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Research Article

Minimal-Invasive Posterior, Anterior and Anterolateral Approach in Hip Replacement: Is There a Difference in Functional Outcome and Restoration of Hip Biomechanics?

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Abstract

Background: Minimal invasive approaches to the hip are becoming popular in total hip arthroplasty. Especially, the direct anterior approach by Hueter, mostly due to the faster recovery and shorter hospital stay. Beside the functional recovery, the goal of a hip replacement is to restore hip biomechanics by correct implant placement. Most studies in the literature are comparing the posterior (PA) and Direct Anterior Approach (DAA) but few are comparing them to the minimal invasive Anterolateral Approach (ALA) described by Rottinger.

The goal of our study is to compare these 3 approaches by assessing the functional outcome and quality of life, hip biomechanics restoration and length of stay.

Methods: We did a prospective study in 52 patients divided into posterior approach (n=16), a direct anterior approach (n=17) and anterolateral approach (n=19). Four well-trained senior surgeons performed all procedures. Functional outcome and health-related quality of life evaluated by the Oxford Hip Score (OHS) and SF-36 were assessed preoperatively at 6 months of follow up by an independent collaborator. The hip offset and leg length discrepancy are measured on standard x-ray preoperatively and at 6 months of follow up.

Results: We found a significant improvement of OHS and SF-36 score at 6 months but no significant difference between the 3 approaches. Correct offset and leg length discrepancy restoration is seen without any difference between the 3 groups. Hospital stay was significantly longer in the PA group (7days vs 5 days in DAA and ALA, $p<0.001$).

Conclusion: Good functional outcome, health-related quality of life and hip biomechanics restoration is achieved after hip replacement by posterior, direct anterior and anterolateral approach without having a significant difference between them. The only difference found was correlated to the length of stay, which was longer in the PA group.

Introduction

Total hip arthroplasty remains the treatment of choice for the symptomatic osteoarthritis of the hip. The most common approach used is the Posterior Approach of Moore (PA), known to give good and reliable results [1,2]. Nevertheless, during the last decades the minimal invasive approaches have become more and more popular, especially the Direct Anterior Approach (DAA) by Hueter [3]. This is mainly due to studies showing the advantage of faster recovery (in the first 6 to 12 weeks) and shorter length of stay in hospital but no advantage is seen in long term results [4-8]. However, it's a technically demanding approach particularly during the early stage of the learning curve [9,10] with occurrence of more intra-operative fractures, nervous lesions and implant malpositioning [11-13]. Beside these two frequently used approaches, the mini-invasive anterolateral approach described by Rottinger (ALA) shows good functional and radiological results [14,15].

The importance of restoring the biomechanics of the hip joint is not clearly proven in the literature. The decrease of the offset seems to give the same long-term functional results and quality of life but is correlated to a decreased abduction force [16,17]. Restoring the limb length is crucial because even a slight leg length discrepancy mostly lengthening can be source of dissatisfaction by the patient or even legal complaint [18,19].

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Despite a large number of studies, the choice of the most effective hip approach remains difficult. To our knowledge, no prospective study has been compared the posterior, anterior and anterolateral approach.

Therefore, our main goal was to identify whether there is a difference in functional outcome (Oxford Hip Score) and quality of life related to health (SF-36) at a follow up of 6 months comparing the 3 approaches. Our second objective was to assess the offset and leg length to confirm restoration of the hip biomechanics and to evaluate whether there is a superiority of one approach to another. Finally, financial constraints are becoming increasingly important in orthopedic surgery, mainly due to the length of stay in hospital. For this reason, we compared the length of stay to evaluate whether an approach possibly achieves an earlier discharge.

Materials and Methods

Patients

We performed a prospective study in 52 patients who underwent a total hip replacement done by 4 senior surgeons in 2 centers Cliniques universitaires Saint Luc Brussels and Clinique de l'Europe Saint Elisabeth Brussels between September 2015 and December 2016. The study was approved by the research ethics committee of the Cliniques universitaires Saint Luc Brussels (registration number: B403201523492) and each patient signed a written consent before entering the study.

Inclusion criteria were clinical and radiological diagnosis of hip osteoarthritis resisting to conservative treatment and planned to have a hip replacement. Exclusion criteria were history of hip surgery on the hips, major hip dysplasia, neuro-muscular disease and especially the refusal to participate in the study which is associated for every patient with a gait analysis. Patients not being able to move without walking aid, with existing pain on another joint of the lower limb (like osteoarthritis of the opposite hip or knees) and history of chronic heart failure were therefore further excluded.

