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Ira Zaltz
William Beaumont Hospital

Geneva Baca
Washington University School of Medicine in St. Louis

Young-Jo Kim
Boston Children's Hospital

Perry Schoenecker
Shriner's Hospital, St. Louis

Robert Trousdale
Mayo Clinic

See next page for additional authors

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A Prospective Multicenter Study

Ira Zaltz, MD, Geneva Baca, BA, Young-Jo Kim, MD, Perry Schoenecker, MD, Robert Trousdale, MD, Rafael Sierra, MD, Daniel Sucato, MD, Ernie Sink, MD, Paul Beaulé, MD, Michael B. Millis, MD, David Podeszwa, MD, and John C. Clohisy, MD

Investigation performed at the Washington University School of Medicine, St. Louis, Missouri, and William Beaumont Hospital, Royal Oak, Michigan

Background: The purpose of this prospective multicenter study was to determine and categorize all complications associated with the periacetabular osteotomy performed by experienced surgeons.

Methods: We prospectively analyzed perioperative complications in 205 consecutive unilateral periacetabular osteotomies performed at seven institutions by ten surgeons. All perioperative complications were recorded at an average of ten weeks and one year after surgery in standardized fashion using a validated complication grading scheme applied to hip preservation procedures. The mean patient age was 25.4 years. There were 143 female and sixty-two male patients. The most common diagnosis was developmental acetabular dysplasia, and concomitant procedures most commonly included femoral osteochondroplasty (58%) or hip arthroscopy (20%), which could include labral repair or resection.

Results: Major complications (grade III or IV) occurred in twelve patients (5.9%). Seven complications were evident at the ten-week visit and five at the one-year visit. Nine of the complications required a second surgical intervention, including repair for acetabular migration or implant adjustment (four patients), incision and drainage for a deep infection (two patients), and heterotopic bone resection, contralateral peroneal nerve decompression, and posterior column fixation (one patient each). Three thromboembolic complications were managed medically. There were no vascular injuries, permanent nerve palsies, intra-articular osteotomies and/or fractures, or acetabular osteonecrosis. The most common grade-I or II complication was asymptomatic heterotopic ossification.

Conclusions: For surgeons experienced with the periacetabular osteotomy, it is a safe procedure but is associated with a 5.9% risk of grade-III or IV complications beyond the learning curve. The majority of these complications are resolved without permanent disability.

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

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Acetabular dysplasia is a skeletal disorder that is associated with the development of osteoarthritis of the hip[1-3]. Malalignment of the acetabulum contributes to the development of pathomechanical stress along the rim of the acetabulum that eventually results in labrochondral failure[4-7]. Multiple osteotomies have been designed to enable surgical reorientation of the acetabulum, improve femoral head coverage, and redistribute weight-bearing forces more evenly across the acetabulum[8,9]. The Bernese periacetabular osteotomy described by Ganz et al. enables reorientation of the acetabulum while preserving posterior column pelvic continuity[10]. Multiple surgical approaches have been utilized to perform the

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osteotomy[11-13]. Clinical outcome studies have indicated that the majority of patients experience major pain reduction and improved function after periacetabular osteotomy[14].

A therapeutic intervention that is designed to alter the natural history of a symptomatic yet variably progressive disorder such as acetabular dysplasia is required to be safe, efficacious, reproducible, and associated with few and tolerable complications. It is accepted that the Bernese periacetabular osteotomy is a complex procedure with a steep learning curve that can be associated with a substantial number of variably morbid perioperative complications[11,15-20]. The prevalence of severe complications seems to diminish with more surgical experience, on the basis of retrospective reports[16,19,21]. Previous reports have described subjective categories of minor, moderate, and major complications with little attention to subsequent medical, surgical, or radiographic interventions required or to long-term consequences of the complications. Complication reporting for the periacetabular osteotomy has been inconsistent, and the findings regarding complication rates have been variable, with small patient cohorts and without a standardized grading scheme[14]. Currently, there are no available prospective data regarding the prevalence of surgical complications following the Bernese periacetabular osteotomy performed in centers by surgeons experienced with the procedure.

