



Original article

Surgical hip dislocation is more powerful than arthroscopy for achieving high degrees of acetabular correction in pincer type impingement

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ABSTRACT

Background: With the development of hip arthroscopy (HA), a shift away from surgical hip dislocation (SHD) is becoming a noticeable reality. It was the aim of this study to examine whether SHD provides a benefit over HA regarding its corrective power in the treatment of femoroacetabular impingement (FAI).

Hypothesis: It was hypothesized that SHD provides the more powerful tool for acetabular correction in FAI surgery compared to HA.

Method: The examined cohort consisted of 85 hips of which 31 (36%) underwent a high degree of acetabular correction which was defined as a correction of > 2 standard deviations from the population mean. A lateral center edge angle (LCE) correction > 12° or an acetabular index (AI) correction > 8° were therefore considered to high correction. A logistic regression model was applied to determine factors influencing high correction in FAI surgery. Subsequent adjustment was performed using a multivariate model.

Results: After adjusting for pre-operative acetabular orientation, SHD showed a pronounced influence on the likelihood of achieving the adequate degree of high acetabular correction (odds ratio (OR) 10.0 confidence interval (C.I) 2.3 to 44.0, $p=0.002$). On the other hand, SHD showed no influence on femoral correction ($p=n.s.$).

Conclusion: Surgical hip dislocation is a powerful modality for achieving high degrees of acetabular correction in the situation of a femoroacetabular conflict, being defined as an LCE correction of > 12° or AI correction of > 8°. The reason for these results may be seen in the excellent exposure and the improved possibility of performing dynamic intra-operative examination to verify the results. The benefits are only limited to large acetabular correction. These findings should provide a helpful tool for decision making in clinical practise.

Level of evidence: Level III retrospective cohort study.

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1. Introduction

Femoroacetabular impingement (FAI) is a dynamic conflict within the hip joint arising from an extra-physiological hip morphology that frequently presents as excessive acetabular coverage alongside asphericity of the femoral head. The bony conflict is well defined as a cause of pain during motion [1,2]. The conflict has also been shown to lead to secondary articular cartilage damage and joint degeneration [2–4].

Recognition of the femoroacetabular conflict as a pathology provoked the initiation of a new era in hip preservation surgery [5]. Interestingly, the first mentioning of the pathology was in an article describing an approach to the hip and acetabulum, now known as the “surgical hip dislocation” [6]. The authors obviously developed an approach for maximum circumferential exposure of the femoral head, neck and acetabulum that was utilized to correct what they called “anterior hypertrophy - an idiopathic non-spherical femoral head or an insufficiently narrowed head-neck junction” [6]. Therefore, a new approach was described that provided a working horse for a new principle that showed global expansion during the last years [5].

It is not to neglect that alongside the further development of arthroscopic surgery, there was a continuous urge to scope every

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Table 1
Table illustrating the characteristics of the two groups.

	Normal correction group (n = 54)	High correction group (n = 31)	p-value
Age (y)	33.5 ± 11.7 (12–57)	37.9 ± 10.9 (14–55)	n.s
Gender (% male)	50.0	54.8	n.s
SHD/arthroscoy (% arthroscopy)	83.3	38.7	< 0.001
Pre-op AI (°)	5.1 ± 5.1 (–13–15)	–1.1 ± 6.3 (–12–18)	< 0.001
Delta AI (°)	2.7 ± 2.7 (0–8)	9.9 ± 4.0 (0–17)	< 0.001
Pre-op LCE	30.4 ± 5.9 (19–45)	40.7 ± 7.5 (23–55)	< 0.001
Delta LCE	3.8 ± 3.7 (–1–12)	15.7 ± 5.2 (3–28)	< 0.001
Pre-op Alpha	62.3 ± 10.2 (41–88)	67.8 ± 12.5 (39–89)	0.03
Delta-Alpha	16.5 ± 9.3 (2–35)	20.2 ± 11.2 (0–37)	n.s

joint including the hip. So it was not long until treatment of FAI was performed through a full arthroscopic and thereby minimally invasive approach [7,8].

