The Importance of Soft-Tissue Balance in Total Knee Arthroplasty

A CLINICAL AND ECONOMIC LITERATURE REVIEW
The following abstracts, taken from peer-reviewed literature, have proven the clinical and economic benefit of obtaining soft-tissue balance during total knee arthroplasty.
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The Increasing Financial Burden of Knee Revision Surgery in the United States

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ABSTRACT
The popularity of total knee arthroplasty combined with the aging US population indicates a dramatic increase in revision TKA procedures. Our objective was to project revision surgery costs in the United States, and to estimate the financial burden for hospitals historically under-reimbursed for these complex surgical procedures. Inflation adjusted charge data derived from a series of knee revision surgeries performed by a single surgeon practice (CJL) (n = 100) were applied to population projections of the number of revision surgeries expected for the Medicare population from 2005-2030. The average charge of TKA revision surgery was 73,696 dollars, (Cost was 36,848 dollars) with substantially higher costs for patients undergoing surgery because of deep joint infection, patients receiving a three component exchange, and patients receiving hinged or constrained condylar knee implants. The number of revision procedures is expected to increase from 37,544 in 2005 to 56,918 in 2030. Projected hospital costs for these procedures may exceed 2 billion dollars by 2030. The number of revision knee surgeries may increase by 66% in the next 25 years. Reimbursement rates will not cover hospital costs for this procedure despite recent increases in Medicare payments for revision arthroplasty.
Future Young Patient Demand for Primary and Revision Joint Replacement

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ABSTRACT

Previous projections of total joint replacement (TJR) volume have not quantified demand for TJR surgery in young patients (< 65 years old). We developed projections for demand of TJR for the young patient population in the United States. The Nationwide Inpatient Sample was used to identify primary and revision TJRs between 1993 and 2006, as a function of age, gender, race, and census region. Surgery prevalence was modeled using Poisson regression, allowing for different rates for each population subgroup over time. If the historical growth trajectory of joint replacement surgeries continues, demand for primary THA and TKA among patients less than 65 years old was projected to exceed 50% of THA and TKA patients of all ages by 2011 and 2016, respectively. Patients less than 65 years old were projected to exceed 50% of the revision TKA patient population by 2011. This study underscores the major contribution that young patients may play in the future demand for primary and revision TJR surgery.

- Objective: to project the demand of total knee replacement in a young patient population (< 65 years)
- Projections based on historical growth trajectories
- Results: By 2011, patients less than 65 years old are projected to account for 50% of the annual TKA revision population
- Thus, young patients will be a major contributing patient group to the revision burden
What Are the Rates and Causes of Hospital Readmission After Total Knee Arthroplasty?

Steven M. Kurtz PhD, Edmund Lau MS, Kevin Ong PhD, Ke Zhao MA MS, Michael Kelly MD, Kevin J. Bozic MD MBA

ABSTRACT

BACKGROUND: Total knee arthroplasty (TKA) and related interventions such as revision TKA and the treatment of infected TKAs are commonly performed procedures. Hospital readmission rates are used to measure hospital performance, but risk factors (both medical and surgical) for readmission after TKA, revision TKA, and treatment for the infected TKA have not been well characterized.

QUESTIONS/PURPOSES: We measured (1) the unplanned hospital readmission rate in primary TKA and revision TKA, including antibiotic-spacer staged revision TKA to treat infection. We also evaluated (2) the medical and surgical causes of readmission and (3) risk factors associated with unplanned hospital readmission.

METHODS: This retrospective cohort study included a total of 1408 patients (1032 primary TKAs, 262 revision TKAs, 113 revision of infected TKAs) from one institution. All hospital readmissions within 90 days of discharge were evaluated for timing and cause. Diagnoses at readmission were categorized as surgical or medical. Readmission risk was assessed using a Cox proportional hazards model that incorporated patient demographics and medical comorbidities.

RESULTS: The unplanned readmission rate for the entire cohort was 4% at 30 days and 8% at 90 days. At 90 days postoperatively, revision of an infected TKA had the highest readmission rate, followed by revision TKA, with primary TKA having the lowest rate. Approximately three-fourths of readmissions were the result of surgical causes, mostly infection, arthrofibrosis, and cellulitis, whereas the remainder of readmissions were the result of medical causes. Procedure type (primary TKA versus revision TKA or staged treatment for infected TKA), hospital stay more than 5 days, discharge destination, and a fluid/electrolyte abnormality were each associated with risk of unplanned readmission.

