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ORIGINAL STUDY

Minimal-invasive posterior approach for total hip arthroplasty versus standard lateral approach

Iris SCHLEICHER, Holger HAAS, Tim S. ADAMS, Gabor SZALAY, Heiko KLEIN, Jens KORDELLE

From the University Hospital Giessen and Marburg in Giessen, Germany

In this prospective study we compared clinical and radiological results and rehabilitation progress of 64 patients who underwent total hip arthroplasty using the standard lateral approach with 64 patients operated with a minimal-invasive (MIS) posterior approach.

The outcome of our study did not show any significant differences with regard to patient's safety such as complication rate and radiological assessment of the cup position.

There was no difference in the duration of surgery, blood loss, hospital stay and postoperative leg length discrepancy.

Rehabilitation milestones were achieved earlier by MIS patients and three and six months postoperatively, the Harris Hip Score of the MIS group was significantly higher.

Keywords : minimal-invasive surgery ; hip arthroplasty ; minimal invasive posterior approach ; rehabilitation ; complication ; cup position.

INTRODUCTION

Major advances have occurred in total hip arthroplasty [THA] over the last few decades. Fixation of components, design, material type or tribology were previously the points of focus, but more attention has been paid in recent years to surgical approaches especially with respect to minimal invasive surgery (MIS). Various minimal-invasive approaches have been developed, often based on traditional approaches like those described by Smith-Petersen (*37*), Watson-Jones (*42*), Moore (*24*) or Bauer (*2*) using different muscle intervals around the hip joint. A modification of the posterior approach according to Moore (*24*) represents the minimal-invasive posterior approach.

Minimal-invasive approaches have been propagated rapidly via the modern media but lacked scientific background. Thus, the high standard of a very successful operation like THA is set at risk. In some cases minimal invasive arthroplasty has

■ Iris Schleicher, MD, Orthopaedic Surgeon.
■ Gabor Szalay, MD, General and Trauma Surgeon.
Department of Trauma Surgery, University Hospital Giessen and Marburg, Giessen, Germany.
■ Holger Haas, MD, Orthopaedic surgeon.
Department of Orthopaedic and Trauma Surgery, Gemeinschaftskrankenhaus Bonn, Bonn, Germany.
■ Tim S. Adams, MD, Staff Surgeon.
Department of General Surgery, Prostestant Hospital Düsseldorf, Düsseldorf, Germany.
■ Heiko Klein, MD, Orthopaedic surgeon.
Department of Orthopaedic Surgery, University Hospital Giessen and Marburg, Giessen, Germany.
■ Jens Kordelle, MD, Orthopaedic surgeon, Privat Dozent of orthopaedic surgery *Centre of Orthopaedic Surgery, Agaplesion Prostestant Hospital Giessen, Giessen, Germany.*
Correspondence : Iris Schleicher, Department of Trauma Surgery, University Hospital Giessen and Marburg, Rudolf-Buchheim-Strasse 7, 35385 Giessen, Germany. E-mail : iris.schleicher@ortho.med.uni-giessen.de

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resulted in major surgical failure (*11*). The patient often looks at the shorter scar but by far more important are the reduction in soft-tissue and muscle trauma and the possibility of accelerated rehabilitation. In the beginning of the minimal-invasive era, reduced blood loss and reduced postoperative pain were valued as being the most positive advances, but this has not yet been proven.

In this prospective cohort study, patients with a posterior minimal-invasive approach were compared to those undergoing a standard lateral technique. By introducing a new technique to an orthopaedic department, patient's safety compared to the standard technique might be uncertain, therefore the main purpose of this study was to assess whether there is a higher risk for the patient with the newly introduced minimal-invasive posterior approach compared to the standard approach.

PATIENTS AND METHODS

In a prospective study 64 patients for THA with a standard lateral approach according to Bauer (*2*) [standard group] were compared to 64 patients with a minimal-invasive posterior approach [MIS group]. Assignment to each group did not follow a randomization list but was decided together with the patient ahead of surgery during long informed consent.

Included were adult patients with primary or secondary coxarthrosis. Patients with a fracture or a tumour were excluded. All patients were operated mainly by two orthopaedic surgeons ; in the standard group some patients were operated by 3 additional surgeons, all of them specialized in arthroplasty.

