Comparison of Tibiofemoral Contact Mechanics After Various Transtibial and All-Inside Fixation Techniques for Medial Meniscus Posterior Root Radial Tears in a Porcine Model

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Purpose: To compare tibiofemoral contact mechanics after fixation for medial meniscus posterior root radial tears (MMPRTs).

Methods: Seven fresh knees from mature pigs were used. Each knee was tested under 5 conditions: normal knee, MMPRT, pullout with simple sutures, fixation with modified Mason-Allen sutures, and all-inside fixation using Fastfix 360. The peak contact pressure and contact surface area were evaluated using a capacitive sensor positioned between the meniscus and tibial plateau, under a 1,000-N compression force, at different flexion angles (0°, 30°, 60°, and 90°). Results: The peak contact pressure was significantly higher in MMPRTs than in normal knees (P = 0.018). Although the peak contact pressure decreased significantly after fixation at all flexion angles (P = 0.031), it never recovered to the values noted in the normal meniscus. No difference was observed among fixation groups (P = 0.544). The contact surface area was significantly lower in MMPRTs than in the normal meniscus (P = 0.018) and increased significantly after fixation at all flexion angles (P = 0.018) but did not recover to within normal limits. For all flexion angles except 60°, the contact surface area was significantly higher for fixation with Mason-Allen sutures than for fixation with simple sutures or all-inside fixation (P = 0.027). At 60° of flexion, the contact surface area was significantly better for fixation with simple sutures than for all-inside fixation (P = 0.031). Conclusions: The peak contact pressure and contact surface area improved significantly after fixation, regardless of the fixation method, but did not recover to the levels noted in the normal meniscus after any type of fixation. Among the fixation methods evaluated in this study, fixation using modified Mason-Allen sutures provided a superior contact surface area compared to that noted after fixation using simple sutures or all-inside fixation, except at 60° of flexion. However, this study had insufficient power to accurately detect the differences between the outcomes of various fixation methods.

Clinical Relevance: Our results in a porcine model suggest that fixation can restore tibiofemoral contact mechanics in MMPRT and that fixation with a locking mechanism leads to superior biomechanical properties.

MMPRTs have been shown to entail the same consequences as those of total meniscectomy, with pathological loads leading to degenerative arthritis.2 Nevertheless, MMPRT repair has been found to provide encouraging clinical results, slowing the

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Medial meniscus posterior root radial tears (MMPRTs) disrupt the continuity of the circumferential fibers and lead to loss of hoop tension,1 causing abnormal load sharing and unacceptable peak pressures in the tibiofemoral joint.

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progression of arthritis clinically, which has led to increased interest in this procedure.\textsuperscript{3,5}

There have been several studies showing biomechanics in MMPRT repair. Most biomechanical studies have investigated outcomes of suture constructs after MMPRT fixation with different suture methods.\textsuperscript{6-8} Compared with simple or nonlocking sutures, complex suture patterns with locking mechanisms are reportedly associated with higher failure loads.\textsuperscript{3,8} These studies have only examined load-to-failure strength between the fixation constructs and the meniscus itself, without focusing on tibiofemoral biomechanics. Few reports have investigated tibiofemoral contact mechanics after pullout fixation using simple sutures in MMPRTs.\textsuperscript{9,10}

To our knowledge, there are limited data on comparative outcomes of tibiofemoral contact mechanics after different fixation methods, including techniques using locking constructs or all-inside repair devices. Therefore, this study was designed to examine tibiofemoral contact mechanics and determine whether each different fixation technique can restore meniscal function.

This study aimed to compare tibiofemoral contact mechanics after fixation for MMPRTs. It was hypothesized that fixation using Mason-Allen sutures with a locking mechanism, rather than using simple sutures or all-inside fixation, would be associated with better biomechanical outcomes.

**Methods**

**Specimen Preparation**

Seven fresh knee specimens from Yorkshire pigs (body weight, 110 ± 2 kg) were used. Knee joints were dissected free of skin, subcutaneous tissue, muscle, and the patella; however, the femur, tibia, anterior and posterior cruciate ligaments, and both collateral ligaments were preserved. The femur and tibia were cut 20 cm distally to the knee joint line. Then, the femur and tibia were potted in an aluminum cylinder with polymethyl methacrylate resin (Vertex Self-Curing: Vertex, Zeist, The Netherlands). The molded resin encased the femur and tibia up to 5 to 6 cm distally to the knee joint to maintain the knee joint parallel to the base.

