International Orthopaedics (SICOT) (2013) 37:1013–1018
DOI 10.1007/s00264-013-1833-5

ORIGINAL PAPER

# A minimally invasive approach for total hip arthroplasty does not diminish early post-operative outcome in obese patients: a prospective, randomised trial

**Thomas Dienstknecht · Christian Lüring · Markus Tingart · Joachim Grifka · Ernst Sendtner**

Received: 5 February 2013 / Accepted: 11 February 2013 / Published online: 28 February 2013


**Abstract**
*Purpose* The benefits of minimally invasive surgical techniques in total hip arthroplasty (THA) are well known, but concerns about applying those techniques in obese patients are controversial. We prospectively compared patients with increased body mass index (BMI ≥30) undergoing THA with normal weight patients.
*Methods* A total of 134 patients admitted for unilateral THA were randomised to have surgery through either a transgluteal or a minimally invasive approach (MicroHip). In each group a BMI ≥30 was used to define obese patients. Pre- and early post-operative demographics, intraoperative data, baseline haematological values, hip function (Harris Hip Score, Oxford Hip Score) and quality of life (EQ-5D) were assessed with follow-up at three months.
*Results* Duration of surgery, blood loss, C-reactive protein levels, radiographic measurements and complication rates were comparable in all groups. There was a tendency for lower serum creatine kinase levels in the MicroHip group. Intraoperative fluoroscopic time and dose area products were significantly elevated in patients with a BMI exceeding 30 regardless of the approach used. Time points of mobilisation, length of hospital stay and functional outcome measurements were similar in the different weight groups.
*Conclusions* Our data suggest that obese patients gain similar benefit from MicroHip THA as do non-obese patients. The results of this study should be further investigated to assess long-term survivorship.

T. Dienstknecht · C. Lüring · M. Tingart · J. Grifka · E. Sendtner
Department of Orthopaedic Surgery, Regensburg University Medical Center, Asklepios Klinikum Bad Abbach, Kaiser-Karl V.-Allee 3, 93077 Bad Abbach, Germany

T. Dienstknecht (✉) · C. Lüring · M. Tingart
Department of Orthopaedic Surgery, Aachen University Medical Center, Pauwelsstreet 30, 52074 Aachen, Germany
e-mail: tdienstknecht@ukaachen.de

## Introduction

The reported advantages of minimally invasive surgical techniques in total hip arthroplasty (THA) include high patient satisfaction and rapid rehabilitation [1, 2], with benefits mostly seen in the early recovery period [3]. Orthopaedic surgeons performing THA are under pressure from peers and patients to broaden their portfolio with minimally invasive procedures. Intraoperative reduced visualisation, with a higher risk for component malpositioning, possible increased risk of neurovascular injury and lack of well-designed long-term trials are arguments against minimally invasive techniques [4, 5]. These concerns are reinforced in obese patients adding reduced access to the operative field, more surfaces from which to bleed from and greater force of retraction [6]. Although there is no evidence of an overall worse outcome in patients with a body mass index (BMI) exceeding 30 kg/m$^2$ [7], elevated rates of component malplacement, prolonged operative times and higher intraoperative blood loss are eagerly debated [8, 9].

To examine whether patients with an increased BMI have an increased risk of developing complications with the MicroHip technique, we compared patients undergoing minimally invasive THA and an elevated BMI (≥ 30) with normal weight patients regarding intraoperative data and early functional outcome.

## Methods

One hundred and thirty-four patients admitted for unilateral THA were enrolled in this randomised, prospective study between January and October 2010. The patients were randomly allocated to have surgery through either a transgluteal, lateral approach (Bauer et al. [10]) or a minimally invasive approach (MicroHip [11]). Ethics Committee approval and informed consent from every patient were obtained. Exclusion criteria were a history of previous surgery on the affected hip or severe inflammatory polyarthritis at a grade likely to compromise post-operative mobility.

Preoperatively, demographic data, BMI, the grade according to the system of the American Society of Anesthesiologists (ASA) and baseline haemoglobin, haematocrit and serum levels of C-reactive protein were recorded. Preoperative hip function, quality of life and general health were assessed using the Harris Hip Score, the Oxford Hip Score [12] and the EQ-5D general health questionnaire [13].

