

# Multicenter Study of Complications Following Surgical Dislocation of the Hip

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**Background:** Surgical hip dislocation enables complete exposure of the hip joint for treatment of various hip disorders. There is limited information regarding the complications associated with this procedure. Our purpose is to report the incidence of complications associated with surgical dislocation of the hip in a large, multicenter patient cohort.

**Methods:** A retrospective, multicenter analysis of patients who had undergone surgical hip dislocation was performed. Patients who had undergone a simultaneous osteotomy were excluded. Complications were recorded, with specific assessment for osteonecrosis, trochanteric nonunion, femoral neck fracture, nerve injury, heterotopic ossification, and thromboembolic disease. We graded complications with a validated classification scheme that includes five grades based on the treatment required to manage the complication and any long-term morbidity. With this classification, a Grade-I complication is one that requires no change in the routine postoperative course, Grade II requires a change in outpatient management, Grade III requires invasive surgical or radiologic management, Grade IV is associated with long-term morbidity or is life-threatening, and Grade V results in death.

**Results:** The study included 334 hips in 302 patients seen at eight different North American centers. There were eighteen complications (5.4%) that were classified as Grade I (not clinically relevant and required no deviation from routine postoperative care). There were six complications (1.8%) classified as Grade II (treated on an outpatient basis or with close observation and resolved). There were nine complications (2.7%) classified as Grade III (treatable and resolved with surgery or inpatient management). There was one complication (0.3%) classified as Grade IV (resulting in a long-term deficit). A total of thirty hips had one or more complications, for an overall incidence of 9%. Excluding heterotopic ossification, the complication rate was sixteen (4.8%) of 334.

**Conclusions:** Surgical hip dislocation is a safe procedure with a low complication rate. Many of the complications were clinically unimportant heterotopic ossification. There were no cases of femoral head osteonecrosis or femoral neck fracture, and, with the exception of one sciatic neurapraxia that partially resolved, no other complication resulted in long-term morbidity.

**Level of Evidence:** Therapeutic Level IV. See Instructions to Authors for a complete description of levels of evidence.

Over the past decade, there have been major advances in the understanding of femoroacetabular impingement as a mechanism for hip pain and later osteoarthritis. Surgical dislocation of the hip is one of the many approaches to the treatment of hip impingement disorders<sup>1-5</sup>, along with arthroscopy<sup>6-8</sup> and arthroscopy with a limited open anterior approach<sup>9</sup>. Surgical dislocation of the hip, as originally described by Ganz et al.<sup>1</sup>, has increased the knowledge of the pathomechanics of hip impingement syndromes and provided a unique surgical strategy for treatment. The surgical approach enables 360° visualization and access to the acetabulum and the proximal part of the femur<sup>5</sup>, allowing the surgeon to address not only impingement, but

a variety of hip disorders. With this approach, surgeons are able to perform labral repair, resection of the acetabular rim, femoral head-neck osteochondroplasty, relative femoral neck lengthening, trochanteric advancement, fracture reduction, reduction of a slipped capital femoral epiphysis, proximal femoral osteotomies, and tumor resection. Although surgical hip dislocation is becoming more commonplace worldwide, concerns regarding the potential risks and complications associated with it remain.

While reports in the past decade have suggested that surgical hip dislocation is an effective procedure, the data collected, particularly regarding complications, have not been uniform or standardized in these reports<sup>10</sup>. Also, except for

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symptomatic impingement, there are no clear standardized indications for this procedure. The contraindications—specifically, advanced osteoarthritis—are clearer<sup>11</sup>. Additionally, these previous reports have been on relatively small cohorts of patients treated by a single surgeon. Documentation of complications following this procedure is important for patient counseling, improved surgical care, and comparison with alternative, less-invasive surgical techniques.

Currently, there is no universal definition, grading system, or classification for the magnitude of orthopaedic complications. Often, complications have been classified as major, moderate, or minor<sup>12</sup>, a system that is not objective and does not indicate the need for unplanned treatment or of any future morbidity. Therefore, there is a major need for improved methodologies for reporting and categorizing complications. As joint preservation surgery of the hip assumes a larger role in orthopaedics, it is critically important to establish uniform methods for analyzing clinical outcomes and reporting complications.

The purpose of this study was to determine the incidence and character of complications associated with surgical dislocation of the hip in a large, multicenter patient cohort. We hypothesize that this information will solidify the belief that surgical hip dislocation is a safe surgical approach for treating multiple hip disorders. We utilized a complication classification scheme that has been validated for general surgical procedures<sup>13,14</sup> and should assist in standardizing the reporting of complications of hip preservation surgery.

