Similar outcome for total knee arthroplasty after previous high tibial osteotomy and for total knee arthroplasty as the first measure

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Background and purpose — Patients having a total knee arthroplasty (TKA) after a previous high tibial osteotomy (HTO) constitute a minor group among those undergoing primary TKA for knee osteoarthritis (OA). There have been few reports on whether such patients differ pre- and postoperatively from those who undergo TKA as the first measure. We evaluated patient characteristics, knee-related pain, function, quality of life, and general health before and 1 year after TKA surgery in these 2 groups of patients.

Patients and methods — We included 119 HTOs that were operated on for knee OA in the Skåne region, Sweden, in the period1998–2007 and that had been converted to a TKA during 2009–2013 (the C group). We also included 5,013 primary TKAs performed for knee OA in the same region, during the same period, and in patients of the same age range (42–82 years) (the P group). The patients were evaluated with the Knee Injury and Osteoarthritis Outcome Score (KOOS) and the EQ-VAS preoperatively and 1 year after the TKA surgery, when they were also asked about their satisfaction with the surgery. Case-mix variables available were Charnley category, American Society of Anesthesiologists (ASA) classification, sex, age, and body mass index (BMI).

Results — Most of the HTOs were performed using open-wedge osteotomy with external fixation (81 of 119). Compared to the P group, the patients in the C group were more often men, were younger, and were healthier (according to the ASA classification). With respect to pre- and postoperative knee-related pain, function, quality of life, and general health, the 2 groups had similar mean values without any statistically significant differences. A similar proportion of patients in the 2 groups were satisfied with the surgery 1 year postoperatively (82% vs. 80%).

Interpretation — Our findings indicate that HTO is a reasonable alternative for delaying TKA surgery in younger and/or physically active OA patients.

High tibial osteotomy (HTO) is a joint preserving surgery with the purpose of reducing pain, enhancing function, and delaying the need for—or in best case avoiding—a knee arthroplasty in younger and/or physically active knee osteoarthritis (OA) patients. In Sweden, HTO is a minor part of the knee reconstruction surgery. From being 7% of the knee reconstruction surgery in 1998 (W-Dahl et al. 2012), it was less than 2% in 2013 (figures from the National Board of Health and Welfare).

The risk of being converted to a knee arthroplasty was 30% at 10 years in a population-based study on patients who were operated on by HTO for knee OA between 1998 and 2007 in Sweden (W-Dahl et al. 2012). The reported grade of technical severity at conversion to knee arthroplasty after HTO varies (Nizard et al. 1998, Toksvig-Larsen et al. 1998, Haddad and Bentley 2000, Karabatsos et al. 2002, van Raaij et al. 2007, Meding et al. 2011). There is little information on whether patients who are converted to knee arthroplasty after previous HTO differ from those who are operated on by a knee arthroplasty as the first measure regarding patient characteristics, pre- and postoperative pain, function, and satisfaction with the surgery.

Most of the studies published on HTO-to-TKA conversions have been based on a small number of patients (12–42) and they were mostly compared to matched controls who had a TKA as the first measure (Toksvig-Larsen et al. 1998, Haddad and Bentley 2000, Karabatsos et al. 2002, van Raaij et al. 2007, Haslam et al. 2007, Kazakos et al. 2008, Amendola et al. 2010, Efe et al. 2010, Meding et al. 2011). Comparisons have also been made within the same individuals—operated in staged fashion or simultaneously—with a knee arthroplasty in 1 knee after previous HTO and in the other as a first measure (Meding et al. 2000). However, Bergenudd et al. (1997) and Erak et al. (2011) used consecutive series of TKAs and compared those with previous HTO to those without.