A minority of published studies compared both procedures underlining aspects related to invasiveness and early patient satisfaction [9–11]. However, the reality is that protagonists of arthroscopy are more likely to scope the hip and protagonists of open surgery are more likely to perform a surgical hip dislocation (SHD). Long-term follow-up studies looking into progression of osteoarthritis and patient satisfaction are lacking. There is also lack of evidence concerning the limits of arthroscopy and the role of the rather more invasive SHD procedure in the management of FAI. One may ask whether the advantages of the excellent surgical exposure that is achieved with SHD allows for more efficient correction that would justify the drawbacks of an extensive surgical incision and longer recovery period. Clinical research in this area is necessary to address these questions.

It was the aim of this study to determine whether surgical hip dislocation is more powerful than hip arthroscopy regarding the degree of bony correction.

It was hypothesized that more acetabular bony correction can be achieved with surgical hip dislocation.

2. Patients and methods

Conventional radiographs from patients undergoing surgery for the treatment of FAI between 09/2008 and 08/2012 were retrospectively obtained. All procedures were performed by one surgeon with a large experience in both arthroscopic and open surgical techniques. Patients were considered for surgery if presenting with groin pain with a radiographic correlate indicating overcoverage of the acetabulum or asphericity of the femoral head. Patients underwent either surgical hip dislocation (SHD) or hip arthroscopy. The type of surgery was not based on any defined criteria. Individual decision-making was undertaken by the primary surgeon with consideration of patient preference. Exclusion criteria included: advanced osteoarthritis defined as Tönnis grade two or higher ($n=2$), previous hip surgery ($n=51$), incomplete pre- or postoperative radiographic or surgical documentation ($n=88$).

A total of 82 patients (85 hips) were included. Hips were divided into two groups based on the degree of achieved acetabular correction: group A: high correction group (31 hips), group B: normal correction group (54 hips). Definitions of correction angles upon which the groups were based are found below (Table 1).

2.1. Surgical treatment

2.1.1. Surgical technique

SHD was performed as previously described [12]. In brief, the skin incision was centered over the innominate tuberosity. Deep dissection to the fascia and identification of the plane between the gluteus maximus and tensor fascia lata was performed. The interval was split and the retrotrochanteric space exposed. The piriformis

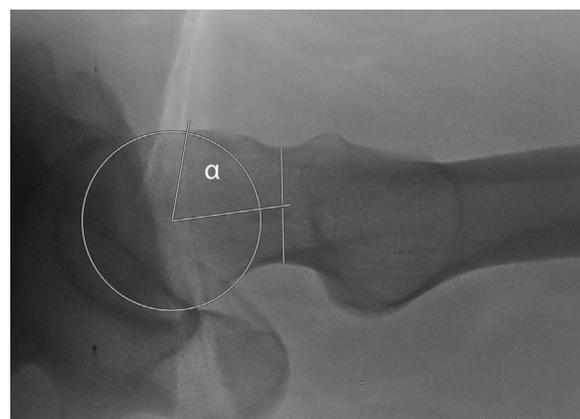


Fig. 1. Femoral head sphericity defined as the angle alpha between the femoral neck axis and a line perpendicular to the tangent point where the femoral head sphericity resumes, measured on the lateral cross table view.

tendon was further identified and the gluteus minimus separated from the cranial border to expose the capsule and develop the interval for later dislocation of the hip. A stepped bigastric osteotomy of the trochanter was then performed and the capsule exposed. A capsulotomy was performed and the hip was dislocated. Work on the hip joint was performed correspondingly.

Hip arthroscopy was performed as described in previously published reports of the technique, with the aid of a traction table and fluoroscopy using a lateral paratrochanteric and a mid-anterior portal [13].

2.1.2. Radiographic measures

All radiographic measures were assessed prior to surgery and at final follow-up 2 years postoperatively. To maintain clinical relevance, the number of radiographic measures were limited to frequently used radiographic parameters applied by clinicians in the FAI outpatient clinic [14]. Imaging was performed in a standardized manner. Anterior-posterior pelvic X-rays were performed by centering the beam at the midpoint of the vertical line between the symphysis pubis and a line connecting both anterior superior iliac spines. A cross-table view was obtained for measurement of the asperity of the femoral head as described previously [15,16].

