What's New in Adult Reconstructive Knee Surgery

Carl A. Deirmengian and Jess H. Lonner


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Specialty Update
What’s New in Adult Reconstructive Knee Surgery

By Carl A. Deirmengian, MD, and Jess H. Lonner, MD

The purpose of this review is to discuss the research presented on selected topics in adult knee reconstruction during the year 2007. The articles referenced in this update were selected from both The Journal of Bone and Joint Surgery (American and British Volumes) and The Journal of Arthroplasty.

Epidemiology
The total number of primary and revision total knee arthroplasties performed in the United States is projected to increase dramatically during the next several decades. Population growth, the increasing use of arthroplasty, and changing demographic patterns interact synergistically toward these projections. In addition to an overall increase in the total number of surgical procedures, it is expected that the proportion of infections and revisions will increase. Publications focusing on future epidemiologic trends in knee arthroplasty are critical for driving future economic and public health policies.

Kurtz et al. projected the expected number of primary and revision hip and knee arthroplasty procedures in the United States from 2005 to 2030. They utilized Nationwide Inpatient Sample data for the years 1990 to 2003 as well as United States Census Bureau data to formulate a model for projecting the number of cases per year. The projection model, taking both surgical prevalence and population data into consideration, predicted a 673% increase in primary total knee arthroplasty to a total of 3.48 million procedures in 2030. Also projected was a 601% increase in revision total knee arthroplasty to a total of 268,000 procedures in 2030. The authors suggested that this massive increase in projected knee arthroplasty procedures will require additional surgeons, improved surgical efficiency, and increased economic resources.

Kurtz et al. in a separate study, quantified the expected future clinical and economic burdens imposed by infections and revisions in patients managed with arthroplasty. Again, the Nationwide Inpatient Sample data along with United States Census Bureau data were used. The authors projected that, from 2005 to 2030, the number of infections after revision total knee arthroplasty will increase from 6400 to 175,500. In comparison, the number of infections after revision total hip arthroplasty will increase from 3400 to 46,000. Additionally, the authors projected that the proportion of revision total knee arthroplasty performed specifically for the treatment of a deep infection will increase from 16.8% in 2005 to 65.5% in 2030. The economic burden resulting from these projections is a 450% increase in hospital charges and a 160% increase in surgical charges from 2005 to 2015 for revision total knee arthroplasty.

Petterson et al. studied the impact of osteoarthritis on male and female candidates for knee arthroplasty. A variety of strength and function scores, including the Short Form-36 and Knee Outcome Survey scores, were used to compare healthy patients of both sexes as well as arthroplasty candidates of both sexes. The authors found that, in addition to the expected baseline differences between healthy patients of both sexes, there was an even larger difference between arthroplasty candidates of both sexes. The authors suggested that this massive increase in projected knee arthroplasty procedures will require additional surgeons, improved surgical efficiency, and increased economic resources.

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Fehring et al. studied the epidemiology of obesity and its relationship to total knee arthroplasty. The authors retrospectively reviewed the body mass index for patients managed with total knee arthroplasty at their institution in 1990, 1995, 2000, and 2005 and compared these data with general population data from the Centers for Disease Control and Prevention. From 1990 to 2005, the proportion of obese patients undergoing total joint arthroplasty at their institution increased from 30% to 52%. In contrast, regional obesity rates during the same time only increased from about 12% to about 22%. The authors also found that, from 1990 to 2005, physician reimbursement for total knee arthroplasty decreased 59% in inflation-adjusted dollars. Identifying the relationship between obesity and the need for total knee arthroplasty is an important factor when considering public health policy and also may prove to be important in the evaluation of physician reimbursement.

**Unicompartmental Arthritis**

While unicompartmental knee arthroplasty offers both the possibility of a more rapid recovery than total knee arthroplasty does as well as a conservative approach to the treatment of knee arthritis by virtue of the preservation of the cruciate ligaments and the maintenance of the non-arthritic compartments, universal endorsement of unicompartmental knee arthroplasty has been tempered by concerns about inferior long-term outcomes and the inherent difficulties of performing the surgery accurately.

Mullaji et al. assessed functional recovery after 100 consecutive quadriceps-sparing medial unicompartmental knee arthroplasty procedures. Inclusion criteria included isolated medial joint line tenderness, isolated medial compartment radiographic changes, an intact anterior cruciate ligament, a flexion deformity of <10°, a correctable varus deformity of <15°, and a body mass index of <30. The mean patient age was fifty-nine years, 31% of the patients were male, and the mean body mass index was 27. Patients younger than seventy years of age received the Oxford mobile-bearing unicompartmental knee arthroplasty (Biomet, Warsaw, Indiana), whereas older patients received the Preservation fixed-bearing unicompartmental knee arthroplasty (DePuy, Warsaw, Indiana). The average hospital stay was 2.1 days, the average time to unassisted walking was 4.3 days, and 95% of the patients could ascend and descend stairs by the second postoperative day. At three months, the mean knee flexion was 139°, with no flexion contractures of >5°. The radiographic results were satisfactory, and there were no reported wound-healing complications, thromboembolic events, or infections.

