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Knee arthroplasty for spontaneous osteonecrosis of the knee: unicompartimental vs bicompartimental knee arthroplasty

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Abstract Spontaneous osteonecrosis of the knee (SON) is an osteonecrosis that mainly affects the medial femoral condyle. In endstage SON, knee arthroplasty is the therapy of choice. Because of the unicompartimental nature of the knee, unicondylar knee arthroplasty is considered an ideal implant for treatment of this condition. The purpose of this study was to prove that the long-term results of unicondylar implants are better than the results of bicondylar implants for the treatment of SON. All patients treated for SON between 1984 and 2000 have been recorded. Two groups were formed according to the implant used. In all patients the preoperative radiograph was analyzed according to stage and size of the osteonecrotic lesion and the osteoarthritic changes. Postoperatively, the Knee Society Score and the radiograph were recorded. Thirty-nine patients were included in this study, of which 23 patients were treated by a unicondylar implant and 16 by a bicondylar implant. On a short-term basis, unicondylar implants had better clinical results; however, on a long-term basis bicondylar implants were better. In comparison, only unicondylar implants had to be revised. Radiolucency lines were mainly observed in patients with unicondylar impants and large areas of osteonecrosis. Our long-term results suggest that patients with SON are better treated by bicondylar implants. The reasons for the higher failure rate for unicondylar implants are poor bone stock and secondary arthritic changes.

Keywords Spontaneous osteonecrosis knee · Ahlbäck disease · Unicondylar knee arthroplasty · Bicondylar knee arthroplasty · Long term results

Introduction

Spontaneous osteonecrosis of the knee (SON) was first described by Ahlbäck et al. in 1968 [2]. Ever since, the terms spontaneous osteonecrosis of the knee and Ahlbäck's disease have been used synonymously [2]. The incidence of SON in patients treated by knee arthroplasty varies between 0.05 and 7% [4, 7, 13, 21] of the knees. SON typically affects elderly women between 50 and 65 years of age [2]. The medial femoral condyle is mainly involved [16]. According to Aglietti [1] SON can be divided into five stages according to the radiographic appearance. In end stage SON, knee arthroplasty [3, 5, 10, 17, 20] is the only effective therapy. In the beginning of late-stage SON, secondary osteoarthritis affecting other compartments is rarely seen [16, 29]. A unicompartimental knee arthroplasty is therefore considered to be an appropriate implant for late-stage SON by some

authors [5, 10, 17]. Most studies [26] analyzing the failure rate of unicondylar arthroplasties did not observe more failures in patients with SON when compared to patients with osteoarthritis, which is probably due to the small number of patients with osteonecrosis included. Only Jones [13] gave a detailed analysis of failure in his study dealing with unicondylar knee arthroplasty for various indications, and was able to show that there were twice as many implant failures in patients with osteonecrosis compared to osteoarthritis. The use of unicondylar knee arthroplasty in patients with SON therefore remains controversial.

We therefore analyzed our data to see whether the long-term results of unicompartimental knee arthroplasty are better in patients with SON compared to those of total knee arthroplasty.

Material and methods

Between 1984 and 2000, 39 consecutive patients were treated for SON in our department. The patients were divided into two groups according to the implant used.

Group uni included only patients treated by a unicompartimental knee arthroplasty (Richards modular 1 or modular 3, Tuttlingen, Germany) that was exclusively used between 1984 and 1988. *Group TKA* included only patients treated by a PFC knee system (Johnson & Johnson Orthopaedics, Norderstedt, Germany) that was exclusively used between 1989 and 2000.

Group uni included 23 patients (20 females and three males). The average age was 70.2 years (54–80 years). The average weight was 66.95 kg (50–84 kg). The right knee was involved in 11 patients, the left knee in 12 patients. One patient had radiation therapy, three patients had corticosteroid therapy; the rest had no apparent risk factors.

Group TKA included 16 patients (13 females and three males). The average age was 74.71 years (65–82 years). The average weight is 70.8 kg (56–104 kg). The right and left knee were equally affected. In regards to risk factors, two patients had elevated cholesteol levels, three patients had corticosteroid therapy and one patient had cortico-steroid therapy and radiation.

