

Functional outcome of total knee arthroplasty after high tibial osteotomy

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Objective: To evaluate the functional outcome for patients who undergo total knee arthroplasty (TKA) after high tibial osteotomy (HTO). **Design:** Retrospective matched cohort study. **Setting:** University of Toronto affiliated hospital. **Patients:** Twenty patients who underwent TKA after HTO and 20 matched patients who received a primary TKA. **Intervention:** TKA. **Outcome measures:** The Medical Outcomes Study Short Form (SF-36) health survey score and the Western Ontario and McMaster Universities (WOMAC) Osteoarthritis Index. Univariate analyses were used to compare the case and control groups with respect to baseline variables using the *t*-test, χ^2 test or Fisher's exact test. Functional outcomes were assessed by multivariate analyses. **Results:** Operative problems were more frequently encountered in the study group, which had longer operative times ($p < 0.0001$), more difficulties with patellar eversion ($p = 0.021$) and an increased number of lateral releases performed ($p = 0.0089$). There were trends toward a significant difference in the pain ($p = 0.07$), function ($p = 0.18$) and stiffness ($p = 0.14$) categories of the WOMAC Osteoarthritis Index between the 2 groups, suggesting poorer functional outcomes of TKA after HTO, but the results did not reach statistical significance. A previous HTO does not affect the general health of patients after TKA, as there was no difference between the 2 groups in SF-36 scores. **Conclusions:** TKA after HTO is a technically more challenging procedure than primary TKA. The functional outcomes at a mean follow-up of 5 years after TKA in patients with a previous HTO tended to be inferior but the differences were not significant ($p \geq 0.05$).

Objectif : Évaluer le résultat fonctionnel chez les patients qui subissent une arthroplastie totale du genou (ATG) après une ostéotomie tibiale haute (OTH). **Conception :** Étude rétrospective de cohortes jumelées. **Contexte :** Hôpital affilié à l'Université de Toronto. **Patients :** Vingt patients ayant subi une ATG après une OTH et 20 patients jumelés ayant subi une ATG primaire. **Intervention :** ATG. **Mesures de résultats :** Le résultat de l'enquête sur la santé indiqué par la formule abrégée du questionnaire sur l'état de santé (SF-36) et l'indice de l'arthrose des universités Western Ontario et McMaster (WOMAC). On a utilisé des analyses univariées pour comparer les variables de référence des groupes de sujets et de témoins en utilisant le test-t, le test du χ^2 ou la méthode exacte de Fisher. On a évalué les résultats fonctionnels au moyen d'analyses multivariées. **Résultats :** Les problèmes opératoires ont été plus fréquents chez les sujets du groupe d'étude, dont l'intervention a duré plus longtemps ($p < 0,0001$), à qui l'éversion patellaire a causé plus de difficultés ($p = 0,021$) et qui ont subi un plus grand nombre de décompressions latérales ($p = 0,0089$). On a constaté des tendances à une différence importante aux niveaux des catégories douleur ($p = 0,07$), fonction ($p = 0,18$) et raideur ($p = 0,14$) de l'indice d'arthrose WOMAC entre les deux groupes, ce qui indique que les résultats fonctionnels de l'ATG sont moins bons après une OTH. Les résultats n'ont toutefois pas atteint le niveau de l'importance statistique. Une OTH antérieure n'a pas d'effet sur l'état de santé général des patients après une ATG, car on n'a constaté aucune différence entre les deux groupes dans les résultats du questionnaire SF-36. **Conclusions :** Une ATG après une OTH est une intervention plus difficile sur le plan technique que l'ATG primaire. Les résultats fonctionnels à un suivi moyen de cinq ans après l'ATG chez les patients qui avaient subi auparavant une OTH ont tendance à être inférieurs, mais les différences ne sont pas significatives ($p \geq 0,05$).

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High tibial osteotomy (HTO) is an effective surgical procedure in the treatment of medial compartment osteoarthritis associated with a varus deformity of the knee.¹⁻⁴ Most series report an overall success rate ranging from 60% to 80% at 10 years in properly selected patients.⁵⁻⁹ Since HTO is preferred in younger patients, a significant number of them will eventually require a total knee arthroplasty (TKA).

In earlier reports, the results of TKA after HTO vary.¹⁰⁻¹⁵ Amendola and associates,¹⁰ Bergenudd and colleagues¹¹ and Staeheli and colleagues¹⁵ reported that the results of TKA in patients with a previous HTO were similar to those after primary TKA. Others have suggested inferior results of TKA after HTO, with increased complications and technical difficulties.¹²⁻¹⁴ None of these reports evaluated outcomes using validated functional outcome measures.

The Medical Outcomes Study Short Form 36 (SF-36) health survey and the Western Ontario and McMaster Universities (WOMAC) Osteoarthritis Index are reliable, validated instruments for assessing the functional outcome in hip and knee arthritis.¹⁶⁻²⁰ The SF-36 measures the general health status of a population. It comprises 8 categories: physical functioning, role-physical, pain index, general health perception, vitality, social functioning, role-emotional and mental health index. The WOMAC instrument is a disease-specific measure for hip and knee arthritis. It consists of 3 scales — pain, function and stiffness.

