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# The Effects of Previous Meniscus and Anterior Cruciate Ligament Injuries in Patients with Total Knee Arthroplasty

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## SUMMARY

**Background.** Patients undergoing total knee replacement constitute a suitable population for studying the natural history of traumatic joint injuries.

**Material and methods.** We studied all patients who received a TKA (Total knee arthroplasty) over the course of one year, in five different centers. The study involved 474 patients who had undergone a primary TKA for knee OA over a one-year period. In each patient, we analyzed age, sex, side of operation, weight, height and body mass index (BMI, kg/m<sup>2</sup>). BMI results were stratified into four groups according to the WHO classification: normal (<25), overweight (>25 and <30), obese (>30 and <40), and morbidly obese (>40).

**Results.** In the TKA group, 74% of the patients were women, while in the THA group the percentage of men and women was similar. No differences were found in the sides operated on. Differences between both groups were found in knee alignment. Women were operated on more frequently for TKA, as there was a higher incidence of OA of the knee joints in women aged over 65.

**Conclusions.** Patients who required a total knee arthroplasty are likely to have previously undergone surgery or trauma to the knee joints.

**Key words:** total knee arthroplasty, arthritis, knee, meniscus, meniscectomy, risk factors

## BACKGROUND

Seven percent of the subjects aged over 55 have joint pain associated with radiographic signs of degenerative joint disease, of which 2% are regarded as severe [1]. After the age of 50, there is a greater prevalence of osteoarthritis (OA) in hands and knees among women, and a correlation has been established between obesity and risk of OA, particularly in the knee joint [2,3].

Total knee arthroplasty (TKA) is commonly undertaken to relieve pain and functional restriction in patients with knee OA, with good long-term results and high survival rate of the implant 20 years from the operation [4,5,6].

Injuries to the menisci and ligaments have been associated with early onset of OA. Patients with chronic lesions of the anterior cruciate ligament (ACL) also had greater risk of secondary meniscal injuries which were associated with developing knee OA [7,8].

Meniscectomy is often followed by radiographic signs of OA [9-13]. In a study of 155 patients operated on for isolated injuries to the meniscus, Englund et al observed that, 16 years after the meniscectomy, 43% of the knees presented radiographic signs of degeneration [11]. They concluded that meniscectomy is accompanied by a high risk of knee OA, and suggested that the symptoms of a degenerated meniscus are in fact the first symptoms of OA.

Patients in whom joint replacements are indicated typically present severe joint degeneration, and constitute a suitable population for studying the natural history of traumatic joint injuries to determine whether they are associated with a greater incidence of joint degeneration. We therefore studied all patients who received a TKA over the course of one year, in five different centers, taking as a control group patients who received a total hip arthroplasty (THA) in the same centers during the same period of time.

## MATERIAL AND METHODS

Our institutional ethics review board approved the study, and all patients gave written informed consent to participate in this clinical trial.

### Eligibility criteria

The study included 474 patients who had undergone primary TKA for knee OA over a one-year period. Patients were included in the study if they had received a primary TKA.

Their characteristics were analyzed, as were any previous injuries and operations to the knee joint. Exclusion criteria were revision arthroplasties, onco-

logical patients, and multiple trauma patients. A population of 129 patients who received THA in the same centers over the same period of time was taken as control group, and the same data were obtained for both groups.

In each patient, we analyzed age, sex, side of operation, weight, height and body mass index (BMI, kg/m<sup>2</sup>). BMI results were stratified into four groups according to the WHO classification: normal (<25), overweight (>25 and <30), obese (>30 and <40), and morbidly obese (>40).

The variables evaluated in each patient were the alignment of the knee (0 = normal, 1 = varus, 2 = valgus, whenever the radiographic angle was greater than 5°); occupation prior to or at the time of the operation; physical activity (0 = none, 1 = sedentary, 2 = little, 3 = habitually walks, 4 = walks a lot, and 5 = participates in sports); illnesses and operations before the index operation; traumas; operations on the knee joint and also bone health (normal or osteoporotic bone), considering osteoporosis to be present when the patient had been diagnosed with it or was receiving treatment for it. We also took note of any earlier prostheses in the contralateral or in other joints, and the year in which they were inserted.