CONCLUSIONS: Patients having revision TKA, whether for infection or other causes, are more likely to have an unplanned readmission to the hospital than are patients having primary TKA. When assessing hospital performance for TKA, it is important to distinguish among these surgical procedure.

- Objective: to evaluate the medical and surgical causes of unplanned readmission in primary and revision TKA
- 1408 patients evaluated for readmission
- Results: Readmission rates were 4% at 30 days; 8% at 90 days.
- Results: Most readmissions resulted from surgical causes (i.e., infection)
- Results: Patients undergoing revision TKA are more likely to be readmitted for complications that those undergoing primary TKA (P = 0.067)
Instability in Total Knee Arthroplasty: Loose as a Goose

Kenneth A. Krackow MD

ABSTRACT

As total knee arthroplasties last longer and are used in younger patients, as well as for a variety of other reasons, greater interest in postoperative tibiofemoral instability has developed. Initial evaluation emphasizing correlation of symptoms and findings together with elucidation of the specifics of the instability are mandatory. Gap inequality, gap asymmetry, and the causes of each are noted. Soft tissue repair or reconstruction alone has not been very successful for such instabilities. Some aspect of revision with component change is generally necessary, and some correction of alignment, gap features, and other issues, with advancement to a higher order of constraint, will generally be necessary.

• Several principles are necessary when addressing an unstable total knee replacement:
  – The degree of laxity and its causes must be carefully understood (traditionally done with radiograph)
  – Alignment aberrations must be ruled out
  – Symptoms must be meticulously evaluated. Especially pain, when unrelated to mechanical problems
  – Revision is commonly the most appropriate treatment for instability
Causes of Instability After Total Knee Arthroplasty

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ABSTRACT
The purpose of the present study was to characterize the underlying causes that lead to instability after total knee arthroplasty (TKA). We reviewed 83 revision TKAs (79 patients) performed for instability. After detailed analysis of patient’s history, physical examination, operative report and radiographs, we identified six categories: flexion/extension gap mismatch, component malposition, isolated ligament insufficiency, extensor mechanism insufficiency, component loosening, and global instability. Twenty-five knees presented with multi-factorial instability. When these knees were classified according to the most fundamental category, each category above included 24, 12, 11, 10, 10 and 16 knees respectively. The unstable TKA may result from a variety of distinct etiologies which must be identified and treated at the time of revision. The revision TKA could be tailored to the specific causes.

- Objective: To determine if the causes of instability can be classified into specific categories, based on causation.
- n=83 revision TKAs
- Results: Unstable TKA can be the result of a variety of etiologies; many patients may present with more than one:
  - Component malpositioning
  - Flexion/Extension mismatch
  - Ligament insufficiency
  - Component loosening
  - Extensor mechanism insufficiency
  - Global instability
Accuracy of Soft Tissue Balancing in Total Knee Arthroplasty

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ABSTRACT

To the best of our knowledge, this is the first study to assess the accuracy of balancing of the flexion and extension gaps in total knee arthroplasty (TKA). Measurements of the heights of the flexion and extension gaps were obtained during 104 consecutive primary, posterior-stabilized TKAs in osteoarthritic patients. Clinically, all knees appeared to be well balanced intraoperatively. Rectangular flexion and extension gaps almost always were obtained within 1 mm (84%-89%). None of the knees was >3 mm from being perfectly rectangular. Equality of the flexion and extension gaps was more difficult to obtain (47%-57% were within 1 mm). With meticulous attention, perfect soft tissue balance is not always achieved in TKA.

