



## Obesity does not influence the outcome after unicompartmental knee arthroplasty

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We retrospectively reviewed all 147 medial UKA's placed between 2001 and 2011 with a minimum follow-up of two years. The VAS for pain and satisfaction, the New Knee Society Score (KSS) for satisfaction and the Knee Injury and Osteoarthritis Outcome Score (KOOS) were used as patient reported outcomes (PROs). Pre-operative and follow-up radiographs of the knee were assessed.

The survival rate with a median follow-up of 5.0 years is 87%. No significant difference in survival, PROs or radiographical results were seen between the obese and non-obese group.

Mid-term survival, radiographical results and PROs of a UKA are not influenced by obesity. Obesity in patients with medial compartment knee osteoarthritis should not form a contra-indication when selecting patients for a UKA.

**Keywords :** unicompartmental knee arthroplasty ; UKA ; obesity ; BMI ; survival.

### INTRODUCTION

Unicompartmental knee arthroplasty (UKA) is a well-accepted and cost-effective treatment for patients with medial osteoarthritis (OA) of the knee (52,44). Continuous improvement of UKA design as well as fine-tuning of the indications has led to 10-year survival rates of approximately 90% (37,42,1,15,23) with favorable patient reported outcomes (PROs) (31,36).

Defining the population that benefits most from a UKA is still a challenge. Especially, the influence of Body Mass Index (BMI) on the results of a UKA has attracted the attention of many authors for almost 30 years (47,32,23,51,50,30,11,49,33,7,6,35,54). The more recently reported results predicting the effect of BMI on the survival of the UKA are contradictory. Several studies show similar survival rates and outcome scores (49,35,54,6,33,16), whereas others have reported increased complication and failure rates in obese patients (30,11,7). However, most studies have reported on small cohorts, mixing medial and lateral replacements and do not report on patient satisfaction. Besides, some studies represent a

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supposedly overweight population that is incomparable to the increased average BMI of modern times.

Therefore, the purpose of this study is to present our clinical and radiographical results of the UKA placed in our hospital with a follow-up of two to ten years and to determine the influence of obesity on these results.

## PATIENTS AND METHODS

All patients who underwent a medial UKA between January 2001 and May 2011 in our clinic (a major teaching hospital), with a minimum follow up of two years, were contacted to participate in this study. There were no exclusion criteria. Between July 2012 and May 2013, patients were seen at the outpatient clinic during their regular two to three year follow-up visit for physical and radiographical examination and questionnaires. Moreover, the medical files of all participating patients were retrospectively studied for demographic data and pre-operative BMI measured by the anesthetist. We considered 30kg/m<sup>2</sup> as cut-off point for non-obese versus obese (41).

### Measurements

At the follow-up visit patients filled in the visual analogue scale (VAS) for pain (43) and satisfaction (12,13), the New Knee Society Score (KSS) for satisfaction (48,38) and the Knee Injury and Osteoarthritis Outcome Score (KOOS). The KOOS questionnaire included five subscales: pain, symptoms, functioning in activities of daily living (ADL), function in sport and recreation, and knee-quality of life (QOL). A normalized score from 0 to 100 was calculated for each subscale (100 indicating no symptoms) (19,45).

Pre-operative and follow-up radiographs of the knee were made in the anterior-posterior and lateral view. The pre-operative radiographs were assessed for radiographical grade of OA and the follow-up radiographs for progressive radiolucent lines > 2 mm, heterotopic ossifications and signs of migration or subsidence (9,15,51). The radiographical grade of OA was scored according to the Kellgren and Lawrence scale (28).

### Indications and contra-indications

The indications for a medial UKA were isolated medial gonarthrosis or avascular necrosis in the medial compartment of the knee. OA of the lateral compartment and symptomatic patellofemoral OA were considered

contra-indications to receive a UKA. Moreover, the quality of the cartilage of the lateral and patellofemoral compartment was checked during the surgical procedure. If the condition of the cartilage was considered impaired, the operating surgeon would proceed with a total knee arthroplasty (TKA) instead of a UKA.