The purpose of this prospective multicenter study was to use a standardized complication grading scheme[22-25] to determine and categorize all complications associated with the Bernese periacetabular osteotomy performed by experienced surgeons for the correction of symptomatic acetabular deformities.

Materials and Methods

Patient Selection

Following individual institutional review board approval at seven North American centers, prospective data were collected on 205 consecutive patients who underwent periacetabular osteotomy from August 15, 2007, to August 31, 2009. There were 143 female and sixty-two male patients with a mean age of 25.4 years (range, eleven to fifty-four years). The mean body mass index (BMI) was 25.3 kg/m^2 (range, 11.7 to 46.6 kg/m^2) (Table I). All patients with a periacetabular osteotomy were included regardless of preoperative diagnosis, comorbidities, prior surgical procedures, or simultaneous associated procedures. The preoperative diagnoses were developmental dysplasia (179 patients; 87%), femoroacetabular impingement (twelve patients; 6%), Legg-Calvé-Perthes disease (nine patients; 4%), cerebral palsy (three patients; 1%), Charcot-Marie-Tooth disease (two patients; 1%), proximal femoral focal deficiency (one patient; 0.5%), and multiple epiphyseal dysplasia (one patient; 0.5%). (Two patients had more than one diagnosis.)

TABLE I Preoperative Demographic Data and Patient-Reported Comorbidities of 205 Patients Treated with the Periacetabular Osteotomy

Characteristic	Value
Sex *(no. [%])*	
F	143 (69.8)
M	62 (30.2)
Age* *(yr)*	25.4 (11.4-53.6)
Height* *(cm)*	167 (114.3-200.6)
Weight* *(kg)*	71.3 (25.5-135)
BMI* *(kg/m^2)*	25.3 (11.7-46.6)
Patient-reported comorbidities *(no. [%])*	
Heart disease	2 (1)
Hypertension	5 (2.4)
Asthma	25 (12.2)
Liver disease	1 (0.5)
Overweight	20 (9.8)
Cancer	1 (0.5)
Osteoarthritis	25 (12.2)
Back pain	47 (23)
Tobacco use	17 (8.3)
Drug use	2 (1)

*The values are given as the mean, with the range in parentheses.
BMI = body mass index.

Surgical Procedure

The ten surgeons performing periacetabular osteotomies within the seven selected centers were considered experienced with the procedure. All except one surgeon were certified by the American Board of Orthopaedic Surgery and had subspecialty concentration in either pediatric orthopaedic surgery or adult reconstruction surgery. They had been in practice for an average of thirteen years (range, one to thirty-seven years). Prior to the commencement of data acquisition, they had performed the periacetabular osteotomy for an average of nine years (range, one to eighteen years) and each surgeon had performed an average of 231 periacetabular procedures (range, eighteen to 715 procedures). The one surgeon with more limited experience (one year in practice and eighteen periacetabular osteotomies) who was included in the study was considered to have adequate experience because this surgeon had major exposure to the procedure as a resident, had specific fellowship training in the procedure, and worked with an experienced mentor in practice before the study commenced. Surgical education and training in the periacetabular osteotomy varied among the ten surgeons: five reported additional fellowship training, seven reported visiting another experienced surgeon, six reported independent learning, and six performed practice cadaveric dissections. All surgeons were involved in at least two of these educational activities.

The periacetabular osteotomy was performed according to the technique described by Ganz et al.[10] using the Smith-Petersen interval to preserve the hip abductor origin[13]. The periacetabular cuts are made as previously described, and the mobilized acetabulum is then appropriately reoriented; assessed using fluoroscopy or radiographs, or both, depending on the institution; and stabilized using screws primarily directed from proximal to distal. Postoperatively, patients were prescribed intravenous antibiotics for twenty-four hours. The use of prophylaxis for venous thromboembolism depended on the individual surgeon. All patients were prescribed toe-touch weight-bearing until visible radiographic union was evident.