A transverse incision was made through the anterior and posterior meniscalbital portions of the joint capsule. A capacitive pressure sensor (128 [8 × 16] capacitive sensors: Novel, Munich, Germany) was inserted through the previous incision and positioned between the medial meniscus and medial tibial plateau to assess tibiofemoral contact mechanics. Sutures were applied between the tabs of the sensor and the anterior and posterior joint capsule to secure the sensor in position during testing.

**Fixation Methods**

All specimens underwent measurements under 5 different conditions: (1) normal meniscus, (2) MMPRT, (3) transtibial pullout fixation using simple sutures (simple group), (4) transtibial pullout fixation using modified Mason-Allen sutures (Mason-Allen group), and (5) all-inside fixation using Fastfix 360 (Smith & Nephew, Andover, MA) (all-inside group). An MMPRT was induced by creating a complete radial tear of the meniscus 5 mm medially from the attachment of the native root. During pullout fixation (i.e., in the simple and Mason-Allen groups), nonabsorbable No. 2 FiberWire (Arthrex, Naples, FL) was used. In the all-inside group, Fastfix anchors loaded with No. 2-0 Ultrabraid sutures (Smith & Nephew) were used. The sutures were passed at the same distance from the root tear in all specimens and in all experiments, which was verified using an electronic ruler. In the simple group, 2 sutures, positioned 3 mm medially from the torn edge, were inserted parallel to one another at the inner and outer areas of the meniscus. In the next step, to create a tibial tunnel, an anterior cruciate ligament reconstruction tibial tunnel guide (Linvatec, Largo, FL) was inserted with its tip placed in contact with the root attachment site. A Kirschner wire was then passed through the guide. After confirmation that the tibial tunnel was suitable, the K-wire was pulled back. A metal wire was then inserted into the tibial tunnel and removed together with the suture strands. The meniscus was reduced and stabilized by pulling the ends of the sutures through the tibial tunnel and tying them over a polypropylene button (Ethicon, Somerville, NJ) at the anteromedial tibial cortex (Fig 1A).\textsuperscript{3}

In the Mason-Allen group, 2 sutures, positioned 3 mm medially from the torn edge, were inserted parallel to one another at the inner and outer areas of the meniscus. The superior ends of the 2 simple sutures were then tied, and the inferior end of the first suture was pulled out. By use of the shuttle relay method, the first suture was exchanged with the second suture so that a horizontal loop was completed. After this step, the remaining procedures were the same as those performed for the simple group (Fig 1B).\textsuperscript{11,12}

In the all-inside group, torn meniscal root tissue and remnant meniscal tissue on the root attachment were fixed using the Fastfix 360 system. Two all-inside sutures, positioned 3 mm away from the torn edge, were inserted into the inner and outer portions of the meniscal tissue. The meniscus was reduced and stabilized by pulling the ends of the sutures (Fig 1C).

**Biomechanical Testing**

A hydraulic compression machine (model 8511; Instron, Norwood, MA) with which it was possible to control the axes of vertical and rotational movement was used. The potted femur and tibia were installed securely in a custom jig to simulate the 6 motions of the knee joint (flexion, extension, adduction, abduction, internal...
onto the specimens and the pressure sensor to prevent desiccation and reduce shear force on the sensor. All measurements were taken in triplicate, with the knee specimen in various degrees of flexion. The mean value of the 3 measurements was recorded as the final measurement. For each flexion angle, peak contact pressure and contact surface area values were compared among the groups. First, the measurements in the normal meniscus were performed randomly according to different flexion angles. Second, the measurements in the meniscus with an MMPRT were performed in a similar manner. Last, the measurements at different flexion angles in the meniscus repaired by 3 different methods were measured in a randomized order. In the repaired meniscus, the order of measurement among the different fixation methods was first decided by computer-assisted randomization. Subsequently, the order of measurement at different angles for each fixation method was decided by the same randomization method.

rotation, and external rotation). After confirmation of fixation of the specimens, the experiment was performed under constrained conditions, except for flexion and extension motions (Fig 2).