- Objective: To determine the accuracy of soft-tissue balancing of flexion and extension gaps in TKA
- n=104 knees (consecutive)
- Knees were “perfectly balanced” when the flexion and extension gaps exhibited a perfectly rectangular shape
- Results: Even with meticulous attention, soft-tissue balanced is not always achieved.
ABSTRACT

The incidence of failure after knee replacement is low, yet it has been reported that more than 22,000 knee replacements are revised yearly. The purpose of the current study was to determine current mechanisms of failure of total knee arthroplasties. A retrospective review was done on all patients who had revision total knee arthroplasty during a 3-year period (September 1997-October 2000) at one institution. The preoperative evaluation in conjunction with radiographs, laboratory data, and intraoperative findings were used to determine causes of failure. Two hundred twelve surgeries were done on 203 patients (nine patients had bilateral surgeries). The reasons for failure listed in order of prevalence among the patients in this study include polyethylene wear, aseptic loosening, instability, infection, arthrofibrosis, malalignment or malposition, deficient extensor mechanism, avascular necrosis in the patella, periprosthetic fracture, and isolated patellar resurfacing. The cases reviewed included patients who had revision surgery within 9 days to 28 years (average, 3.7 years) after the previous surgery. More than half of the revisions in this group of patients were done less than 2 years after the index operation. Fifty percent of early revision total knee arthroplasties in this series were related to instability, malalignment or malposition, and failure of fixation.

- Objective: To determine why TKAs fail
- n=212 knees (consecutive revisions)
- Results: Causation for revision listed from most to least prevalent:
  - Polyethylene wear
  - Loosening
  - Instability
  - Infection
  - Arthrofibrosis
  - Malalignment/Malpositioning
  - Extensor mechanism deficiency
  - AVN – patella
  - Periprosthetic fracture
  - Isolated patellar resurfacing
Results of Revision Surgery and Causes of Unstable Total Knee Arthroplasty

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ABSTRACT

BACKGROUND: The aim of this study was to evaluate causes of unstable total knee arthroplasty and results of revision surgery.

METHODS: We retrospectively reviewed 24 knees that underwent a revision arthroplasty for unstable total knee arthroplasty. The average follow-up period was 33.8 months. We classified the instability and analyzed the treatment results according to its cause. Stress radiographs, postoperative component position, and joint level were measured. Clinical outcomes were assessed using the Hospital for Special Surgery (HSS) score and range of motion.

RESULTS: Causes of instability included coronal instability with posteromedial polyethylene wear and lateral laxity in 13 knees, coronal instability with posteromedial polyethylene wear in 6 knees and coronal and sagittal instability in 3 knees including post breakage in 1 knee, global instability in 1 knee and flexion instability in 1 knee. Mean preoperative/postoperative varus and valgus angles were 5.8°/3.2° (p = 0.713) and 22.5°/5.6° (p = 0.032). Mean postoperative $\alpha$, $\beta$, $\gamma$, $\delta$ angle were 5.34°, 89.65°, 2.74°, 6.77°. Mean changes of joint levels were from 14.1 mm to 13.6 mm from fibular head (p = 0.82). The mean HSS score improved from 53.4 to 89.2 (p = 0.04). The average range of motion was changed from 123° to 122° (p = 0.82).

CONCLUSIONS: Revision total knee arthroplasty with or without a more constrained prosthesis will be a definite solution for an unstable total knee arthroplasty. The solution according to cause is very important and seems to be helpful to avoid unnecessary over-constrained implant selection in revision surgery for total knee instability.

- Objective: To evaluate the causes of revision surgery, and surgical outcomes, of unstable knees
- n=24 knees
- Results: Causation for revision listed from most to least prevalent:
  - Coronal instability
  - Coronal/sagittal instability (combined)
  - Global instability
  - Flexion instability
- Revision surgery for instability is a definite solution. Matching the appropriate revision type to the cause for revision is crucial to post-operative clinical outcomes
Component Rotation and Anterior Knee Pain After Total Knee Arthroplasty

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ABSTRACT

All patients undergoing cruciate-retaining primary total knee arthroplasty for degenerative osteoarthritis at one center were studied prospectively. Clinical and radiographic followup was obtained at a minimum 5 years in 102 knees in 73 patients. Patients were asked specifically about the presence of the pain in the anterior aspect of the knee in the vicinity of the patella and rated the severity of the pain on a visual analog scale. Significant anterior knee pain rating at least 3 of 10 on the visual analog scale was present in 16 knees (13 patients). Eleven patients with 14 symptomatic knees agreed to undergo computed tomography scanning to accurately determine the rotation of the tibial and femoral components. The epicondylar axis and tibial tubercle were used as references using a previously validated technique. A control group of 11 asymptomatic patients (14 knees), matched for age, gender, and length of followup also underwent computed tomography scanning. All patients in both groups had normal axial alignment. There was a highly significant difference in tibial component rotation between the two groups with the patients with anterior knee pain averaging 6.2 degrees internal rotation compared with 0.4 degrees external rotation in the control group. There also was a significant difference in combined component rotation with the patients with anterior knee pain averaging 4.7 degrees internal rotation compared with 2.6 degrees external rotation in the control group. There was no significant difference in the degree of radiographic patellar tilt or patellar subluxation between the two groups. Patients with combined component internal rotation were more than five times as likely to experience anterior knee pain after total knee arthroplasty compared with those with combined component external rotation. Component malrotation is a significant factor in the development of anterior knee pain after total knee arthroplasty.