In this study we compared the functional outcome of TKA in patients who had had an HTO to those without a previous HTO, using the WOMAC Osteoarthritis Index and the SF-36 as outcome measures.

Patients and methods

One of us (G.L.M.) performed 22 cemented TKAs on 20 patients who

had a failed HTO (Table 1). This study group was compared to a control group of 20 patients who had 21 cemented primary TKAs during the same period. The study group was matched to the control group with respect to date of surgery, age, gender and etiology. The eligibility criteria for inclusion into this study were age more than 18 years, no previous TKA and a minimum follow-up of 2 years.

The medical record was reviewed using a standardized instrument to collect patient demographics, comorbidities, operative data and postoperative complications. The comorbidity categories included rheumatoid arthritis, hypertension, depression, back pain, gastrointestinal problems, cancer, kidney disease, hypothyroidism, anemia, lung disease, fibromyalgia and heart disease. Follow-up data were obtained by questionnaires (SF-36 and WOMAC) mailed to each patient. We made every effort to contact the patients who did not respond to the questionnaires by telephone and by a second mailing of the questionnaires. Thirty-four (85%) of the 40 patients returned their questionnaires, 17 patients from each group. Appropriate univariate analyses were used to compare the cases and controls with respect to baseline variables using the

t-test, χ^2 test, or Fisher's exact test. Functional outcomes were assessed by univariate and multivariate analyses. Since these results were equivalent, we report the results of univariate analysis. All tests were conducted using the PC-SAS version 6.12 software package (SAS Institute, Cary, NC), with a *p* value of less than 0.05 being considered significant.

Results

In the study group, there were 10 men and 10 women, whose average age at follow-up was 64 (range from 46-79) years. In all patients unicompartmental arthritis had been diagnosed and they had undergone a lateral closing wedge osteotomy. The average time from HTO to TKA was 8.4 years. The indications for revision to a TKA were continued or progressive pain after osteotomy. The primary diagnosis was osteoarthritis in 19 patients and rheumatoid arthritis in 1 patient. The diagnosis of rheumatoid arthritis had been confirmed after the HTO. It is generally understood that HTO is contraindicated in patients with inflammatory arthritis. The average follow-up was 5.2 years.

The control group comprised 10 men and 10 women whose average age at follow-up was 65 (range from 50-76) years. The primary diagnosis was osteoarthritis in 19 patients and rheumatoid arthritis in 1 patient. The average follow-up was 4.7 years. There were no statistically significant differences in any of the baseline variables between the 2 groups.

Most patients had comorbidity (Table 2), but the differences between the 2 groups were not significant.

Two types of condylar knee replacements were used in both groups. Patients received either a cemented Genesis (Smith and Nephew Orthopaedics, Memphis, Tenn.) TKA system or a cemented Tricon Genesis (Smith and Nephew Orthopaedics) TKA system. There was

Table 1

Demographics of Patients Who Underwent Total Knee Arthroplasty After High Tibial Osteotomy (Study) or Total Knee Arthroplasty Alone (Control)

Demographic	Study	Control
Gender, no.		
Male	10	10
Female	10	10
Mean age, yr	64	65
Etiology		
Osteoarthritis	19	19
Rheumatoid arthritis	1	1
Implant used		
Tricon	7	4
Genesis	15	17
Mean follow-up, yr	5.2	4.7
Preoperative ROM, °	83	93
ROM = range of movement.		

no difference between the 2 groups in the ratio of implants used (Table 1). The average operative time in the study group was 170 (range from 75–240) minutes compared with 118 (range from 70–165) minutes in the control group ($p < 0.0001$). The most frequently encountered intra-operative technical difficulties in the study group were related to patellar eversion and patellar tracking. Although there were no cases of intra-operative patellar tendon avulsion, complete eversion of the patella was unattainable in 6 of 22 arthroplasties in the study group, compared with none in the control group ($p = 0.021$). A lateral release was required in 7 of 22 arthroplasties in the study group, compared with only 2 of 21 arthroplasties in the control group ($p = 0.0089$). Wedge augmentations were used in 2 procedures in the study group compared with none in the control group ($p = 0.049$).

Postoperatively in the study group there was 1 superficial infection that resolved when a course of antibiotics was given orally. In that group, 1 patient required manipulation under anesthesia, and 1 patient complained of instability but functioned satisfactorily with the use of a brace. There were no other complications that required subsequent operative intervention. No patients had required revision of the TKA components at the time of follow-up.

The results of the SF-36 and WOMAC instruments are displayed

in Tables 3 and 4. There was a trend toward better outcomes in the control group than in the study group in terms of the 3 WOMAC scales. The control group tended to have less pain, less stiffness and better overall function. There were no significant differences between the study and control groups with respect to the 8 scale scores of the SF-36.