Data Collection

Data regarding surgeon experience, training, years in practice, method of learning the periacetabular osteotomy, and previously performed procedures were obtained by a questionnaire completed by all participating surgeons.

Regardless of diagnosis, patients undergoing periacetabular osteotomy were entered in the study and were followed prospectively for medical and surgical complications associated with the procedure. Preoperatively acquired data included height, weight, sex, race, preoperative diagnosis, Tönnis grade, medical comorbidities, and prior hip operations. All perioperative and postoperative complications or events associated with a deviation from routine postoperative recovery were recorded in a prospective fashion at scheduled follow-up visits.

The primary outcome measure was the presence or absence of perioperative complications. Complications were graded according to the modified Clavien-Dindo grading scheme[22-25], a validated scheme applicable across cultures and surgical disciplines that focuses on treatments required to manage complications and on the long-term impact of surgical complications. This grading scheme was recently modified, validated for hip preservation surgery, and applied to hip preservation procedures[24,25] (see Appendix). A grade-I complication required no treatment and no deviation from a normal postoperative course. A grade-II complication deviated from the normal postoperative course by requiring either pharmacological treatment or close monitoring as an outpatient. A grade-III complication required surgical, endoscopic, or radiographic intervention and may require an unplanned hospital admission. A grade-IV complication was life-threatening or was not treatable, with potential for permanent disability. A grade-V complication resulted in death. All perioperative complications within one year of surgery were recorded prospectively in a standardized fashion. Decreased sensation in the distribution of the lateral femoral cutaneous nerve, a known sequela of the surgical approach and retraction with periacetabular osteotomy, was not considered a complication. However, dysesthesia related to the lateral femoral cutaneous nerve was considered a complication because of the potential for long-term pain. In addition, persistent pain, considered a "treatment failure" in some cases, was not considered a complication as the etiology of pain following hip-preserving surgery is multifactorial. A complication form (see Appendix) was completed by one of the treating surgeons and/or research assistants under the direction of the treating surgeon at each patient's first postoperative visit and again at the one-year postoperative visit. Each complication was considered individually; thus, a single patient could have more than one complication. Deidentified forms were sent to the coordinating center (Washington University) for entry into the prospective multicenter database.

The first postoperative appointment occurred at an average of ten weeks (range, two to fifty-six weeks) following surgery and the second postoperative visit at an average of fourteen months (range, eight to thirty-five months). Four patients (four hips) did not return for short-term follow-up. Twenty-eight patients (twenty-eight hips) did not return for the one-year follow-up visit despite efforts to contact patients via telephone. Therefore, complications were documented on 98% of the patients at the time of the short-term follow-up and 86% at the one-year follow-up.

Statistics

The incidence of complications was presented using descriptive statistics. To compare patient comorbidities, BMI, intraoperative blood loss, and previous surgery by the level of complication, we used linear and logistic regression as appropriate. Multivariable-adjusted models included number of visits and any variables found to be associated with the level of complication in univariate analyses at an alpha level of 0.25. Two-sided p values of <0.05 were considered significant. All analyses were performed using SAS software (version 9.3; SAS Institute, Cary, North Carolina).

Source of Funding

Resources from the Curing Hip Disease Fund and the Academic Network for Conservational Hip Outcomes Research (ANCHOR) Fund were used for research personnel salary support and biostatistical consultation fees.