Sah and Scott reported on the five-year results of forty-eight lateral unicompartmental knee arthroplasty procedures that had been performed through a medial parapatellar approach by a single surgeon. Inclusion criteria included clinical and radiographic changes isolated to the lateral compartment, a flexion contracture of <10°, and a valgus deformity of <10°. Intraoperatively, the states of the patella and anterior cruciate ligament were evaluated for inclusion as well. A variety of lateral unicompartmental knee arthroplasty implants were used. The mean age was sixty-one years, and 80% of patients were female. At a mean of five years, there had been no revisions or soft-tissue complications. All patients with osteoarthritis had an excellent result. Knee and function scores were inferior when the preoperative etiology was posttraumatic arthritis as opposed to osteoarthritis. The authors emphasized the advantages of a medial parapatellar approach, including the ability to inspect the other joint compartments carefully.

Although several studies have demonstrated ten-year survival rates of >90% after medial unicompartmental knee arthroplasty, there remains a concern that certain designs or populations may experience unacceptably high early failure rates. Mariani et al. described their early results after thirty-nine medial unicompartmental knee arthroplasties that had been performed with use of a single design (Preservation) from 2002 to 2004. At nine to twelve months, 38% of the arthroplasties had failed as a result of femoral loosening. Failure did not correlate with any patient or surgery-related factors. The authors hypothesized that, in flexion, edge loading of the tibial component on the posterior condyle of the femoral component exerted an anterior force pushing the femoral component off of the femur as evidenced radiographically.

**Surgical Approaches**

Currently, there is mixed enthusiasm for minimally-invasive approaches and techniques, and there is general agreement that the size of the skin incision has little physiologic benefit on early or long-term outcomes after knee replacement.

Kolisek et al. conducted a prospective, randomized, multicenter study of eighty total knee arthroplasties in which they compared the early results of standard and mini-incision approaches. Patients were divided into groups on the basis of the length of the skin incision, with patients with an incision of <13 cm being placed in the minimal-incision group. The midvastus arthroplasty was used for the minimal-incision group, whereas a combination of approaches was used in the standard-incision (control) group. There were no significant differences between groups in terms of early postoperative scores or blood loss. However, there were four wound complications in the mini-incision group, compared with one in the standard-incision group. It is clear from that study that the length of the skin incision has very little effect on postoperative recovery or blood loss after total knee arthroplasty. The use of smaller incisions may actually compromise wound-healing. If there is a true benefit from minimally-invasive surgery, it likely lies more specifically in the deep dissection of the knee.

King et al. conducted a retrospective review comparing standard and quadriceps-sparing total knee arthroplasty, with an emphasis on early outcomes and the surgical learning curve. The first 100 quadriceps-sparing total knee arthroplasties were compared with forty-five standard total knee arthroplasties...
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that were performed by one high-volume surgeon. The surgeon did not evert the patella or dislocate the tibia in the quadriceps-sparing group. There were no differences between the groups in terms of the physical therapy protocol. The quadriceps-sparing group had a shortened mean hospital stay (2.8 compared with 3.7 days), a higher proportion of discharges to home (95% compared with 33%), less narcotic use, and a higher rate of walking without assistive devices at two and six weeks after surgery. The authors specifically stated that no special efforts were made for the postoperative care of the patients in the quadriceps-sparing group. However, a learning curve was noted with respect to tourniquet times and the accuracy of patellar resection, both of which improved through the course of the study. No complications or radiographic outliers were observed in the quadriceps-sparing group. No data were provided regarding intermediate-term outcomes.

Huang et al. reported on a prospective series of total knee arthroplasty and compared the results with those for a matched group of thirty-five patients who had been managed with a standard approach with a medial parapatellar arthrotomy. The greatest benefit was realized within the first two postoperative weeks, with the quadriceps-sparing group having significantly improved quadriceps strength and range of motion as well as less pain in comparison with the standard total knee arthroplasty group. However, the quadriceps-sparing group had increased tourniquet times (mean, 122 compared with fifty-five minutes) and a higher number of radiographic outliers of implant alignment. The authors recommended the use of minimally invasive techniques to decrease the morbidity after total knee arthroplasty but warned the surgeon of potential difficulties associated with the learning curve.

Tanaavee et al. reported on a prospective series of total knee arthroplasties in which the patients were divided into three groups on the basis of the length of the medial arthrotomy proximal to the patella (1, 2, and 3 cm). All other patient care-related factors, including anesthesia, physical therapy, and pain management protocols, were identical among the groups. The authors found that although range of motion and Knee Society scores were similar between the groups, patients who had the longer arthrotomy (3 cm proximal to the patella) exhibited a significant early delay in time to walking and straight-leg raising. Walter et al. performed a randomized prospective study of 122 consecutive total knee arthroplasties to study the effect of patellar eversion on early function and discharge. One surgeon used a midvastus arthrotomy, with or without patellar eversion, whereas another surgeon used either a midvastus or a parapatellar approach without patellar eversion. The only significant difference between the groups was an earlier time to straight-leg raising for the patients managed with a midvastus approach without patellar eversion. The authors recommended avoidance of patellar eversion during total knee arthroplasty.