## Materials and Methods

A retrospective analysis was performed on 355 hips (323 patients) treated by eleven surgeons at eight different North American centers that participate in the ANCHOR (Academic Network for Conservational Hip Outcomes Research) group, which is studying the outcomes of hip preservation surgery. Patients included in the study had undergone a surgical dislocation in the period from October 2001 to December 2007 and had been followed for a minimum of one year. Patients were excluded if they had had a simultaneous intertrochanteric, femoral neck, or acetabular osteotomy or had received treatment for an unstable slipped capital femoral epiphysis. Since we specifically reviewed the records for complications of the surgical dislocation approach, we included patients who had had the procedure for many different diagnoses, including femoroacetabular impingement, Legg-Calvé-Perthes disease in a skeletally mature hip, trauma, and deformity following a slipped capital femoral epiphysis. The indications established for surgery at the eight study centers were debilitating hip joint pain, usually in the anterior aspect of the groin; limitations in hip motion, particularly flexion and internal rotation; and radiographic evidence of an osseous or soft-tissue deformity that correlates with the symptoms and results of the physical examination. Radiographically evident deformities included a deficient offset at the anterior and anterolateral aspects of the femoral head and neck junction, a nonspherical femoral head, or a labral/chondral tear seen on magnetic resonance imaging (MRI). Institutional review board approval was obtained from each of the participating centers.

Specific demographic data that may affect complications, including patient age, sex, diagnosis, and the year of the surgery, were obtained. Pertinent surgical information included the size and number of screws used for trochanteric fixation and whether a labral repair or trimming of the acetabular rim with labral fixation had been performed. The latter was included in the analysis because labral fixation may require more muscle retraction and affect the rate of heterotopic ossification. Complications were categorized with use of an adaptation of the validated Dindo-Clavien classification of surgical complications (see Appendix)<sup>13,14</sup>.

A chi-square or t test was used for univariate analysis to examine the association of complications with age, sex, diagnosis, year of the surgery, diameter and number of screws used for trochanteric fixation, and whether a labral repair (with or without trimming of the acetabular rim) had been performed. Furthermore, logistic regression analysis was used to examine the interplay of the factors performed in the univariate analysis. Precision of incidence was estimated with the 95% confidence interval calculated with the exact method.

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No external funding was received for this study.

## Results

The records on 355 hips in 323 patients seen at eight different North American centers were retrospectively reviewed. Of the 355 hips, 334 (94%) in 302 patients were followed for a minimum of twelve months and twenty-one (6%), for less than twelve months. We attempted to contact these twenty-one patients by telephone and e-mail but could not accomplish the required minimum twelve-month follow-up. This subgroup of patients was followed for an average of 5.8 months (range, two to eleven months), and no complications were reported during this short time. The remainder of the analyses were performed on the 334 hips with a minimum of twelve months of follow-up. The mean age was twenty-six years (range, eight to sixty-one years). Of the hips studied, 179 were in males and 155 were in females.

The surgical hip dislocation approach was used to treat femoroacetabular impingement (288 hips), deformity following a slipped capital femoral epiphysis (thirty-three), deformity related to Legg-Calvé-Perthes disease (twenty-one), hip dysplasia (seven), synovial chondromatosis (three), loose body (one), osteochondroma (one), pigmented villonodular synovitis (one), femoral head chondral damage (one), and trauma (one). The median duration of follow-up of the hips with a minimum duration of follow-up of twelve months was thirty-six months (range, twelve to eighty-eight months). A labral repair or a labral repair along with trimming of the acetabular rim was performed in 178 (53.3%) of the 334 hips. Trochanteric fixation was performed with two 4.5-mm screws in 189 hips (56.6%), three 4.5-mm screws in forty-five (13.5%), three 3.5-mm screws in seventy-five (22.5%), and two 3.5-mm screws in twenty-four (7.2%).

Thirty hips had one complication or more, for an overall incidence of 9% (95% confidence interval [CI]: 5.5% to 11.5%) (see Appendix). Four patients had more than one complication. Eighteen (60%) of the thirty hips with a complication had Brooker<sup>15</sup> Grade-I or II heterotopic ossification with no clinical relevance. Excluding Grade-I and II heterotopic ossification, the complication rate was sixteen of 334, or 4.8% (95% CI: 2.4% to 6.9%), and all but one were treatable Grade-II or III complications (see Appendix). There was one Grade-IV complication (95% CI: 0% to 1%): sciatic sensory and motor sciatic nerve paralysis immediately following the surgery. This improved to slight numbness/tingling on the dorsum of the foot and some pain extending over the peroneal distribution of the sciatic nerve. At forty-seven months after the surgery, the patient limped occasionally. There were nine Grade-III complications (2.7%; 95%