In both groups cemented or non-cemented tapered stems with either polyethylene-cups or non-cemented press fit cups and screw-cups were used in a statistically comparable proportion, all following the same rehabilitation scheme.

Forty four patients in the standard group and 48 in the MIS group were female (not significant [n.s.], $p = 0.43$). The average age was 68.3 (SD 9.5) years in the MIS-group versus 69.1 (SD 9.4) in the standard group ($p = 0.63$, n.s.). Average Body-Mass-Index [BMI] was 27.1 (SD 3.9) for the MIS-group und 28.8 (SD 4.2) for the standard group ($p = 0.04$). Health status expressed in ASA-score (American Society of Anesthesiologists (*1*) was comparable, with a median of 2 (range 1-3) in both groups ($p = 0.74$, n.s.).

Table I. — Evaluation milestones ("rehabilitation paper")

1. Knee flexion > 45° (yes/no)
2. Angle of knee flexion
3. Lifting of straight leg (yes/no)
4. Active hip abduction (yes/no)
5. Standing (yes/no)
6. Independently getting out of bed (yes/no)
7. Independently getting into bed (yes/no)
8. Walking distance (< 10 min, 10-20 min, > 20 min)
9. Climbing stairs (yes/no)

Duration of surgery, blood loss measured by haemoglobin [Hb] drop 24 hours postoperatively and complication rates were compared. Clinical and functional outcome was evaluated by Harris-hip-score [HHS] and general health status by the SF-12-score preoperatively, 3 and 6 months postoperatively. Three months after operation, the length of incision was measured and leg length discrepancy was looked for and assessed.

The position of the cup was determined radiologically with inclination measured on a standardized AP pelvic view ; anteversion was measured on a standard AP-view of the hip by the method of Pradham (*31*).

In addition, we compared the immediate postoperative rehabilitation progress every 24 hours after operation according to a standardized evaluation-paper (Table I) in 14 patients of each group.

These two small subgroups of 14 patients each were also comparable regarding sex ratio (11 females and 3 males each group), age (67.2 (SD 11) for MIS patients and 71.4 (SD 9.4) for standard patients ($p = 0.3$, n.s.), BMI (28.3 (SD 2.3) MIS-group and 29 (SD 2.3) standard-group, $p = 0.6$, n.s.) and ASA-score (median 2 (1-3) in each group, $p = 1$, n.s.).

The groups were compared with Chi^2 test for cross tables. Differences in normal distribution were assessed by Student's t test and for abnormal distributed features with the non-parametric U-test of Mann-Whitney. Level of significance was < 0.05.

Aim of the present study was to assess the safety of the MIS approach compared to the standard approach, on the basis of complication rate and position of implants. With additional parameters such as blood loss, surgery-time, length of incision, leg length discrepancy, length of hospital stay, HHS-score and SF-12 score further differences are described. Possible advantages in the early rehabilitation were sought with the help of a rehabilitation paper.

RESULTS

There was no significant difference in surgery-time between the two approaches (93.8 min (SD 23.5) for the MIS group and 98.7 min (SD 23.4) for the standard-group, $p = 0.24$).

Blood loss was expressed as Δ-Hb between pre-operative and 24 hours postoperative Hb. There was no significant difference ($p = 0.16$) with 32.5 (SD 14.1) g/l for the standard-group and 35.9 (SD 13.6) g/l for the MIS-group.

No significant difference ($p = 0.84$) was noted for duration of hospital stay with a median of 12.5 days (range 10-45) for the standard-group and 12 (range 8-19) for the MIS-group.

Incision length measured 3 months postoperatively was 14.9 (SD 3.1) cm in the standard group and 10.4 (SD 2.4) cm in the MIS group, which represents a significant difference ($p < 0.0001$).

Postoperative leg length discrepancy was measured on average at 0.34 (SD 0.6) cm for the standard group and 0.38 (SD 0.7) cm for the MIS group (n.s., $p = 0.73$).

HHS preoperatively was 43.5 (SD 14.1) for the standard-group and 45.6 (SD 14.3) for the MIS-group (n.s., $p = 0.41$), whereas 3 months postoperatively the score was 78.2 (SD 17.9) for the standard-group und 85.5 (SD 15.8) for the MIS-group ($p < 0.0001$) and 6 months postoperatively it was 78.03 (SD 20.13) for the standard-group and 86.89 (SD 13.98) for the MIS-group ($p = 0.03$).