The pressure sensor was placed on a flat surface and calibrated to confirm a "0" setting. Then, the sensor was positioned between the meniscus and tibial plateau so that the whole meniscus could be evaluated through a transverse incision in the joint capsule. To remove the compressive pressure caused by the thickness of the sensor itself before the application of real compressive force, pre-tensioning was performed and a real 0 setting was confirmed. The pressure sensor had a maximum detection limit of 3.2 MPa, and the experiment was performed within the permissible detection range. All specimens were tested at 4 different flexion angles (0°, 30°, 60°, and 90°) under axial compression loads of up to 1,000 N applied at 50 N/s. A pressure-mapping program (Pliance-X 32 bit; Novel) was used to measure the peak contact pressure (in kilopascals) and contact surface area (in square centimeters). The contact pressure generated a pressure map for each condition that was measured under compression conditions in real time, and the contact surface was calculated to analyze the value taken from each pressure map (Fig 3). During the procedures, 0.9% normal saline solution was sprinkled abundantly

Fig 1. Three different suture methods. (A) Transtibial pullout fixation using simple sutures. (B) Transtibial pullout fixation using modified Mason-Allen sutures. (C) All-inside fixation using Fastfix 360.

Fig 2. A hydraulic compression machine with which it was possible to control 2 axes of vertical and rotational movement was used. The potted femur and tibia were installed in a custom jig made to realize motion of the knee joint. The specimens were installed on the custom jig. After confirmation of fixation of the specimens, the experiment was performed under constrained conditions, except for flexion and extension motions. A capacitive pressure sensor was positioned between the medial meniscus and medial tibial plateau.
Statistical Analysis

Statistical analyses were performed using SPSS software for Windows (version 21.0; SPSS, Chicago, IL). The statistical significance threshold was set at a P value of .05. The Wilcoxon signed rank test was used to compare measurements between the root conditions at the same flexion angle. On the basis of the peak contact pressure data obtained for the MMPRT and the all-inside group at 0° in the first 5 specimens evaluated, a sample size calculation was conducted in terms of mean and standard deviation of peak contact pressure values. A sample size of 6 specimens per group was calculated as the minimum requirement to ensure 85% power to detect differences in the peak contact pressure assessed using a t test at a .05 significance level.

Results

Peak Contact Pressure

The peak contact pressure was significantly higher in the meniscus with an MMPRT than in the normal meniscus ($P = .018$; Table 1, Fig 4), with an increase of 72.9% ± 22.4% and 52.4% ± 9.1% at 0° and 60° of flexion, respectively (Table 2). After fixation, the peak contact pressure decreased significantly from the values noted under MMPRT conditions, regardless of fixation method. However, there were no significant differences among the 3 groups with respect to the absolute values of peak contact pressure ($P = .054$, Table 1), except that the peak contact pressure was significantly lower in the Mason-Allen group than in the all-inside group at 0° of flexion ($P = .031$, Table 1, Fig 4). In the comparison of the peak contact pressure in the normal meniscus with that achieved after MMPRT repair using different fixation methods, a difference of $4.4% ± 20.8%$ to $25.1% ± 24.5%, 12.7% ± 5.6%$ to $19.7% ± 21.6$, and $14.9% ± 3.9%$ to $30.7% ± 16.3%$ was noted for the simple, Mason-Allen, and all-inside groups, respectively (Table 2).

Contact Surface Area

The contact surface area was significantly lower in the meniscus with an MMPRT than in the normal meniscus ($P = .018$; Table 1, Fig 5), with a difference of $55.7% ± 6.1%$ and $51.9% ± 10.3%$ at 0° and 60° of flexion, respectively (Table 3). After fixation, the contact surface area increased significantly from the values noted under MMPRT conditions, regardless of fixation method. In terms of absolute values of contact surface area, the Mason-Allen group showed significantly better outcomes than those of the simple and all-inside groups ($P = .027$), except at 60° of flexion ($P = .621$). The simple group showed a significantly higher contact surface area than that noted in the all-inside group at
90° of flexion \((P = .031)\), but no difference was observed between the simple and all-inside groups at 0°, 30°, or 60° of flexion \((P = .063; Table 1, Fig 5)\). In the comparison of the contact surface area of the normal meniscus with that achieved after repair using different fixation methods, a difference of 13.1% ± 11.6% to 24.1% ± 5.7%, 11.1% ± 6.9% to 19.9% ± 4.4%, and 22.4% ± 13.1% to 30.1% ± 6.5% was noted for the simple, Mason-Allen, and all-inside groups, respectively (Table 3), indicating that none of the 3 fixation methods evaluated could completely restore the normal contact surface area.