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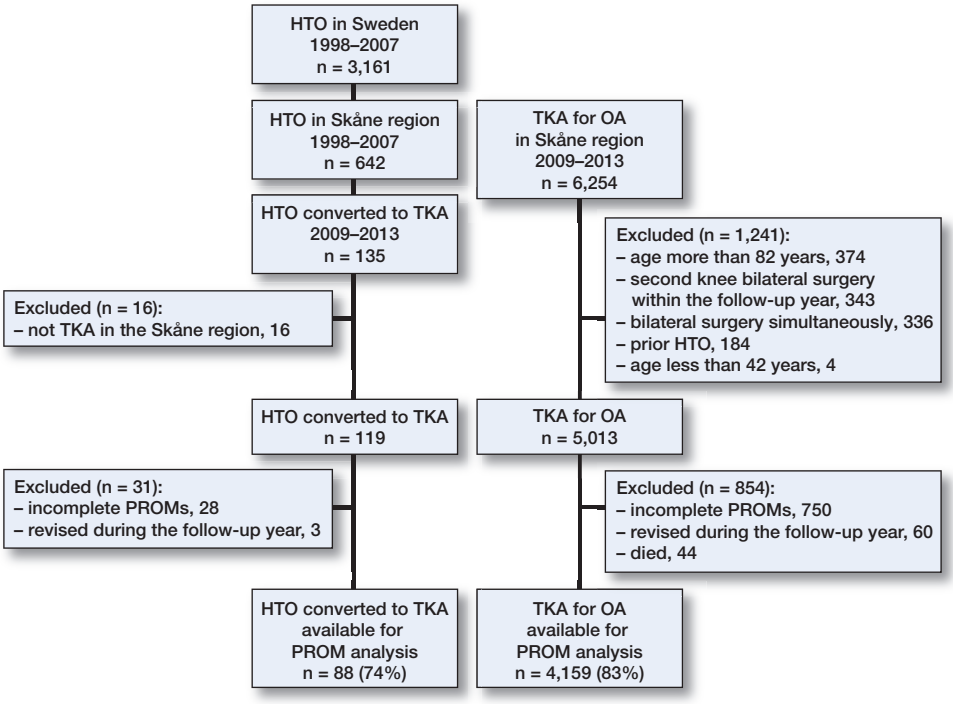

Figure 1. Flow chart of the study population.

Nizard et al. (1998) and Erak et al. (2011) found worse patient-reported outcome measures (PROMs) after TKA surgery in patients with previous HTO than in those without, while others have found no differences (Toksvig-Larsen et al. 1998, Haddad and Bentley 2000, Karabatsos et al. 2002, Huang et al. 2002, van Raaij et al. 2007, Amendola et al. 2010, Meding et al. 2011).

The aim of the present study was to evaluate patient characteristics, knee-related pain, function, quality of life, and general health before and after TKA for knee OA in patients who were operated on by HTO previous to TKA and compare them with those of patients who were operated on by TKA as the first measure. We also wanted to evaluate satisfaction with the surgery in both groups 1 year after the TKA.

Patients and methods

The information on the HTO patients comes from a population-based study of 3,161 HTOs performed in Sweden during the period 1998–2007 (W-Dahl et al. 2012). To be included in the present study, both the HTO and a later conversion had to have been performed in the Skåne region, where pre- and postoperative PROMs for arthroplasty patients are routinely collected. 119 HTO-to-TKA conversions done during the period 2009–2013 were considered, 88 of which had complete preoperative and 1-year postoperative PROM data (the C group). The P group consisted of 5,013 TKAs (without previous HTO) performed in the same region, during the same period, in patients in the same age range (42–82 years) as in the C group. 4,159 had complete PROM data. Both the HTO conversions and the primary TKAs were identified through the Swedish Knee Arthroplasty Register (SKAR) (Figure 1).

Patient characteristics such as sex, age, body mass index (BMI), and American Society of Anesthesiologists (ASA) classification grades 1–4 were recorded. Modified Charnley classification (categories A–C, see Footnote c in Table 1) was assessed by the patients using 4 questions.