The three coxometric indices utilized in this study included:

- femoral head sphericity defined as the angle alpha between the femoral neck axis and a line perpendicular to the tangent point where the femoral head sphericity resumes, measured on the lateral cross table view (Fig. 1);
- the lateral center edge (LCE) angle defined as the angle between a vertical line through the center of the femoral head a line connecting the head center to the lateral edge of the subchondral sclerosis of the weightbearing zone [17] (Fig. 2);



Fig. 2. The lateral center edge (LCE) angle defined as the angle between a vertical line through the center of the femoral head a line connecting the head center to the lateral edge of the subchondral sclerosis of the weightbearing zone.



Fig. 3. The acetabular index (AI) defined as the angle between the horizontal and a line connecting the medial and lateral limits of the subchondral sclerosis of the roof on an ap X-ray.

- the acetabular index (AI) defined as the angle between the horizontal and a line connecting the medial and lateral limits of the subchondral sclerosis of the roof on an ap X-ray (Fig. 3).

2.1.3. Definition of high acetabular correction

The target values for the analysis in this study were the delta values of bony correction.

It was necessary to define high acetabular correction to allow for binary modelling for later analysis. For this purpose, well-established reference values from an article by Tannast et al. were considered [18]. A high correction was defined as either:

- an LCE correction $> 2 \times$ the standard deviation of LCE from the mean in a population with acetabular overcoverage;
- an AI correction $> 2 \times$ the standard deviation of AI from the mean in a population with acetabular overcoverage [18].

Based on the above, high correction was defined as an LCE correction $> 12^\circ$ or AI correction $> 8^\circ$ [18].

For the secondary research question, a high femoral correction was defined as a correction $> 2 \times$ the standard deviation from the mean in symptomatic patients with a symptomatic CAM deformity [19]. An alpha angle correction of $> 22^\circ$ was therefore considered a high correction.

2.1.4. Statistics

Normally distributed data were presented as mean \pm standard deviation. Analysis of Variance (ANOVA) was used for comparison between groups. Chi-squared was applied for binary data.

Adjustment was performed using a logistic regression model. All potential confounders from a univariate analysis were included in a multivariate model for adjustment. A *p*-value < 0.05 was considered statistically significant.

The study followed the standards of the local Ethics Committee and protection of data privacy and informed consent was obtained from all patients.

3. Results

The characteristics of the cohorts with corresponding comparison are illustrated in Table 1. Six measures significantly differed between groups.

Table 2
Logistic regression after adjustment.

	Odds ratio	95% confidence interval		<i>p</i> -value
		Lower	Upper	
Surgical hip dislocation	10.0	2.3	44.0	0.002
Præoperative LCE	1.4	1.2	1.7	< 0.001

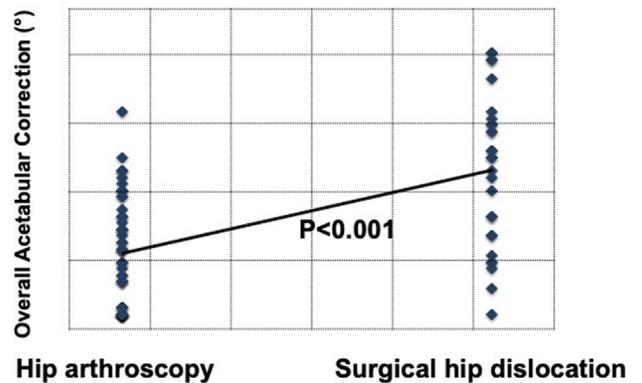


Fig. 4. The overall sum of acetabular correction incorporating both AI and LCE was 10° (range 0 to 31) in patients undergoing hip arthroscopy and 22° (range 0 to 40) in patients undergoing SHD.