Flören et al. also studied the impact of patellar eversion in a retrospective review comparing minimally-invasive and standard total knee arthroplasty. Seventy-four total knee arthroplasties that had been performed through a mini-midvastus approach without patellar eversion were compared with fifty-seven total knee arthroplasties that had been performed through a medial parapatellar approach with patellar eversion. The authors found a lower rate of patellar tendon shortening and patella baja in the group that had not undergone patellar eversion during surgery. The increased rate of patella baja in the standard-approach group (37% compared with 12%) was correlated with increased pain and decreased flexion at one year after surgery.

The ongoing debate about the differences between the midvastus and subvastus surgical approaches has also led to a number of important studies. Berth et al. performed a randomized prospective study of twenty patients undergoing bilateral simultaneous total knee arthroplasty, with the procedure on one side being performed through a subvastus approach and the procedure on the contralateral side being performed through a midvastus approach. At three and six months, there was no difference in the maximal voluntary activation of the quadriceps muscles between extremities. However, limbs in the subvastus group exhibited a higher level of pain until six months after surgery. Kelly et al., in a prospective randomized study of forty-two total knee arthroplasties, compared a standard medial parapatellar approach with a vastus-splitting approach. At six months and five years, there were no functional differences between the groups, although there was a significant increase in the frequency of lateral releases in the standard-approach group. Although electromyographic changes were found in 43% of the knees in the vastus-splitting group, there were no functional consequences of these findings. Furthermore, these electromyographic changes were completely reversed in patients who had had a blunt vastus dissection when studied at five years. These studies indicate that a midvastus or vastus-splitting approach does not lead to a functionally important injury to the vastus medialis muscle.

Navigation and Robotics in Total Knee Arthroplasty

The use of computer-assisted surgery in an effort to improve component and limb alignment continues to be of interest. Bauwens et al. and Mason et al. performed meta-analyses of navigated total knee arthroplasty and found that the risk of limb malalignment was slightly higher in the conventional total knee arthroplasty group. However, the functional outcomes and complication rates were not clearly different. Matziolis et al. and Mullaji et al. used prospectively randomized methods to study the differences in limb and implant alignment between conventional and computer-assisted total knee arthroplasty; both groups of authors found a higher rate of radiographic outliers in association with conventional total knee arthroplasty. The clinical consequences of these small
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Differences are not clear. Novak et al. studied the cost-effectiveness of computer-assisted surgery. On the basis of a review of the literature, they estimated that coronal malalignment of >3° results in an elevenfold increase in revision total knee arthroplasty at fifteen years. Assuming a 14% improvement in coronal alignment in association with computer-assisted total knee arthroplasty, the authors concluded that it is possible that computer-assisted total knee arthroplasty is cost-effective, depending on the exact variability in costs of the computer-assisted system and the variability in revision rates.

Haider et al. and Park and Lee reported on the concepts and techniques of robotic-assisted surgery. However, the field is in its infancy and, while the early reports are encouraging, additional study is necessary to more clearly define the clinical advantages and utility of robotic surgery.

Perioperative Management

The evolution of perioperative pain management and physical therapy protocols has had a profound impact on patient care after total knee arthroplasty. In a prospective randomized study, Parvataneni et al. studied 131 patients undergoing total knee arthroplasty or total hip arthroplasty who were randomized to receive either a multimodal pain protocol or a standard protocol that involved patient-controlled analgesia. The multimodal pain protocol included preemptive analgesia; avoidance of high-dose, short-acting intravenous narcotics; and a periarticular injection of a combination of bupivacaine, morphine, epinephrine, methylprednisolone, and cefuroxime. The percentage of patients who were able to perform a straight-leg raise on the first postoperative day was significantly higher in the multimodal pain protocol group than in the standard protocol group (63% compared with 21%). While the study group demonstrated less narcotic consumption and fewer side effects as well as improved early functional recovery compared with the control group, the pain scores in the two groups were not significantly different.

Rama et al. conducted a meta-analysis of eleven studies in which the use of the tourniquet until wound closure was compared with tourniquet release before closure during total knee arthroplasty. The authors found that early tourniquet release increased the blood loss by a mean of 229 mL and was associated with a greater decrease in hemoglobin concentration after surgery. However, early tourniquet release also resulted in a significant decrease in reoperations for the treatment of hematoma after total knee arthroplasty. Keating et al. reported the results of a prospective randomized trial comparing postoperative vigor and handgrip strength in patients receiving epoetin alfa (Procrit; Ortho Biotech Products, Bridgewater, New Jersey) and those donating autologous blood preoperatively. Multivariate analyses revealed an independent treatment effect in favor of epoetin alfa treatment for the overall change in vigor but not for handgrip strength. The patients who were managed with epoetin alfa also had higher postoperative hemoglobin levels and a decrease in the transfusion rate in comparison with those who predonated autologous blood.

