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Total Knee Arthroplasty After Previous Knee Surgery

Expected Interval and the Effect on Patient Age

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Background: With more than 650,000 knee arthroscopies and 175,000 anterior cruciate ligament reconstructions performed annually in the United States, patients presenting for total knee arthroplasty are increasingly likely to have had previous knee surgery. The purpose of this study was to assess the prevalence of previous knee surgery in patients undergoing total knee arthroplasty and to test the hypothesis that patients with previous knee surgery undergo total knee arthroplasty at a younger age.

Methods: All patients undergoing primary total knee arthroplasty over the study period who consented to enroll in a prospective total joint registry were reviewed. Inclusion criteria included a diagnosis of osteoarthritis or posttraumatic arthritis.

Results: Of 1372 patients in the registry, 1286 met inclusion criteria. Twenty-nine percent had a history of knee surgery, and significantly more men (39%) than women (24%) had a history of knee surgery ($p < 0.0001$). Patients with previous knee surgery were significantly younger ($p < 0.0001$) at total knee arthroplasty; the mean age (and standard deviation) was 59 ± 10 years for patients with previous knee surgery compared with 66.6 ± 10.4 years for patients without previous knee surgery. Patients with a history of ligament reconstruction underwent total knee arthroplasty at a significantly younger age ($p < 0.0001$) than patients with a history of other knee surgery; the mean age (and standard deviation) was 50.2 ± 9.1 years for patients with a history of ligament reconstruction and 59.9 ± 9.6 years for patients with a history of other knee surgery. Among patients who had not undergone previous knee surgery, women underwent total knee arthroplasty at a significantly younger age ($p < 0.001$) than men; the mean age (and standard deviation) was 65.4 ± 10.3 years for women and 69.3 ± 10 years for men. However, there was no difference in age between the sexes in those with previous knee surgery; the mean age (and standard deviation) was 58.6 ± 10.1 years for women and 59.6 ± 9.8 years for men. The average interval (and standard deviation) from previous knee surgery to total knee arthroplasty is 13.1 ± 12.6 years, longer in men (17.7 ± 13.8 years) than in women (9.1 ± 9.8 years) ($p < 0.0001$).

Conclusions: Patients with previous knee surgery undergo total knee arthroplasty at a significantly younger age than patients without previous knee surgery, especially men and patients with a history of ligament reconstruction. This may be a factor in the rising demand for total knee arthroplasty. Future investigation to identify those at risk for early total knee arthroplasty after knee surgery and to develop methods to delay or to prevent the need for future total knee arthroplasty in these patients is warranted.

Level of Evidence: Prognostic Level III. See Instructions for Authors for a complete description of levels of evidence.

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A commentary by Adolph V. Lombardi Jr., MD, is linked to the online version of this article at jbsj.org.

The demand for total knee arthroplasty in the United States is expected to rise substantially in the next twenty years, with a concomitant sharp increase in cost^{1,2}. With more than 650,000 knee arthroscopies and approximately 175,000 anterior cruciate ligament (ACL) reconstructions performed annually in the United States^{3,4}, patients presenting for total knee arthroplasty are increasingly likely to have had previous knee surgery. Although there is substantial evidence that injuries such as meniscal and ACL tears are associated with a higher risk for developing knee osteoarthritis⁵⁻⁹, there are relatively limited data on how this risk translates into the potential need for, and timing of, future total knee arthroplasty.

Patients often inquire as to the likelihood of needing a total knee arthroplasty after knee surgery such as ligament reconstruction or partial meniscectomy. Despite a couple of recent studies looking at the temporal relationship between knee arthroscopy and knee arthroplasty^{10,11}, the risk for and timing of total knee arthroplasty after previous knee surgery are not well documented. This is potentially important information to physicians, patients, and health-care systems in terms of understanding the future implications of knee surgery in the adolescent and younger adult populations.

One approach to assess the impact of knee surgery on the need for total knee arthroplasty is to compare the age of patients undergoing total knee arthroplasty with a history of knee surgery to those without a history of knee surgery. This information

could provide data to guide patients, physicians, and health-care systems on how knee surgery in younger patients relates to the timing of potential total knee arthroplasty in the future. The purpose of the present study was to assess the prevalence of previous knee surgery in patients undergoing total knee arthroplasty to determine the interval from previous knee surgery to total knee arthroplasty and to test the hypothesis that patients with a history of knee surgery undergo total knee arthroplasty at a younger age compared with those without a history of knee surgery.