Information regarding surgical time, type of prosthesis, and fixation was available from the SKAR. The type of prosthesis was defined as being an ordinary TKA or a TKA revision model, but the SKAR classifies revision models as models specifically made for revision cases and also ordinary TKAs that are stabilized and/or used with longer stems than normally (SKAR 2015). We also considered the few linked/rotating hinge models used to be TKA revision models.

The patients' experiences of knee-related pain, function, and quality of life were obtained using the disease-specific questionnaire KOOS. A normalized score (with 100 indicating no symptoms and 0 indicating extreme symptoms) is calculated for each of the 5 subscales (www.koos.nu). A difference of 8–10 points is considered a clinically significant difference (Roos and Lohmander 2003).

The patients reported their self-perceived general health using the EQ-VAS on a scale (0–100) from the best (100) to the worst imaginable health status (0) (www.euroqol.org), and their satisfaction with the arthroplasty surgery using a 0–100 scale (VAS) in which 0 was the highest imaginable degree of satisfaction and 100 was the worst imaginable degree of satisfaction. The satisfaction (VAS) score was categorized into 5 groups: very satisfied (0–20), satisfied (21–40), moderately satisfied (41–60), dissatisfied (61–80), and very dissatisfied (81–100).

PROMs have been routinely collected in the Skåne region since 2009 and included in the SKAR PROM pilot project. The patients filled in the questionnaires at the outpatient visit approximately 2–6 weeks before surgery. 1 year postoperatively, the same questionnaire was mailed to the patients together with the question on satisfaction. The patients had been informed of the planned 1-year follow-up, but no reminders were sent to non-responders (n = 778) at that time.

Table 1. Patient characteristics

	C group n = 119	P group n = 5,013	p-value
Sex, n (%)			
Male	84 (71)	2,131 (43)	< 0.001
Female	35 (29)	2,882 (58)	
Age, mean (SD)	63 (7.7)	69 (8)	< 0.001
BMI [a], mean (SD)	29.1 (3.5)	28.9 (4.4)	0.6
ASA classification [a,b], n (%)			0.003
I	42 (35)	1,056 (21)	
II	62 (52)	3,229 (64)	
III	15 (13)	725 (15)	
Charnley category [a,c], n (%)			0.8
A	32 (30)	1,338 (27)	
B	38 (36)	1,623 (33)	
C	37 (35)	2,033 (41)	

[a] Missing: BMI = 2, ASA = 3, Charnley category = 19.
[b] ASA classification:I – healthy; II – mild systemic disease; III – severe systemic disease.
[c] Charnley classification category A: unilateral knee disease; category B: bilateral knee disease; category C: multiple joint diseases or other major medical condition impairing walking capacity.

Statistics

The PROMs, age, BMI, and surgical time are presented as a mean value and standard deviation (SD) or 95% confidence interval (CI). Welch's t-test was used for statistical analysis. For analysis of proportions for sex, ASA, Charnley classification, type of prosthesis, fixation, and satisfaction, the chi-squared test or Fisher's exact test was used. Statistical analyses were carried out using Stata version 12.

Ethics

The data collection was approved by the Ethics Committee of the Medical Faculty, Lund University (LU88/2008, LU2013/36), and the study was performed in accordance with the Declaration of Helsinki.

Results

Most of the HTOs had been performed by open-wedge osteotomy using external fixation (81 of 119). 21 patients were operated on with the closed-wedge method and 17 patients were operated on with open-wedge osteotomy and internal fixation. None had been re-osteotomized.

The patients in the C group were more often men (71% vs. 43%), younger (mean age 63 years vs. 69 years), and healthier according to the ASA classification than the patients in the P group (ASA I; 35% vs. 21%) (Table 1). 61% of them were less than 65 years of age, as compared to 30% of the P group (p < 0.001) (Figure 2). The patients reported having similar preoperative problems in the 5 subscales of KOOS and similar general health in the EQ-VAS without there being any statistically significant differences (Table 2).