Discussion

The treatment of isolated medial compartment arthritis of the knee in young patients remains a challenging condition to treat effectively. At present, osteotomy of the proximal tibia is the preferred method of treatment. Even if HTO provides sufficient pain relief for many years, it is extremely important that this procedure not compromise the outcome of subsequent revision TKA.¹⁵

There are 9 published reports of the outcome of TKA after an HTO, but only 5 studies compared the results to matched controls of primary TKA.^{10–14} The conclusions reached by

the authors varied. Amedola and associates¹⁰ found no difference in outcome between primary TKA and revision arthroplasty after HTO. There was no increase in complication rates or operative time at approximately 3 years' follow-up. Other reports have contradicted these findings.^{11–14} Most recently, Nizard and colleagues¹⁴ compared their results of primary TKA with TKA after HTO. They found that the HTO group had a significantly greater number of operative problems and that the results of TKA after HTO were inferior, especially with respect to pain. Although different measures of outcomes were used in this investigation, the findings of this study are consistent with those of Nizard's group and others.^{11–14}

One of the difficulties in comparing results of outcomes among groups and among a number of studies is the use of many different rating systems in the literature. Of the 5 matched studies assessing the outcome of TKA after HTO, 3 different rating systems were used. The relia-

Table 2

Preoperative Comorbidities in Patients Who Underwent Total Knee Arthroplasty After High Tibial Osteotomy (Study) or Total Knee Arthroplasty Alone (Control)

Comorbidity, no.	Study (n = 20), no. (and %)	Control (n = 20), no. (and %)
0	2 (10)	2 (10)
1	4 (20)	7 (35)
2	9 (45)	6 (30)
3	3 (15)	4 (20)
4	2 (10)	1 (5)

Table 3

Results from the Medical Outcome Study Short Form (SF-36) in Patients Who Underwent Total Knee Arthroplasty After High Tibial Osteotomy (Study) or Total Knee Arthroplasty Alone (Control)

SF-36 category	Study (n = 17), mean (and SD)	Control (n = 17), mean (and SD)	Overall (n = 34), mean (and SD)
Physical functioning	44 (21)	56 (28)	50 (25)
Role-physical	60 (45)	49 (38)	54 (42)
Pain index	51 (23)	60 (23)	55 (23)
General health perception	63 (20)	61 (20)	62 (19)
Vitality	56 (20)	54 (22)	55 (21)
Social functioning	62 (25)	72 (22)	67 (24)
Role-emotional	90 (26)	71 (44)	80 (37)
Mental health index	76 (16)	75 (19)	75 (17)

Table 4

Results from the Western Ontario and McMaster Universities (WOMAC) Osteoarthritis Index in Patients Who Underwent Total Knee Arthroplasty After High Tibial Osteotomy (Study) or Total Knee Arthroplasty Alone (Control)

WOMAC category	Study (n = 17), mean (and SD)	Control (n = 17), mean (and SD)	p value
Pain	6.7 (4.9)	3.9 (3.9)	0.07
Stiffness	3.3 (2.0)	2.2 (2.0)	0.14
Function	27.7 (16.1)	20.4 (15.4)	0.18

bility of these rating systems has never been demonstrated. Furthermore, these rating scales use arbitrary weighting schemes, and the relationship between total points and clinical outcomes has never been validated for any of the rating systems.²¹ The SF-36 and WOMAC instruments, however, have been validated and are reliable scales for measuring the functional outcomes in this population.¹⁶⁻²⁰ This study is unique in its utilization of reliable, validated scoring instruments in the assessment of functional outcome in patients who undergo TKA after HTO. Furthermore, we eliminated the variability of multiple surgeons because a single surgeon performed all the procedures in both groups, and a mean follow-up period of 5 years with a response rate of 85% provides an adequate representation of the functional outcome in this group of patients.

In this study, the patients with a previous HTO more often required wedge augmentation, had longer operative times, more difficulties with patellar eversion and an increased number of lateral releases performed. The rate of postoperative complications encountered in the HTO group was comparable to the control group, but it is difficult to draw any definitive conclusions because of the low incidences of these complications after TKA. A previous HTO does not affect the general health of patients after TKA, as there were no differences between the 2 groups in SF-36 scores. However, a prior osteotomy might adversely affect the functional outcome of the TKA. There was a trend toward a significant difference in the 3 scales of the WOMAC Osteoarthritis Index between the 2 groups. The difference in the WOMAC function score is clinically significant according to Bellamy.²⁰ The results of this study are supported by the findings of Nizard and colleagues,¹⁴ who concluded that the results of TKA after tibial osteotomy appear inferior to those of primary TKA, especially with respect to pain.

The current study has some limitations. Although there was a trend toward better functional outcomes on the WOMAC scale for the control group, the difference was not significant ($p \geq 0.05$). This is likely the result of the small sample size of this study. Furthermore, the study is retrospective, so we were unable to obtain complete baseline data, including functional health status measures.

TKA after HTO is a technically more challenging procedure than primary TKA and is associated with longer operative times and greater difficulties in mobilizing the patella. The functional outcomes at a mean follow-up of 5 years in patients with a previous HTO tend to be inferior to primary TKA, but the difference is not significant. Further prospective studies are required to fully evaluate outcomes of TKA after HTO.

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