Injuries suffered were analysed by anatomical region, as were other surgical operations of the musculo-skeletal system.

Under joint surgery we included osteotomy of the hip or knee, arthroplasty, and arthroscopy. Under previous knee injuries we included cartilage damage, meniscal injury, rupture of the ACL, injury to both meniscus and ACL or rupture of the collateral ligaments. We also took into consideration the time passed between the operation and the insertion of the prosthesis, or between the osteotomy or meniscectomy and the definitive operation to implant the prosthesis.

### Statistics

We tested for normality using the Kolmogorov-Smirnov test with the Lilliefors correction. To compare quantitative variables with qualitative ones for two categories, we used Student's t test for independent variables if the variable in question showed a normal distribution, and the Mann-Whitney U test if it did not. To compare quantitative variables with qualitative variables for more than two categories, one way ANOVA was used, followed by Tukey's multiple comparison test if the variable in question had normal distribution and Kruskal-Wallis followed by the Mann-Whitney U test and Bonferroni's test if not. To compare qualitative variables, rxc contingency tables with Chi-square tests were used. Values of p<0.05 were taken as significant. All the statistical

analyses were carried out with SPSS for Windows version 11.0.

**RESULTS**

In the TKA group, 74% of the patients were women, while in the THA group the percentage of men and women was similar. No differences were found in the sides operated on. Most patients received a unilateral arthroplasty, and bilateral TKA was more frequent in women (Table 1).

The mean age of the patients was greater in the TKA group than in the THA group, but there were no statistical differences between the groups. The men who had received a THA were the youngest group (Table 1). In the TKA group, over half of the patients were aged between 66 and 75. In the THA group, the ages were more widely distributed, and 30% of the patients were aged between 66 and 75 (Figure 1).

Differences between both groups were found in knee alignment. Sixty percent of the TKA patients

had a varus knee, which was only the case with 5.5% of patients with THA (Table 2) (Figure 2). No correlation was found between the alignment of the knee and age or BMI in either group.

Fifty-seven percent of the TKA patients were housewives, and one-third were manual workers in both groups (Figure 3). Approximately half of the patients in the two groups walked frequently or were very active, while 31% of the TKA and 20% of the THA groups were not particularly active, and 18% of the TKA and 8.5% of the THA were sedentary (Figure 4).

Patients diagnosed with or under treatment for osteoporosis accounted for 31% of the TKA and 25% of the THA groups, the age in the osteoporotic group being similar to that in the non-osteoporotic group for the TKA and older for the THA patients. The housewives had a greater incidence of osteoporosis.

The mean BMI in both groups showed that, as a group, the patients were overweight, and the BMI was slightly higher in the TKA group; there were no

Tab. 1. Age, weight, height and BMI in different TKA and THA groups

|                |     | Age (yrs)             |    | Weight (kg) |       | Height (cm) |        | BMI   |       |       |
|----------------|-----|-----------------------|----|-------------|-------|-------------|--------|-------|-------|-------|
|                |     | (kg/cm <sup>3</sup> ) | #  | %           | X     | DS          | X      | DS    | X     | DS    |
| Total TKA      | 465 |                       | 72 | 7           | 78.23 | 13.33       | 160.20 | 8.65  | 27.73 | 4.17  |
| Total THA      | 128 |                       | 66 | 13          | 74.13 | 12.33       | 163.49 | 9.68  | 27.74 | 4.18  |
| Female TKA     | 338 | 73.4                  | 72 | 7           | 76.14 | 13.06       | 157.18 | 7.31  | 30.85 | 5.17  |
| Female THA     | 68  | 52.4                  | 71 | 12          | 70.09 | 12.23       | 157.21 | 7.55  | 28.26 | 4.37  |
| Male TKA       | 124 | 26.6                  | 72 | 6           | 83.4  | 12.20       | 168.40 | 6.58  | 29.35 | 3.59  |
| Male THA       | 61  | 47.6                  | 61 | 14          | 78.64 | 10.91       | 170.33 | 6.71  | 27.16 | 3.90  |
| Unilateral TKA | 342 | 73.6                  | 72 | 7           | 77.70 | 13.12       | 79.7   | 13.84 | 73.89 | 14.45 |
| Unilateral THA | 93  | 72.6                  | 65 | 14          | 74.23 | 11.40       | 163.12 | 9.28  | 27.91 | 3.90  |
| Bilateral TKA  | 123 | 26.4                  | 74 | 6           | 79.7  | 13.84       | 160.7  | 8.7   | 30.94 | 5.32  |
| Bilateral THA  | 38  | 27.4                  | 69 | 12          | 73.89 | 14.45       | 164.37 | 10.64 | 27.33 | 4.82  |