Venous Thromboembolism Prophylaxis

Prophylaxis against venous thromboembolism after total joint arthroplasty continues to be a source of contention, particularly as hospital and nationwide initiatives and protocols are being implemented. The most referenced recommendation, by the American College of Chest Physicians, is thought by many joint arthroplasty surgeons to be based on older data that do not give due emphasis to the complications that may result from anticoagulation. Given the recent advances in rapid recovery protocols, early ambulation, minimally-invasive techniques, and risk-identification protocols, the selection of chemoprophylaxis after total knee arthroplasty is being reexamined.

In May 2007, the Board of Directors of the American Academy of Orthopaedic Surgeons approved a clinical guideline on the prevention of symptomatic pulmonary embolism in patients after joint arthroplasty. This guideline provides evidence-based statements that hinge on the stratification of patients according to the risk of pulmonary embolism and the risk of major bleeding. A summary of the statements can be found at www.aaos.org/Research/guidelines/PE_summary.pdf.

Burnett et al. prospectively evaluated the American College of Chest Physicians 1A protocol for Lovenox (enoxaparin) in a study of 290 consecutive patients managed with total hip arthroplasty or total knee arthroplasty. They found that a ten-day course of Lovenox resulted in major complications in 9% of the patients, including a 5.1% rate of prolonged hospitalization for wound drainage, a 4.7% rate of readmission, a 3.8% rate of symptomatic deep-vein thrombosis, and a 3.4% rate of reoperation for the treatment of wound complications. These values were highly unfavorable compared with the authors’ own historical controls who had been managed with warfarin for anticoagulation. The authors discontinued recruitment of additional patients, terminated the study because of concerns regarding the complications, and considered their outcomes to be a failure of the 1A protocol for Lovenox recommended by the American College of Chest Physicians.

Dorr et al. reported the results of a retrospective study evaluating a multimodal approach to prophylaxis against thromboembolism in patients managed with hip and knee arthroplasty. Patient risk factors were used to stratify patients into treatment groups. Factors that designated a patient as being at high risk included a history of a venous thromboembolic event that had occurred within the previous five years, congestive heart failure that was classified as Class II or III according to the system of the New York Heart Association, atrial fibrillation with cardiac disease and the use of Coumadin (warfarin) preoperatively, recent surgery for the treatment of malignant disease or current adjuvant drug treatment, and thrombophilia (including factor-V Leiden, prothrombin
disorders, protein-C and S deficiency, antithrombin disorders, or hypercoagulability states). Of 970 consecutive patients, 856 were considered low-risk and were managed with aspirin, di- 
pyramidole, or clopidogrel bisulfate and limb-compression 
devices. One hundred and fourteen patients were classified as 
high-risk and were managed with warfarin or low-molecular-
weight heparin and intermittent calf compression. All patients 
had an ultrasound Doppler study performed before discharge 
and were mobilized within twenty-four hours after surgery. 
There were no significant differences between the high and 
low-risk groups with regard to pulmonary embolism or 
symptomatic deep-vein thrombosis. However, wound hema-
tomas were only found in patients receiving warfarin or low-
 molecular-weight heparin. The authors recommended this 
multimodal approach as a method for protecting patients from 
venous thromboembolism while minimizing the risks of 
anticoagulation.

In the study by Brooks et al., 224 patients who un-
derwent total knee arthroplasty with use of spinal anesthesia, 
intermittent compression stockings, and postoperative treat-
ment with low-molecular-weight heparin were compared with 
137 patients who underwent a total knee arthroplasty with an 
indwelling epidural catheter for pain control, intermittent 
compression stockings, and no postoperative chemoprophyl-
axis. Monitoring at three days with venous ultrasound re-
vealed no significant differences between the groups with 
regard to the prevalence of deep-vein thrombosis, with about 
3% of the patients in both groups having a positive study 
demonstrating either proximal or distal thrombi. Pearse et al. 
conducted a retrospective study to compare the rates of deep-
vein thrombosis in patients with and without early mobiliz-
ation after total knee arthroplasty. All patients were managed 
with low-molecular-weight heparin and compression stock-
ings. The prevalence of deep-vein thrombosis in patients 
managed with early mobilization (within twenty-four hours) 
was 1%, compared with 28% in patients who were mobilized 
on the second postoperative day. There was a thirtyfold de-
crease in the risk of deep-vein thrombosis when patients were 
mobilized within the first twenty-four hours. This raises a 
question about whether early mobilization has a greater pro-
phyllactic effect against thromboembolism than chemopro-
phyllaxis does after total knee arthroplasty.

Outcomes After Total Knee Arthroplasty
Collier et al. studied polyethylene tibial bearings that had 
been retrieved from 170 patients after unicompartmental or total 
 knee arthroplasty, with a focus on identifying the main factors 
that contribute to wear after implantation. All tibial bearings 
were retrieved from patients who had had a preoperative varus deformity, and a large variety of implant polyethylene 
types were included. The authors found that wear of the me-
dial tibial bearing of both unicompartmental and total knee re-
placements depended on the same three factors: patient age, 
the postoperative hip-knee-ankle angle, and the shelf age of the 
polyethylene utilized. That study emphasizes the importance of 
limb alignment and polyethylene shelf age to the rate of 
polyethylene wear after total knee arthroplasty.