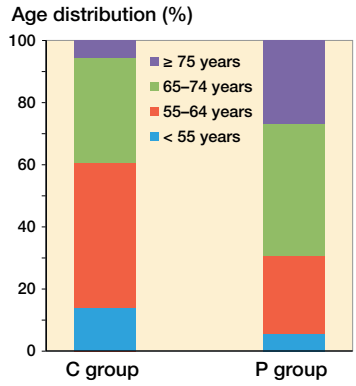

Figure 2. Age distribution.

When we compared patient characteristics and preoperative PROM data between patients with missing data and those without missing data, several statistically significant differences were found in the P group but without any clinically relevant differences. In the C group, the patients with missing data had statistically significantly higher BMI than those with complete data, but with only small clinical difference. Furthermore, there was a statistically significant and clinically relevant difference in Charnley category between patients with missing data and those without missing data, but in those with missing data more than one third of the data were missing (Table 3).

In the C group, TKA revision models were used in 5 of 119 surgeries as compared to 99 of 5,013 in the P group (2%) (p = 0.03). All the 5 revision models in the C group were in patients with previous open-wedge osteotomy with external fixation. The surgical time for the TKA was longer in the C group (77 min, CI: 72–82) than in the P group (68 min, CI: 68–69; p = 0.002). Closed-wedge osteotomy patients had longer surgical time (103 min, CI: 89–118; p < 0.001) than in the P group whereas open-wedge osteotomy patients with external and internal fixation took a similar amount of time to that in the P group: 72 min (CI: 66–73; p = 0.8) and 70 min (CI: 56–83; p = 0.2), respectively.

Preoperative and 1-year postoperative KOOS and EQ-VAS, and also rating of satisfaction with the surgery, was available for 88 patients (74%) in the C group and 4,159 patients (83%) in the P group. Regarding pre- and postoperative knee-related

Table 2. Preoperative PROMs values. Values are mean (SD)

	C group n = 107 [a]	P group n = 5,013	p-value
EQ-VAS	63 (22)	64 (22)	0.5
KOOS pain	42 (15)	41 (15)	0.6
KOOS symptoms	46 (19)	48 (18)	0.5
KOOS ADL	49 (17)	46 (16)	0.1
KOOS sport/rec	11 (13)	12 (14)	0.6
KOOS QoL	23 (12)	24 (14)	0.4

[a] Preoperative PROMs available for 107 patients.

Table 3. Patient characteristics and PROMs preoperatively in patients with complete data and in patients with missing data

	C group			P group		
	Complete PROMs n = 88	Missing PROMs n = 31	p-value	Complete PROMs n = 4,159	Missing PROMs n = 854	p-value
Sex, n (%)						
Male	64	20	0.4	1,800 (43)	340 (40)	0.06
Female	24	11		2,359 (57)	514 (60)	
Age, mean (SD)	63 (8)	60 (9)	0.09	68 (8)	68 (8)	0.3
BMI,					n = 851	
mean (SD)	29.1 (4)	30.4 (5)	0.03	28.8 (4.4)	29.2 (4.5)	0.01
ASA classification, n (%)					n = 850	
I	32	9	0.8	951 (23)	168 (20)	0.01
II	45	18		2,652 (64)	538 (63)	
III	11	4		555 (13)	144 (17)	
Charnley category, n (%)		n = 19			n = 728	
A	29	3	0.02	1,111 (27)	189 (26)	0.01
B	34	4		1,351 (32)	201 (28)	
C	25	12		1,690 (41)	339 (46)	
EQ-VAS		n = 19			n = 728	
	64 (2)	55 (25)	0.2	64 (22)	60 (22)	< 0.001
KOOS		n = 19			n = 694	
pain	43 (16)	36 (13)	0.07	41 (15)	37 (16)	< 0.001
symptoms	47 (19)	43 (16)	0.3	48 (18)	46 (18)	0.02
ADL	50 (18)	45 (15)	0.2	46 (16)	42 (17)	< 0.001
sport/rec	12 (12)	9 (13)	0.4	12 (14)	10 (14)	0.01
QoL	23 (12)	19 (12)	0.2	24 (14)	20 (14)	< 0.001

See footnote to Table 1 for definitions.