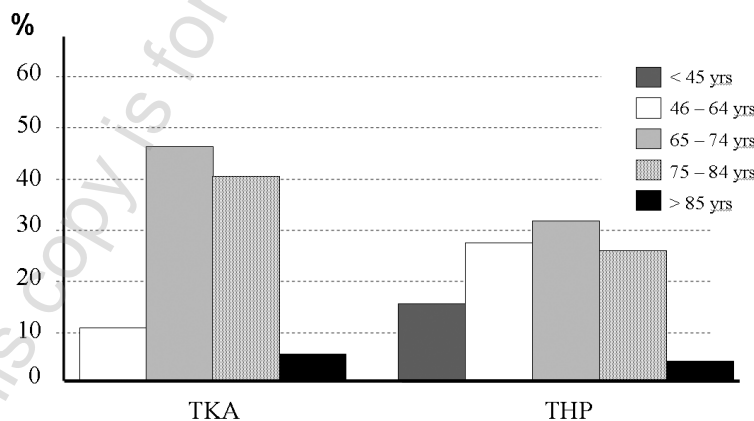


Fig. 1. Age group percentages in TKA and THA patients

Tab. 2. Knee alignment

|        | Age (yrs) |    | BMI (kg/cm <sup>2</sup> ) |      |
|--------|-----------|----|---------------------------|------|
|        | X         | DS | X                         | DS   |
| TKA    |           |    |                           |      |
| Normal | 72        | 7  | 31.20                     | 4.54 |
| Varus  | 73        | 7  | 30.51                     | 4.9  |
| Valgus | 71        | 8  | 28.21                     | 5.00 |
| THA    |           |    |                           |      |
| Normal | 66        | 13 | 27.91                     | 4.35 |
| Varus  | 76        | 9  | 27.91                     | 4.30 |
| Valgus | 64        | 17 | 26.88                     | 3.29 |