We included 52 patients divided into 3 groups: 16 in the PA group operated by DP at the Clinique de l'Europe, 17 patients in the DAA group operated by MVC and 19 patients in the ALA operated by JED and OC all 3 working at the Cliniques Saint Luc.

Table 1: Demographic data and functional scores in preoperative.

	Posterior (n=16)	Hueter (n=17)	Rottinger (n=19)	p
Age (years)	64.5[52.2-76.2] $	71[60.5-82]	65[58-75]	0.192
BMI	25.1[22.1-27.8]	27.7[24.8-30.4]	27.3[24.9-31.1]	0.019
Oxford Hip Score	29.4 ± 10.6	25.1 ± 10.07	26.5 ± 10.1	0.474
SF-36 (PC)	37.9[34.5-44.4]	35.1[31.5-28.5]	33.6[32.4-43.6]	0.429
SF-36 (MC)	51.3[44.8-53.4]	44.9[41.7-52.4]	45.3[41.8-52.4]	0.439
M/F: 24/28	04/12	10/7	10/9	0.12 (χ^2=4.3)

BMI: Body Mass Index (kg/m^2).

SF-36 PC: Physical Component and MC: Mental Component.

$: median [interquartile range] or mean± standard deviation.

M=male/F=female.

Outcomes

The demographic data and clinical scores were collected prospectively and independently to the surgeon by a collaborator of the gait analysis laboratory preoperatively and at a follow up of 6 months. We decided to use the joint-specific questionnaire Oxford Hip Score (OHS) concerning 12-items about pain and function in daily activities [20]. This produced a score range from 0 (severe symptoms and disability) to 48 (no difficulties) [21]. To evaluate the health-related quality of life we used the Physical and Mental Component (PC and MC) of SF-36 both ranging from 0 (worst) to 100 (best). Demographic data as well as preoperative OHS and SF-36 are shown in Table 1.

At the same time, another collaborator performed a radiological analysis independently to the surgeon preoperatively and at 6 months of follow-up on a standard antero-posterior view of a pelvis X-ray. We measured the offset and leg length discrepancy of the affected side according to the standard technique [22-24] (Figures 1 and 2). We specially emphasized the calculation of the difference of pre- and postoperative offset (delta offset) which should be close to 0mm to confirm the restoration of preoperative offset. We also compare the postoperative leg length discrepancy in the 3 groups which have also to be the nearest to 0mm.

Surgical procedure

We use the original techniques as described in the literature. For the posterior (or posterolateral) approach described first by Moore, the patient was placed in lateral decubitus position. The approach consists on splitting the gluteus maximus muscle and to incise the external hip rotators. We used the minimal invasive modification by preserving the piriformis tendon [25-27].

The direct anterior approach described by Hueter is a muscle sparing minimal invasive modification of the Smith-Petersen approach, passing in the internervous space between the tensor fasciae latae and the Sartorius. The patient was placed in decubitus which

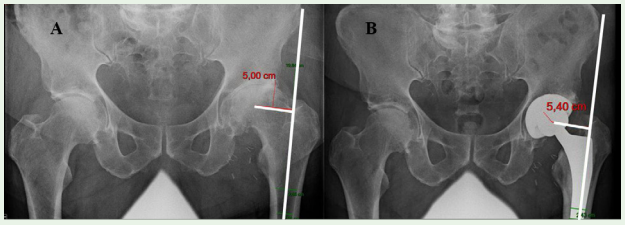

Figure 1: Radiological measurement of offset. A is preoperative and B at 6-month follow-up.

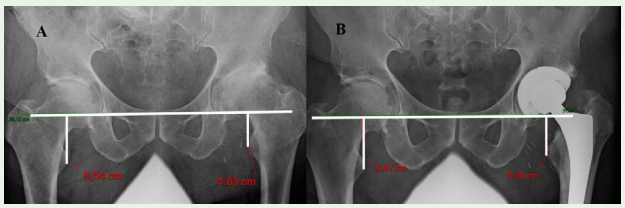

Figure 2: Radiological measurement of leg length difference. A is preoperative and B at 6-month of follow-up.