### Discussion

The most important finding of this study was that any fixation method could improve meniscal function in terms of the peak contact pressure and contact surface area after an MMPRT, but no such method could restore meniscal function to normal levels. Specifically, the MMPRT caused a significant increase in peak contact pressure (ranging from 52.4% ± 9.1% to 72.9% ± 22.4%, according to flexion angle) and decrease in contact surface area (ranging from 51.9% ± 10.3% to 55.7% ± 6.1%) from the values noted in the normal meniscus, whereas subsequent fixation led to a significant improvement in both indicators, although without full recovery to normal meniscal function. No significant difference was observed among the 3 fixation groups regarding the values of peak contact pressure after fixation; however, the contact surface area was better in the Mason-Allen group, whereas no significant difference was observed between the simple and all-inside groups, except at 90° of flexion. Overall, regarding the contact surface area, the Mason-Allen group showed the best improvement, followed by the simple group and, finally, the all-inside group.

Several studies have examined the characteristics of suture constructs, such as load-to-failure strength or displacement between the fixation constructs and the meniscus itself. Moreover, several reports have investigated tibiofemoral contact mechanics after pullout fixation using simple sutures for MMPRT repair. However, there are limited data on the outcomes of tibiofemoral contact mechanics after different fixation methods, including techniques using locking constructs or all-inside repair devices. Therefore, our study was designed to examine tibiofemoral contact mechanics and determine whether each fixation technique can restore meniscal function. In agreement with the initial hypothesis, pullout fixation using modified Mason-Allen sutures with locking led to superior results in MMPRT repair. However, applying this fixation technique to patients with a narrow joint compartment is quite challenging and requires a learning period to achieve satisfactory performance. Comparatively, fixation using simple sutures is easier.

### Table 1: Comparison of Peak Contact Pressure and Contact Surface Area Between Root Conditions at Different Flexion Angles

<table>
<thead>
<tr>
<th>Fixation</th>
<th>0°</th>
<th>30°</th>
<th>60°</th>
<th>90°</th>
<th>120°</th>
<th>150°</th>
<th>180°</th>
</tr>
</thead>
<tbody>
<tr>
<td>Peak contact pressure</td>
<td>0.018</td>
<td>0.016</td>
<td>0.016</td>
<td>0.016</td>
<td>0.016</td>
<td>0.016</td>
<td>0.016</td>
</tr>
<tr>
<td>Contact surface area</td>
<td>0.018</td>
<td>0.016</td>
<td>0.016</td>
<td>0.016</td>
<td>0.016</td>
<td>0.016</td>
<td>0.016</td>
</tr>
</tbody>
</table>

**Table 1:** Comparison of Peak Contact Pressure and Contact Surface Area Between Root Conditions at Different Flexion Angles

Note: Normal indicates the peak contact pressure of contact surface area of the normal meniscus. The results are shown as \(P\) values analyzed by the Wilcoxon signed-rank test. It was impossible to assess peak contact pressure because of the detection limit of the supportive contact sensor.
and also showed significantly improved biomechanical outcomes over those achievable by all-inside fixation. Thus, fixation using simple sutures may represent a second option for MMPRT repair if it is difficult to perform fixation using modified Mason-Allen sutures.

However, it should be noted that transitional pullout fixation is generally challenging because of poor visibility, several crowded sutures, and a narrow working space in the medial compartment of the knee joint. It is difficult to deal with instruments smoothly. The longer operative time and resultant iatrogenic chondral damage are considered disadvantages of pullout fixation. To overcome such disadvantages and facilitate fixation, the familiar meniscal device Fastfix 360 is regarded as another option in MMPRT repair. The Fastfix system showed comparable load-to-failure performance with that of fixation using vertical mattress sutures. Moreover, a systematic review reported no difference between the outcomes of inside-out repair and those of all-inside repair using a meniscal device. In our study, all-inside fixation achieved a significant decrease in peak contact pressure and increase in contact surface area compared with the values noted before fixation (i.e., under MMPRT conditions), although the improvement in contact surface area was inferior to that achieved by fixation using modified Mason-Allen sutures. These findings suggest that the Fastfix 360 system may be considered an option when the surgeon is not familiar with pullout fixation methods or if the medial joint space is narrow. However, all-inside fixation can be performed when both torn ends of the meniscal tissue are sufficiently preserved for end-to-end anastomosis. There is ongoing debate regarding what constitutes a real root tear. When performing end-to-end anastomosis is possible, the tear might not represent a real root tear but rather a mid-substance tear of the meniscus posterior horn. However, according to the classification of root tears, a meniscal tear 0 to 9 mm from the root attachment is defined as a root tear. Thus, performing end-to-end anastomosis is possible in some cases. In our study, both torn ends of the meniscal tissue were well preserved, allowing all-inside fixation; however, it should be considered that these outcomes were based on experimental observations of biomechanical behavior, not on observations in the real clinical setting, suggesting that they may not reflect actual meniscal healing and hoop tension. Although both the peak contact