Surgery was performed by orthopaedic surgeons with several years of experience in THA. The minimally invasive approach used has been performed for over five years in our clinic [14].

For the MicroHip approach, patients were positioned in the lateral decubitus position. Skin midway between the greater trochanter and the anterior superior iliac spine was incised. The subcutis and fascia were dissected and the interval between the tensor fascia lata muscle and the rectus muscle was followed. The joint capsule was split and osteotomy of the femoral neck was followed by removal of the head. A special acetabular reamer with an modified angulation was used. Acetabular components were implanted. After repositioning the leg in extension, adduction and external rotation, stem preparation was performed with bone rasps adapted to the size of the medullary cavity. After implantation, the fascia was closed and the skin stapled.

The Bauer approach was carried out according to its classical description [10]. In both groups press-fit acetabular components and cement-free hydroxyapatite-coated stems (Pinnacle cup, Corail stem, DePuy, Warsaw, IN, USA) with metal heads were used. When femoral bone stock seemed to be reduced, cemented stems were used. Stem and acetabular position were checked intraoperatively with mobile C-arm fluoroscopy before wound closure. Corrections were made directly if necessary.

Intraoperatively, a cell saver system was used and blood loss was estimated by the volume in this system. All collected blood was retransfused, starting in the first hour after surgery.

All patients were mobilised under prophylaxis against deep vein thrombosis with a maximum of 30 kg weight-bearing for six weeks. After this they were allowed full weight-bearing.

Post-operatively, the haematocrit and haemoglobin levels were recorded on the first, second and seventh postoperative days. C-reactive protein was analysed on days two and seven. The length of incision was measured two days after surgery.

The grade of mobilisation was recorded daily and categorised into mobilisation out of the bed, able to walk on flat ground and able to manage stairs. Length of hospital stay and any complications during the primary hospital stay or in the first three months after surgery were recorded. Complications included intraoperative complications and technical difficulties or post-operative luxation, prolonged drainage, periprosthetic fractures or any infection in the hip region.

Radiographic evaluation consisted of an anteroposterior and lateral hip radiograph one week post-operatively. Cup inclination and the varus/valgus direction of the stem position were analysed by goniometric measurements as described elsewhere [15].

Assessment of the Harris Hip Score, the Oxford Hip Score and the EQ-5D general health questionnaire was repeated at six weeks and at the end of the third month after surgery.

Data were assessed prospectively. From this database we divided patients into four different groups. The first two groups included patients with a BMI under 30 with a Bauer (group 1) or a MicroHip approach (group 2). Patients with a BMI exceeding 30 were accordingly allocated to group 3 (Bauer) or group 4 (MicroHip).

Statistical analysis was performed using the SPSS software package (Version 19, SPSS Inc., Chicago, IL, USA). With this a Kolmogorov-Smirnov test for normal distribution was performed before further statistical analysis was conducted. Continuous values were then analysed using Student's $t$ test. Non-parametric variables were analysed with the Mann-Whitney U test. A chi-square test was used for dichotomous values. A $p$ value of $<0.05$ was considered to be significant for each alpha analysis.

## Results

More men had a BMI exceeding 30 (groups 3 and 4) and there was a significant shift to higher ASA grades in obese patients (Table 1).

Intraoperative data and haematological parameters are presented in Table 2. Duration of surgery and estimated blood loss were comparable in all groups. There was a significant post-operative reduction in the haemoglobin and haematocrit levels in each group ($p<0.001$), and when calculating the differences between preoperative and post-operative day one haemoglobin levels there was significantly less reduction in the MicroHip groups regardless of

