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Knee arthroplasty until age 60 – role of sports and other injuries

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ABSTRACT

BACKGROUND: The primary aim of the study was to investigate how total knee arthroplasty (TKA) patients with underlying injuries differ in injury type and physical activity after the arthroplasty.

METHODS: A questionnaire was sent to TKA patients, ≤ 60 years at surgery, and knee injury as the cause of knee OA. The final study group consisted of 70 patients.

RESULTS: Average age of patients at TKA was 51.8 years (Standard Deviation [SD] 5.2), and at follow-up 57.6 years (SD 6.5). Of the injuries, 26% were sports-related, 29% had occurred at work, 23% in traffic accidents, and 13% during leisure-time (no sports-related). Sports-related injuries had occurred at younger ages than others had (mean 23.4 vs. 35.2 years, $p=0.001$). Time from injury to arthroplasty was longer in patients with sports-related injuries compared to others (mean 26.6 vs. 17.4 years, $p=0.003$). At follow-up age-adjusted mean amount of weekly physical activity measured as leisure-time metabolic equivalent (MET) index (MET-hours/week) was higher in patients with sports-related injuries than in patients with other injuries (42.1 vs. 18.5, $p=0.001$).

CONCLUSIONS: Previous knee injury was the cause of severe knee osteoarthritis and TKA in 20% of the patients 60 years or younger. The time from injury to arthroplasty was longer among patients with sports-related than among those with others. Patients with previous sports-related knee injury were more physically active after arthroplasty than patients with others.

Key words: Knee Osteoarthritis - Total Knee Arthroplasty - Knee Injury - Physical Activity

Introduction

Recent meta-analyses and prospective studies have reported that subjects with previous knee injury are at an almost three-fold risk for knee osteoarthritis (OA) compared to those without such injuries.¹⁻³ In the early stage of the disease, conservative treatment is usually recommended, and operative treatment has traditionally been preferred for older patients with severe OA. In the 1980's the incidence of total knee arthroplasty (TKA) among Finns in Finland aged 30 to 59 was 0.5 operations per 100,000 inhabitants, but at the end of the follow-up period in 2006 the incidence had risen to 65 operations per 100,000 inhabitants.⁴

Despite the fact that physical activity has many health benefits, some sports-related injuries may cause problems later in life. The type of knee injury has an impact on the risk of OA. A ligament or tendon injury, meniscal injury or meniscal resection and fracture of a lower limb carried a nearly six-fold risk of OA.² Among athletes, knee injury is often followed by OA and is the most common reason for permanent disability.⁵ The increase in total knee replacements among younger patients may be a result of a growing number of knee injuries and expanding indications for the procedure.⁶ The role of knee injury, and especially the type of injury, as a risk factor for severe knee OA leading to TKA among people in their working age should be studied in more detail.

The aim of this study was to investigate the role of acute injuries (sports vs. others) in the aetiology of knee OA leading to TKA in patients aged 60 or younger. The secondary aim was to study whether previous sports injury correlated with higher level of physical activity after arthroplasty.

Materials and Methods

Between the years 2000 and 2013 total knee replacements were performed on 652 patients aged 60 years or younger in Orton Orthopaedic Hospital, Finland. We excluded nine patients not speaking Finnish or Swedish. The operating orthopaedic surgeons recorded his/her opinion on the cause of the knee OA in light of the patient history. Based on this opinion, 350 patients with primary OA as the cause of OA were excluded. Of the remaining patients, 127 (20%) had previous knee injury as the cause of knee OA, and they were included in our study. Ninety-six percent (122/127) of them could be reached (Fig. 1).

A postal questionnaire was sent in 2014 to the patients with previous injury as the cause of OA (n=122, 69 male). Besides detailed questions on previous knee injuries the questionnaire included questions on anthropometrics, work history, chronic diseases other than OA, symptoms, recent physical activity and also questions on possible OA among relatives. Body mass index (BMI) was calculated based on patients' self-reported height and weight at follow-up. We calculated a leisure time activity metabolic equivalent (MET) index (cumulative leisure MET hours/week) by assigning a multiple of resting metabolic rate to activity, and by calculating the product of intensity x frequency x times of activity.^{7,8}

Eighty-five patients (70%) responded to our questionnaire and 73 (60%) of these agreed to participate; 12 patients declined to complete the questionnaire. After checking patients' records three participants were excluded because of diagnoses other than OA (one patient with recurring dislocation of the patella, one with juvenile idiopathic arthritis and one with spastic diplegia. Thus, the final study group consisted of 70 patients, 36 females and 34 males. Patients' characteristics are shown in Table I.