<table>
<thead>
<tr>
<th>Flexion Angle (°)</th>
<th>Normal Root</th>
<th>Root Tear</th>
<th>Simple Repair</th>
<th>Modified Mason-Allen</th>
<th>All Inside</th>
</tr>
</thead>
<tbody>
<tr>
<td>0°</td>
<td>1.517</td>
<td>72.9 ± 22.4</td>
<td>18.7 ± 24.1</td>
<td>13.4 ± 16.2</td>
<td>28.2 ± 26.1</td>
</tr>
<tr>
<td>30°</td>
<td>1.598</td>
<td>61.9 ± 23.8</td>
<td>29.1 ± 26.3</td>
<td>19.7 ± 21.6</td>
<td>30.7 ± 16.3</td>
</tr>
<tr>
<td>60°</td>
<td>1.997</td>
<td>52.4 ± 9.1</td>
<td>4.4 ± 20.8</td>
<td>13.2 ± 12.4</td>
<td>20.6 ± 16.9</td>
</tr>
<tr>
<td>90°</td>
<td>2.591</td>
<td>14.7 ± 2.9</td>
<td>12.7 ± 5.6</td>
<td>14.9 ± 3.9</td>
<td></td>
</tr>
</tbody>
</table>

NOTE: Normal indicates the peak contact pressure of the normal meniscus. A positive percentage difference indicates a higher peak contact pressure than the normal meniscus. Measurements are presented as mean ± standard deviation.

*It was impossible to assess peak contact pressure because of the detection limit of the capacitive contact sensor.
pressure and contact surface area improved after all-inside fixation, the results from this study suggest that pullout fixation is recommended. Moreover, pullout fixation remains widely accepted and was shown to provide clinically favorable outcomes in MMPRTs. Future studies should examine the clinical outcomes after all-inside fixation of MMPRTs.

In a study of tibiofemoral contact biomechanics using human knees with MMPRTs under a 1,000-N axial compression force, anatomic pullout fixation provided a mean peak contact pressure that was higher by approximately 26% and a mean contact surface area that was lower by approximately 17% compared with the values noted in the intact knee; on the other hand, anatomic pullout fixation provided a mean peak contact pressure decrease of approximately 26% and a mean contact surface area increase of approximately 40% compared with the values noted under MMPRT conditions at all flexion angles analyzed (0°, 30°, 60°, and 90°). In a biomechanical study using porcine knees with MMPRTs under a 1,500-N axial compression force, pullout fixation also achieved decreased peak contact pressure and increased contact surface area compared with the values noted under MMPRT conditions.

Porcine knees were used in our study because key anatomic features and functional characteristics are similar to those of human knees; however, porcine models are commonly used in biomechanical studies of the meniscus. Tibiofemoral contact mechanics were measured at various flexion angles (0°, 30°, 60°, and 90°) to reproduce environments similar to those in the human knee. Other biomechanical studies also evaluated such flexion angles. Furthermore, the axial compression force (1,000 N) loaded in this study is the same as that used in other studies. Nevertheless, caution should be exercised when extrapolating the conclusions of this study in pigs to clinical practice in humans because the basic characteristics and functioning of porcine knees differ from those of human knees.

In this study a capacitive contact sensor was used for measurements instead of a resistive sensor because a capacitive contact sensor has a lower detection error.