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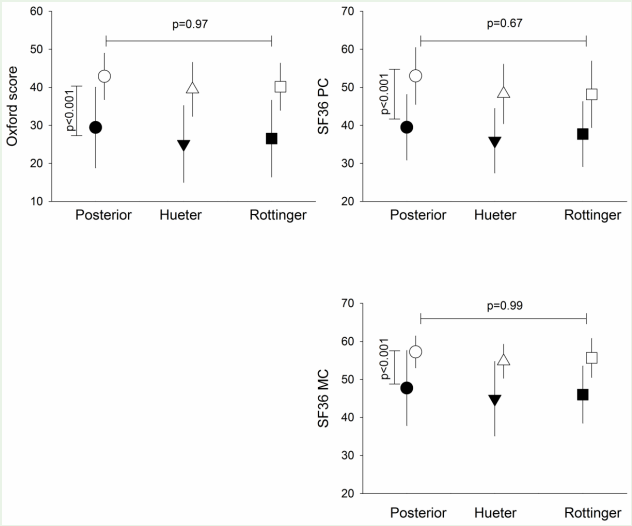

Figure 3: Comparison of Oxford Hip Score, SF-36 Score preoperatively and at 6 months of follow up. Mean and standard deviation of Oxford hip scores and SF-36 (MC and PC) in preoperative (black symbols) and at 6 month postoperative (white symbols) for the 3 approaches. Horizontal lines indicated p value of intercation. Vertical lines indicated pvalue of time (pre *vs* post).

both legs in the operation field thus permitting the intraoperative verification of the limb length [28,29].

Rottinger described a modification of the Watson-Jones approach which is like the DAA a muscle sparing minimal invasive approach passing between the tensor fascia latae and the gluteus medius. The patient was placed in lateral decubitus [30-32].

The implants used are the Polarstem-R3 (Smith and Nephew Inc., London and Hull, UK) and Avenir/Fitmore-Trilogy/Advantage (Zimmer Biomet Inc., Warsaw, IN, USA) mostly non-cemented for both components with ceramic-ceramic, metal-XLPE (cross-linked ultra-high-molecular-weight polyethylene) and ceramic-XLPE bearing couples.

All patients were lifted the same day of surgery. The first steps of walk were done with a physiotherapist who informed the patients about the movements at risk of dislocation. The patient was discharged without needing physiotherapy sessions and asked to walk by using crutches if necessary depending on comfort.

Statistics

The statistical analysis was done with Sigmaplot v13 (SPSS). Significance threshold was set at p value <0.05.First, a power study calculated with a minimum clinically important change of 5 for the OHS fixed a total number of 51 patients needed to find a significance [21,33].

A t-test or Rank Sum Test (if the data were not normally distributed (Shapiro-Wilk test) and the variances were not equal) was used to determine whether the two groups were homogenous in terms of demographic data (age, BMI, and male–female ratio) and preoperative OHS and SF-36 scores.

A two-way repeated ANOVA was realized to assess the effect of time (pre- vs post) and type of approach. We were mainly focused on interaction pvalue (time x approach). The correlation between change of OHS and approach was assessed by the Pearson correlation coefficient.

Table 2: Oxford Hip Score, SF-36 Score preoperatively and at 6 months of follow up.

		OHS	SF-36 (PC)	SF-36 (MC)
PA	Preoperative	29.4 ± 10.6	39.4 ± 8.6	47.7 ± 9.8
	at 6 months	42.8 ± 6.1	52.9 ± 7.4	57.2 ± 4.1
DAA	Preoperative	25.1 ± 10.1	35.9 ± 8.4	44.9 ± 9.8
	at 6 months	39.4± 7.1	48.2 ± 7.8	54.7 ± 4.4
ALA	Preoperative	26.5 ± 10.1	37.7 ± 8.5	46.0 ± 7.5
	at 6 months	40.1 ± 6.2	48.1 ± 8.7	55.6 ± 5.1

PA = Posterior Approach, DAA = Direct Anterior Approach, ALA = Anterolateral Approach

All values are given in mean ± standard deviation. The p-value for the OHS and SF-36 is seen in Figure 3.

Results

The 3 groups were homogenous in preoperative with only the BMI slightly lower in the PA group (Table 1).

Primary outcome

For the 3 groups, we observed a significant increase of the OHS, SF36-PC and SF36-MC scores between preoperative and at a follow-up at 6 months without having a significant difference between each group (Figure 3 and Table 2).

We found 88.5% of good to excellent results for OHS (Figure 4).

Secondary outcomes

The radiological measurements of the hip showed no significant difference in the offset preoperatively and at 6 months follow up at any group (Figure 5 and Table 3).