- Objective: To use a CT scan protocol to evaluate the relationship between anterior knee pain and component rotation in TKA
- n=102 knees
- Results: The CT analysis supports the hypothesis that anterior knee pain is associated with component malrotation.
- Results: Of the patients who described knee pain, there was an average component incongruency of 6.2° of internal rotation
MRI Evaluation of Rotational Alignment and Synovitis in Patients with Pain After Total Knee Replacement

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ABSTRACT

Component malalignment can be associated with pain following total knee replacement (TKR). Using MRI, we reviewed 50 patients with painful TKRs and compared them with a group of 16 asymptomatic controls to determine the feasibility of using MRI in evaluating the rotational alignment of the components. Using the additional soft-tissue detail provided by this modality, we also evaluated the extent of synovitis within these two groups. Angular measurements were based on the femoral transepicondylar axis and tibial tubercle. Between two observers, there was very high interobserver agreement in the measurements of all values. Patients with painful TKRs demonstrated statistically significant relative internal rotation of the femoral component (p = 0.030). There was relative internal rotation of the tibial to femoral component and combined excessive internal rotation of the components in symptomatic knees, although these results were significant only with one of the observers (p = 0.031). There was a statistically significant association between the presence and severity of synovitis and painful TKR (p < 0.001). MRI is an effective modality in evaluating component rotational alignment.

• Objectives: To understand if MRI can be used to determine rotational alignment of TKA components, and to compare the prevalence of synovitis in symptomatic and asymptomatic patients.
• n=50 painful TKA patients; 16 control patients
• Angular measurements based on femoral transepicondylar axis and tibial tubercle.
• Results: Patients with painful TKA showed significant internal rotation of the femoral component (P=0.030), as well as combined internal rotation of both components (P=0.031).
• There was a significant association between painful TKA and the presence of synovitis
• MRI is a useful tool in evaluating tibial rotation
Malrotation Causing Patellofemoral Complications After Total Knee Arthroplasty

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ABSTRACT

Thirty patients with isolated patellofemoral complications after total knee arthroplasty were compared with 20 patients with well functioning total knee replacements without patellofemoral complications. The epicondylar axis and tibial tubercle were used as references on computed tomography scans to measure quantitatively rotational alignment of the femoral and tibial components. The group with patellofemoral complications had excessive combined (tibial plus femoral) internal component rotation. This excessive combined internal rotation was directly proportional to the severity of the patellofemoral complication. Small amounts of combined internal rotation (1 degree-4 degrees) correlated with lateral tracking and patellar tilting. Moderate combined internal rotation (3 degrees-8 degrees) correlated with patellar subluxation. Large amounts of combined internal rotation (7 degrees-17 degrees) correlated with early patellar dislocation or late patellar prosthesis failure. The control group was in combined external rotation (10 degrees-0 degree). The direct correlation of combined (femoral and tibial) internal component rotation to the severity of the patellofemoral complication suggests that internal component rotation may be the predominant cause of patellofemoral complications in patients with normal axial alignment. The epicondylar axis and tibial tubercle are reproducible landmarks which are visible on computed tomography scans and can be used intraoperatively. Using this computed tomography study can determine whether rotational malalignment is present and thus, whether revision of one or both components may be indicated.
Patellar Tracking After Total Knee Arthroplasty: The Effect of Tibial Tray Malrotation and Articular Surface Configuration