A number of studies have compared the effect of dif-
f erent implants on the outcome after total knee arthroplasty. 
Bertin compared the clinical and radiographic outcomes of 
225 cruciate-retaining total knee arthroplasties that had been 
performed with use of either a stemmed or pegged cemented 
tibial component. After as many as seven years, both implants 
exhibited excellent clinical and radiographic results, with 98% 
survival at seven years for both implants. Beaupré et al. , in a 
randomized prospective study of eighty-one patients, com-
pared cementless hydroxyapatite-coated tibial implants with 
cemented tibial implants. The only significant difference found 
in that study was slightly more pain in the cementless fixation 
group at six months that resolved at one year. No revisions 
were performed in either group. Duffy et al. retrospectively 
evaluated the fifteen-year results of sixty-five hybrid total knee 
arthroplasties that had been performed with a cementless 
femoral component and a cemented tibial component. The 
authors found a low femoral component survival rate of only 
72% at fifteen years and reported that they have abandoned 
this technique in favor of other implantation methods. Mabry 
et al., in a retrospective study of seventy knees that had had 
aseptic failure of a primary total knee arthroplasty, evaluated 
the ten-year results of revision total knee arthroplasty per-
formed with use of modular fully cemented tibial and femoral 
stemmed components. The five and ten-year survival rates, 
with further revision for aseptic failure as the end point, were 
98% and 92%, respectively.

Outcome studies have also focused on survivorship and 
results in various age groups. Duffy et al. retrospectively re-
viewed fifty-two consecutive total knee arthroplasties that had 
been performed with a cemented press-fit condylar design in 
patients who were fifty-five years of age or younger. After an 
average duration of follow-up of twelve years, there had been 
a total of eight revisions, yielding a predicted survival rate of 
96% at ten years and 85% at fifteen years. Morgan et al. studied a consecutive cohort of eighty total knee arthroplasties 
that had been performed with use of a cemented highly-
congruent fully mobile prosthesis in patients with a mean age 
of 50.7 years. After a mean duration of follow-up of 7.3 years, 
there had been no revisions for aseptic loosening and only one 
revision for polyethylene dislocation. Alfonso et al. retrospectively reviewed twenty-five patients with a minimum age 
of ninety years who had undergone hip or knee replacement. 
Although there was an 8% rate of surgical complications and a 
56% rate of medical complications, the patients experienced 
pain relief and had a slightly higher functional capacity and 
survival rate than did age-matched controls.

The risks and benefits of components designed with the 
intention of promoting or accommodating high flexion after 
total knee arthroplasty have been addressed. In the random-
ized prospective study by Weeden and Schmidt, a standard
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Posterior stabilized total knee arthroplasty was compared with a high-flexion posterior stabilized total knee arthroplasty. After an average duration of follow-up of one year, patients who had received the high-flexion design achieved 13° more flexion in comparison with those who had received the standard design. Also, significantly more patients who had received the high-flexion design had >135° of flexion. The authors concluded that these early results favor the use of femoral components with a high-flexion design, although long-term follow-up is necessary to report on implant survival. Meneghini et al. studied the relationship between the degree of flexion and overall pain and function after total knee arthroplasty. In their retrospective review, they divided 311 total knee arthroplasties into categories of flexion and made correlations with function and pain scores. Patients with >125° of flexion had no benefit in terms of overall knee function, but they did have a higher likelihood of achieving optimal climbing function. The early benefits of high-flexion knee designs may be more apparent as improved outcome tools are generated.

Outcome studies also have focused on disease-specific patient groups in an effort to understand potential outcome effects of differing demographic characteristics or disease states. Krushell and Fingeroth conducted a retrospective study evaluating the five to fourteen-year results of thirty-nine total knee arthroplasties in morbidly obese patients. Although the authors found suboptimal alignment, an increase in the rate of minor wound complications, and a slightly higher rate of late revision, the overall complication rate was low in this morbidly obese group. Additionally, 85% of the patients were satisfied with the outcome. Jordan et al. retrospectively reviewed the results of seventeen total knee arthroplasties that had been performed in limbs affected by poliomyelitis, including eight arthroplasties that had been performed with a posterior-stabilized design, eight that had been performed with a constrained condylar design, and one that had been performed with a hinged design. Despite severe quadriiceps weakness, all patients exhibited a stable knee at an average of forty-two months of follow-up, with no signs of loosening. The authors concluded that despite soft-tissue and osseous abnormalities, improvements in terms of pain and function can be reliably achieved after total knee arthroplasty in patients with poliomyelitis, given that an implant of appropriate constraint is utilized.