Results

Study Group Characteristics, Surgical Procedures, and Total Complications

Two hundred and five consecutive patients who underwent a periacetabular osteotomy at one of the study sites are the focus of this report (Table I). The most common patient-reported comorbidities included back pain (23%), asthma (12.2%), and osteoarthritis (12.2%). Twenty patients (9.8%) self-reported being overweight. The preoperative diagnosis was developmental dysplasia of the hip for 87% of hips. The Tönnis osteoarthritis grade indicated no radiographic changes (grade 0) or mild (grade 1) osteoarthritic changes in 89% of the hips. Twenty-nine patients (14%) had prior hip surgery. The mean operative time measured from skin incision until the completion of skin closure was 171 minutes (range, fifty-seven to 510 minutes). The mean estimated blood loss was 714 mL (range, 100 to 3900 mL), and no patient had a blood loss-related complication. Concomitant procedures were commonly performed with the periacetabular osteotomy (Table II). The most frequently combined procedures were femoral head-neck osteochondroplasty (58%) and hip arthroscopy (20%). Hip arthroscopy was performed for cartilage staging, labral debridement, labral refixation, removal of a loose body, or ligamentum teres debridement. Combining the first and second follow-up evaluations, seventy-one patients (34.6%) had documented complications. Fifty-nine patients (28.8%) had grade-I or II complications, and twelve (5.9%) had grade-III or IV complications. Nine of the twelve grade-III or IV complications required additional surgery.

TABLE II Concomitant Procedures Performed in Conjunction with the Periacetabular Osteotomy in 205 Patients

Concomitant Procedures	No. (%)
Head and/or neck osteochondroplasty	118 (58)
Arthroscopy	42 (20)
Labral resection	16 (8)
Surgical dislocation	18 (9)
Labral repair	14 (7)
Femoral neck lengthening	13 (6)
Chondroplasty	13 (6)
Trochanteric advancement	12 (6)
Femoral intertrochanteric osteotomy	3 (1)
Microfracture	2 (1)
Capsulorrhaphy	1 (0.5)
Acetabular rim osteoplasty	1 (0.5)
Psoas lengthening	1 (0.5)

Early Postoperative Complications

At the first postoperative appointment (at an average of ten weeks), a total of thirty (15%) of 201 hips had complication events. Four patients (four hips) did not return for the first postoperative follow-up visit, but these patients had no known complications. There were thirteen grade-I, ten grade-II, four grade-III, and three grade-IV complications (Table III). There were no permanent nerve injuries, intra-articular fractures, vascular injuries, acetabular osteonecrosis, or deaths. For the twenty-three patients (77%) with grade-I and II complications, the complication either resolved without treatment or required minor alterations in treatment during follow-up visits.

There were seven grade-III or grade-IV complications in six patients (2.9%). Four complications required operative management and three required pharmacologic management.

TABLE III Complications Recorded at First Follow-up Evaluation

Grade I		Grade II		Grade III		Grade IV	
Complication*	No. of Patients	Complication	No. of Patients	Complication	No. of Patients	Complication*	No. of Patients
Stitch abscess	2	Wound drainage	1	Acetabular migration	1	VTE	3
Superficial dehiscence	1	Dehiscence	3	Deep infection	2		
Posterior column fracture	1	Hematoma	1	Peroneal palsy	1		
Spinal headache	1	Bent screw	1				
Brooker grade-II heterotopic ossification	2	Femoral nerve dysfunction	2				
Brooker grade-III heterotopic ossification	1	Cardiac arrhythmia	1				
Delayed union of pubis	1	Suture abscess	1				
LFCN dysesthesia	4						
Total	13		10		4		3

*LFCN = lateral femoral cutaneous nerve, and VTE = venous thromboembolism.

Specifically, in one patient, the acetabular fragment migrated following surgery, and a second surgery for reduction and repeat fixation of the acetabulum was needed, with a proximal femoral osteotomy added to enhance hip stability. In a second patient, a postoperative compressive peroneal palsy that developed in the contralateral limb from a sequential pneumatic compressive boot required peroneal neurolysis. This patient had motor function return four months after surgery and, at the twenty-two-month follow-up evaluation, had intact motor function and a residual mild sensory deficit. Two patients with deep infections required incision and drainage procedures at three and eight weeks. Although both infections resolved,

TABLE IV Complications Recorded at Second Follow-up Evaluation

Grade I		Grade II		Grade III		Grade IV	
Complication	No. of Patients	Complication*	No. of Patients	Complication*	No. of Patients	Complication	No. of Patients
Brooker grade-I heterotopic ossification	21	LFCN dysesthesia	1	Brooker grade-III heterotopic ossification	1		
Brooker grade-II heterotopic ossification	7			Intra-articular screw	2		
Brooker grade-III heterotopic ossification	3			Acetabular migration	1		
Brooker grade-IV heterotopic ossification	2			Posterior column nonunion required ORIF	1		
Snapping psoas	1						
Ischial stress fracture	1						
Inferior pubic ramus fracture	1						
Total	36		1		5		0

*LFCN = lateral femoral cutaneous nerve, and ORIF = open reduction and internal fixation.