**TABLE I** Incidence of Complications in Relation to Demographic and Clinical Factors

Factor	No. of Hips	All Complications		Grade-I Complications		Grade-II, III, or IV Complications	
		No. (%) of Hips	P Value	No. (%) of Hips	P Value	No. (%) of Hips	P Value
Chi-square test							
Sex							
Male	179	22 (12.3)	0.04	14 (7.8)	0.03	8 (4.5)	0.98
Female	155	9 (5.8)		4 (2.6)		7 (4.5)	
Labral repair							
Yes	178	18 (10.2)	0.57	12 (6.8)	0.24	8 (4.5)	0.99
No	156	13 (8.3)		6 (3.8)		7 (4.5)	
Yr of op.							
2001-2005	91	10 (11.0)	0.31	5 (5.5)	0.51	6 (6.6)	0.50
2006	150	16 (10.7)		10 (6.7)		6 (4.0)	
2007	93	5 (5.4)		3 (3.2)		3 (3.2)	
Logistic regression analysis							
Screw diameter							
3.5 mm	99	13.1*	0.09	9.9*	0.03	5.1*	0.59
4.5 mm	234	6.4*		2.7*		3.7*	
Age†		1.065†	0.47	1.067†	0.56	1.189†	0.13

\*The values represent the incidence, which was the least-squares estimate calculated with logistic regression analysis adjusted for the number of screws used. The model showed that the incidence increased with the number of screws, but the increase was not significant ( $p > 0.05$ ). †Age was treated as a continuous variable in the univariate logistic regression analysis. ‡The values are given as the odds ratio for each five-unit (year) increase.

CI: 1.6% to 5.5%) that were treatable and that resolved. There were six Grade-II complications (1.8%; 95% CI: 0.3% to 2.9%) and eighteen Grade-I complications (5.4%; 95% CI: 3.03% to 7.9%). There were no cases of osteonecrosis, femoral neck fracture, or any complication leading to long-term morbidity, with the exception of the one sciatic nerve injury, which partially resolved.

Of the nine Grade-III complications, six were trochanteric nonunions (a 1.8% rate of trochanteric nonunion). All united after repeat open reduction and internal fixation. Three of these patients had had 4.5-mm screws for trochanteric fixation and three, 3.5-mm screws. There were two cases of deep venous thrombosis in the calf. One was in a patient with a familial coagulation abnormality and was treated with inpatient anticoagulation followed by Coumadin (warfarin) for six weeks. The other was in a forty-year-old and was managed with inpatient anticoagulation followed by Coumadin for six weeks. Both patients had had mechanical and pharmacologic prophylaxis postoperatively. There was no consistent method of prophylaxis against deep venous thrombosis among the eight centers included in this series. The one deep infection in this series was managed effectively with surgical incision and debridement. No Grade-III complications resulted in long-term morbidity.

The six complications that resolved with observation or outpatient management (Grade II) included two superficial wound infections that resolved with oral antibiotics, one transient sciatic

neurapraxia that resolved in five weeks, two trochanteric delayed unions (delayed for more than three months) that healed without invasive treatment, and one trochanteric fracture, sustained in a fall, that united without surgery. The eighteen Grade-I complications were all cases of Brooker Grade-I or II heterotopic ossification that required no treatment and were not associated with clinical symptoms.

Table I shows the rates of complications grouped by demographic and clinical variables. There was no significant decrease in complications over time from 2001 to 2007. Males had a significantly lower incidence of Grade-I heterotopic ossification (7.8% versus 2.6% in females,  $p = 0.03$ ), but there was no difference in the rates of Grade-II, III, or IV complications between the sexes ( $p = 0.98$ ). Multiple logistic regression analysis with sex, labral fixation, screw size, and number of screws as predictors showed the same results as univariate analysis (Table I).

### Discussion

The purpose of this study was to determine the incidence of complications associated with surgical dislocation of the hip in a large, multicenter patient cohort. Our data suggest that this technique is a safe approach to the hip joint to treat femoro-acetabular impingement and other complex hip disorders. It has a low complication rate that is uniform among multiple North American centers. Many of the complications consisted of clinically unimportant heterotopic ossification. There were

no cases of osteonecrosis of the femoral head or femoral neck fractures. There was one complete sciatic nerve paralysis with incomplete recovery. None of the other complications resulted in long-term morbidity.

The overall complication rate was 9% in this retrospective study of 334 hips. What is reported as a “complication” is of critical importance in determining this rate. This was a rigorous analysis of complications that included even asymptomatic ones that required no treatment. The complication rate was 4.8% if Grade-I and II heterotopic ossification is excluded.

Recent investigators noted that the reporting of surgical complications was not homogeneous, well defined, or standardized in orthopaedic prospective randomized studies<sup>16</sup>. Reporting of complications has been inconsistent in non-randomized studies of surgical treatment for femoroacetabular impingement and hip preservation surgery<sup>10</sup>. One of our aims was to standardize the grading and definition of complications of hip preservation surgery. If the complication grading is based on the treatment required or the “therapeutic consequences of the complication,” including long-term disability, it becomes less subjective<sup>14</sup>.