Retrospectively the patients' records and radiographs were reviewed. Radiographs were analyzed for typical signs of SON. The radiographic stage of osteonecrosis was determined according to Aglietti et al. [1], and the size according to Muheim and Bohne [19] and Lotke et al. [16]. The location of the lesion was classified into medial and lateral. The grade of osteoarthritis was determined radiographically according to Tapper and Hoover [28]. Perioperative complications as well as revision surgery were noted.

For follow-up, the patients were either clinically and radiographically examined, or the last chart records were reviewed to assess the clinical status. The radiographs were analyzed for radiolucency lines around the femoral and tibial components.

The clinical evaluation for both groups was compared by calculating a repeated-measures analysis of variance for the follow-up period of up to 5 years (group A), greater than 5 years (group B) and up to 8 years (group C). The points of measurement used were the preoperative examination and the last postoperative examination.

Results

Radiographically the patients were distributed among the Aglietti stages III, IV and V as shown in Table 1. In all patients the area of necrosis was located medially. The size of the lesion is shown for both groups in Fig. 1. The distribution of the arthritic changes of the knee according to Tapper-Hoover is visualized in Table 2. The perioperative complications for Group uni were one haematoma and one early infection. In group TKA there was only one postoperative thrombosis.

The postoperative clinical data were evaluated in three groups according to the different follow-up times. The entrance criteria for group A (FU $\leq$ 5 years) were met by ten patients with a PFC with a follow-up of 3.4 (1–5) years, and six patients with a unicondylar prosthesis with a follow-up of 3.3 (1.25–4.75) years. Clinically the pain score was 96.60 for the patients with a PFC prosthesis, and 89.8 for the patients with a unicondylar prosthesis. The function score was 82.5 for patients with a PFC, and 83.3 in patients with a unicondylar prosthesis.

The univariant variance analysis in group B (FU > 5 years) was done on ten patients with a unicondylar implant with an average follow up of 10.4 (5.5–16.8) years, and six patients with a PFC prosthesis with an average follow-up of 7.8 (6.3–10.5) years. Clinically the pain score on follow up was 86.2 for patients with a PFC, and 89.7 for patients with a unicondylar implant.

Table 1 Distribution of Aglietti stages between the different groups

Stage	Group	Number of patients
III	uni	5
	TKA	2
IV	uni	12
	TKA	4
V	uni	4
	TKA	9
Missing	uni	2
	TKA	1
Total		39

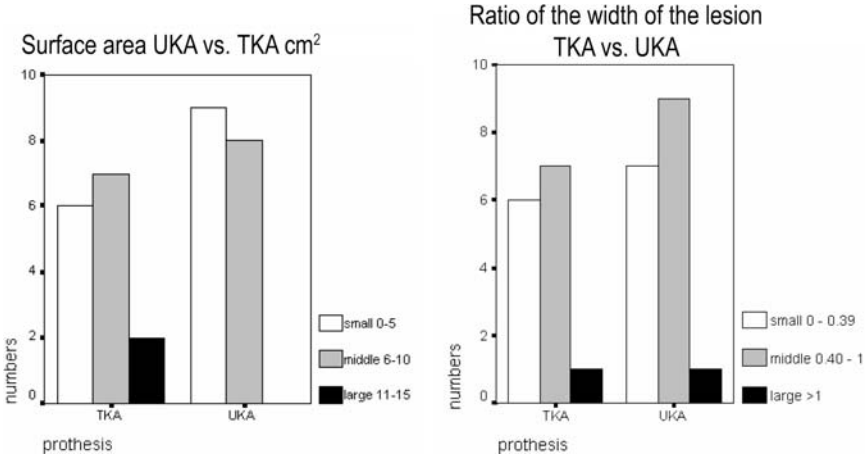

Fig. 1 Size of the osteonecrotic lesion

The function score for patients with a PFC was 76.7, and 67.0 for patients with a unicondylar implant.