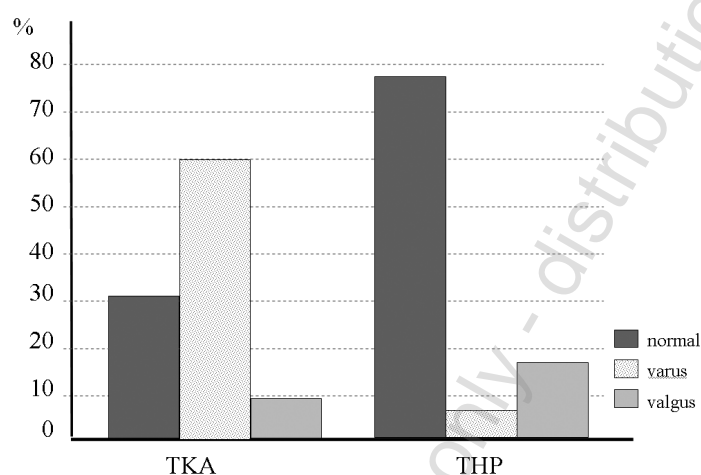


Fig. 2. Knee alignment group percentages in TKA and THA patients

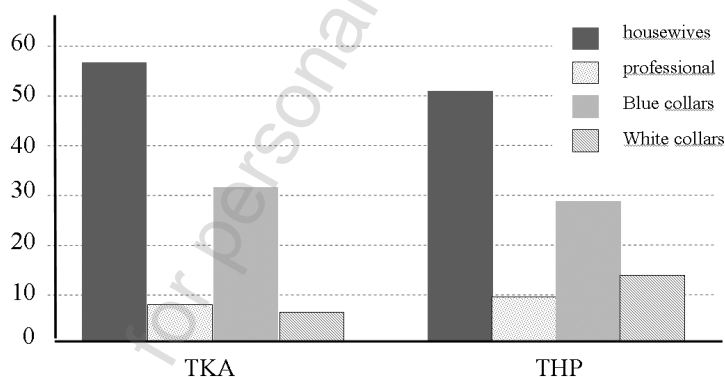


Fig. 3. Previous work activity group percentages in TKA and THA patients

differences in BMI between patients with uni- or bilateral prostheses, or between men and women (Table 1). Forty-eight percent of patients with TKA and 27% of those with THA were obese, and 4% of those with TKA were morbidly so (Figure 5). In the TKA group, the housewives had a mean BMI indicating obesity, while the other groups were overweight. In

the THA, all the occupational groups were overweight, with white collar workers being close to normal weights.

The bone mineral status did not correlate with the BMI in any of the groups, nor did physical activity, except in the case of TKA patients who took part in sports, who were within the normal range.

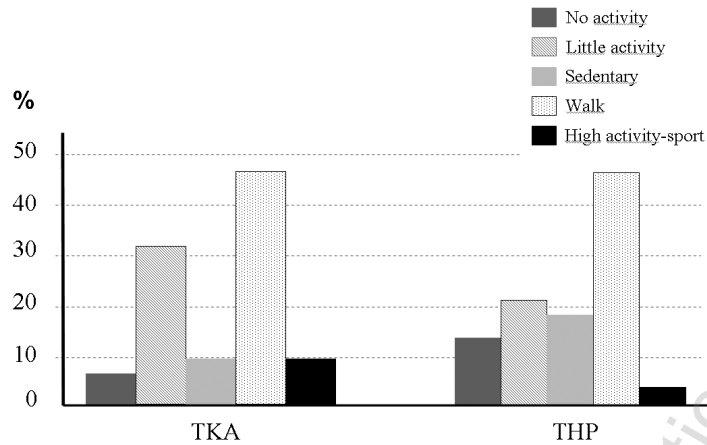


Fig. 4. Physical activity at surgery group percentages in TKA and THA patients

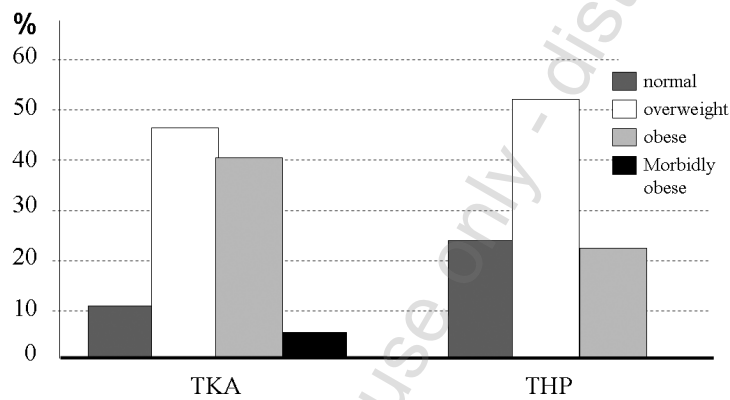


Fig. 5. BMI group percentages in TKA and THA patients

When earlier injuries were analyzed, 32 patients in the TKA group (7.4%) and 26 in the THA group (20.1%) had a history of trauma. Only 5 (1%) of TKA patients had a history of trauma referred to the knee, and only one THA patient had such a history.

