Electronic Measurement of Soft-Tissue Balancing Reduces Lateral Releases in Total Knee Arthroplasty


Abstract

Soft tissue balancing during total knee arthroplasty (TKA) has a direct affect on patello-femoral tracking and knee range of motion, which are necessary for a well functioning TKA postoperatively. We report on the use of an electronic pressure sensing instrument for soft tissue balancing of the knee before completion of all intraoperative bone cuts, as a way to improve patellar tracking. In a retrospective study of 99 consecutive TKAs, with intraoperative electronic instrument guided soft tissue balancing performed, a reduction in the incidence of lateral patellar retinacular release was found, as compared with the 100 consecutive TKAs prior to its use (5.5% v 12%, respectively). Electronic measurement of soft tissue balancing during TKA reduced the need for lateral patellar retinacular release.

Total knee arthroplasty (TKA) is a highly successful procedure that can reduce pain and improve range of motion and function by correcting angular deformities and restoring the integrity of articulating surfaces. Soft tissue balance and accurate patellar tracking are an integral part of any successful TKA. Patellofemoral maltracking remains a common complication after TKA, particularly in valgus deformity. Over the past 3 decades, different instrumentation systems have been developed to make the outcome of a TKA more reproducible and predictable. This instrumentation focused on cutting guides and alignment tools and, more recently, on incorporating the use of computer navigation and robotics. These technologies rely heavily on bony measurements and cuts to restore alignment to the damaged articulation. They are not designed to integrate soft-tissue balancing into consideration. This is an important limitation, because the knee is an inherently unstable joint that depends on soft-tissue integrity and balance to achieve stability and optimal function. Instability results in accelerated wear of the articular cartilage, as demonstrated in the premature osteoarthrosis seen in anterior cruciate ligament deficient knees.

Precision bone cuts lead to a more accurate prosthesis fit, but they do not guarantee optimal range of motion or joint stability. A well aligned prosthesis must also be accompanied by good ligament balance to produce the best functional results. Otherwise, there are potential complications involving knee instability, which may lead to aseptic loosening, accelerated wear, and premature mechanical failure of the reconstructed joint.

Rotational alignment, particularly of the femoral component about the long axis of the femur, plays a critical role in determining soft-tissue balance of the knee, as well as patellar tracking. Until recently, three conventional referencing methodologies have been used to dictate rotational alignment of the femoral component. They include the transepicondylar axis, Whiteside’s line, and 3° of external rotation off the posterior condyles. Olcott and Scott compared these three intraoperative methods to determine femoral component rotation on 100 TKA procedures. Whiteside’s line, the transepicondylar axis, and a line placed in 3° of external rotation off the posterior condyles were used to plan the femoral bone cuts. The medial and lateral flexion gaps were assessed for asymmetry at 90° of flexion by laminar...
spreader placement. Olcott and Scott concluded there was variable consistency in the three conventional methods and that any single method used to determine rotation carries at least a 10% chance of creating a flexion space asymmetry. Another disadvantage of conventional rotation determinants is their primary concern with bone cuts and the neglecting of soft-tissue balancing as a secondary concern after bone resection has been completed.

The eLibra Dynamic Knee Balancing System™ (Synvasive, El Dorado Hills, California) is a pressure sensor that electronically measures the relative pressures within the medial and lateral compartments before final bony cuts are performed. It guides femoral bone cuts to create the appropriate rotation of the femoral component relative to the longitudinal axis of the femur and, consequently, may reduce the necessity of soft-tissue releases. The eLibra® balancing system can be considered as a soft-tissue management tool that is complementary to traditional bone cutting instrumentation. Previous systems such as the Tensor/Balancer device (Stryker Howmedica Osteonics, Allendale, New Jersey) reported comparable but not improved outcomes to existing techniques.

Before the advent of the eLibra Dynamic Knee Balancing System™, the conventional methodologies dictated the bone cuts be made before patellofemoral tracking was assessed. In cases of lateral patellar subluxation, most surgeons relied on surgical release of the lateral patellar retinacular tissues in order to restore optimal patellar tracking. Though a very simple procedure, it is not a benign one. It is often associated with the division of the lateral geniculate vessels, risk of hematoma, and an increase in potential for avascular necrosis of the patella. We retrospectively compared 99 consecutive cases with the use of the eLibra® pressure sensing device to the 100 TKA consecutive cases prior to its use, to test the hypothesis that it would lead to a reduction in the incidence of lateral retinacular release to TKA.

**Methods and Materials**

A retrospective chart review of all patients who underwent TKA with intraoperative use of the eLibra® device, by two senior surgeons between March 3, 2008, and August 20, 2009, was conducted to analyze the incidence of lateral patellar retinacular release. All patients underwent a traditional parapatellar approach. After the initial distal femur and tibial cuts, the eLibra® soft-tissue force sensor (El Dorado Hills, California) was positioned in the joint between the femur and tibia, and the pressures of the medial and lateral compartments were balanced. At this point, an instrument-guided accurate completion of the remaining cuts was performed. All patients received a nonconstrained cruciate-retaining TKA implant, manufactured by Encore Medical Corporation (San Jose, California). After implantation of components and reduction of the patella, the tourniquet was deflated, and the knee was tested for full range of motion. When confronted with patellar subluxation, a lateral retinacular release was performed to improve patellar tracking. Data collected included gender, date of birth, date of surgery, preoperative diagnoses, operative side, use of eLibra®, and surgical lateral retinacular release. A retrospective review of 100 consecutive TKAs performed before March 3, 2008, was conducted to find the incidence of lateral retinacular release prior to the use of the eLibra® system. Fisher’s exact test was used to compare the rates of lateral release between the different groups. The study was approved by the Institutional Review Board (IRB).