Pierson et al., in an interesting retrospective study, evaluated the effect of “overstuffing” the patellofemoral compartment on outcomes after total knee arthroplasty. Preoperative and postoperative anterior patellar displacement, anteroposterior femoral sizing, and combined anteroposterior patellofemoral sizing were measured in 830 knees that had been followed for a minimum of two years after total knee arthroplasty. The authors found that these parameters had very little effect on the need for lateral release during total knee arthroplasty or on postoperative functional results and pain scores. The authors concluded that in their population of patients, patellofemoral “overstuffing” was not a cause of complications and should not be regarded as a reason for revision in the absence of other identifiable causes of failure. Woolson and Kang compared the outcomes of total knee arthroplasties that had been performed by a single attending surgeon in private practice with those that had been performed by the same surgeon with the participation of a resident or a fellow on a teaching service. A retrospective review of 171 total knee arthroplasties revealed no difference in the complication rates or outcomes between the two groups; however, total knee arthroplasties performed at the teaching service had, on the average, a seven-minute longer tourniquet time. The authors concluded that well-supervised residents or fellows can participate in total knee arthroplasty without an increased risk of complications.

Complications

Just as surgical techniques and implants continue to be refined for improved function and survival after total knee arthroplasty, so have the understanding and treatment of complications advanced. The diagnosis and treatment of infection continues to dominate the literature on complications after total knee arthroplasty. However, there have also been substantial refinements of our understanding of patellofemoral complications and stiffness after total knee arthroplasty.

Parvizi et al. retrospectively reviewed the local and systemic complications in 1636 patients within six weeks after primary unilateral hip or knee replacement. Among the 104 major, life-threatening complications, there were twenty-five pulmonary emboli, fourteen cases of acute renal failure, thirty-three cases of tachyarrhythmia, and ten cases of pulmonary edema or heart failure. Ninety percent of the complications occurred within four days after surgery. Although age, obesity, and comorbidities were predictors of these complications, 58% of the patients who had a major complication had no predisposing factors. The authors cautioned against early hospital discharge after joint arthroplasty. Restrepo et al. performed a meta-analysis of eighteen selected publications involving 27,807 patients to analyze the relative risks of simultaneous bilateral total knee arthroplasty. The authors found a higher prevalence of pulmonary embolism (odds ratio, 1.8), cardiac complications (odds ratio, 2.5), and mortality (odds ratio, 2.2) in association with simultaneous bilateral total knee arthroplasty. Staged bilateral total knee arthroplasty had similar rates of complications when compared with unilateral total knee arthroplasty. It is not clear how the time between staged procedures relates to risk, nor is it clear which intraoperative factors contribute to the increased risk associated with simultaneous bilateral total knee arthroplasty.

Fisher et al. identified seventy-one knees (from a group of 1024 primary total knee arthroplasties) that were stiff or painful at one year after the index procedure. This group was compared with a matched control group of 148 nonpainful knees with a well-functioning total knee replacement that had
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had a similar preoperative range of motion to identify patient-related factors that contribute to poor results after total knee arthroplasty. The authors identified female sex, a higher body mass index, previous knee surgery, disability status, diabetes mellitus, pulmonary disease, and depression as being significantly associated with the risk of having stiffness or pain at one year after surgery despite the presence of well-aligned, well-fixed components. The importance of patient-related factors to the eventual outcome of total knee arthroplasty is clear, and these factors should influence preoperative counseling of patients awaiting total knee arthroplasty. Patel et al. conducted a retrospective observational study of 1226 primary total knee arthroplasties to identify the risk factors for prolonged wound drainage after surgery. After considering pharmacological, surgical, and patient-related risk factors, the authors reported that increased drain output was the only identified risk factor for prolonged drainage and that obesity was the only identified risk factor for infection after total knee arthroplasty.

Although infection continues to be one of the more serious complications after total knee arthroplasty, advances in the diagnosis and treatment of infection have led to improved care. Bindelglass and Pellegrino studied the contribution of blood cultures to the management of a patient who has a fever after primary joint arthroplasty. Of 240 patients who had had a total knee arthroplasty, forty had a fever of >101°F (38.3°C) and were evaluated with blood cultures. Only one patient had a positive blood culture, and this was deemed to be a false-positive result without any resulting complication. The authors concluded that blood cultures have limited value in the evaluation of postoperative fevers after total knee arthroplasty. Barrack et al. retrospectively reviewed their experience with unexpected positive intraoperative cultures after revision total knee arthroplasty. In a group of 692 consecutive revision total knee arthroplasties, forty-one patients had unexpected positive cultures. Twenty-nine of these patients had only one positive culture in the absence of any other suspicion for infection, and twenty-four patients from that group were discharged without any additional treatment. At an average of four years, none of these twenty-four patients were found to have an infection. The authors concluded that, in the absence of any suspicion for infection, a single positive intraoperative culture does not mandate additional treatment after revision total knee arthroplasty.