The median postoperative length discrepancy in the PA group was 0mm, -1mm in the DAA group and -5mm in the group operated via ALA. The results are rather in favor of a slight persistence of shortening without being statistically relevant between the 3 groups. Overall, there is at least a partial correction of the preoperative shortening of the leg.

No correlation was found between the change of the Oxford Hip Score nor both components of SF-36 is seen and the variation of offset. There was no correlation between the limb length discrepancy and the functional scores.

Table 3: Offset preoperatively and at 6 months.

	Preoperative Offset	Postoperative Offset
PA	46.3 ± 6.5	45.5 ± 7.7
DAA	50.0 ± 7.0	48.8 ± 6.2
ALA	52.8 ± 4.6	52.1 ± 7.5

PA = Posterior Approach, DAA = Direct Anterior Approach, ALA = Anterolateral Approach.

All values are given in mean ± standard deviation. The p-value for the offset is seen in Figure 5.

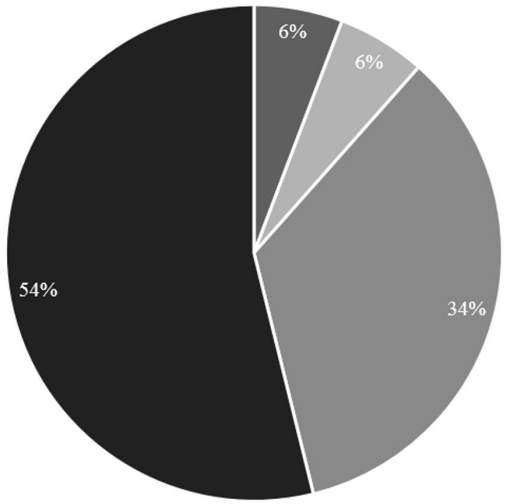

Figure 4: Oxford Hip Score results for all patients. <27 as a poor result: 6%, 27-33 as fair: 6%, 34-41 as good: 34% and > 41 as excellent: 54%.

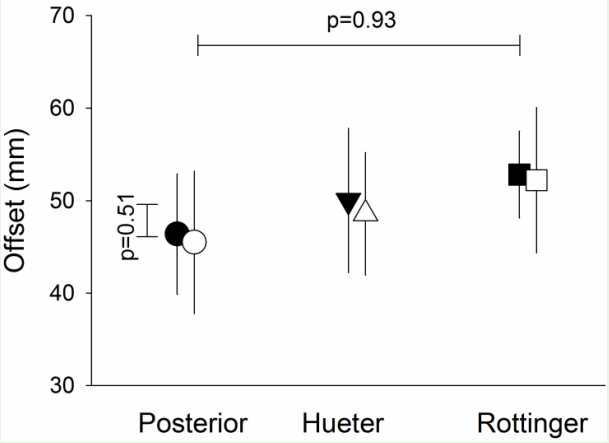

Figure 5: Comparison of pre- and postoperative Hip Offset. Mean and standard deviation of hip Offset in preoperative (black symbols) and at 6 month postoperative (white symbols) for the 3 approaches. Horizontal lines indicated pvalue of intercation. Vertical lines indicated pvalue of time (pre *vs* post).

By comparing the length of stay, we found that the posterior approach-group had a significant longer stay in hospital (7 days vs 5 days for the DAA and ALA; p<0.001).

Discussion

Our study showed in all 3 groups, better functional scores, and greater health related quality of live 6 months after hip replacement with about 88% having a good to excellent functional result. This confirms the efficacity of the treatment of hip osteoarthritis by arthroplasty, already well documented in the literature [1].

The main objective was however to see if there was an advantage to use one of the 3 approaches concerning the functional outcome. No significant difference was shown regarding the Oxford Hip Score and both components of the SF-36 between the 3 groups. Ware et al. assessed the SF-36 score in the European healthy population with a mean age of 41.1-47.6years and showed that both the PC and MC component tend around 50, like already shown in the standard US-derived scoring method [34]. Shan et al. published a meta-analysis on mid-term quality of life after hip replacement [35]. PC did not reach population norm. MC improves rapidly and becomes higher than the norm. Shi et al. shows at 6-month follow-up a PC at 35 and a MC at 55.5 but improving until 5-year follow up [36,44,60]. When we compare it to our result, mean SF-36 PC 48.9 and mean MC 55.5, we confirm that we restore a good health-related quality of life.