No difference was found for SF-12-Score, either for physical or for the mental part, details are shown in table II.

No significant difference was found for inclination and anteversion of the cup, with 41.3° (SD 5.7) inclination in the standard-group and 43.1° (SD8.4) in the MIS-group, respectively ($p = 0.15$, n.s.). Anteversion was measured at 25.8° (SD 9.7) in the standard group and 28.8° (SD 9.5) in the MIS-group ($p = 0.08$, n.s.).

Six complications were noted in the standard group : one intraoperative fissure of the femur, treated with cerclage wire, 1 seroma and 2 haematomas which had to be revised, 1 dislocation and 1 thrombosis. Only 2 complications were noted for the MIS-group (1 seroma and 1 haematoma which had to be revised). Nevertheless this difference was not significant ($p = 0.09$).

Analysis of the 14 patients who were evaluated regarding their rehabilitation milestones showed no significant difference except for incision length. Details are shown in table III.

Generally the 14 MIS patients achieved certain rehabilitation milestones more rapidly, which was expressed by significant differences for important parameters (Table IV).

DISCUSSION

During recent years there has been an impetus for minimal invasive surgery in THA. Various minimal-invasive approaches have been proposed for THA, but definite evidence is still lacking whether these approaches can compete with standard approaches regarding quality, safety and longevity.

Literature search mainly provides retrospective studies, often without control group or reports, whereas prospective or randomized studies are still rare.

Nevertheless, most studies have shown an advantage of minimal-invasive surgery especially during

Table II. — SF-12-Score of both groups 3 and 6 months post-op

	Standard group n = 64	MIS group n = 64		Standard group n = 64	MIS group n = 64	
	3 mon. po	3 mon. po	Significance	6 mon. po	6 mon. po	Significance
SF-12-physical scale	39.69 (SD13.02)	44.56 (SD12.01)	p = 0.05 (n.s.)	39.22 (SD12.59)	43.82 (SD11.98)	p = 0.06 (n.s.)
SF-12-mental scale	48.46 (SD8.66)	49.4 (SD8.03)	p = 0.68 (n.s.)	48.46 (SD8.66)	48.18 (SD7.08)	p = 0.8 (n.s.)

Table III. — Data of the rehabilitation subgroups (n = 28)

	Rehab-group standard (n = 14)	Rehab-group MIS (n = 14)	Significance
Incision length (cm)	16.4 (SD3.4)	11.2 (SD3)	p = 0.0002, significant
Duration of surgery (min)	92.7 (SD21.8)	90.9. (SD19)	p = 0.82, n.s.
ΔHb (g/l)	30.7 (SD18.6)	35.5 (SD11)	p = 0.42, n.s.
Hospital stay (d) Median	12 (9-30)	12 (11-23)	p = 0.32, n.s.
HHS (preop/6wk.po/3 mo. po)	40.6/65.1/65.8	39.1/73.5/74.,1	p = 0.81, n.s./p = 0.17, n.s./p = 0.27, n.s.
SF12 (physical) (preop/6wkpo/3 mo.po)	24.8/33.7/36.9	27.4/36.3/41.4	p = 0.17, n.s./p = 0.43, n.s./p = 0.23, n.s.
SF12 (mental) (preop/6wkpo/3 mo.po)	43.1/47.1/46.7	39.9/51.3/52.1	p = 0.41, n.s./p = 0.35, n.s./p = 0.15, n.s.
Leg length discrepancy (cm)	0.2 (SD0.4)	0.5 (SD0.8)	p = 0.16, n.s.
Complications	2 (superficial infection, hematoma)	1 (thrombosis)	p = 0.56, n.s.
Inclination cup (°)	40.2 (SD5.4)	40.9 (SD10.9)	p = 0.83, n.s.
Anteversion cup (°)	26.7 (SD5.6)	31.4 (SD6.5)	p = 0,05, n.s.

the early postoperative course, but not in the mid-term. Some authors also express concern due to higher complication risks.