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ABSTRACT
The effect of total knee arthroplasty (TKA) with neutrally aligned and malrotated tibial trays were studied in five fresh anatomic specimen knees. Patellar shift, tilt, and rotation, and the rotational position of the tibia were measured in normal knees and after TKA with the Ortholoc Modular knee system. Both semiconstrained and unconstrained articular surfaces were assessed in the neutral position and at anatomic, 15 degrees internal, and 15 degrees external rotation of the tibial tray. After TKA, the patellae shifted slightly medially in the early phase of knee flexion because the anterior lateral flange of the femoral component was longer than the lateral trochlea of the femur and because the tibia rotated internally. The raised lateral flange on the femoral component tilted the patella medially at full extension after TKA. The semiconstrained tray allowed minimal tibial rotation because of its articular configuration. As much as 15 degrees malrotation of the unconstrained tibial tray did not affect patellar tracking. The semiconstrained tibial tray in the neutral position had almost the same patellar tracking as the unconstrained tray, but at 15 degrees external rotation, the semiconstrained tray internally rotated the tibia, leading to medial shift of the patella. Although 15 degrees internal rotation caused external rotation of the tibia, the patella did not shift as much laterally, despite the increase in the Q angle.

• Objectives: To determine the effects of component rotation in semiconstrained and unconstrained liners of a modular knee system, versus normal, non-TKA knees
• n=5 fresh cadaver knees
• Neutral position, 15° of internal rotation and 15° of external rotation were evaluated
• Results: Even the semiconstrained components exhibited medial patellar shift when at 15° of external tibial rotation.
Early Revision for Component Malrotation in Total Knee Arthroplasty

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ABSTRACT

Component malrotation may result in unsuccessful total knee arthroplasty. We asked whether revision improves function in patients with malrotated total knee arthroplasty components. We retrospectively reviewed 22 revision total knee arthroplasties performed for femoral and/or tibial component malrotation. Revision surgery was performed within 2 years of the primary arthroplasty in 81% of the cases (18 of 22) with the remainder within 5 years. Although all patients had pain, 32% of patients had associated instability and 36% of patients had poor range of motion. Average Knee Society Scores improved from 42 preoperatively to 77 postoperatively. Average Oxford Knee Scores improved from 38 preoperatively to 29 postoperatively. Although clinical and functional improvement was observed, these results are inferior to those for primary knee arthroplasty, and they emphasize the need for proper component rotational positioning during primary total knee arthroplasty. Internal component malrotation leads not only to patellofemoral problems, but also to difficulty in gap balancing and femoral component sizing, which may in turn lead to either poor range of motion or symptoms of knee instability.

- Objectives: To determine if early revision improves the results for patients with symptomatic malrotation
- n=22 retrospectively reviewed revision TKAs
Alignment in Total Knee Arthroplasty, Still More Questions Than Answers…

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Objectives: To review the existing literature surrounding technology use in obtaining alignment during TKA

Results: Computer-assisted surgery (navigation) significantly reduces the number of positioning outliers, however it has yet to demonstrate consistent clinical advantages.

Results: Patient specific instrumentation promises the accuracy of navigation, without the need for anatomical mapping. However, there can be mismatch between planning by the engineer and implantation by the surgeon, resulting in intraoperative incongruencies.
Why Are Total Knees Failing Today? Etiology of Total Knee Revision in 2010 and 2011


ABSTRACT

Revision knee data from six joint arthroplasty centers were compiled for 2010 and 2011 to determine mechanism of failure and time to failure. Aseptic loosening was the predominant mechanism of failure (31.2%), followed by instability (18.7%), infection (16.2%), polyethylene wear (10.0%), arthrofibrosis (6.9%), and malalignment (6.6%). Mean time to failure was 5.9 years (range 10 days to 31 years). 35.3% of all revisions occurred less than 2 years after the index arthroplasty, 60.2% in the first 5 years. In contrast to previous reports, polyethylene wear is not a leading failure mechanism and rarely presents before 15 years. Implant performance is not a predominant factor of knee failure. Early failure mechanisms are primarily surgeon-dependent.

- Objectives: To evaluate the failure mechanism and time-to-failure in a cohort of patients in order to understand if reasons for revision have change in the past 10-15 years.
- n=844 knees (retrospectively reviewed)
- Results: Mean time to revision: 5.9 years, over 1/3 of revisions occurring within in the first year
- Results: Most common modes of failure (in descending order of prevalence)
  - Aseptic loosening
  - Instability
  - Polyethylene wear
  - Arthrofibrosis
  - Malalignment
- Implant performance is not a foremost factor in revision. Early failure is typically surgeon-dependent.
Does Knee Alignment Effect Gait in Patients With Severe Osteoarthritis?