The univariant variance analysis of those patients with a follow up of up to 8 years (group C) was based on 15 patients with a PFC with an average follow up of 4.7 (0.8–8.0) years, and ten patients with a unicondylar implant with an average follow up of 4.7 (1.3–7.8) years. Clinically the pain score was 92.4 in the patients with a PFC, compared to a pain score of 86.7 in patients with a unicondylar implant. The postoperative function score in contrast was 81.3 on follow up for the PFC. For the unicondylar implant the function score was 72.0. The unicondylar implant seems to do worse with regard to pain and function on a long term basis.

The follow-up radiographs showed radiolucency lines (RLL) in group uni in three patients on the femoral side. All patients were preoperatively at Aglietti stage IV, and had a larger surface area and surface-condylar ratio than the remaining patients. On the tibial side RLL's were seen in two patients on the lateral view, and in three patients on the a.p. view. RLL's were not seen along the tibial stem. All RLL's were in total greater than 2 mm. In group TKA, RLL's were only seen on the tibial side. On the lateral view four patients had RLL's below the tibial tray, two with RLL's greater 2 mm in total. Seven patients had RLL's on the a.p. view, in three patients the RLL's were greater than 1 mm. However, clinically there was no evidence of loosening on the last examination.

Four patients in group uni had to be revised. All of them were female. The right and left side were equally affected. The average age was 86.5 (83–91) years. The average time between implantation and revision was 60.8 (6–99) months. The average weight was 63.8 (55–79) kg. In two patients, the affected knee had been operated on before the implantation of the unicondylar knee arthroplasty. Radiographically one patient had preoperatively an Aglietti stage III, and three an Aglietti stage IV. The lesion surface according to Aglietti was 7.7 in one patient, and belonged to the largest lesions in group uni. In comparison, patients with an equal size in group TKA were not revised. The radiograph before revision showed loosening of the femoral component in one case and loosening of the tibial component in two cases. One patient had to be arthroscopically revised because of an intraarticular scar formation. Failure due to malalignment was not seen.

Table 2 Tapper-Hoover stages between the two groups

Stage	Group	Number of patients
I	uni	5
	TKA	2
II	uni	2
	TKA	–
III	uni	13
	TKA	9
IV	uni	1
	TKA	4
Missing	uni	2
	TKA	1
Total		39

Discussion

A unicondylar knee arthroplasty is linked with little blood loss [15], better proprioreception [18], better flexion, preservation of the cruciate ligaments [6], and a better 'feeling' compared to a bicondylar implant [22]. The ideal indication, however, is rare [14, 23, 15]. It is agreed [6] that a unicondylar knee arthroplasty should only be considered in patients with an unicondylar involvement of the femur, no retropatellar osteoarthrosis [22, 27], stable collateral and cruciate ligaments, a knee deformity of less than 10° [8], a range of motion of more than 90°, no extension deficit and no obesity [8, 25]. With regard to the age of implantation, it remains

controversial whether a unicondylar implant should be used as a temporizing procedure for younger patients [23] or in patients above 65 years of age [9].

Late-stage SON meets the above criteria, and is therefore considered to be an ideal indication for unicondylar knee arthroplasty. In contrast, the impaired anchorage of a unicondylar implant due to osteonecrosis and riskfactor-induced poor bone stock, secondary arthritic changes and a progression of osteonecrosis to the other knee compartments [17] give rise to poor long-term results for unicondylar implants.

The aim of this study was to test whether unicondylar knee arthroplasty gives better long-term results than total-knee arthroplasty in patients with SON.