Materials and Methods

Approval for the study was received from the institutional review board. All patients undergoing total knee arthroplasty enrolled in a prospective total joint registry from 1998 through 2010 were reviewed to select patients with a history of osteoarthritis or posttraumatic arthritis. Patients with a diagnosis of osteonecrosis, failed total knee arthroplasty, or inflammatory arthropathy were excluded. Patient age at the time of the total knee arthroplasty, sex, body mass index (BMI), any previous knee surgery, and the type of knee surgery were recorded. History of knee surgery was collected from patient questionnaires administered as part of the standard of care and included in the registry. This information was cross-checked with patients' medical records as part of the current study to confirm a history of knee surgery and the type of knee surgery. The time from previous knee surgery to total knee arthroplasty, when available, was collected from the medical record.

Summary statistics for age at the time of total knee arthroplasty and BMI were calculated for those with a history of knee surgery and those without a history of knee surgery for the overall cohort and were segregated by patient sex. Subgroups by type of previous knee surgery were also analyzed. Two-sample

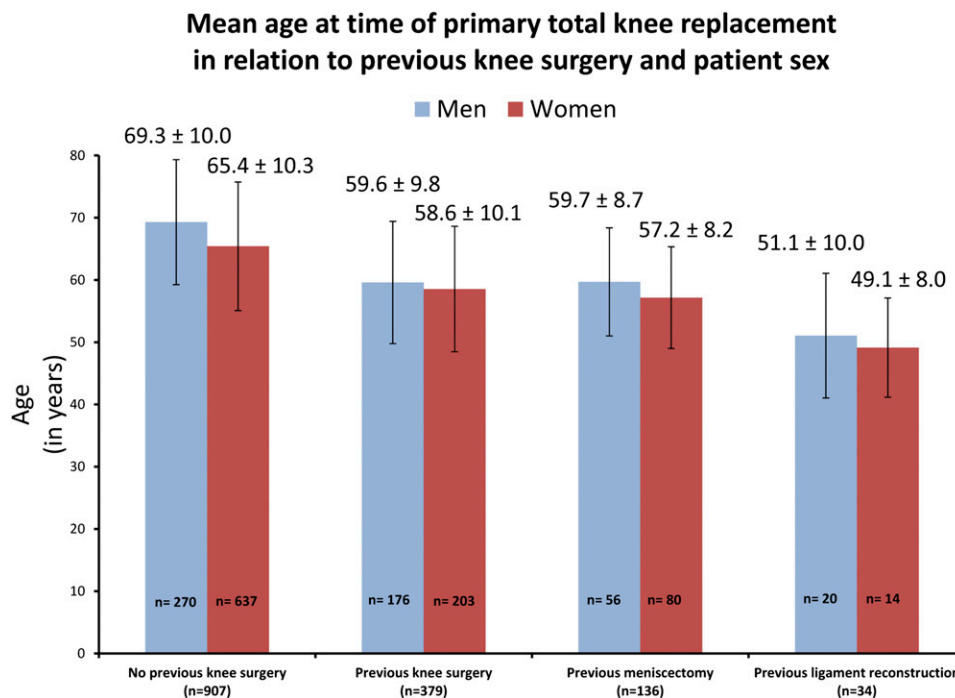


Fig. 1

A bar graph showing the mean age (and standard deviation) at primary total knee arthroplasty in relation to previous knee surgery and patient sex. Men without previous knee surgery were significantly older ($p < 0.001$) than women without previous knee surgery. Patients with previous knee surgery were significantly younger ($p < 0.0001$) than patients without previous knee surgery. Patients with previous ligament reconstruction were significantly younger ($p < 0.0001$) than patients with other previous knee surgery. The error bars indicate the standard deviations. Note that the categories may overlap and do not add up to the total cohort population.

t tests were used to compare age at the time of total knee arthroplasty and BMI between patients with previous knee surgery and those without, as well as between different types of previous knee surgery. Summary statistics for the time from the previous surgery to the time of the total knee arthroplasty were recorded for the patients with this information available. Two-sample t tests were used to compare the time from the previous knee surgery to the time of the total knee arthroplasty between different types of previous knee surgery.

Source of Funding

There was no source of external funding for this study.