Table 4. PROMS preoperatively and 1 year postoperatively. Values are mean (SD)

	C group n = 88	P group n = 4,159	p-value
Preoperatively			
EQ-VAS	64 (22)	64 (63)	0.9
KOOS pain	43 (16)	41 (15)	0.3
KOOS symptoms	47 (19)	48 (18)	0.8
KOOS ADL	50 (18)	46 (16)	0.08
KOOS sport/rec	12 (13)	12 (14)	0.9
KOOS QoL	23 (13)	24 (14)	0.8
1 year postoperatively			
EQ-VAS	77 (20)	76 (20)	0.6
KOOS pain	78 (19)	79 (21)	0.8
KOOS symptoms	73 (18)	75 (19)	0.3
KOOS ADL	78 (18)	77 (21)	0.5
KOOS sport/rec	34 (23)	36 (27)	0.4
KOOS QoL	59 (25)	63 (25)	0.1
Satisfaction [a]	23 (23)	22 (23)	0.8

[a] Missing: 244 in the P group.

pain, function, quality of life, and general health, the 2 groups had similar mean values without any statistically significant differences (Table 4). Similar proportions of patients were satisfied with the surgery: 80% in the C group and 82% in the P group.

Discussion

Irrespective of whether or not a previous HTO had been performed, we found that the patient-reported outcome prior to the TKA surgery and 1 year postoperatively was similar. As compared to patients with primary TKAs, the HTO conversion patients were generally 5 years younger, were more often men, and were generally healthier. To our knowledge, this is the largest study to compare patients and their self-reported outcome after TKA surgery with or without previous HTO. It is also one of the few studies in which most of the patients included had HTO with open-wedge osteotomy (86%). Most of them with open-wedge osteotomy had external fixation (70%).

Like most published register-based studies we had no information on preoperative biomechanical data such as grade of OA and knee alignment, and it is also a limitation that we had no information on perioperative complications. As surrogate variables for indication of conversion problems/complications, we used surgical time and the type of prosthesis used. The statistically significantly longer surgical time for the C group only applied to the closed-wedge osteotomies, which may indicate that there were more problems in converting to TKA than with the open-wedge techniques. However, all the TKA revision models in the C group were used after open-wedge osteotomy using external fixation, which may indicate some problems of instability.

Another limitation was the short follow-up period of 1 year. However, Nilsdotter et al. (2009) found in their 5-year follow-up study of patients operated on with TKA for OA that the best outcome regarding self-reported pain, physical function, walking ability, and leisure-time activities was seen at the 12-month follow-up and declined after 5 years. On the other hand, the inclusion of patients from different hospitals, the number of surgeons, and the different methods and techniques of HTO used might be seen as strengths.

74% in the C group and 83% in the P group had complete pre- and postoperative data on PROMs. Those patients with missing PROM data 1 year postoperatively were similar to those with complete data regarding patient characteristics and preoperative PROM data.

In most of the studies that have compared TKA surgery with previous HTO and TKA surgery without previous HTO, the HTOs were performed by closed-wedge osteotomy (Toksvig-Larsen et al. 1998, Haddad and Bentley 2000, Meding et al. 2000, Karabatsos et al. 2002, van Raaij et al. 2007, Haslam et al. 2007, Kazakos et al. 2008, Amendola et al. 2010, Efe et al. 2010, Meding et al. 2011), while Erak et al. (2011) compared 33 consecutive patients who had been operated on with open-

wedge osteotomy using internal fixation. They concluded that converting to TKA was relatively straightforward technically, but that the clinical results at early follow-up were inferior to those in patients without previous HTO. However, 6 of the TKAs were after revision HTOs, mainly due to delayed union or non-union of the osteotomy. They found statistically significant differences in Knee Society score (KSS) for pain and in overall KSS in favor of the patients without previous HTO, but the differences were small and hardly clinically relevant (Erak et al. 2011). In a matched-pair study, Nizard et al. (1998) also found inferior pain score as measured by the International Knee Society (IKS) score in a group of patients who had HTO before TKA compared to those who had TKA as the first measure, while other authors have found similar pain scores in patient- or surgeon-reported outcome. The reasons for dissimilarities may be differences in study size, in loss to follow-up, in patient selection, in methods of scoring, or in other factors.