**Table 1** Demographic characteristics

| | Bauer BMI <30 (*n*=42) | MicroHip BMI <30 (*n*=36) | Bauer BMI ≥30 (*n*=41) | MicroHip BMI ≥30 (*n*=15) | *p* value |
|---|---|---|---|---|---|
| Gender (F:M) | 28:14 | 24:12 | 17:24 | 5:10 | 0.018* |
| Side (R:L) | 20:22 | 18:18 | 20:21 | 8:7 | 0.949 |
| Age[a] (years) | 61±13 (35–89) | 62±13 (36–85) | 61±11 (38–82) | 61±10 (33–72) | 0.983 |
| Weight[a] (kg) | 73±12 (53–97) | 68±14 (38–100) | 99.2±17 (67–160) | 103.7±17 (83–141) | < 0.001* |
| Height[a] (m) | 1.67±0.08 (1.55–1.84) | 1.67±0.09 (1.40–1.83) | 1.70±0.09 (1.48–1.87) | 1.73±0.11 (1.51–1.89) | 0.149 |
| BMI[a] (kg/m$^2$) | 26.1±3.0 (17.6–29.7) | 24.3±3.6 (15.7–29.9) | 34.3±4.4 (30.0–48.8) | 34.6±4.1 (30.5–42.0) | < 0.001* |
| ASA grade (1/2/3/4) | 7/24/11/0 | 7/15/14/0 | 1/24/16/0 | 0/6/9/0 | 0.027* |

*The difference was significant

[a] The values are given as the mean and standard deviation with the range in parentheses

the BMI [group 1, Bauer, BMI <30 (−2.9±1.2 g/dl) compared to group 2 (−2.2±1.3 g/dl; $p$=0.041) and group 4 (−2.0±0.8 g/dl; $p$=0.048)]. Post-operative C-reactive protein levels were significantly elevated ($p<0.001$); no effect of BMI was found. Serum creatine kinase levels were lower in the MicroHip group on post-operative days two and seven without reaching statistical significance. Intraoperative fluoroscopic time and dose area products were significantly elevated in patients with a BMI exceeding 30 regardless of the approach used. The time of mobilisation was similar in all groups, as was the length of hospital stay (Table 3).

Radiographic measurements showed no significant differences between the four groups. The cup inclination in groups 1/3 averaged 49.2±7.0°/50.1±5.0° and in groups 2/4 48.2±6.1°/48.1±6.0°. Average values for stem alignment in groups 1/3 were 2±2°/3±2° and in groups 2/4 2±2°/3±2°. Functional outcome was significantly improved at the end of the third post-operative month compared to the preoperative status ($p<0.001$) without differences between the groups (Table 4).

Six patients received a cemented stem implantation (groups 1/2/3/4: 2/1/3/0). There was one revision in the MicroHip group 2 due to early loosening of the cup. The

**Table 2** Intraoperative and haematologic data

| | Bauer BMI <30 (*n*=42) | MicroHip BMI <30 (*n*=36) | Bauer BMI ≥30 (*n*=41) | MicroHip BMI ≥30 (*n*=15) | *p* value |
|---|---|---|---|---|---|
| Incision length (cm) | 13±2 | 9±1 | 14±3 | 9±1 | < 0.001* |
| Surgical time (min) | 66±27 | 58±15 | 70±28 | 60±9 | 0.411 |
| Blood loss in cell saver (ml) | 440±821 | 346±170 | 383±265 | 302±138 | 0.697 |
| Fluoroscopic time (min) | 0.10±0.07 | 0.06±0.05 | 0.09±0.08 | 0.11±0.09 | 0.018* |
| Dose area product (cGy/cm$^2$) | 42+27 | 29.2±28 | 49±34 | 56±40 | 0.001* |
| Haemoglobin (g/dl) | | | | | |
| Preop. | 14.0±1.4 | 13.8±1.4 | 14.6±1.5 | 14.1±1.3 | 0.142 |
| Post-op. day 1 | 11.2±1.7 | 11.6±1.6 | 11.7±1.4 | 12.0±1.4 | 0.363 |
| Post-op. day 2 | 10.5+1.6 | 11.3±1.7 | 11.2±1.6 | 11.4±1.3 | 0.081 |
| Post-op. day 7 | 10.8+1.6 | 11.3±1.5 | 11.3±1.6 | 11.5±1.5 | 0.416 |
| Haematocrit (%) | | | | | |
| Preop. | 42.1±4.9 | 41.1±4.0 | 40.2±8.2 | 39.3±4.7 | 0.227 |
| Post-op. day 1 | 34.4±5.0 | 35.4±5.0 | 36.1±4.4 | 36.9±4.6 | 0.401 |
| Post-op. day 2 | 30.1±4.9 | 31.4±7.3 | 31.6±4.6 | 32.5±3.5 | 0.222 |
| Post-op. day 7 | 31.1±4.8 | 32.9±4.3 | 32.4±4.7 | 33.4±4.5 | 0.216 |
| C-reactive protein (mg/l) | | | | | |
| Preop. | 2.5±3.8 | 3.3±5.3 | 4.8±8.0 | 3.0±2.8 | 0.345 |
| Post-op. day 2 | 142±56 | 118±53 | 149±62 | 178±115 | 0.151 |
| Post-op. day 7 | 56±35 | 47±28 | 52±24 | 47±21 | 0.545 |