In this prospective study we compared the minimal-invasive posterior approach with the standard lateral approach according to Bauer (*2*) which had been up to the time of the study the standard approach for THA in our department. The main purpose of the study was to compare the levels of patient security for both approaches.

No significant differences were shown in the main target complication rate and cup positioning.

Most other studies also did not reveal a higher complication rate with minimally invasive surgery (*5,6,17,35,39,43*). Only Woolson *et al* (*46*) described a higher complication rate of the minimal-invasive posterior approach compared to a standard approach. This may be due to some differences in group parameters and the number of different surgeons in this study. Goosen *et al* (*14*) also revealed a higher complication rate for MIS surgery but this mainly got on the account of the group which was operated by a minimal-invasive anterolateral approach. In some retrospective studies without control group a very low complication rate was described (*9,15,18,33*), others warned of very high complication rates (*11,32,45*). In a recent meta-analysis no higher complication rate for MIS surgery could be noted, only the incidence of iatrogenic nerve injury was higher (*36*). Learning curve and refinement of surgical expertise, improvement and adaptation of the instruments as well as patient selection are, without doubt, the main factors to reduce complication rates.

Regarding cup positioning, this study is also in line with most other studies (*17,25,28,35,43*) and a recent systematic review (*36*). Others (*39,46*) noted poorer cup positions in MIS THA, although these statements should be taken with caution due to different group parameters or retrospective assignment to groups based on incision lengths.

At the beginning of the learning curve, MIS usually takes longer, whereas most authors subsequently do not note a difference in operation time (*5, 6,35,46*). Some authors even reported a reduced operation time for minimal-invasive operations (*16, 25,27,47*), but this is sometimes due to different group parameters especially in terms of BMI. Also the effect of the surgeon has to be considered. Certainly one weak point of our study is the contribution of more surgeons to the standard group than to the MIS group. Even though all these surgeons

Table IV. — Rehabilitation parameters during the early postoperative period. Parameters with significant differences are highlighted. "h rs po = hours postoperative)

[mean ± SD]	Rehab-group standard (n = 14)	Rehab-group MIS (n = 14)	Significance level
Knee flexion > 45° [hrs po]	66.9 (SD28.5)	65.1 (SD21.9)	p = 0.86, n.s.
Knee flexion at discharge [°]	74.3 (SD25.2)	83.6 (SD18.6)	p = 0.23, n.s.
Lifting straight leg [hrs po]	171 (SD68.4)	73.9 (SD30.1)	**p = 0.005, significant**
Active hip abduction [hrs po]	130 (SD62.6)	60 (SD15.6)	**p = 0.003, significant**
Standing [hrs po]	63.4 (SD26)	54.9 (SD14.7)	p = 0.3, n.s.
Getting independently out of bed [hrs po]	128.6 (SD64.3)	65.1 (SD19.8)	**p = 0.003, significant**
Getting independently into bed [hrs po]	128.6 (SD64.3)	63.4 (SD17.9)	**p = 0.002, significant**
Walking distance 10 min [hrs po]	66.9 (SD23.4)	60 (SD20.5)	p = 0.42, n.s.
Walking distance 10-20 min [hrs po]	130.3 (SD67)	70.3 (SD23.9)	**p = 0.006, significant**
Walking distance > 20 min [hrs po]	135.4 (SD65.6)	78.9 (SD25.7)	**p = 0.008, significant**
Climbing stairs [hrs po]	172 (SD46.7)	156 (SD32.3)	p = 0.33, n.s.

were comparable regarding their expertise in THA, in order to ensure statements concerning operation time, both groups should ideally have been operated by the same surgeon.

A frequent point of discussion is reduced blood loss in MIS. This is also an issue for MIS THA and has been reported in several other studies (*5,6,7,8,12, 13,16,17,20,25,30,34,43*). On the other hand, some studies could not confirm this (*28,39,46*), but nevertheless 2 recent reviews and meta-analyses confirmed a trend toward slightly reduced blood loss in MIS THA (*4,40*) whereas another one stated only less perioperative blood loss but no statistical difference for postoperative blood loss or requirement for blood transfusion (*36*).