In a study dealing only with SON, Hermichen et al. [10] observed in their 3.9 years results with a unicondylar knee arthroplasty no signs of implant loosening. Only one patient had an implant fracture, which was due to a false implantation. They considered a unicondylar implant as suitable for patients with SON and no accompanying osteoarthrosis. Only an involvement of further knee compartments was considered to be an indication for TKA. In a study by Marmor [18] including 32 cases with osteonecrosis of the knee treated by a unicondylar knee arthroplasty, a subsidence was found in only one patient—who was physically extremely active and younger than 60 years—after an average follow-up of 5.5 years (range 2–16 years). A revision of a unicondylar implant was further necessary in two patients in which the osteonecrosis subsequently extended to the lateral femoral and tibial condyle, and in one patient who experienced constant pain. He concluded that patients with an advanced disease of SON and an osteoarthritc involvement of other parts of the knee joint are better treated by a total knee arthroplasty. More precise in their indication for unicondylar knee arthroplasty were Soucacos et al. [24], who considered patients older than 65 years, with a necrotic lesion greater than 50% of the transverse diameter of the medial femoral condyle, to be ideal candidates for an unicondylar knee arthroplasty. After a follow-up ranging between 2 and 20 years all patients had satisfactory results; a revision was not necessary in any case. Total knee arthroplasty was reserved for patients with an additional involvement of the lateral knee compartment. In comparison to unicompartimental knee arthroplasty the range of motion was worse. Lotke et al. [16] came to the same conclusion in their study with a 2.5 years follow-up. They used a unicompartmental knee replacement only in patients with a normal lateral knee compartment and an osteonecrotic lesion that was well localized. In their study, only one unicondylar implant loosened and had to be replaced by a bicondylar implant. Two patients with a bicondylar implant had poor results, which was probably due to design related problems.

The problems associated with unikondylar knee arthroplasty can be avoided by a bicondylar implant. Rozing et al. [21] and Insall et al. [11] therefore do not consider SON an indication for unicondylar knee arthroplasties because of the better total condylar results. Aglietti et al. [1] reported 95% satisfactory results after a 4.4 years follow up after TKA in patients with osteonecrosis. In a further study, Insall et al. [12] observed an overall success rate for both osteoarthritis and osteonecrosis after TKA of 91%. Stern et al. [25] reported 86% good or excellent results on a series of 43 TKAs at an average 6-year follow-up. Ritter et al. [20] made a survivorship analysis in which pain and radiolucency were used as an end point. The results between patients with osteonecrosis and osteoarthritis were comparable after a follow-up time of 3.9 years. Only one patient with osteonecrosis had to be revised due to loosening of the femoral and tibial component. Bergman and Rand [3] reported a satisfactory reliability and durability of TKA fixation after a 5-year follow-up in patients with SON. Osteonecrosis-related problems due to poor bone stock were not observed. There was no necessity for bone grafts or extended stems of the tibial and femoral component despite several larger osteonecrotic lesions.

This is the first study comparing results of unicondylar and bicondylar knee arthroplasty in patients with SON.

Between 1984 and 2000, 39 patients were treated for SON by knee arthroplasty, using unicondylar implants before 1988 and bicondylar implants afterwards. The reason for the use of different implant designs was a new philosophy unrelated to the success of the implants used before. We are therefore able to compare the results of two types of implant design. There are limitations to this study due to the retrospective design, the long observation period and consequently a large mortality rate. However, both groups—which are comparable in regard to group size, group age and follow-up times—could be further analyzed by a univariant variance analysis with regard to clinical findings. The clinical and functional scores up to 5 years are better for unicondylar knee arthroplasty than those for total knee arthroplasty. The late results after 5 years, and up to 8 years, worsen with a unicondylar implant. This can be explained by progressive secondary arthritic changes.

In this series only unicondylar implants had to be revised. The lesion size in the revised cases was larger than average. Furthermore, there were more femoral radiolucencies seen in the group of patients treated by unicondylar implants at the last radiographic follow-up examination, which is suggestive of a poorer stability of unicondylar knee arthroplasty.

Based on our own results and the literature [1], bicondylar knee arthroplasties have better clinical long-term results, due to a better fixation of the implant in necrotic lesions and a lack of secondary arthritic and

potential osteonecrotic transformation of further knee compartments. If a unicondylar implant is to be used because of the better short-term function in younger patients with SON, a precise preoperative planning with staging and determination of lesion size is mandatory.

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