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ABSTRACT

BACKGROUND: Patients with knee osteoarthritis present an altered gait pattern. Amongst many factors, the lower limb alignment (varus, valgus) has been identified as an important risk factor for the progression of knee osteoarthritis. Among the large number of studies on knee osteoarthritis gait, only a few have included patients with a valgus deformity. The aims of this study were to determine how knee alignment influences full-body gait in patients with knee osteoarthritis and if knee malalignment is associated with pain and functional capacity.

METHODS: Sixty patients with severe knee osteoarthritis scheduled for a total knee arthroplasty were included in this study. Twenty-six subjects were recruited as the control group. The spatio-temporal parameters, three-dimensional full-body kinematics, and lower body kinetics were evaluated during a comfortable gait and compared between the groups. Pain and function were assessed with the WOMAC questionnaire.

FINDINGS: The full-body gait analysis demonstrated substantially different gait patterns and compensation mechanisms between the three groups. Patients with varus knee alignment significantly augmented their trunk movements in sagittal and frontal planes compared to patients with a valgus knee. In addition, patients with a valgus knee reported lower pain and lower functional deficits compared to patients with a varus knee.

INTERPRETATION: We found that gait compensations were significantly influenced by lower limb alignment. These new insights related to different knee osteoarthritis gait patterns might help in the understanding of gait compensation behaviours prior to total knee arthroplasty and better manage the strategies of rehabilitation following surgery.

- Objectives: To determine if different gait compensations are observed depending on knee alignment
- n=60 (46 varus/14 valgus)
- Results: Substantially different gait patterns were exhibited in varus and valgus patients.
- Knowing gait compensation patterns prior to surgery may help to establish appropriate rehabilitation mechanisms following TKA
Effect of Body Mass Index on Limb Alignment After Total Knee Arthroplasty

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ABSTRACT

Prior studies have reported increased failure rates in obese patients with postoperative limb mal-alignment. This study was undertaken to determine if a relationship exists between postoperative limb alignment and BMI in patients undergoing primary TKA performed with mechanical instruments. An IRB-approved retrospective review of 196 knees was undertaken. Limb alignment was determined on full-length, standing, hip-to-ankle x-rays, preoperatively and postoperatively. The effects of gender, side, preoperative mechanical alignment and BMI on postoperative alignment were analyzed via multivariate regression analysis. Both preoperative mechanical limb alignment (P<0.001) and BMI (P=0.009) had a significant effect on postoperative limb alignment following TKA performed with mechanical instruments.

- Objectives: To determine incidence of malaligned knees in obese patients.
- n=196 consecutive knees
- Results: BMI had a significant, unfavorable effect on limb alignment during TKA (P=0.009)
Bone Anatomy and Rotational Alignment in Total Knee Arthroplasty

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ABSTRACT

The purpose of the current study was to investigate the bone anatomy in determining the rotational alignment in total knee arthroplasty using computed tomography. Axial images of 109 knees in 83 patients with varus osteoarthritis who had total knee arthroplasty were analyzed. On the images of the distal femur and the proximal tibia, a baseline for the anteroposterior axis of each component was drawn based on the epicondylar axis for the femur and the medial (1/3) of the tibial tuberosity for the tibia. The angle between these two lines was analyzed as the rotational mismatch between the components when they were aligned to the anatomic landmarks of each bone. Fifty-four knees (49.5%) had an angle of 5 degrees or greater and 13 knees (11.9%) had an angle of 10 degrees or greater. There was a tendency to align the tibial component in external rotation relative to the femoral component. The results indicated that the landmarks of each bone were the intrinsic cause of the rotational mismatch in knees with varus osteoarthritis. Surgeons doing total knee arthroplasties should be aware of this and check the rotational mismatch between the components. When it is present, the tibial component should be realigned to match the femoral component rotation to minimize problems caused by the mismatch.