Ethical aspects

The ethics committee of the Universities of Applied Sciences in Helsinki Area approved the study protocol (16.10.2013), and permission to use the patient registration was granted by the National Institute for Health and Welfare (Dnro THL/1648/5.05.00/2013).

Statistical analysis

Statistical analyses were performed with SPSS (version 22.0; SPSS Inc., Chicago, Illinois, USA). Comparisons between the groups were performed with T-test. When comparing BMI and MET index between patients with sports-related injuries and other injuries, analysis of covariance (ANCOVA) were performed with using age at follow-up as a covariate. Results are given in proportions or in mean differences and their 95 % Confidence Intervals (CI). $p < 0.05$ (two-tailed) was accepted as a statistically significant threshold.

Results

The average age of the patients at the time of the TKA was 51.8 years (SD 5.4, range 38.0-60.0), mean age at the time of the follow-up questionnaire was 57.6 years (SD 6.4, range 44.0-70.0), and mean follow-up time between the TKA and questionnaire was 6.2 years (SD 3.6, range 0.5-13.0) (Table I). Ten of the patients were over 65 years at the time of follow-up, and were retired. Fifty-eight patients younger than 65 years reported their employment status and 53% of them were working full-time or part-time. Twenty-six of the patients younger than 65 years were retired. Only two patients with earlier sports injury (2/18) reported not working either full-time or part-time work while, as in the group with other injuries, 67% (30/45) reported being retired. When responding to follow-up questionnaire patients with sports-related knee injuries were on average younger than patients with other

injuries (54 years vs. 58 years, mean difference -4.3 years, 95 % CI -7.7 - -0.9, $p=0.014$) (Table I).

Previous knee injury

Twenty-six percent (18/70) of the knee injuries had occurred in sports and 29% (20/70) of the knee injuries had occurred at work. All except one of the patients (17/18) with sports-related injuries reported the sports in which the injury had occurred. Half of the injuries had occurred in team sports ($n=9$), such as soccer, basketball, ice hockey or Finnish baseball. Sports-related knee injuries had also occurred in badminton, downhill and cross-country skiing. Traffic accidents were the cause for the injury in 23 (16/70) percent of the patients, and 13% (9/70) of the patients reported that the injury had occurred in leisure time, such as falling at home or when hunting or disembarking from a boat. Seven of the patients did not provide exact details of the injury situation. There was no gender difference in the type of injury ($p=0.369$). Fifty-three percent (35/66) of the patients with knee injuries leading to TKA reported more than one injury in the lower limb.

One-third (33%, 16/48) of all patients with previous knee injuries reported that they had suffered a combined knee ligament and meniscal injury. These types of injuries were more common in sports than elsewhere (57% vs. 24%, $p=0.025$). Only five patients had had isolated anterior cruciate ligament (ACL) injury and one of the fourteen lower-limb bone fractures was sports-related (7% vs. 38%, $p=0.031$). Slightly fewer isolated meniscal injuries had occurred in sports than elsewhere (7% vs. 27%, $p=0.134$).

Sports-related injuries had occurred at younger ages than other injuries (mean age 23.4 vs. 35.2 years, mean difference -11.8 years, 95% CI -18.6 - -5.0, $p=0.001$), and the time from

injury to arthroplasty was longer in patients with sports-related injuries than with others (mean 26.6 vs. 17.4 years, mean difference 9.2 years, 95% CI 3.4 – 15.0, $p=0.003$). In seventeen patients, the arthroplasty was performed less than ten years after the knee injury, and in only one of these was the injury sports-related.

Almost every patient (97%, 57/59) reported having had knee surgery, such as meniscal resection or ACL and medial collateral ligament (MCL) repair surgery before TKA. Some of the patients had had several arthroscopies before TKA, no differences between sports-related and others injury were seen.