Other contraindications for UKA were flexion of less than 90 degrees or an extension deficit of more than 15 degrees. Furthermore, rheumatoid arthritis, anterior cruciate ligament insufficiency, excessive varus or valgus deformity (over 10 degrees), patellectomy or subluxation of the knee joint were considered as contraindications.

### Surgical procedure

A mid-line incision was used, followed by a medial parapatellar arthrotomy. When needed, a vastus medialis snip was made up to 3 cm to create the necessary operative field. With a lateralized patella, resection of both tibia and femur was performed using the guiding instruments. After thorough flexion and extension gap balancing, cemented placement of the definitive components of the Miller Galante (MG) prosthesis or Unicompartmental Knee System (ZUK) (Zimmer, Warsaw, IN- USA) was performed. In 2007, the MG was replaced by the ZUK by the producing firm. Although articulation and fixation surfaces and material remained the same, a few changes were made in the design. The distal contour of the femoral component has been slightly narrowed to avoid contact with the patella. The longer sagittal curvature ensures safe deep flexion. Minor changes were made to the shape of the insert and locking mechanism to the baseplate to reduce micro-motion.

When tolerated, full weight bearing was allowed immediately post-operatively.

### Statistical analysis

Statistical analysis was performed using PASW Statistics (SPSS science Inc., Chicago, USA version 20) and a p-value < .05 was considered to be statistically significant. Data of obese and non-obese patients are presented separately. To evaluate the presence of a possible selective dropout during follow-up, we compared the baseline characteristics of the responders with the non-responders with the Kruskal-Wallis or Chi-square test.

Differences between obese and non-obese patients were analyzed using the independent t-tests (Student T-test) or Chi-square test. A survival analysis according to Kaplan Meier was carried out. Failure was defined as revision of one of the components of the UKA.

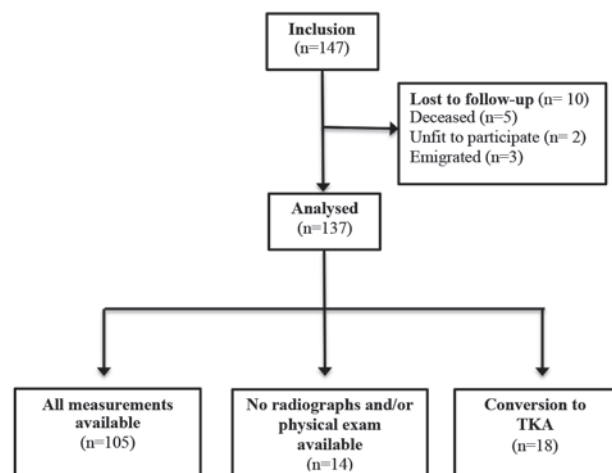


Fig. 1. — Flowchart of the study representing the number of knees.

## RESULTS

From January 2001 to May 2011, 147 medial UKA procedures were performed in 130 patients in our clinic (Fig. 1). Of these 130 patients (147 UKAs) 122 (137 UKAs) were available for follow-up. Four patients (five UKAs) died. The cause of death was

not related to the UKA. Two patients (three UKAs) emigrated and two patients (two UKAs) were terminally ill. Consequently, eight patients (ten UKAs) were lost to follow-up. Fourteen people were available only for the PROs.

The median follow-up time was 5.0 years (range 2.0-12.2). The mean pre-operative BMI was 30.2 and 63% of the patients was female. The ZUK design was used in 55.5%. In 98.5% the UKA was performed because of primary medial osteoarthritis of the knee, and in 1.5% for osteonecrosis.

The baseline characteristics of the obese and non-obese group were not significantly different. Characteristics of the eight patients lost to follow-up were also similar to those completing the study (Table I).