The values are given as the mean and standard deviation

*The difference was significant

**Table 3** Mobilisation

| | Bauer BMI <30 (*n*=42) | MicroHip BMI <30 (*n*=36) | Bauer BMI ≥30 (*n*=41) | MicroHip BMI ≥30 (*n*=15) | *p* value |
|---|---|---|---|---|---|
| Room (days) | 1±1 | 1±1 | 1±1 | 1±1 | 0.691 |
| Ward (days) | 3±1 | 3±1 | 2±1 | 3±1 | 0.574 |
| Stairs (days) | 7±2 | 6±2 | 6+1 | 6±2 | 0.091 |
| Discharge (days) | 9±2 | 8+1 | 9±2 | 9±2 | 0.277 |

The values are given as the mean and standard deviation

revision was performed four months after the first operation. The following recovery time was uneventful. Four undisplaced fractures of the proximal femur occurred during surgery (three in group 1 and one in group 2) and were treated with cerclages. During the first week two cases of deep vein thrombosis (in group 2) were diagnosed without any therapeutic relevance during the recovery period.

## Discussion

Obesity is a worldwide health problem and a risk factor for developing osteoarthritis [16]. Obese patients in need of THA tend to be younger [17, 18], have higher risk factors for intra- and post-operative complications [8, 19] and compromised functional outcome has been described [20]. However, no overall worse outcome in long-term follow-up has been proven [21].

Minimally invasive surgery is a significant alternative to standard approaches in THA. Advantages are mainly observed in the early recovery period [2]. Various definitions of minimally invasive surgery in THA produce a discrepancy in terminology [14], with several techniques described [1]. Use of the MicroHip technique [11] has proven to result in comparable functional results in comparison to a non-minimally invasive approach [14].

We conducted a prospective, randomised study in patients undergoing THA by using the MicroHip technique, compared to a standard, transgluteal, lateral Bauer approach. From this data pool we grouped patients according to their BMI to analyse differences in intraoperative values and during the early recovery period between normal weight and obese patients. To our knowledge, this is the first study to compare normal and overweight patients regarding their outcome after MicroHip surgery.

Findings from the literature suggest that the majority of patients achieve pain relief through THA regardless of their BMI [7]. Obese patients do not seem to reach the same level of physical function compared to normal weight patients [17]. Various non-minimally invasive approaches showed no consistent differences in long-term functional outcome [17, 22]. There are few studies regarding correlation of BMI and minimally invasive THA. Accuracy of an anterolateral minimally invasive approach was assessed in regard to patients' age and BMI, showing no influence of obesity on implant positioning [9].