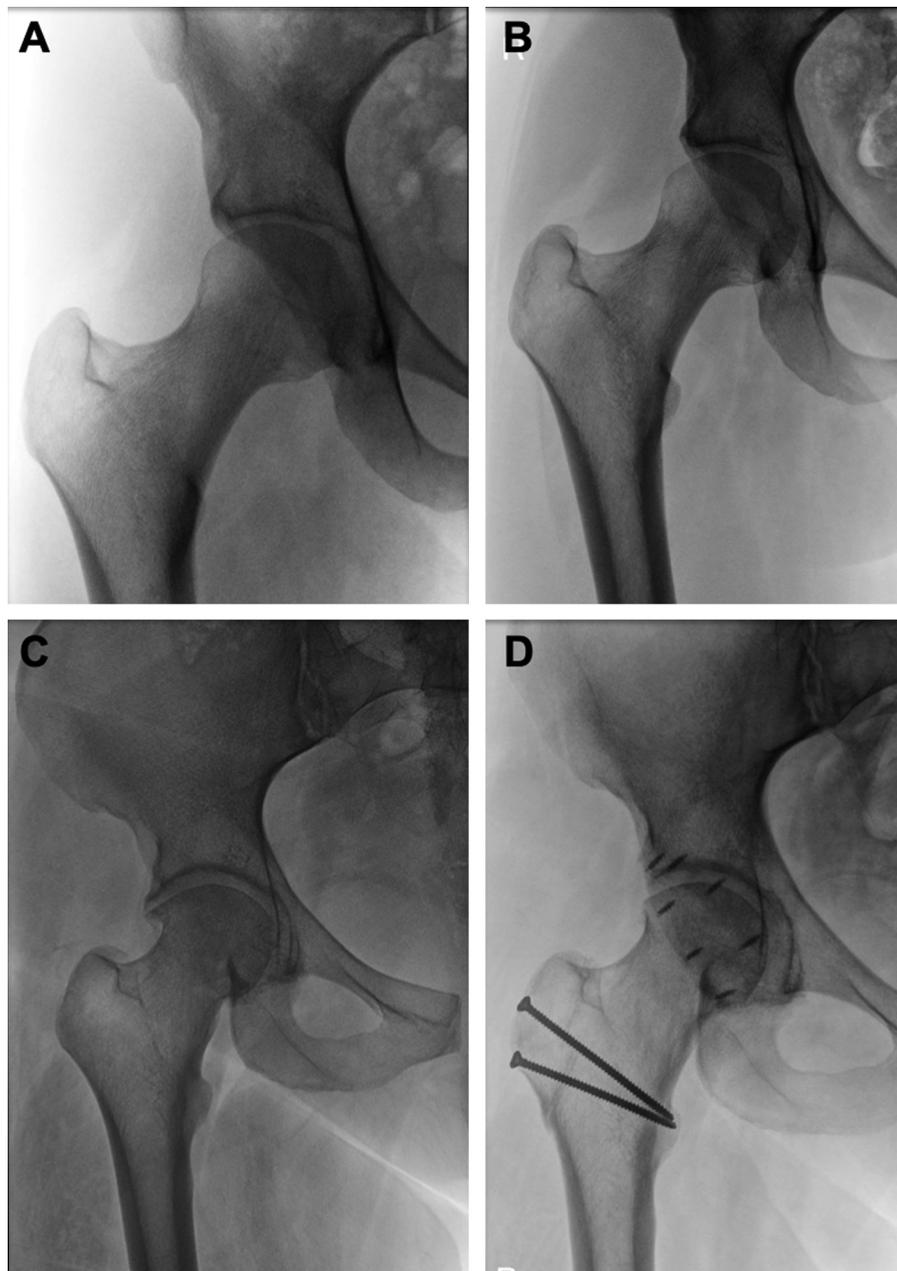


Fig. 5. A. Illustrating an example of a pre-operative antero-posterior (ap) radiograph of a hip prior to undergoing hip arthroscopy. B. Illustrating a postoperative ap radiograph of the same hip shown in image A after hip arthroscopy. C. Illustrating an example of a pre-operative ap radiograph of a hip prior to undergoing surgical hip dislocation (SHD). D. Illustrating a postoperative ap radiograph of the same hip shown in image C after SHD.

3.1. Acetabular correction

Linear regression did not show an influence of SHD on the degree of correction of LCE or AI angles provided that the correction was below the threshold of what was defined as a high correction (both $p = n.s.$).

Despite the above, SHD did demonstrate a pronounced effect on achieving a high correction of acetabular overcoverage. A 10-fold increase in odds was noted compared to hip arthroscopy after adjusting for pre-operative LCE, which was the only confounding factor identified upon univariate analysis (Table 2).

The overall sum of acetabular correction incorporating both AI and LCE was 10° (range 0 to 31) in patients undergoing hip arthroscopy and 22° (range 0 to 40) in patients undergoing SHD is illustrated in Fig. 4. A representative example of a high acetabular

correction in SHD and moderate correction in hip arthroscopy is presented in Fig. 5.