## Adverse events

A per-operative false route in one knee had no adverse effect on rehabilitation and result. Post-operatively, there were five adverse events. In two knees a re-operation was needed: to remove a broken drain in one and to remove a large cement particle in another patient six months after the initial

Table I. — Baseline characteristics of the study population

	Study population (n = 137) <sup>‡</sup>	BMI < 30 kg/m <sup>2</sup> (n = 63) <sup>‡*</sup>	BMI > 30 kg/m <sup>2</sup> (n = 64) <sup>‡*</sup>	Lost to F.U. (n = 10) <sup>‡</sup>	p-value
Women, n (%)	86 (63)	39 (62)	41 (64)	4 (40)	NS
Mean age (yrs)	60.5 (7.3)	60.0 (8.1)	60.9 (6.6)	65.2 (11.2)	NS
Mean BMI	30.2 (4.4)	26.9 (2.3)	33.6 (3.2)	27.4 (3.6)	p < 0.001
Median follow-up (yrs) <sup>#</sup>	5.0 (2.0-12.2)	3.9 (2.0-12.2)	5.1 (2.0-10.8)	NA	NS
K&L score medial, n (%)					
Grade I	9 (7)	5 (9)	5 (8)	0	NS
Grade II	26 (21)	13 (24)	13 (21)	1 (11)	NS
Grade III	56 (45)	21 (38)	31 (49)	6 (67)	NS
Grade IV	34 (27)	16 (29)	14 (22)	2 (22)	NS
K&L grade lateral, n (%)					
Grade 0	92 (74)	2 (76)	48 (76)	6 (67)	NS
Grade I	30 (24)	12 (22)	13 (21)	2 (22)	NS
Grade II	3 (2)	1 (2)	2 (3)	1 (11)	NS

Abbreviations : BMI = Body Mass Index, K&L = Kellgren and Lawrence, NA = Not Applicable, NS = Non-Significant.

All values are presented as mean (± SD) unless indicated otherwise.

<sup>‡</sup> Pre-operative radiographs of 12 patients in the study group, eight patients of the non-obese group, one patient in the obese group and one patient in the lost to follow-up group are missing.

\* Pre-operative BMI of ten patients is missing.

<sup>#</sup> Survivors (n = 119).

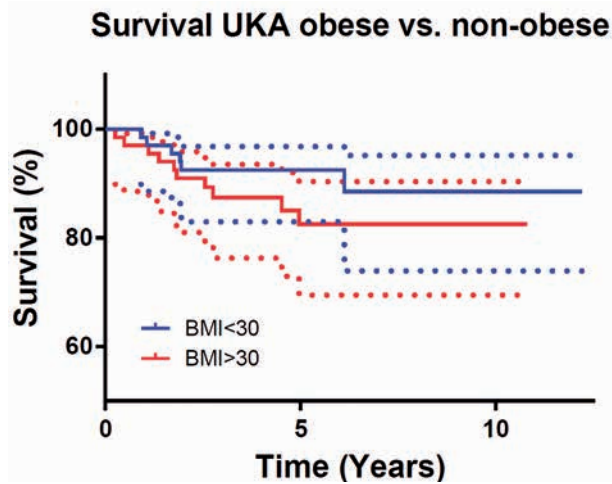


Fig. 2. — Survival percentage of the prosthesis for obese *versus* non-obese patients with revision as end-point. Dotted lines represent confidence intervals of each BMI group.

surgery. One patient had a superficial wound infection treated with antibiotics, one suffered from a bladder retention and another patient was re-admitted because of a post-spinal headache. No significant difference in adverse event rates was seen between the obese and non-obese group.

### Survival

Within the follow-up period 18 (13%) UKAs (18 patients) were converted to a total knee arthroplasty (TKA). Of these patients ten were obese, six were non-obese and the pre-operative BMI of the two remaining patients was missing. No significant difference in survival was seen between the obese and non-obese group (Fig. 2). The mean time to revision was 2.2 years (SD = 1.6) for the obese group and 2.0 years (SD = 1.9) for the non-obese group.

Eight UKAs were converted to TKA for persistent pain without apparent loosening or malpositioning. Revision in case of chronic pain was performed more often in the obese group than in the non-obese group (seven versus one). Two UKAs were converted because of progression of osteoarthritic changes in the lateral compartment of the knee. Three UKAs were converted for instability. Two UKAs were converted for aseptic loosening with accompanying complaints. One UKA was con-

verted after traumatic loosening of the tibial component. One UKA showed migration of the tibial component without a trauma. One patient underwent a revision elsewhere for unknown reason.