Della Valle et al., in a study of ninety-four painful knees undergoing revision total knee arthroplasty, reported on the use of a uniform protocol for the evaluation of infection. The protocol involved determination of the erythrocyte sedimentation rate (>30 mm/hr), determination of the C-reactive protein level (>10 mg/dL), perioperative synovial fluid aspiration, intraoperative frozen-section analysis (>10 cells per field), and culture. Only one of the forty-one patients who were diagnosed with infection had a negative erythrocyte sedimentation rate and a normal C-reactive protein level before revision. A synovial fluid white blood-cell count of >3000 had an accuracy of 99% for the detection of infection. The authors recommended screening patients for infection on the basis of the preoperative erythrocyte sedimentation rate and C-reactive protein level, followed by aspiration of the joint or intraoperative frozen-section analysis when the results of those two laboratory tests are elevated. Greidanus et al. prospectively evaluated the diagnostic utility of the erythrocyte sedimentation rate and C-reactive protein level tests in the assessment of infection before revision total knee arthroplasty. Of 151 knees undergoing revision total knee arthroplasty, forty-five were diagnosed with infection. Statistical analysis identified an erythrocyte sedimentation rate of ≥22.5 mm/hr and a C-reactive protein level of ≥13.5 mg/L as the optimal positivity criterion. This provides a cutoff at which sensitivity and specificity are optimized, producing the most accurate test results. The authors concluded that both the erythrocyte sedimentation rate (sensitivity, 0.93; specificity, 0.83) and the C-reactive protein level (sensitivity, 0.91; specificity, 0.86) are excellent tests for the detection of infection in patients with pain at the site of a total knee arthroplasty. The authors provided a complete description of test performance, including when the erythrocyte sedimentation rate and C-reactive protein level are considered in isolation or together.

Mittal et al. studied the outcomes after two-stage reimplantation total knee arthroplasty when the original infecting organism was identified as methicillin-resistant staphylococcus. Thirty-seven patients were identified, each of whom had had a two-stage reimplantation with negative cultures at the time of reimplantation. Nine patients had a repeat infection, four with the same organism and five with a different organism. The duration of intravenous antibiotics, a history of previous surgery, and comorbidities were not found to be associated with reinfection. The authors recommended two-stage reimplantation even in the setting of antibiotic-resistant organisms. Freeman et al. retrospectively identified seventy-six patients who had undergone a two-stage reimplantation, with use of either static or articulating spacers, for the treatment of infection. The overall infection-eradication rate was 95% in the articulating spacer group and 92% in the static spacer group. There were no eventual differences in terms of pain scores after revision; however, patients managed with an articulating spacer had a 58% rate of good to excellent functional results, compared with a 36% rate in the static spacer group. The authors stated that the use of articulating spacers may lead to improved functional results after two-stage reimplantation for the treatment of infection.

A large number of studies have focused on the etiology and treatment of stiffness after total knee arthroplasty. The impact of flexion contractures was highlighted by Ritter et al., who evaluated the relationship between loss of extension and outcome in a study of 5622 total knee arthroplasties. As expected, preoperative flexion contracture and greater preoperative pain were risk factors for postoperative flexion contractures. Both hyperextension of >10° and flexion contractures were
associated with the risk of a poor outcome. Keating et al. retrospectively evaluated 113 knees with an average flexion of 70° that had undergone manipulation with the patient under anesthesia at an average of ten weeks after total knee arthroplasty. At five years after manipulation, the average improvement in flexion was 35°, with no difference between patients who had undergone manipulation before and after twelve weeks. The authors recommended manipulation for the achievement of improvement in terms of pain and function in knees with ≤90° of flexion following total knee replacement. Namba and Inacio studied 102 patients who had undergone manipulation under anesthesia within ninety days after total knee arthroplasty and ninety-three patients who had undergone manipulation more than ninety days after total knee arthroplasty. Manipulation was found to improve the range of motion and function in both groups, although greater gains were observed in the early-manipulation group. The authors recommended manipulation for the treatment of stiffness after total knee arthroplasty, even if it was delayed beyond ninety days, although that may increase the risk of periprosthetic fracture or extensor mechanism rupture. Fehring et al. retrospectively evaluated the outcomes after revision total knee arthroplasty for the treatment of painful flexion contractures of >15°. Ten of the fourteen patients who were identified had complete resolution of the flexion contracture after revision, with improvement in range of motion and pain scores.

Evidence-Based Orthopaedics

The editorial staff of The Journal reviewed a large number of recently published research studies related to the musculoskeletal system that received a Level of Evidence grade of I. Over 100 medical journals were reviewed to identify these articles, all of which have high-quality study design. In addition to articles already cited in this update, seven additional level-I articles were identified that were relevant to reconstructive knee surgery. A list of those articles is appended to this review following the standard bibliography. We have provided a brief commentary about each of the articles to help guide your further reading, in an evidence-based fashion, in this subspecialty area.

Carl A. Deirmengian, MD
Jess H. Lonner, MD
Booth, Bartolozzi, Balderston Orthopaedics, Pennsylvania Hospital, 800 Spruce Street, Philadelphia, PA 19107.
E-mail address for J.H. Lonner: LonnerJ@pahosp.com

References


**What’s New in Adult Reconstructive Knee Surgery**


In this randomized, prospective study, navigated total knee arthroplasty was compared with conventional total knee arthroplasty in a group of seventy-one patients with two years of follow-up. A variety of clinical scoring systems, including the Knee Society score and the Oxford knee score, were used to compare thirty patients who had had conventional total knee arthroplasty with thirty patients who had had navigated total knee arthroplasty at two years postoperatively. The authors found that despite having improved radiographic alignment, the patients in the navigated total knee arthroplasty group did not exhibit improved clinical results at two years when compared with patients who had been managed with conventional jig-based total knee arthroplasty. Again, this study revealed no early benefit of navigated total knee arthroplasty, and long-term studies are needed to reveal any improvements in survivorship derived from the improvement in limb alignment.