3.2. Femoral correction

Linear regression did not demonstrate an influence of surgical approach on the degree of correction of the femoral head-neck junction. Logistic regression also demonstrated no influence of surgical approach on achieving a high correction of sphericity based on the above definitions ($p = n.s.$).

4. Discussion

The most important finding of this study was that surgical hip dislocation is a more powerful tool for achieving higher

degrees of acetabular correction in femoroacetabular impingement surgery. There was no benefit of surgical hip dislocation over hip arthroscopy in achieving any correction of the asphericity of the femoral head neck junction.

It was not long after the establishment and the wide spreading of the techniques of hip arthroscopy that the necessity of surgical hip dislocation as a rather invasive surgical approach was questioned. A variety of comparative studies were subsequently published [9,10,20–22].

Considering the main findings of previous studies, it would be fair to conclude that the main common trend highlights higher functional and satisfaction scores in the postoperative short term, especially within the first year, in patients undergoing hip arthroscopy [9]. But in the longer term, there seems to be no difference [23]. It is important here to underline that SHD occupies a higher position on the scale of invasiveness due to the necessity of a trochanteric osteotomy for joint exposure. Despite the fact that the approach does not violate the blood supply to the femoral head nor does it violate muscles or tendons if performed correctly, the reduced osteotomy requires a recovery period during which bone union must occur and abductor weakness may become an issue [6]. This initial inferior subjective outcome attributed to SHD in comparative studies is most likely secondary to the longer postoperative recovery period. Long-term outcome reports are lacking, therefore true conclusions cannot yet be drawn regarding the superiority of one technique over the other.

The novelty aspect of this study in particular is underlined in the proposition of the argument that the primary benefit of SHD is to be seen in its power for extensive acetabular correction. This is based on results of the multivariate analysis performed. The most plausible explanation for this result is reflected in the excellent circumferential exposure of the acetabulum that not only allows for achieving a desired high correction, but also allows for visual dynamic intraoperative clinical real-time assessment of the femoroacetabular conflict prior to correction and after correction, thereby reducing the risk of insufficient correction. Interestingly, femoral correction was not influenced by the choice of approach. The observation as such has not yet been emphasized in the previous literature.

It is important for clinicians to consider the above and perform correct planning by understanding the individual pathological morphology and it is also important to recognise the risk of excessive correction. When choosing to perform a SHD in the setting of true acetabular retroversion with a dysplastic posterior wall, an anteverting periacetabular osteotomy (PAO) would be the better choice. Therefore, meticulous preoperative assessment is mandatory to avoid creating a dysplastic situation [24].

The limitation of the current study can be reflected in the fact that all procedures were performed by a single surgeon. The surgeon who performed all procedures was highly experienced in both open and arthroscopic procedures, as an early adopter of both techniques with a record of several hundred procedures. Still, a multicenter study including surgeons who only perform arthroscopy and surgeons who only perform surgical hip dislocation would have allowed for an more generalized image, though would not have completely eliminated bias. Furthermore, a larger cohort size would allow for a more concise result with narrower confidence intervals. The study was also a pure radiological study with no clinical outcome measures; this was though not the primary research question. The current results do allow for an initial proposition and a starting point that would provide some basis and primary evidence for decision taking.

It can be concluded that surgical hip dislocation is an invasive, but powerful modality for achieving high degrees of acetabular correction in the situation of a femoroacetabular conflict, defined as a lateral center edge angle correction of $>12^\circ$ or an acetabular

index angle correction of $>8^\circ$. On the other hand, arthroscopy is as effective for smaller degrees of acetabular correction or any correction of femoral asphericity. The reason of improved acetabular correction with surgical hip dislocation may be due to the excellent exposure and the enhanced possibility of dynamic intraoperative examination of residual conflict.

Disclosure of interest

The authors declare that they have no competing interest.

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Authors contribution

Sufian S. Ahmad performed the statistical analysis, assisted in writing the primary version and prepared the revised version of the manuscript.

Max Heilgemeir screened patient records and extracted and tabulated data. Helen Anwander wrote the primary version of the manuscript. Martin Beck initiated the idea and contributed to manuscript writing.

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