviations from an isometric femoral attachment site may contribute to inferior clinical outcomes because of abnormal joint kinematics, graft elongation, or overconstraint of the knee.[13] Although most published clinical studies have not investigated the specific location of femoral fixation during LET, outcomes after ACLR with the addition of LET are improved, with consistently lower rates of graft rerupture than ACLR without LET.[2,20] Additional studies have indicated that addition of LET to ACLR contributes to a restoration of the knee's native rotational kinematics and a significant reduction in pivot shift without an increased incidence of osteoarthritis.[1,15,21] Although there have been concerns of knee overconstraint and subsequent osteoarthritis when LET is performed,[22] recent studies that have used contemporary techniques and controlled for meniscus and articular cartilage status have not demonstrated an increased risk of arthritis compared to ACLR alone.[23] Although biomechanical studies have established an IAA and radiographic safe isometric area for LET,[7,8] future clinical studies that specifically evaluate femoral fixation location during LET will be necessary to assess how this is associated with clinical outcomes.

Limitations

This study is not without limitations. Radiographic measurements were not normalized in relation to the sizes of the knees, and the technique used on the experimental specimens was based on a single pilot specimen. Because the distal Kaplan fiber attachments and LFE were not identified on each specimen, we did not determine the IAA for each specimen and were therefore unable to determine whether a K-wire that was outside of the radiographic safe isometric area still fell within the IAA. As such, it is possible that K-wires that were deemed "misses" may have been located within the IAA. The sample size was relatively small but comparable with other radiographic studies that have been previously performed.[13] The radiographic landmarks comprising the radiographic safe isometric area are based on the biomechanical results of a single cadaveric study.[8] The clinical implications of a nonisometric femoral attachment site during lateral extra-articular reconstruction are largely unknown.

Conclusion

A landmark-based technique referencing the FCL origin was inaccurate in the placement of femoral fixation within a safe isometric area for LET. Therefore intraoperative imaging should be considered to ensure accurate placement.

Acknowledgment

The authors would like to acknowledge Emory University School of Medicine for funding the project.

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