**Results**

Between March 3, 2008, and August 20, 2009, 84 patients underwent 99 TKA (including 15 bilateral) procedures, with intraoperative use of the eLibra® balancing system (Fig. 1). There were 33 males and 51 females, with an average age of 70.9 years (44.3 to 93.0) (Table 1). All patients had a preoperative diagnosis of osteoarthritis (OA), with three patients noted to have posttraumatic OA and two patients developing OA, secondary to septic arthritis. There were 41 operations performed on the left knee and 58 performed on the right. Of the 99 TKA performed with the use of the eLibra®, five lateral retinacular releases were done (5.05%). On review of 100 consecutive TKAs performed by the same authors before the use of the eLibra® system, the incidence of lateral patellar retinacular release was 12% (Table 2). There was no significant difference between the incidence of moderate and severe (angle > 15°) varus and valgus knee deformity between the two cohorts, which were compared in the study. After analysis with Fisher’s exact test, a statistical significant difference in the rate of lateral release was found between both groups (p < 0.05).

**Discussion**

Over the past 3 decades, there have been significant improvements in the precision of bone cuts while the soft-tissue
Table 1: Demographics of Electronic Measurement TKA Patients

<table>
<thead>
<tr>
<th>Characteristics</th>
<th>Result</th>
<th>Totals</th>
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<tbody>
<tr>
<td>Gender</td>
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<td></td>
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<tr>
<td>Male</td>
<td>33</td>
<td>84</td>
</tr>
<tr>
<td>Female</td>
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<td></td>
</tr>
<tr>
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<tr>
<td>Average</td>
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<tr>
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<tr>
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<td>99</td>
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<tr>
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<tr>
<td>Unilateral</td>
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<tr>
<td>Bilateral</td>
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<td>84</td>
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</tbody>
</table>

Table 2: Incidence of Lateral Release

<table>
<thead>
<tr>
<th>TKA Technique</th>
<th>Lateral Releases</th>
<th>Total TKAs</th>
<th>Incidence (%)</th>
</tr>
</thead>
<tbody>
<tr>
<td>Electronic soft tissue</td>
<td>5</td>
<td>99</td>
<td>5.5</td>
</tr>
<tr>
<td>measurement</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>No soft tissue measurement</td>
<td>12</td>
<td>100</td>
<td>12</td>
</tr>
</tbody>
</table>

The balancing aspect of TKA surgery has been left more to that of an “art form.” Conventional methods and instrumentation have been focused on bony alignment, with adjustments to soft tissue performed empirically when deemed necessary. These adjustments are made based on subjective methods of testing, and different surgeons have varying thresholds for intervention in soft-tissue balancing. Furthermore, the surgical approach also has been found to increase the incidence of lateral retinacular release. Bindelglass and Vince reported a decreased need for lateral release with a subvastus approach (27.5%), compared to a parapatellar approach (51.0%). In the current retrospective study, the rate of lateral retinacular release decreased from 12% to 5.5% (p < 0.05), with the intraoperative use of the eLibra® pressure sensor.

There is great variability within the literature as to the incidence of lateral retinacular release during TKA. Stern and colleagues reported on 134 knees that had a preoperative alignment of 10° or more of valgus. They found a lateral retinacular release necessary in 76% of the arthroplasties performed secondary to intraoperative lateral subluxation of the patella. This percentage does not represent an average for experienced TKA surgeons, but does indicate the difficulty that valgus-deformed knees present. Benjamin and Chilvers reported on 99 patients that were not treated with lateral retinacular release, despite medial patellar lift-off. They concluded that patients with medial patellar lift-off at the time of arthroplasty do not appear to require lateral release to yield acceptable postoperative patellofemoral alignment. Fithian and coworkers conducted a scientific survey among experienced knee surgeons who had a specific interest in the patellofemoral joint and found that they reported a 2% rate of lateral retinacular release. However, Kusuma and associates reported a 28% lateral retinacular release rate on 1108 TKA. So, clearly, surgeons are performing these releases more often than they report.

As there is much variability in the incidence of lateral retinacular release, there is also confounding results reported on the complications of the procedure. Kusuma and colleagues found no statistically significant difference in range of motion, Knee Society score, or postoperative complications of patella fracture, subluxation, postoperative manipulation, or wound complications. Scuderi and coworkers demonstrated, in a prospective study, the compromise of patellar viability using technetium-99m. They reported a greater incidence of transient patellar hypovascularity associated with lateral release. Ritter and associates reported increased patellar fracture rates and loosening in TKA in which a lateral release was done.

It is the authors’ belief that a lateral retinacular release is not a benign procedure and should be used only when all other options have been exhausted. In this retrospective study, the rate of lateral retinacular release decreased from 12% to 5.5% with the intraoperative use of the eLibra® pressure sensor. Using the eLibra® technology as a soft tissue management tool gives the surgeon an objective measurement for soft tissue balancing. It bases femoral rotation on soft tissue balance, which leads to better patellofemoral tracking and decreased incidence of lateral retinacular releases.

Disclosure Statement

None of the authors have further financial or proprietary interest in the subject matter or materials discussed, including, but not limited to, employment, consultancies, stock ownership, honoraria, and paid expert testimony.

References