Results

Of 1372 patients undergoing total knee arthroplasties in the registry, 1286 were undergoing total knee arthroplasties for osteoarthritis or posttraumatic arthritis. Nearly one-third (29%) of these patients had a history of knee surgery. The most common type of surgery was arthroscopy (86%), followed by meniscectomy (36%), ligament reconstruction (9%), open reduction and internal fixation (9%), chondroplasty (4.5%), tibial tubercle transfer (3%), and osteotomy (3%) (the percentages do not add up to 100%, as patients may have had more than one type of previous knee surgery).

A greater percentage of men (39%) had a history of previous knee surgery when compared with women (24%) ($p < 0.0001$). Men and women had a similar distribution of the type of previous knee surgery.

At the time of the primary total knee arthroplasty, patients with a history of knee surgery were significantly younger ($p < 0.0001$) than patients without a history of knee surgery;

the mean age (and standard deviation) was 59 ± 10 years for patients with a history of knee surgery and 66.6 ± 10.4 years for patients without a history of knee surgery. Among patients who had not undergone previous knee surgery, women underwent total knee arthroplasty at a significantly earlier age ($p < 0.001$) than men; the mean age (and standard deviation) was 65.4 ± 10.3 years for women and 69.3 ± 10 years for men. However, there was no difference in age between the sexes in those with a history of knee surgery; the mean age (and standard deviation) was 58.6 ± 10.1 years for women and 59.6 ± 9.8 years for men (Fig. 1). Patients with a history of ligament reconstruction underwent total knee arthroplasty at a significantly younger age ($p < 0.0001$) than patients with a history of other knee surgery; the mean age (and standard deviation) was 50.2 ± 9.1 years for patients with a history of ligament reconstruction and 59.9 ± 9.6 years for patients with a history of other knee surgery. Patients who had a history of ligament reconstruction underwent total knee arthroplasty at a similar age, with no significant difference in sex; the mean age (and standard deviation) was 49.9 ± 9.8 years for women and 50.4 ± 8.7 years for men.

BMI did not appear to have a significant relationship to age at the time of total knee arthroplasty. There was no significant difference in BMI between patients with a history of knee surgery and those without a history of knee surgery (Fig. 2). For patients undergoing total knee arthroplasty with and without a history of knee surgery, men had a lower BMI than women.

Data on the timing of previous knee surgery were available for 309 patients (81.5%). The average interval (and standard deviation)

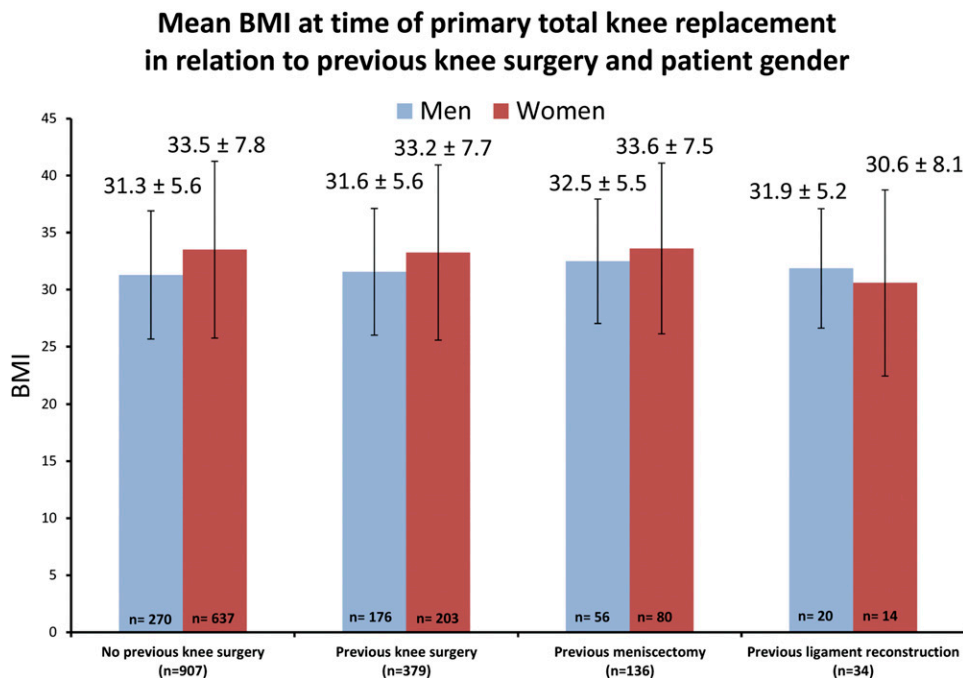


Fig. 2

A bar graph showing the mean BMI (and standard deviation), given in kilograms per square meters, at primary total knee arthroplasty in relation to previous knee surgery and patient sex. Men without previous knee surgery had significantly lower BMI ($p < 0.0001$) than women without previous knee surgery. Men with previous knee surgery had significantly lower BMI ($p = 0.016$) than women with previous knee surgery. The error bars indicate the standard deviations. Note that the categories may overlap and do not add up to the total cohort population.