Unlike our study and those by Bergenudd et al. (1997) and Erak et al. (2011), most studies have used matched controls when comparing the results of HTO to TKA conversion with that of TKAs without previous HTO (Toksvig-Larsen et al. 1998, Haddad and Bentley 2000, Meding et al. 2000, Karabatsos et al. 2002, van Raaij et al. 2007, Haslam et al. 2007, Kazakos et al. 2008, Amendola et al. 2010, Efe et al. 2010, Meding et al. 2011). Matching on age and sex hides the effect of these variables on the results. As we wanted to compare the patient characteristics of the 2 groups, we chose not to use matched controls, which would not have allowed us to demonstrate, for example, differences in mean age at the time of TKA or differences in age- or sex distribution. However, differences between the groups might partly be explained by the patients being dissimilar with respect to age and sex. In the present study, as in the study by Erek et al. (2011), the patients with previous HTO were more often men and those without were more often women, while the study by Bergenudd et al. (1997) had no information on sex. Regarding age, the patients with previous HTO in the study by Erak et al. (2011) were younger (mean 57 years old) at the time of TKA than in our study (mean 63 years old) and considerably younger than the patients in the study by Bergenudd et al. (1997), who had a mean age of 70 years. The differences in mean age at the time of conversion to arthroplasty in these studies may in part be explained by different indications for HTO, by patient selection, or by the fact that they were performed in different periods of time. The patients in the study by Bergenudd et al. (1997) had their conversions to TKA between 1986 and 1989, and the HTOs 2–16 years before that. During this time period, knee arthroplasty surgery was still in its early phase and HTO was more or less standard surgery for knee OA.

One purpose of HTO in younger and/or physically active OA patients is to delay the progress of a disease already started, with the option of later conversion to TKA if required. We have previously found a 10-year conversion rate after HTO of 30%, indicating the possibility of delaying knee arthroplasty surgery in the majority of patients (W-Dahl et al. 2012).

The patients who were converted to TKA after a previous HTO were somewhat different from those who had TKA as the first measure. The majority of the patients in the C group were less than 65 years of age, which means that they would often be active in their working life and might have a different family and economic situation from those in the P group—with other expectations and demands on knee function.

Another difference is that according to the Swedish Knee Osteotomy Register, 58% of cases are reported to have had previous knee surgery at the time of the HTO surgery, with 10% having had more than 1 previous surgery (W-Dahl et al. 2015). By comparison, for TKA in general there is a history of previous knee surgery in 20% of cases with 3% having had more than one (SKAR 2015).

The patients in the C group were generally younger, were classified as healthier, and had a history of more knee surgeries; they may therefore have had higher demands. In spite of these differences, we find it interesting that they reported similar general health, knee-related pain, function, quality of life, and satisfaction with the surgery to those in the P group.

The 1-year results are based on the PROMs available (KOOS and EQ-VAS), and it may be debated whether these outcome measures have the sensitivity to detect subtle differences in outcome. The longer operating time and more frequent use of revision implants indicate that surgery after previous osteotomy is technically more demanding, at least sometimes. However, this does not appear to affect the self-reported outcomes of the patients in the short term.

In summary, patients who had TKA after previous HTO differed significantly with respect to sex, age, and morbidity from those who had TKA as the first measure, but they appeared to have similar pre- and postoperative patient-reported outcome. This indicates that HTO is a reasonable alternative for delaying TKA surgery in younger and/or physically active OA patients.

AWD and OR: study design, data selection, and data analysis. Both authors prepared the manuscript, and read and approved the final draft.

No competing interests declared.

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