TABLE V Patient Demographics, Comorbidities, and Intraoperative Data Compared with the Level of Complication

Characteristic or Comorbidity*	No. of Complications			P Value†
	0	1	≥2	
No. of patients	143	40	22	
Mean age *(yr)*	24.9	28.6	23.7	0.61
Female *(%)*	74.6	50.0	59.1	0.013
Mean BMI *(kg/m²)*	24.8	26.4	26.3	0.069
BMI of ≥30 *(%)*	14.9	17.5	31.8	0.075
Previous surgery *(%)*	17.6	3.4	2.5	0.641
Neuromuscular complications *(%)*	0.7	2.5	4.6	0.13
Migraines *(%)*	0.7	0.0	0.0	0.54
Spinal procedure *(%)*	0.7	2.5	0.0	0.85
Smoking *(%)*	15.0	22.9	4.6	0.55
Cardiovascular complications *(%)*	2.8	7.5	4.6	0.37
Asthma *(%)*	13.4	10.0	9.1	0.47
Back pain *(%)*	21.1	20.0	27.3	0.64
Depression *(%)*	11.8	7.5	4.6	0.22
Anemia *(%)*	1.4	2.5	0.0	0.84
Geometric mean estimated blood loss *(mL)*	525	601	699	0.065

*BMI = body mass index. †P Values for trend were calculated by linear or logistic regression, as appropriate.

one patient required total hip arthroplasty three years after the periacetabular osteotomy. Three venous thromboembolic complications (grade IV) in patients receiving chemoprophylaxis, one accompanied by a nonfatal pulmonary embolus, were reported. All thromboembolic complications were successfully treated with anticoagulation therapy with no long-term adverse sequelae.

Delayed Postoperative Complications

For the second follow-up visit, 177 patients (177 hips; 86%) presented for evaluation at an average of fourteen months. Forty-two new complications were reported at the second visit (Table IV). There were thirty-six grade-I complications, one grade-II complication, and five grade-III complications. There were no grade-IV complications. Thirty-three of thirty-six grade-I complications were asymptomatic heterotopic ossification. Of the patients with heterotopic ossification, twenty-one had Brooker grade-I, seven had Brooker grade-II, three had Brooker grade-III, and two had Brooker grade-IV ossifications primarily located anteriorly and anterolaterally within the gluteus minimus and iliocapsularis. The five grade-III complications included symptomatic heterotopic ossification requiring excision in one hip, intra-articular migration of a screw in two hips, a posterior column fracture requiring operative fixation in one hip, and acetabular migration in one hip that had been precipitated by a fall in the early postoperative period that required revision surgery.

TABLE VI Adjusted Means Calculated by Linear Regression and P Values for Trend Calculated by Linear or Logistic Regression, as Appropriate*

Characteristic†	No. of Complications			P Value
	0	1	≥2	
No. of patients	143	40	22	
Female *(%)*	73.7	49.6	66.0	0.069
Mean BMI *(kg/m²)*	24.7	26.4	26.4	0.058
Neuromuscular complications *(%)*	0.7	2.7	4.7	0.14
Depression *(%)*	11.8	8.2	4.6	0.26
Geometric mean estimated blood loss *(mL)*	534	572	688	0.38

*Models included all variables, as well as number of visits. †BMI = body mass index.

There were no significant associations between patient comorbidities, BMI, intraoperative blood loss, previous surgery, and any type of complication recorded during the follow-up period (Tables V and VI). There was a trend toward an association between male sex and obesity and an increased risk of complications, but it was not significant.