Twenty-six percent of the TKA patients had previously been given a TKA in the contralateral knee, 2.3% had received a contralateral hip replacement, and one an ipsilateral hip replacement. The contralateral TKA were implanted, mostly, between 1 and 6 years before the second TKA (Table 3). In the THA

group, 29.4% of patients had undergone contralateral THA, and 8.5% had received a TKA. Only 3 THA patients had previously undergone an osteotomy, while among the TKA group, 34 (7.1%) had previously undergone osteotomy.

Among the previous injuries to the knee joint, 8.3% of the TKA patients suffered some prior operation on the meniscus or ACL, cartilage or ligaments; the most frequent were operations on the meniscus (37 cases or 7.9%). Among the THA group, we only found 3 previous meniscectomies.

Tab. 3. Time (years) of previous knee surgeries in TKA patients

|             | Meniscectomy | Osteotomy | Contralateral TKA |
|-------------|--------------|-----------|-------------------|
| < 1 yr      | 1            | 0         | 40                |
| 3 – 5 yrs   | 7            | 1         | 54                |
| 6 – 10 yrs  | 11           | 8         | 23                |
| 11 – 15 yrs | 5            | 11        | 6                 |
| > 16 yrs    | 13           | 14        | 0                 |

The meniscectomies and tibia osteotomies in the TKA group had been performed, in the majority of cases, between 6 and 16 years before the operation (Table 3). There were no differences as regards the meniscus which had been injured, or in terms of sex.

In the TKA group, there were significantly more patients with varus knee alignment, meniscal injuries, and significant differences concerning the BMI than in the THA group. The TKA group had the higher number of obese subjects (including overweight and morbidly obese) and the women of the TKA group had a higher BMI ( $p<0.006$ ), with the housewives being the occupational group with the highest BMI ( $p<0.02$ ). Patients with bilateral TKA were older than the unilateral group ( $p=0.001$ ), and there were more obese women ( $p=0.005$ ).

No statistically significant differences were found between the TKA group and the THA group as regards earlier traumas, occupation or previous operations on the musculo-skeletal system. In the TKA group, we found no statistically significant differences among the patients with knee injuries in terms of age, weight, height or BMI, or between the different surgical techniques used previously on the knee in terms of age, weight, height or BMI.

Injuries to the meniscus were more frequent on the left ( $p=0.047$ ), and were more common in the unilateral TKA group ( $p=0.037$ ). There were also more knees with normal alignment among patients with meniscectomy ( $p=0.002$ ). The patients who had undergone meniscectomy were younger (70 years) than those who had not (72 years) ( $p=0.045$ ). Nonetheless, we found no differences between the meniscectomy and no-meniscectomy groups as far as the BMI, or occupation, or state of the bone were concerned.

The patients' history of other surgery and surgery to the musculo-skeletal system contained no data of interest, although in the TKA group there were a large number of appendectomies, cholecystectomies, inguinal hernias and particularly, in contrast to the THA group, hysterectomies (32 cases, that is, 9.1% of the women who had had TKA).

## DISCUSSION

It is difficult to assess the effect of injury to the meniscus on degenerative joint disease of the articular cartilage of the knee. The amount of the meniscus excised is related to joint disorders and the severity of OA [9,10,14,15]. However, knee OA is not simply the consequence of joint injuries. Some patients have never experienced any damage to their knees, yet present degenerative joint disease. In the present

investigation, we studied all patients who underwent prosthetic surgery over one year, to analyze the characteristics of the patients and their history relating to the knee joint, and to find out whether the patients who required a total knee arthroplasty were more likely to have previously undergone surgery or trauma to the knee joints. As a control group, we used a group of patients who received a hip replacement in the same centers and at the same time.

Women are operated on more frequently for TKA, as there is a higher incidence of OA of the knee joints in women aged over 65 [11]. The prevalence of knee OA is 4.9% in women and 2.6% in men. Bilateral knee OA is more frequent in women. A considerable number of patients will sooner or later receive a bilateral prosthesis, and there some patients will undergo prosthetic replacements of joints other than the knee. We found no differences between the patients with uni- and bilateral prostheses [16].