This prospective trial was performed to evaluate the effect of implant sonication, following the removal of components, on the results of culture after revision or resection total knee arthroplasty. At the time of resection or revision arthroplasty, the implants from 331 patients were sonicated to dislodge the adherent bacterial biofilm from the implant surface. The sonicate-fluid, in addition to periprosthetic tissues, was then sent to the laboratory for standard culture for the acquisition of a microbiologic diagnosis. With use of standard microbiologic criteria for infection, it was found that the sonication technique was more sensitive than standard culture techniques (sensitivity, 78.5% compared with 60.8%; p < 0.001). In fourteen cases, the sonication technique identified a bacterial strain when standard culture techniques did not. The ability of implant sonication to identify a bacterial strain was most impressive in patients receiving two weeks of antibiotics immediately before surgery, with the sensitivity improving from 45% to 75%. The authors concluded that sonication of implants after revision or resection total knee arthroplasty is a more sensitive way to identify a periprosthetic infection. The success of this technique is likely due to the dislodging of bacterial biofilm from the implant surface.


This randomized prospective study of 120 patients was performed to compare mobile and fixed-bearing total knee implants of the same design that were inserted into the same patient during simultaneous bilateral total knee arthroplasty. One-stage bilateral total knee arthroplasty was performed for thirty-two patients with use of the same cruciate-retaining prosthesis. At a minimum of ten years, all living patients were evaluated with regard to anterior knee pain, Knee Society scores, patellofemoral complications and revision rates, patellofemoral function, and patient preference. At the time of the most recent follow-up, there were no differences in range of motion, the Knee Society clinical rating score, revision rates, or anterior knee pain. When patients were questioned, 37% preferred the resurfaced side, 22% preferred the nonresurfaced side, and 41% had no preference between sides. There were three revisions for the treatment of patellofemoral complications, including two in the nonresurfaced group and one in the resurfaced group. The authors concluded that there was no significant difference between patellar resurfacing and no resurfacing during total knee arthroplasty.


This randomized prospective study of 120 patients was performed to compare the early outcomes and complications related to standard and quadriceps-sparing arthroplasty during bilateral total knee arthroplasty. With the anesthetic protocol held constant, the authors found no difference in blood loss, knee scores, functional scores, pain scale scores, or range of motion. However, total knee arthroplasty through a quadriceps-sparing arthroplasty was associated with a longer operating time (95.6 minutes compared with 89.5 minutes; p < 0.0001), a longer tourniquet time (62.8 minutes compared with 54.5 minutes; p < 0.0001), and an increased rate of complications (13% compared with 6%; p < 0.0468). Complications included anterior femoral notching and medial epicondylar avulsion fracture in both groups. The authors concluded that the quadriceps-sparing approach to total knee arthroplasty has no clinical benefit but that it was associated with a higher rate of complications in their practice. This study raises questions about the routine use of the quadriceps-sparing techniques; however, it is important to know whether the surgeons had adequate experience with the quadriceps-sparing approach.


This meta-analysis of randomized controlled studies was performed to evaluate the clinical effect of physiotherapy after total knee arthroplasty. Five studies that qualified for inclusion in the meta-analysis were identified. Outcome measures included functional activities, walking, quality of life, range of motion, and strength. At three to four months after total knee arthroplasty, there was a small to moderate effect size for function after total knee arthroplasty. In addition, physiotherapy resulted in small improvements in range of motion and quality of life at three to four months postoperatively. By one year, these early benefits of physiotherapy were no longer evident. The authors concluded that physiotherapy exercises that are performed soon after total knee arthroplasty result in a short-term benefit for the patient. The short-term benefits of physiotherapy that were not clearly measured in the study included the benefits of gait training and feedback regarding progress and the achievement of milestones after total knee arthroplasty.


A randomized clinical trial was performed to compare the long-term differences between patellar resurfacing and no resurfacing during total knee arthroplasty. One-stage bilateral total knee arthroplasty was performed for thirty-two patients with use of the same cruciate-retaining prosthesis. At a minimum of ten years, all living patients were evaluated with regard to anterior knee pain, Knee Society scores, patellofemoral complications and revision rates, patellofemoral function, and patient preference. At the time of the most recent follow-up, there were no differences in range of motion, the Knee Society clinical rating score, revision rates, or anterior knee pain. When patients were questioned, 37% preferred the resurfaced side, 22% preferred the nonresurfaced side, and 41% had no preference between sides. There were three revisions for the treatment of patellofemoral complications, including two in the nonresurfaced group and one in the resurfaced group. The authors concluded that there was no significant difference between patellar resurfacing and no resurfacing at ten years. It is theoretically possible that a study with more patients and higher statistical power would reveal a significant difference between techniques.