At the follow-up there was a trend for patients with sports-related injuries to report less knee pain and fewer symptoms than patients with other injuries ($p=0.055$) (Table II). Otherwise, no difference was seen in pain and symptoms between sports-related injuries and other injuries regarding other anatomic locations.

Physical activity

Most of the patients (82%) reported having received sufficient exercise instructions after TKA, but 11% would have wanted to have more instructions - all of them were patients suffering work or traffic-related accidents.

Most of the patients (80%, 48/60) had exercised regularly during their lifetimes at least two times per week. All patients ($n=18$) with a sports-related injury and 71% ($n=30$) of other patients had exercised regularly before TKA ($p=0.011$) (Table III). At follow-up 78% (47/60) of the patients exercised regularly; 89% (16/18) of patients with sports-related injuries and 74% (31/42) of other patients ($p=0.194$). Sixteen patients had been physically inactive

(exercised less than two times/week) before TKA, and seven of them were still inactive at follow-up, all patients with other injuries. Twenty-one patients had bilateral TKA, and eight of them were patients with sports-related injuries. Despite bilateral knee endoprosthesis these patients were as physically active as the others (age-adjusted mean MET index 30.6 vs. 23.0, mean difference -7.6 MET index, 95% CI -21.8 – 6.6, $p=0.290$).

Preoperatively (11) 17.6% of the patients reported that they could walk only 200 meters or less before TKA. Nine of those eleven patients responded to the specific question on physical activity at follow-up, and all of them reportedly exercised regularly. One of the patients reportedly exercised less than 15 minutes per time, and the others walked or jogged from 15 minutes to over 2 hours.

Average exercise intensity corresponded to the intensity of walking among 68% of the cases (43/63), but 14% of the patients reported engaging in higher-intensity physical activity, such as jogging. Half of the patients exercised at least one hour at a time, and over half of them did exercise 11 times or more during a month. At follow-up the patients with sports-related injuries reportedly exercised at higher intensity ($p=0.002$), and engaged more often in leisure time physical activity at an intensity at least equivalent to jogging ($p=0.001$) compared to patients with other types of injury. No gender differences were found in exercise type, intensity, duration or frequency. Overall, the post-TKA volume of leisure-time physical activity was higher among patients with sports-related injuries than the others (age-adjusted mean MET index: 42.1 vs. 18.5, mean difference 25.0 MET index, 95% CI 10.5 – 39.6, $p=0.001$).

In physically inactive patients BMI was slightly higher than in physically active patients (age-adjusted mean 32.2 vs 29.1, mean difference 3.1 kg/m², 95% CI -0.6 – 6.3, p=0.054). Recent physical activity among the patients is shown in more detail in Table III. Among the sub-group of patients who reported to have some repetitive long-lasting pain at the follow-up, patients with sports-related injuries had a higher age-adjusted MET index than did other patients. The difference in the MET index was 42.3 vs. 18.6 in patients knee pain (mean difference 25.4, 95% CI 8.8 – 41.9, p=0.004). Among patients reporting back pain the corresponding MET index difference was 29.3; 95% CI 10.0 – 48.6, p=0.004 (means 41.8 vs. 14.4), and in patients with shoulder pain 24.4, 95% CI -0.6 – 49.5, p=0.055 (means 45.2 vs. 21.6).

Discussion

Previous knee injury increases the risk of knee osteoarthritis even at a young age. Our primary aim was to investigate the role of acute injuries in the aetiology of knee OA leading to TKA until age 60. In the estimation of the orthopaedic surgeons, 18.7% of the 652 patients treated with TKA in our clinic at the age of 60 years or younger, the cause of knee OA was previous knee injury. Twenty-six percent of them had injured their knees in sports, and the rest of the injuries had occurred mainly in traffic accidents or at work. Patients with sports-related injuries had their TKA nearly 30 years after the injury had occurred, but in the patients with other injuries the mean time to TKA was ten years shorter.

Lohmander et al.⁹ in their review reported that 10-20 years after sports-related knee injury (ACL injury or meniscal tear) half of the patients had radiological signs of OA of the knee and pain with functional impairment. Only one patient with a previous sports-related knee injury in our study had TKA less than ten years after the injury. Patients with sports-related

injuries were on average 12 years younger at the time of the injury than patients sustaining other injuries. In high-energy accidents the most common injuries were bone fractures and combinations of various knee ligament and meniscal tears. ACL and other ligament injuries besides the meniscal tears were especially common among sports-related injuries.