Discussion

The Bernese periacetabular osteotomy and allied procedures[10,26,27] are commonly used for the treatment of symptomatic acetabular dysplasia. Although the so-called learning curve for the periacetabular osteotomy has not been clearly defined, complications associated with this procedure have been reported in a nonstandardized fashion during learning-curve experiences (see Appendix). In their original description, Ganz et al. reported that all clinically important complications occurred within the first eighteen operative procedures[10]. Subsequent authors have reported similar associated complications during the early phase of implementation. Trumble et al. reported on the first 124 patients who underwent a periacetabular osteotomy[17]. The majority of the complications occurred in the so-called early part of the series and were more prevalent in patients treated using the ilioinguinal approach. Crockarell et al. reported the first twenty-one periacetabular osteotomies performed by a single surgeon at the Mayo Clinic, representing what was considered the learning curve at that institution[15]. They reported three ischial fractures, two peroneal palsies that resolved, three asymptomatic pubic nonunions, five hips with heterotopic ossification (two with type I, two with type II, and one with type III), and one peroneal neuralgia. Davey and Santore reviewed the first seventy periacetabular osteotomies at their institution and noted a substantial decrease in the number of complications occurring within the second group of thirty-five procedures compared with the first group of thirty-five procedures[16]. Including what were previously termed trivial complications, now considered Clavien-Dindo grade I and II, they reported a total of fifty complications within the first seventy patients, with a substantial reduction in major and moderate complications from 46% to 14% in the second cohort of patients. Matta et al. reported the results for fifty-eight patients (sixty-six hips) at an average of four years after periacetabular osteotomy that was performed using a modified Smith-Petersen approach[12]. Fourteen percent had moderate formation of heterotopic bone with two requiring excision, and 16% had nonunion of the pubis. No vascular or neurologic complications were reported. Clohisy et al. reported the results following periacetabular osteotomy to treat both high-grade acetabular dysplasia and Legg-Calvé-Perthes-like hip deformities[28]. Two complications were noted among thirteen patients (sixteen hips) with severe dysplasia; one patient had an ischial nonunion, and another, a heavy smoker, had loss of fixation that required open reduction[28]. For hips with major femoral head deformities, those authors reported three complications associated with twenty-four periacetabular osteotomies[29]. Two patients with a previous hip reconstruction had transient peroneal nerve palsies after combined periacetabular osteotomy and femoral procedures. One patient had grade-II heterotopic ossification. Peters et al. reported the results for seventy-three patients following periacetabular osteotomy at a mean follow-up of forty-three months, in which nine of ten major complications occurred within the first thirty hips[19]. These included three femoral and one sciatic nerve palsy, four wound hematomas, two deep infections, and a broken osteotome tip that was left within the patient. Biedermann et al. reported complications and patient satisfaction in sixty periacetabular osteotomies performed from 1988 to 1998 at a single institution by six different surgeons utilizing the classic Smith-Petersen approach[20]. There were twenty-five minor and twenty-two major complications. Biedermann et al. found lower Western Ontario and McMaster Universities Osteoarthritis Index (WOMAC) scores in patients with persistent lateral femoral cutaneous dysfunction compared with controls. Thawrani et al. reported complications following periacetabular osteotomy in adolescents[21]. In contrast to the study by Davey and Santore, there was no change in complication rates when the initial surgical group of forty-two patients was compared with the second group of forty-two patients. Following a mentorship arrangement, Howie et al. described only two complications in their first twenty-six periacetabular osteotomies, suggesting that this learning format may mitigate complications[30].