- Objectives: To evaluate CT scans and determine the level of malrotation prevalent when the TKA components were aligned to bony landmarks
- n=109 knees
- Reference points for rotation were the transepicondylar axis and the medial 1/3 of the tibial tubercle
- Results: There was a tendency for the tibial component to be externally rotated relative to the femoral component
- The results demonstrate that the use of bony landmarks contributes to rotational component mismatch
Dynamic Ligament Balancing in Total Knee Arthroplasty

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ABSTRACT

Complications after total knee arthroplasty, such as malalignment, instability, and excessive wear, have been attributed to poor soft tissue balance. Traditional instruments that assist in intraoperative soft tissue balancing rely on static measurements. We used a custom tibial trial, instrumented with force transducers, for dynamic measurement of soft tissue balance. Six cadaver knees and two patients were implanted with the trial tray along with a standard femoral component and a tibial insert. We recorded tibial forces during passive knee flexion, after the initial bone cuts were made, after soft tissue balancing, and after replacing the selected optimal insert with one that was 2 mm thicker. In all knees, substantial imbalance in tibial forces initially was recorded. Soft tissue balancing substantially reduced the imbalance. Although reasonable balance was achieved at 0-degree and 90-degree flexion, there was some measurable imbalance at flexion angles other than 0 degrees and 90 degrees. Increasing the thickness of the insert by 2 mm substantially increased net tibial forces. Inconsistent soft tissue balance may explain some of the wide variation in knee kinematics. Surgical navigation systems have reduced the variability in component alignment. An instrumented tibial trial can be a valuable adjunct to directly measure soft tissue balance.

- Objectives: To determine if standard soft-tissue balancing techniques result in a symmetrical distribution of forces across the medial and lateral compartments of the tibial plateau
- n=6 cadaver knees; 2 patient knees
- Custom prosthesis was outfitted with 4 force plates, one in each quadrant of the tibial tray. Rectangular flexion gap was end point of balance. All loads were recorded, as shown by the force transducers.
- Results: in all knees, initial imbalance between the two compartments was substantial. Soft-tissue balancing substantially decreased imbalance.
- Instrumented trials may be useful in measuring soft-tissue balance
Gap Balancing Versus Measured Resection Technique for Total Knee Arthroplasty

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ABSTRACT

Multiple differing surgical techniques are currently utilized to perform total knee arthroplasty (TKA). We compared knee arthroplasties performed using either a measured resection or gap balancing technique to determine if either operative technique provides superior coronal plane stability as measured by assessment of the incidence and magnitude of femoral condylar lift-off. We performed 40 TKA using a measured resection technique (20 PCL-retaining and 20 PCL-substituting) and 20 PCL-substituting TKA were implanted using gap balancing. All subjects were analyzed fluoroscopically while performing a deep knee bend. The incidence of coronal instability (femoral condylar lift-off) was then determined using a 3-D model fitting technique. The incidence of lift-off greater than 0.75 mm was 80% (maximum, 2.9 mm) and 70% (maximum, 2.5 mm) for the PCL-retaining and substituting TKA groups performed using measured resection versus 35% (maximum, 0.88 mm) for the gap-balanced group. Lift-off greater than 1 mm occurred in 60% and 45% of the PCL-retaining and -substituting TKA using measured resection versus none in the gap-balanced group. Rotation of the femoral component using a gap balancing technique resulted in better coronal stability which we suggest will improve functional performance and reduce polyethylene wear.

- Objective: To determine whether a measured resection or gap balancing technique would result in (1) a higher incidence of coronal plane instability, as measured by the presence of femoral condylar lift-off greater than both 0.75 mm and 1.0 mm; (2) a greater mean maximum lift-off; (3) a greater maximum lift-off; and (4) a differing lift-off location.
- n=60 selected patients who had TKA performed using one of two operative techniques.
- 40 TKAs were performed using a measured resection technique (20 PCL-retaining and 20 PCL-substituting) and 20 TKAs were performed using gap balancing (20 PCL-substituting). Each patient was asked to perform a deep knee bend from full extension to maximum knee flexion while under fluoroscopic surveillance.
- Results: The incidence of coronal instability (femoral condylar lift-off) greater than 0.75 mm occurring at any flexion interval analyzed (0°, 30°, 60°, 90°, and maximum flexion) was lower (p = 0.003) in the gap balancing group (7 of 20) than in either group performed using measured resection. The mean maximum femoral condylar lift-off values (p = 0.0003) and the maximum magnitude of femoral condylar lift-off observed at any flexion increment (p = 0.0002) were also lower in the gap balancing group than either measured resection group. There were no major differences in the lift-off location among the three groups.
- This analysis demonstrated less coronal plane instability (incidence and magnitude) in subjects who received a TKA using gap balancing.