from previous knee surgery to total knee arthroplasty was 13.1 ± 12.6 years. There was a significant difference ($p < 0.0001$) between sexes in the interval from the previous knee surgery to the time of the total knee arthroplasty; the mean interval (and standard deviation) was 17.7 ± 13.8 years for men and 9.1 ± 9.8 years for women. Eighty-nine percent of patients had an interval of more than one year after the previous knee surgery when they underwent total knee arthroplasty. There was no significant difference ($p = 0.097$) between men (93%) and women (87%) in the percentage of patients who had an interval of more than one year after knee surgery at the time of total knee arthroplasty.

Patients who had undergone previous meniscectomy underwent total knee arthroplasty at an average interval (and standard deviation) of 12.6 ± 12.7 years after meniscectomy. The average interval (and standard deviation) after previous meniscectomy was significantly longer ($p = 0.002$) for men (17.6 ± 14.8 years) than for women (9.6 ± 10.3 years). Fourteen percent of patients underwent total knee arthroplasty within one year after meniscectomy, with no significant difference between men and women. Patients who underwent total knee arthroplasty within one year after partial meniscectomy did not differ significantly in age or BMI from those who underwent total knee arthroplasty at least one year after partial meniscectomy. The average interval (and standard deviation) from ligament reconstruction to total knee arthroplasty was 21.8 ± 11.2 years, which was significantly longer than the interval from meniscectomy ($p = 0.0005$). There was no significant difference between men and women in the interval from ligament reconstruction to total knee arthroplasty.

Discussion

Patients with previous knee surgery undergo total knee arthroplasty at a significantly younger age than patients without previous knee surgery, especially for patients with a history of ligament reconstruction. Men are more likely than women to have had previous knee surgery prior to total knee arthroplasty, and the effect of previous knee surgery is more profound on men, as those patients undergo total knee arthroplasty at an average age of more than ten years younger than men without previous knee surgery. The interval from knee surgery to total knee arthroplasty is longer for men than for women, particularly for meniscectomy. The interval from meniscectomy to total knee arthroplasty is shorter than the interval from ligament surgery to total knee arthroplasty.

The implications are concerning given the increasing prevalence of knee surgery, especially ligament reconstruction in young and female patients. Although the rising prevalence of obesity and the advancing age of the population as a whole have led to a greater demand for knee arthroplasty, the increasing volume of ligament and meniscal surgery may also be a factor increasing the demand for knee arthroplasty in a younger population.

Men are particularly affected by previous knee surgery. They are more likely than women to have had previous knee surgery, and it has a more profound effect on their age at the time of primary total knee arthroplasty. Among patients without previous knee surgery, men undergo total knee arthroplasty almost four years later than women. In contrast, women and men with previous knee surgery essentially undergo total knee

arthroplasty at the same age. Of particular concern is the early age (a mean of fifty years) at which patients with a history of ligament reconstruction undergo total knee arthroplasty.

However, the implications of previous knee surgery may become even more important for women in the near future. There has been a dramatic increase in female sports participation since the passage of Title IX legislation with a concomitant increase in sports-related knee injuries, particularly to the ACL⁴. Therefore, a greater number of female patients are undergoing knee surgery, especially ligament reconstruction, which could portend a rapid future increase in total knee arthroplasties for younger female patients.

From a societal health-care system perspective, all of these findings are concerning for two reasons. Obviously, having total knee arthroplasty at a younger age increases the demand for total knee arthroplasty in the population overall. Perhaps just as important are the potential implications in terms of increasing the demand for revision total knee arthroplasty. The younger patients are at the time of primary total knee arthroplasty, the more likely they will need revision total knee arthroplasty in the future. Patients with previous knee surgery underwent a total knee arthroplasty at an average age of almost seven years younger than patients without previous knee surgery, and this age difference increased to more than sixteen years younger for patients with a history of ligament reconstruction. This age difference nearly guarantees at least one additional revision over each patient's lifetime.