Many factors contribute to the development of early OA after ACL injury, such as trauma to the articular cartilage, age at the time of injury, changes in gait, multiple injuries and knee joint instability.¹⁰⁻¹² Kettunen et al.¹³ concluded that participating in sports involves a risk of knee injuries and this may lead to disability later in life. Tveit et al.¹⁴ also reported that previous knee injury is associated with knee OA in former impact athletes, but not in non-impact athletes. According to the review by Øiestad et al.¹⁵ patients with isolated ACL injuries had lower prevalence of knee OA than with knee ligament injury combined with meniscal tears. Claes et al.¹⁶ in their meta-analysis found that the prevalence of radiographic knee OA after ligament ACL reconstruction was lower than had been thought. When meniscal resection was associated with reconstruction it increased the risk for developing OA. Nearly the entire study group reported having undergone some kind of knee surgery before TKA such as arthroscopy, meniscal resection and ACL or other knee ligament reconstruction. However, the question whether ACL reconstruction leads to early OA is still under debate.¹⁷

Seventy-six percent of the patients had exercised regularly earlier in their lifetimes. After TKA, 78% of all patients reported they had continued their exercise habits. Patients with sports-related injuries were more active than other patients before TKA, but after TKA the difference between the groups disappeared. Likewise in Chang et al.¹⁸ study, low-impact sports, such as walking, cycling and swimming were common in our patients. In Waldstein

and co-authors review¹⁹ low-impact activities increased and high-impact activities decreased after unicompartmental knee arthroplasty. On average our patients with sports-related injuries continued to engage in physical activity at higher levels of intensity than other patients. This was also seen in the amount of physical activity. Patients with sports-related injuries had higher weekly MET index values than the others. It has been concluded that sports activities are not dependent only on TKA itself, but also on the motivation of the patient.²⁰ This may also be the reason for cause of our patients with sports-related injuries; they had been exercising regularly before TKA and were willing to continue physical activities after TKA at the same level of intensity as before TKA. However, Chang et al.¹⁸ refuted the hypothesis that patients participate more actively in physical activities after TKA than they did before surgery. After all the recent review¹⁹ showed that patients, who participated regularly in sports before knee arthrosis, sports participation decreased slightly after unicompartmental knee arthroplasty. Also Arnold et al.²¹ found in their systematic review postoperative physical activity levels in TKA patients were lower than activity levels in their healthy controls. However, our patients had TKA in younger age and this may partly explain that patients with sports-related injury had higher MET index values than patients with other injuries.

We compared pain and symptoms to MET index values and when patients reported pain and symptoms in the knee, patients with sports-related injuries had significantly higher MET indices than others. Paxton et al.²² concluded that patients reported being more physically active after TKA than before TKA. However, in their report accelerometry-based outcomes showed that physical activity was lower or at the same level as before surgery. We did not have either pre-injury, preoperative or post-operative accelerometer recordings. Although TKA improves functional performance and reduces pain associated with knee osteoarthritis, little is known about the influence of TKA on overall physical activity levels.²² Overall,

musculoskeletal symptoms were common in our patients. However, despite self-reported pain in the knee, spine and shoulder, patients with sports-related injuries reported significantly more physical activity than patients with other previous injuries. However, patients with knee injuries sustained at work or in traffic also had more concomitant injuries at different locations in the body. This may explain their slower recovery and return to physical activity. Our material was taken from the knee arthroplasty register of one orthopaedic hospital during the period 2000-2013. Seventy patients responded to our questionnaire, and the final number of patients with sports-related injuries was low, which limits the conclusions that can be drawn from the results. Furthermore, we used a retrospective study design with self-reported questionnaire. The injuries had occurred long ago, thereby increasing the risk of memory recall bias. However, we were able to check the patients' medical records, which considerably improved the reliability of the results of this study.

Conclusions

Previous knee injury was the cause of severe knee osteoarthritis in one-fifth of the young TKA patients, and one-fourth of the injuries were sports-related. Patients with sports-related injuries engaged in more higher-intensity physical activity after arthroplasty than did the other patients.