It's also known that SF-36 is decreasing with age, so we have even better results because our population has a mean age of 65.7years [37]. Another reason to expect a better functional result is that most patients are improving clinical function until the 1st year so we expect better score at 1 year of follow up [38].

We could confirm the correct restoration of the hip offset with the same precision in the 3 groups.

There is a tendency of a persistence of post-operative shortening of the operated limb. But when we compare it to the preoperative leg discrepancy probably due to the osteoarthritic cartilage wear, our study shows a partial or even total correction of this shortening. This confirms the results in the literature. Lin et al. did not find a difference in the offset, leg length discrepancy neither the femoral anteversion of the operated hip when they compared the PA and the DAA but found a better positioning of the cup inclination in the DAA.

A bias factor in the leg length discrepancy assessment is that even in the healthy population there is a variance in leg length often without being symptomatic caused by structural deformities originated by bony leg length differences. However, it also can be due to functional deformities of the knee, ankle and foot [19].

No difference in functional outcome was observed by correlating with the delta offset and leg length. It's rather against the general theory that a difference in biomechanics is a crucial factor in functional outcome. The recent literature confirms our result and describes no significant difference in functional outcome but only a measured force reduction of abduction of the hip when offset is decreased [16,17].

Concerning the length of stay, we observe that the posterior approach group had a longer stay. We are unable to conclude if the difference is due to the approach or other influencing factors. A recent review article from Meermans et al. showed no difference in the length of stay comparing the PA, DAA and ALA [39].

One hypothesis is that all patients in the academic clinic benefit from a preoperative educational session in group but also individually with a coordinator. He explains the conditions of the operation and hospitalization and responds to the remaining questions. He also screens the patients in need of rehabilitation center or home aid and anticipated the discharge by optimizing the social-backup before admission. Napier et al. confirmed that non-medical reasons were important in delaying the discharge. The main factor was attributed to inadequate social support [40,41].

The first limitation of this prospective study is due to the tied margins of the OHS in the three series. Establishing 5 points difference margin, 52 patients were required by the power study. We find a

difference of 3 points in the OHS. To show a statistical significance, a total of 132 patients would have been needed. Therefore, studies with larger cohorts for the 3 groups will be needed.

Another source of bias is that we compared patients operated by 4 surgeons in 2 different hospitals don't using the same implants, most with Corail-type non-cemented femoral stem prosthesis and a small number of short-stem and all press-fit cup implant. A recent meta-analysis by Huo et al. don't show any difference in functional and radiological results (offset and limb length) comparing short-stem versus conventional implant [42].

Other limitation is the follow-up at 6 months, don't showing any difference between our 3 groups regarding the Oxford Hip Score and the SF-36. Possibly we could have found a significant difference at an earlier follow up at 6-12 weeks like found by Meermans et al. [39] where the DAA had a better functional result at 6weeks in comparison with de PA. A late follow up at 1 year could have found better functional results.

We used an X-ray based measurement method to evaluate the offset and leg length discrepancy. Currently, it's the standard technique used but Leclerf et al. show that the CT-scan is more accurate to assess femoral offset [22,24]. A disadvantage of this technique is clearly the cost and higher radiation.

One of our study's strength is that we included not only the 2 approaches the most investigated in the literature (PA, DAA) but also the ALA by Rottinger. Studies show good early results at 6 and 12 weeks or at a follow up at 1 year [14,15] but no comparative study is currently seen in the literature concerning the ALA at 6-12 weeks neither at 6 months. We have confirmed a good clinical and radiological result at 6 months.

A second strength is that the data collection is done independently to the surgeon and in a calm environment without any time restriction. The patient could be influenced during the consultation by the surgeon and by this stressful situation. We think that the questionnaires are answered more sincerely when done by an independent person and could probably explain some poorer results.

Since the goal of our study was to help us and other orthopedic surgeons to choose about which approach to use in current practice, we still don't have more evidence of a superiority of an approach to another.

When we compare the outcomes chosen in our study to the literature, we conclude that the only advantage of the DAA is an earlier functional outcome without evidence that it provides any long term functional improvements compared to the other approaches [39,43]. No clear difference in length of stay or in implant position is seen but increased complication especially during the learning curve.

Conclusion

At present, it's nearly impossible to choose about a hip approach based on evidence. The surgeon must balance the advantages and disadvantage of each approach. It's important that short-term objectives must not compromise long-term performance.

Still, the only deciding factor is more the experience and familiarity that a surgeon has with an approach as well as patient characteristics until new studies prove the advantage for one approach to another.

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