The general surgical literature does describe established methodologies for reporting complications. For our study, we adapted the Dindo-Clavien classification, which has been validated for other surgical subspecialties. The classification system has five grades (see Appendix) based on the treatment required to manage the complication and on the long-term morbidity. The adaptations that we introduced for this study made the system more applicable to the relatively young, healthy population being treated for femoroacetabular impingement and receiving osteotomies to treat dysplasia. For example, Grade IV in the general surgery classification has subcategories, such as single-organ and multi-organ dysfunction, that are less likely in our patient population. However, we kept the basic concept; therefore, Grade IV is given for a complication involving any long-term orthopaedic disability or that is life-threatening, such as a permanent nerve injury, pulmonary embolus, osteonecrosis, or admission to the intensive care unit.

The Dindo-Clavien classification was tested in a cohort of 6336 patients who had undergone elective surgery<sup>14</sup>. The complexity of the surgery and the length of the hospital were strongly correlated with the grades of the classification system<sup>14</sup>. A five-year review of the Dindo-Clavien classification, analyzing its use in the literature and examining interobserver variability in grading scenarios among patients, doctors, and nurses, was recently reported<sup>13</sup>. There was an 89% agreement in the ratings and an increase in use of different forms of the classification in the literature across different subspecialties since its publication in 2004.

One Grade-IV complication (either life-threatening or with the potential for permanent dysfunction) occurred in our series. This complete sciatic paralysis partially resolved, but the patient was left with numbness and pain. There were nine Grade-III complications (requiring invasive treatment): six trochanteric nonunions that healed after repeat fixation, one deep infection that required surgical debridement, and two deep ve-

nous thromboses in the calf that resolved with medical therapy. All of these Grade-III complications resolved with treatment.

The complications observed in this review are similar to those reported in smaller series from individual centers, in which there was about a 1.0% to 1.5% rate of trochanteric screw failure, heterotopic ossification, and rare cases of partial neurapraxia (see Appendix). Ganz et al. originally described this approach, in 213 patients, and reported no cases of osteonecrosis, two cases of partial neurapraxia, three cases of failed trochanteric fixation (a rate of 1.5%, which was similar to the rate in this review), and seventy-nine cases of heterotopic ossification<sup>1</sup>. Peters and Erickson reported on forty-two surgical dislocations, none of which were followed by infection, osteonecrosis, hematoma, or hardware failure<sup>3</sup>. Beaulé et al. reported on thirty-seven hips, with one failure of trochanteric fixation, one case of Grade-IV heterotopic ossification, and painful bursitis due to trochanteric fixation in nine hips<sup>17</sup>. Both 3.5 and 4.5-mm-diameter screws were used for trochanteric fixation in Beaulé’s series, with surgeon preference the deciding factor. Failure was seen in association with both screw sizes, so no conclusion on the effect of screw diameter on the risk of trochanteric nonunion could be provided.

The only significant association identified in our review was a higher rate of heterotopic ossification (a Grade-I complication) in males. We did not see a significant increase in the incidence of complications with age or evidence of a change in complications over the years during which the surgery was performed.

This study had limitations. The data are retrospective, so it is possible that some complications were missed or were not documented in the medical record. The intent of the study was to evaluate a consecutive series treated between October 2001 and December 2007, but some patients were lost to follow-up. Although there were no cases of osteonecrosis, osteonecrosis could present after longer-term follow-up. Any reported complication other than osteonecrosis should have been present within six months. Also, we studied complications that had occurred at centers with experience with the technique, and it may be different when surgical hip dislocation is performed at centers with less experience. Also, although studies examining the reliability of the Dindo-Clavien complication classification have been published in the general surgery literature<sup>13,14</sup>, there are no studies of the reliability of this classification specifically for use in orthopaedic surgery.

In conclusion, these data indicate that surgical dislocation of the hip is a safe surgical approach with a minimal risk of long-term morbidity. Trochanteric nonunion after 1.8% of the surgical procedures was the most serious complication particular to surgical dislocation that would not have occurred with less invasive approaches. Nevertheless, surgeons need to recognize that the dislocation approach also provides extensive exposure of the acetabulum and the proximal part of the femur that cannot be obtained with less invasive techniques. This study provides unique and important information for the expanding field of joint preservation surgery. We have confirmed the safety of surgical hip dislocation and utilized a complication

grading scheme that may be adopted for future reports on hip joint preservation procedures as well as on other orthopaedic procedures.

### Appendix

**eA** Tables showing the adapted Dindo-Clavien complication classification, a summary of complications at single institutions, and an overview of the complications in the present series are available with the online version of this article at [jbjs.org](http://jbjs.org). ■

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