The length of hospital stay is very difficult to compare. We found, like many other authors (*8,28, 33,46*), no differences in hospital stay, whereas some other authors have claimed a reduction (*6,17,27*). Duration of hospital stay is generally managed in different ways depending on the country. In Germany a certain length of stay is required due to the diagnosis-related-groups (DRG)-system, thus earlier discharge is not desired. This is different to the situation, for example, in the United States where patients often have to pay themselves for every day in hospital. Also not every country has an established in-patient rehabilitation system. Thus, there are many differences depending on the health systems, which makes it difficult to evaluate this parameter on an international basis.

Comparing rehabilitation milestones appears to be a more reliable tool. We found significant differences in the early rehabilitation term for important milestones such as : independently getting into and out of bed, lifting straight leg, active hip abduction and achievement of different walking distances. Also Fink *et al* (*12*), Wenz *et al* (*43*), DiGioia *et al* (*8*), Dorr (*9*) and Chung *et al* (*6*) noted advantages during early rehabilitation, whereas Chimento *et al* (*5*), Ogonda *et al* (*28*) and Lawlor *et al* (*22*) of the same study group described no advantages for MIS patients. Dorr *et al* (*10*) found in their prospective randomized blinded study some advantages in early mobilization for MIS patients. Nakata *et al* (*26*) compared early mobilization of patients operated with a MIS anterior approach to those operated with a MIS posterior approach and found an advantage for patients with the anterior approach, whereas Meneghini and Smits (*23*) could not find any difference between patients operated with MIS anterolateral, MIS posterior and double-incision technique. Also Pagnano *et al* (*29*) demonstrated no differences between the MIS posterior approach and the double-incision-technique. Generally, all these results for early rehabilitation lack a response to the question whether improved patient consultation, physiotherapy, postoperative pain management

have more impact on postoperative rehabilitation than a different surgical technique.

The HHS is a well-accepted score to evaluate pain and function before and after hip surgery. In this study we saw a significant difference 3 months and also a slight difference 6 months postoperatively in favour of the MIS-group. DiGioia *et al* (*8*) also noted this and confirmed it one year postoperatively. Berger *et al* (*3*) saw differences 3 weeks and 3 months postoperatively. Wohlrab *et al* (*44*) described in a randomized controlled study an advantage in HHS six weeks and three months postoperatively ; Goosen *et al* also confirmed a higher HHS-score 6 weeks and 1 year postoperatively in a double-blind randomized study (*14*). No difference was seen by Chung *et al* (*6*) 1 year, Chimento *et al* (*5*) 2 years and Ogonda *et al* (*28*) 6 weeks postoperatively. More recent meta-analyses (*4,36,40*) could not demonstrate a difference in the early postoperative HHS.

One concern of operating THA with patients lying on their side (as needed for the posterior approach) instead of the supine position is the difficulty in controlling leg length discrepancy. Comparing our minimal-invasive patients who were operated by laying on their side to the group of patients operated in the supine position we could not find a difference in postoperative leg length discrepancy. This is in line with the findings of Laffosse *et al* (*21*), who compared the mini-posterior approach to the anterolateral approach in supine position. A thorough preoperative planning is however essential.

One weakness of our study is the possible selection bias due to a missing randomization list. Before surgery, we explained to every patient the two different approaches and decided together with the patient which one was used at the end. Though we could not demonstrate a difference between the 2 groups regarding age, gender and only a slight difference for BMI we cannot fully rule out a selection bias like patient's expectation, or a higher open-mindedness of patient willing to undergo a newer procedure.

In summary, we could demonstrate a comparable safety for the minimal-invasive posterior approach and the standard lateral approach. No difference was found in complication rate and cup position. We saw advantages in accelerated postoperative rehabilitation. Even after six months we still found some advantages in the HHS. We could not confirm the concern of a higher rate of dislocation or leg length discrepancy with the mini-posterior approach. This is in accordance with more recent reviews (*19,38*). To date, the minimal-invasive posterior approach is the best evaluated approach of all described minimal-invasive incisions with some randomized studies of good quality (*41*). One advantage is without doubt the versatility of the approach and applicability also in patients with higher BMI and the possible extension to a wider approach in the case of intra-operative problems.

Generally, differentiation between the effect of patient's expectations, improved consultation and postoperative pain management and physiotherapy to the surgical-technical effect is very difficult. More studies are needed to answer this question. Also the longevity and longer-term comparability have to be confirmed by longer-term studies.

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