### Patient reported outcomes

Considering pain measured by VAS for the intensity of the pain and the KOOS subscale for pain, there was no significant difference between the obese and non-obese group. Furthermore, the remaining KOOS subscales for symptoms, ADL, sports and QOL also showed no significant difference between the obese and non-obese patients. The obese and non-obese patients were as satisfied with their UKA according to the New KSS and VAS for satisfaction (Table II).

### Radiographic outcomes

During follow-up 35% of all knees showed progression of OA in the lateral and 19% in the patellofemoral compartment. No significant difference was seen in progression of OA in the lateral compartment between obese and non-obese patients. Patellofemoral osteoarthritic changes were seen more often in the obese cohort compared to the non-obese cohort ( $p < .01$ ). Otherwise, the radiographic outcomes between the obese and non-obese groups were not significantly different (Table III).

## DISCUSSION

Since the controversy about the effect of BMI on the results of UKA persists, we studied the effect of BMI on the clinical and radiographical outcomes of all consecutive UKAs placed in our clinic between 2001 and 2011. We have chosen a minimum follow-up of two years, since functional recovery seems to continue for up to two years (29).

Survival of the UKA, PROs or radiographical results were not significantly different between obese and non-obese patients receiving a UKA, although the survival is slightly lower in the obese group. Other authors (49,35,33) have reported similar results but these studies either included very few UKAs or had a short follow-up (2.0-2.6 years). One recent

Table II. — Patient Reported Outcomes of obese *versus* non-obese survivors

	Study population (n = 119)	BMI < 30 kg/m <sup>2</sup> (n = 57)*	BMI > 30 kg/m <sup>2</sup> (n = 53)*	p-value	95% CI
VAS pain	1.1 (2.0)	1.3 (2.2)	0.9 (1.6)	0.27	[-0.3;1.2]
KOOS					
Pain	83.5 (21.3)	83.6 (21.5)	82.5 (22.0)	0.83	[-9.2;11.5]
Symptoms	81.5 (18.5)	81.4 (19.1)	80.5 (18.5)	0.83	[-8.0;10.0]
ADL	79.8 (22.9)	80.8 (23.0)	77.2 (23.2)	0.51	[-7.4;14.7]
Sports	48.9 (32.0)	49.4 (33.1)	45.7 (29.6)	0.61	[-12.2;19.6]
QOL	67.7 (27.5)	65.8 (27.2)	66.9 (28.7)	0.88	[-14.5;12.4]
Satisfaction					
New KSS	28.8 (11.0)	29.2 (11.4)	27.9 (10.8)	0.53	[-2.8;5.5]
VAS	7.9 (2.2)	7.9 (2.4)	7.8 (2.1)	0.27	[-0.7;1.0]

Abbreviations : ADL = Activities of Daily Living, BMI = Body Mass Index, CI = Confidence Interval, KSS = Knee Society Score, VAS = Visual Analogue Scale, QOL = Quality of Life

All values are presented as mean ( $\pm$  SD)

\*Of all patients who filled in the questionnaires nine pre-operative BMIs are missing.

larger study by Cavaignac (16) with a follow-up of seven years with mixed medial and lateral UKAs also shows that BMI > 30 kg/m<sup>2</sup> is not a risk factor for a poor outcome following UKA. Although arthroplasty of obese patients is subject to a heavier load, obese people also have a less active lifestyle (34,24,53).

Conflicting findings have been reported concerning satisfaction in obese patients after TKA. Obese patients have been found to be as satisfied with their TKA as non-obese patients (4,26). This view has been challenged by other recent reports (55,25). To date, no author has addressed satisfaction of the

obese patient after UKA placement. Our study shows equal satisfaction amongst obese and non-obese patients. Again, an obese patient might have adopted a less strenuous lifestyle.

Pre-operatively, patients had a mean BMI of 30.2 kg/m<sup>2</sup> (range, 19.1 to 43.7) and post-operatively at follow-up a mean BMI of 31.1 kg/m<sup>2</sup> (range, 14.0 to 43.0). Admitting a minimal increase or decrease of one point in BMI, 48.7% of patients were stable or lost weight and 51,3% put on weight after UKA, similarly to other reports (20,11). Pain relief does not necessarily result in a more active *modus vivendi*.