These findings should not be interpreted as a condemnation of knee surgery, particularly in the adolescent and young adult population. Surgery is a marker for knee injury in the younger patient, not the cause of early knee osteoarthritis. The injuries being treated with surgery, such as meniscal and ligament tears, are the underlying clinical problem. Electing not to treat these injuries with surgery is not an attractive option, nor would it necessarily change the long-term development of osteoarthritis and the need for total knee arthroplasty in these patients^{7,8}. For example, patients have a greater risk of developing knee osteoarthritis after an ACL tear with or without ACL reconstruction⁸.

Given the high incidence of meniscal tears in older patient populations¹², magnetic resonance imaging (MRI) is not indicated in patients over the age of fifty years without mechanical complaints, unless specifically ruling out osteonecrosis. It is imperative to make weight-bearing radiographs in this population prior to arthroscopic partial meniscectomy, which will not be efficacious with substantial joint space narrowing, although a recent prospective, multicenter study demonstrated that arthroscopic partial meniscectomy can be an effective treatment for patients over the age of forty years with a meniscal tear and mild to moderate degenerative changes¹³. Knee arthroscopy is not an effective treatment for knee osteoarthritis^{14,15} and patients should be advised of the low expectation for improvement.

A number of studies have looked at the incidence of and time interval to knee arthroplasty after knee arthroscopy. Johanson et al.¹¹ reported an 8.5% to 10.2% rate of arthroplasty within one year after arthroscopy in the Medicare population, with rates of 29.5% to 32.1% by nine years after arthroscopy. Studies from Canada have shown knee arthroplasty rates of 8.5%¹⁰ and 9.2%¹⁶ within one year after knee arthroscopy. In our

population, 14.3% of patients underwent total knee arthroplasty within one year after arthroscopic meniscectomy. As might be expected, older and obese patients have a higher rate of knee arthroplasty after knee arthroscopy^{17,18}. These findings are consistent with our data that patients with a history of knee arthroscopy undergo knee arthroplasty at an earlier age than patients without previous knee surgery, but demonstrate that, even in older populations, not all patients who undergo knee arthroscopy will need knee arthroplasty.

Patients undergoing these surgical procedures should be counseled regarding these findings. Although these findings do not predict the rate of future knee replacement, they do show that these patients are at risk for needing total knee arthroplasty at a younger age than the general population. Patients should be advised to optimize their knee health by maintaining a healthy BMI, strengthening their lower-extremity musculature, and minimizing high-impact activities. More studies should look at how interventions such as medications, injections, and potentially protective surgical procedures, such as realignment surgery or meniscal replacement, could delay the need for total knee arthroplasty.

A major limitation of the current study was the lack of data on patients with previous knee surgery who did not have total knee arthroplasty. Only including the patients who have total knee arthroplasty is a strong selection bias, as there may be subgroups that do very well over time. Therefore, this study does not predict the incidence of future total knee arthroplasty in younger patients undergoing outpatient knee surgery such as partial meniscectomy or ligament reconstruction, nor does it identify risk factors for needing future total knee replacement. As a retrospective study of previous knee surgery, it had potential recall bias, particularly with regard to which type of knee surgery was performed. Many of these patients may have undergone first-generation procedures such as open total meniscectomy and extra-articular ligament reconstructions, and these findings may not be predictive for the impact of current approaches to knee surgery such as meniscal repair and more anatomic ligament reconstruction.

Furthermore, we do not have any data on the time from the previous knee surgery or whether patients with multiple previous procedures are more severely affected than patients with a single previous procedure. Timing may be particularly important for meniscectomy, as the effect of this surgery at a younger age is likely different from the effect of meniscectomy closer to the time of total knee arthroplasty. Finally, we do not have any data on whether a history of knee surgery impacts the clinical outcome and, particularly, the need for revision surgery after total knee arthroplasty.

Despite these limitations, the present study clearly demonstrates that patients who have knee surgery will undergo total knee arthroplasty at a younger age than patients without a history of knee surgery, particularly in men, while women have a shorter interval from knee surgery to total knee arthroplasty. This information may be helpful in counseling patients undergoing knee surgery. The health-care system as a whole needs to be aware of the implications of these findings for increased demand for total knee arthroplasty in younger patients. Future research should investigate whether previous knee surgery affects the outcome of total knee arthroplasty; these factors could predict which patients are likely to need total knee arthroplasty following knee surgery, especially ligament reconstruction, and how to delay the need for total knee arthroplasty in patients who undergo knee surgery in adolescence and early adulthood. ■

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