In obese patients more perioperative complications were observed [23–25], whereas other studies found no significant increase in complication rates [6, 18, 26]. One recent

**Table 4** Functional scores and health status

| | Bauer BMI <30 (*n*=42) | MicroHip BMI <30 (*n*=36) | Bauer BMI ≥30 (*n*=41) | MicroHip BMI ≥30 (*n*=15) | *p* value |
|---|---|---|---|---|---|
| Preop. | | | | | |
| Harris Hip Score | 48±15 | 46±16 | 44±15 | 46±16 | 0.773 |
| Oxford Hip Score | 20±8 | 21±8 | 19±8 | 18±7 | 0.381 |
| 6 weeks post-op. | | | | | |
| Harris Hip Score | 72±16 | 79±13 | 77±10 | 77±10 | 0.253 |
| Oxford Hip Score | 36±8 | 40±7 | 38±4 | 39±8 | 0.159 |
| 3 months post-op. | | | | | |
| Harris Hip Score | 84±18 | 88±16 | 88±12 | 88±11 | 0.718 |
| Oxford Hip Score | 39±10 | 42±6 | 41±6 | 43±5 | 0.684 |
| EQ-5D | | | | | |
| Preop. | 0.482±0.285 | 0.500±0.254 | 0.450±0.220 | 0.429±0.192 | 0.774 |
| 6 weeks post-op. | 0.792±0.181 | 0.849±0.172 | 0.818±0.155 | 0.859±0.132 | 0.437 |
| 3 months post-op. | 0.810±0.277 | 0.842±0.241 | 0.883±0.161 | 0.886±0.164 | 0.855 |

The values are given as the mean and standard deviation study analysing over 3,000 THA found similar rates of complications in all BMI groups assessed [27]. In our study an elevated BMI was not a risk factor for developing intraoperative or early post-operative complications. Differences in studies might be explained by the different surgical approaches. Especially with the broad use of the term minimally invasive surgery, a specific description of the technique used is essential. A common complication in minimally invasive THA is transient palsy of the lateral femoral cutaneous nerve [14, 22]. Our hypothesis that the thicker soft tissue layer in obese patients leading to greater retraction forces being used would increase this complication was not substantiated as no patient showed this complication.

Analysis of functional outcome over five years showed significant differences in the Harris Hip Score, with non-obese patients scoring higher. However, a significant individual improvement in Harris Hip Score was found in patients regardless of their weight [23]. Another study found over two thirds good or excellent results five years after THA regardless of the BMI, with the lowest (worst) scores in obese women [28]. A significant multiple regression coefficient for BMI and follow-up Harris Hip Score was found by Moran et al. [29]. One point increase in BMI value resulted in 0.25–0.35 points reduction in Harris Hip Score. A five year comparison of Oxford Hip Scores in patients was not different based on BMI [18]. Early outcomes in THA revealed no intergroup difference between non-obese and obese patients [6]. Our study revealed no significant differences in early functional outcome.

Cup inclination and femoral stem positioning were described as similar in obese compared to normal weight patients using standard approaches [18, 26]. There are few studies correlating BMI and minimally invasive THA with regard to implant positioning. A BMI over 25 kg/m$^2$ did not negatively affect the accuracy of implant positioning [9]. This was supported by our data. The cup inclination and stem position were not significantly influenced by the BMI in either of the groups. However, intraoperative X-ray doses were higher in patients with an increased BMI.

There are some limitations of this study. We did not assess the long-term results for these patients. However, the main question was whether obesity increases intraoperative problems or counteracts the advantages of minimally invasive surgery, mainly concerns the early recovery period. There were no significant differences in the functional scores or the general health status at the end of the third post-operative month. Nevertheless, long-term investigations need to be done, especially to answer the question of whether unchanged obesity leads to early implant loosening.

Another limitation is the general relevance of this study. This study was carried out by a dedicated joint replacement team with years of experience in THA and especially in the minimally invasive approach described. Results may vary if familiarisation with this approach is not thorough.

With respect to the above-mentioned limitations we feel it is justified to draw the following conclusion: This randomised, prospective study compared in-hospital data and early functional capacity for normal weight and obese patients undergoing THA using a standard lateral or MicroHip approach. Our findings suggest that obese patients gain similar benefit from MicroHip THA as their non-obese counterparts. The results of this study should be further investigated to assess long-term survivorship and increase sample size.

**Acknowledgment** The authors wish to acknowledge Benjamin Jacob for excellent assistance in data acquisition.

**Conflict of interest** The authors declare that they have no conflict of interest.

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