Table III. — Radiographical outcomes of the obese *versus* non-obese survivors

	Study population (n = 119)	BMI < 30 kg/m <sup>2</sup> (n = 57)*	BMI > 30 kg/m <sup>2</sup> (n = 53)*	p-value
Progression of OA				
Lateral	38 (35)	19 (31)	23 (37)	0.622
Patellofemoral	22 (19)	5 (8)	18 (29)	0.007
Lucencies				
Femur	6 (5)	1 (2)	3 (6)	0.522
Tibia	7 (6)	3 (5)	5 (10)	0.479
Migration	5 (4)	2 (3)	3 (6)	0.325
Subsidence	7 (6)	1 (2)	3 (6)	0.621
Heterotopic ossifications	10 (8)	6 (11)	4 (8)	0.474

Abbreviations : BMI = Body Mass Index, OA = osteoarthritis

All values are presented as number (%).

Significant values are presented in bold.

\* Of all patients with a post-operative radiograph nine BMIs are missing.

The survival rate of the entire study population is 87%, which is in the lower range of the 10-year survival rate of 84-98%, reported in literature (1,2,8, 14,15,17,27,31,23,36,40,49,44,50). The only study concerning the ZUK prosthesis, which is only on the market since 2007, shows an extremely good result of 100% survival after an average follow-up of 4.5 years (39). We reached a survival rate of 89.5% with the ZUK design.

Most of the conversions (44%) to TKA were performed for unexplained pain and were performed rather early. The threshold to revision of a UKA is lower (5,18) than for a more complicated TKA revision. Edmondson *et al* (21) found no correlation between radiographic scores and medial knee discomfort in case of unexplained persistent medial knee pain after the Oxford Unicompartmental Knee.

Five different senior orthopaedic surgeons performed the procedures of the UKAs in this study. Consequently, the total number of placed UKAs per surgeon in our center is low, since patient selection is strict and the UKA has a lower popularity compared to the TKA. It is known from recent studies (3,10), that low-volume centers and low-volume surgeons have a higher revision rate compared to high-volume groups. The effect is highest for the surgeon-volume and the threshold is determined to be 13 UKA procedures per surgeon per year. Low-volume surgeons performing UKAs are more prevalent than high-volume (46,33). The volume in our center was on average 14 procedures per year, done by several orthopaedic surgeons, with two surgeons performing the bulk of the procedures. To some extent, the overall revision rate might also be explained by this phenomenon.

Revision to TKA was performed mostly in the first few years after the primary operation after a mean time of 2.0-2.2 years. Revisions after UKA procedures are often seen in two separate peaks: early failure because of persistent pain or implant subsidence and late failure because of loosening and progression of arthritis (7,22,50). The median follow-up time of 5.0 years is expected to have included at least all early failures.

Our study has several limitations. Firstly, we lost ten patients to follow-up. The UKA they received all survived the follow-up period. Based on the

absence of significant differences in baseline characteristics of these patients with the followed patients, we assume that there was no selective drop-out and that the lost patients did not significantly influence our results.

Secondly, five different senior orthopaedic surgeons performed the procedures. This could have introduced an operator-dependent variability and a single surgeon would have been preferable. However, a higher number of surgeons improves generalizability of the results.

Thirdly, this study was retrospective, which made it subject to challenges and biases inherent to this type of study. Also, incomplete data points as missing radiographs and dependency on accuracy of record keeping remain an issue. Our response rate of 96.6% was good, with only five people unwilling or unable to cooperate, keeping the lost to follow-up number low.

Finally, within this study period 61 Miller Galante arthroplasties and 76 arthroplasties with the ZUK design were performed. Even though this could have introduced heterogeneity in the study population, we could not demonstrate any difference between the models concerning survival or satisfaction.

In conclusion, UKA in our clinic over the past ten years has led to reasonable results. Obesity did not influence survival, radiographical results and PROs. Obesity should not form a contra-indication.

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