In North America, periacetabular osteotomy has become the procedure of choice for the correction of symptomatic acetabular dysplasia. Evidence supporting the surgical complexity includes complication rates as high as 46% in some series[16,20]. In the literature, the documentation of complications is primarily retrospective, obtained with inconsistent methodology, and is neither comprehensively categorized nor stratified. To our knowledge, there is no prior documentation of complications following periacetabular osteotomy performed in high-volume centers by surgeons with substantial experience using the procedure. The present study is important for several reasons. First, it is comprehensive and prospective and utilizes a validated classification scheme to categorize all complications of the periacetabular osteotomy. As such, the study defines complications that are associated with this procedure when performed by experienced surgeons. Second, it serves as a benchmark to which surgeons can compare complication outcomes. Third, it illustrates the complexity of the procedure and the persistence of some complications beyond the initial learning curve.

Since there were no permanent neurologic or vascular injuries directly attributable to the operative procedure, our data suggest that serious complications occur at lower rates in the hands of experienced surgeons. Although no complication resulted in permanent disability, there were nine complications over the study period that required reoperations. Additionally, major heterotopic ossification, i.e., Brooker grade III and IV, is a potential complication that may require excision and prophylaxis should affected patients require future prosthetic joint reconstruction. Although these patients are currently asymptomatic, the clinical importance of heterotopic ossification will require long-term follow-up. At this point, we do not have data to make specific recommendations for heterotopic ossification prophylaxis. This is a subject of ongoing investigation.

This study has certain limitations. First, the prior experience of the surgeons varied considerably among the participating centers, with one surgeon participating after only one year of independent practice. This surgeon, however, had substantial advanced training in performing periacetabular osteotomy. Second, we did not assess surgeon skill and so were not able to correlate skill with complications. At present, there is neither an objective measure of skill nor a method of correlating skill with experience. Third, many patients traveled to the participating centers for surgery. These young and mobile patients are frequently lost to follow-up, and twenty-eight patients (14%) failed to return at one year. Fourth, the long-term consequence of certain complications is not known because of the length of follow-up in this study. Finally, the majority of grade-I complications have little if any clinical importance yet are reported because of our rigorous data collection methodology. Fifth, we were not able to correlate persistent pain with complications. Presently, persistent pain may occur following an uncomplicated periacetabular osteotomy, potentially indicating treatment failure in certain situations. How complications relate to persistent pain is a focus of ongoing studies.

Our data indicate that the periacetabular osteotomy is a safe procedure for the correction of acetabular dysplasia in the hands of experienced surgeons. Nevertheless, there remains a risk for perioperative complications, with grade-III or IV complications occurring in 5.9% of our patients. Our data suggest that most of these complications are manageable with no associated permanent disability.

Appendix

eA Complication forms and tables showing the modified Clavien-Dindo classification scheme and data on selected historically reported complications following periacetabular osteotomy are available with the online version of this article as a data supplement at jbjs.org. ■

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Ira Zaltz, MD
William Beaumont Hospital – Royal Oak,
30575 Woodward Avenue, Suite 100,
Royal Oak, MI 48073

Geneva Baca, BA
John C. Clohisy, MD
Department of Orthopaedic Surgery,
Washington University School of Medicine,
One Barnes-Jewish Plaza, Suite 11300,
West Pavilion, Campus Box 8233,
St. Louis, MO 63110.
E-mail address for J.C. Clohisy: clohisyj@wudosis.wustl.edu

Young-Jo Kim, MD
Michael B. Millis, MD
Department of Orthopaedic Surgery,
Boston Children's Hospital,
Hunnewell-2,
300 Longwood Avenue,
Boston, MA 02115

Perry Schoenecker, MD
Shriner's Hospital,
Medical Staff Office,
2001 South Lindberg Boulevard,
St. Louis, MO 63131

Robert Trousdale, MD
Rafael Sierra, MD
Mayo Clinic,
200 1st Street SW E14B,
Rochester, MN 55905

Daniel Sucato, MD
David Podeszwa, MD
Texas Scottish Rite Hospital,
2222 Welborn Street,
Dallas, TX 75219

Ernie Sink, MD
Hospital for Special Surgery,
535 East 70th Street,
New York, NY 10021

Paul Beaulé, MD
Ottawa General Hospital,
501 Smyth Road,
Suite 5004, Ottawa,
ON K1H 8L6, Canada

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