A correlation has also been demonstrated between OA changes and previous injuries to the menisci or the cruciate ligaments [17]. A reconstruction of the ACL may not protect against the progression of OA in the knee [18]. Fifteen months after surgery, the joint cartilage is more likely to degenerate, particularly in women and patients aged over 30, while anterior laxity and meniscal injuries do not correlate with degenerative changes [18].

The factors which have been associated with radiographic progression of OA are obesity, generalized arthritis, particular alignments of the legs, and synovitis [7].

In a meta-analysis, Meredith et al indicated that patients with extensive meniscal resections and females had the highest correlations with radiographic evidence of OA [12]. Statistical significance in the same study was not reached by age and type of meniscal injury. In addition, in a follow-up study of 328 unstable knees in 4 different centers, the best correlation with the severity of OA was that of time elapsed since meniscectomy [19].

Nebelung and Wuschech analyzed developments after tears of the meniscus and the ACL in 19 elite athletes over a 35- to 37-year period [8]. The joint degeneration process was severe in the athletes who returned to highly competitive sports after treatment. Twenty years after the injury, most of the knees had severe symptoms of OA and instability, and 10 of the 19 athletes underwent a TKA operation.

Andersson-Molina et al compared the long term outcome of two groups of patients who had undergone total and partial meniscectomy, and, after a 14-year lapse, noted that the range of joint motion was lower in knees that had undergone total meniscecto-

my than in the contralateral knee, but found no differences between total and partial meniscectomy [15]. Radiographically, there were no differences between the two groups that had received surgery. Equally, Schimmer et al. found no differences between patients who had received total and partial meniscectomy after 12 years, although both groups presented activity levels lower than that of the control group [20].

Varus knee increases the risk of OA of the lateral compartment, and, when greater than 5° in the frontal plane, it is associated with functional deterioration in older subjects [21]. Ritter et al, in a retrospective study of 2796 patients, found a relationship between knee alignment and OA [22]. Our study obtained a greater frequency of genu varus in TKA patients with significant differences to the THA group.

One of every five US citizens is obese, and this figure will rise to 40% in 2025 [23]. The trends are similar in other western countries. There is a relationship between being overweight and suffering from degenerative joint disease, and a high proportion of patients who receive TKA are obese, even to morbid levels [2,3,24,25,26,27].

We demonstrated a correlation between BMI and TKA. The incidence of obesity in OA patients is greater than that in the normal population, particularly when the knees are affected. Weight increase is a factor which predisposes to the development of OA, and, although obesity is an independent condition with no relationship with the inactivity caused by the joint injury, it may actually result from impaired mobility and joint pain [28]. Overweight women are reported to experience worse results following TKA in terms of quality of life, and less satisfaction after sur-

gery, than women of normal weight, but there is no evidence that age, sex or obesity are prognostic factors for the subsequent evolution of the prosthesis [29,30].

Unilateral OA of the knee is associated with joint injuries, whereas bilateral arthritis is associated with obesity. This would seem to be consistent with the results of the present study, although these observations are difficult to evaluate.

Epidemiological studies of OA are not straightforward, either in terms of methodology, or in the ways that the presence and extent of degenerative joint disease is determined or defined. We set out to study the effects of injuries to the meniscus and ACL on joint degeneration, and found that there is a relatively weak correlation between meniscectomy and OA, and a more significant correlation between knee OA and obesity.

In future studies it might be useful to differentiate between patients who have suffered severe injuries to the knee, and obese women with genu varus. The body mass index is the variable which reduces the difference between the sexes, although obesity might be a consequence of the knee OA rather than a risk factor. Prospective studies should be performed in athletes and workers who have undergone meniscectomy or rupture of the ACL, and who have been operated on or left to observe the natural history of the condition, to determine how their degenerative joint disease is progressing.

## CONCLUSION

Patients who required a total knee arthroplasty are likely to have previously undergone surgery or trauma to the knee joints.

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