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Conflicts of interest

The authors have none to declare.

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Table III. - Leisure-time physical activity reported by patients with a history of sports-related injuries or other injuries at follow-up among patients with total knee arthroplasty

TITLE OF FIGURE

Figure 1 - TKA had been done between years 2000-2013 to 60 years or younger

Table I. - Characteristics of patients undergoing with total knee arthroplasty.

	All	Group with previous sports- related injuries	Group with previous other injuries	Mean difference	95% CI ^b	p - value ^c
	n=70 mean±SD ^d	n=18 ^a mean±SD ^d	n=45 ^a mean±SD ^d			
Gender, male (n (%))	34 (49)	7 (39)	25 (56)			0.645
At the time of surgery						
Age (yrs)	51.8±5.2	50.0±5.3	52.2±5.3	2.2	-5.1 - 0.8	0.219
BMI ^e (kg/m ²)	29.0±5.0	27.8±4.1	28.7±4.8	-0.9	-3.5 - 1.6	0.155
At the time of follow-up						
Age (yrs)	57.6±6.5	54.1±5.9	58.4±6.2	4.3	-7.7 - 0.9	0.064
Time from surgery to follow-up (yrs)	6.2±3.7	4.5±3.0	6.6±3.7	-2.2	-4.1 - 0.2	0.075
BMI ^e (kg/m ²)	29.9±5.3	28.6±4.3	29.9±5.5	-1.2	-4.2 - 1.7	0.645

^aThe study group consisted of 70 patients, 63 of them reported where their injury occurred

^b 95% Confidence Interval, 95% CI

^c p - values for statistical difference between groups with previous sports injuries and previous other injuries

^dSD=Standard deviation

^eBMI=Body mass index

Table II. - *Self-reported prolonged pain and/or recurrent symptoms in different joints among patients with total knee arthroplasty.*

Region	Pain and symptoms			
	All	Group with previous sports-related injuries	Group with previous other injuries	
	n (%)	n (%)	n (%)	p-value*
Hip	24 (48)	8 (47)	16 (49)	0.924
Knee	50 (88)	18 (16)	32 (82)	0.055
Ankle	18 (34)	5 (28)	13 (37)	0.495
Shoulder	26 (47)	9 (50)	17 (46)	0.778
Hand	14 (27)	5 (28)	9 (27)	0.919
Back	31 (54)	8 (44)	23 (59)	0.306
Other pain, no arthrosis pain	21 (36)	7 (41)	14 (33)	0.569

*p-values for statistical difference between the group with previous sports-related injuries and group with previous other injuries

Table III. - *Leisure-time physical activity reported by patients with a history of sports-related injuries or other injuries at follow-up among patients with total knee arthroplasty.*

	Group with previous sports-related injuries	Group with previous other injuries	<i>p</i> -value ^a
	n=18 n (%)	n=42 n (%)	
Exercise at least 2 times /week	18 (100)	30 (71)	0.011
Present exercise (yes)	16 (89)	31 (74)	0.194
Average exercise intensity corresponds			0.002 ^b
to walking	10 (56)	29 (71)	
alternative walking and jogging	1 (6)	10 (24)	
jogging	7 (39)	2 (5)	
Average exercise duration per session			0.544 ^b
less than 15 minutes	2 (11)	5 (12)	
15 minutes and less than 30 minutes	0 (0)	6 (14)	
30 minutes and less than 1 hour	6 (33)	10 (24)	
1 hours and less than 2 hours	9 (50)	19 (45)	
over 2 hours	1 (6)	2 (5)	
Monthly exercise frequency			0.202 ^b
5 times or less	1 (6)	12 (29)	
6 to 10 times	4 (22)	7 (17)	
11 to 19 times	5 (28)	12 (29)	
20 times or more	8 (44)	11 (26)	
MET index (MET-hour/week) ^c [age-adjusted mean]	42.3	18.5	0.001

^a*p*-values for statistical difference between the group with previous sports-related injuries and the group with previous other injuries

^b*p*-values for differences over categories.

^cIndex used in the calculation of MET hour/week based on intensity * duration * frequency

Fig. 1. TKA had been done between years 2000-2013 to 60 years or younger.