Table 3. Percentage Difference in Contact Surface Area Between Normal and Subsequent Root Conditions

<table>
<thead>
<tr>
<th>Flexion Angle</th>
<th>Normal, cm²</th>
<th>Root Tear</th>
<th>Simple</th>
<th>Modified Mason-Allen</th>
<th>All Inside</th>
</tr>
</thead>
<tbody>
<tr>
<td>0°</td>
<td>4.999</td>
<td>−33.7 ± 6.1</td>
<td>−19.4 ± 13.5</td>
<td>−14.7 ± 11.1</td>
<td>−22.4 ± 13.1</td>
</tr>
<tr>
<td>30°</td>
<td>4.738</td>
<td>−34.3 ± 8.3</td>
<td>−20.7 ± 5.6</td>
<td>−14.2 ± 5.8</td>
<td>−28.7 ± 9.6</td>
</tr>
<tr>
<td>60°</td>
<td>4.832</td>
<td>−31.9 ± 10.3</td>
<td>−13.1 ± 11.6</td>
<td>−11.1 ± 6.9</td>
<td>−24.1 ± 7.1</td>
</tr>
<tr>
<td>90°</td>
<td>5.002</td>
<td>−54.3 ± 2.4</td>
<td>−24.1 ± 5.7</td>
<td>−19.9 ± 4.4</td>
<td>−30.1 ± 6.5</td>
</tr>
</tbody>
</table>

NOTE: Normal indicates the contact surface area of the normal meniscus. A negative percentage difference indicates a lower contact surface area than the normal meniscus. Measurements are presented as mean ± standard deviation.
(force detection with error between − 3% and +5%), higher reproducibility, and higher load transmission performance than a resistive contact sensor (force detection with error between −12% and +20%), which is the type of sensor (Tekscan, Boston, MA) used in a previous study.1,2 Therefore, the data acquired in our study are estimated to be more accurate. The strength of this study is that it investigated tibiofemoral contact mechanics obtained using various fixation methods, whereas previous studies typically reported failure loads according to suture constructs.6,7,21,22

Limitations

Several limitations of this study should be mentioned. First, as noted earlier, porcine knees were used in this study, and tibiofemoral contact mechanics after fixation of MMPRTs in pigs may not entirely correspond to those of human knees. The human knee moves dynamically through a wide range of flexion angles and directions, and the axial compression load used in this study might not reflect the behavior of the knee during real-life functional activities. Nonetheless, the results regarding the relative performance of the fixation methods are unlikely to have been biased by the use of a porcine model. Second, the results were based on an in vitro biomechanical experiment and time 0 results, not accounting for biological factors such as healing status, hoop tension, or cartilage status. The question of what repair provides the most robust resistance to mechanical stress is not best answered by measuring the peak contact pressure or contact surface area at time 0 but rather by measuring displacement under cyclic loading.8 In addition, this study did not analyze how the distances between the tear and root attachment influence the clinical indication for conversion to an inside-out technique. Third, although our power calculation is expected to be sufficient to determine improvements between the pre- and post-fixation states, the limited number of specimens did not provide sufficient power to accurately assess the differences in outcomes between fixation groups, which may be affected by a β or type II error. Ninety-five percent confidence intervals could not be provided because a nonparametric test was used for statistical analysis. Fourth, under MMPRT conditions, the peak contact pressure at 90° of flexion exceeded the upper detection limit of the capacitive contact sensor, so exact outcomes could not be assessed in this case. Fifth, although we expected to find a linear inverse relation between the peak contact pressure and contact surface area among the various fixation methods, no such relation was found, which may be related to the described limitations. Sixth, the Fastfix 360 device requires polymer bars to be left in the intra-articular space after fixation, not in the extracapsular space, which may limit the clinical applicability of our findings regarding fixation with the Fastfix system.

Seventh, the number of clinical cases in which an all-inside fixation is feasible may be small, so such a procedure may be uncommon in clinical practice. Moreover, no reference was provided for all-inside fixation of MMPRTs using the Fastfix system. In the future, the clinical outcomes of all-inside fixation should be evaluated. Eighth, the suture materials used in pullout fixation and all-inside fixation were No. 2 FiberWire and No. 2-0 Ultrabraid sutures, respectively, which might be associated with differences in outcomes; nonetheless, we expect that such bias is not substantial because no damage or deformity of the suture materials was noted. Ninth, an anterior and posterior capsular incision at the meniscofemoral junction was performed to insert the contact sensors, which might have influenced knee stability; however, the critical ligamentous structures were preserved, showing no instability, and the procedures used in our experiment are similar to those used in a previous study.10

Conclusions

The peak contact pressure and contact surface area improved significantly after fixation, regardless of the fixation method, but did not recover to the levels noted in the normal meniscus after any type of fixation. Among the fixation methods evaluated in this time 0 study, fixation using modified Mason-Allen sutures provided a superior contact surface area compared with that noted after fixation using simple sutures or all-inside fixation, except at 60° of flexion. However, this study had insufficient power to accurately detect the differences between the outcomes of various fixation methods.

References


