Total Hip Arthroplasty in Patients with Cerebral Palsy
A Cohort Study Matched to Patients with Osteoarthritis

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Background: The spasticity and increased muscle tone observed in patients with cerebral palsy can lead to hip degeneration, subluxation, and pain. Currently, there is hesitation to perform total hip arthroplasty in patients with cerebral palsy because of fears of early wear and dislocation. The purpose of this study was to review the outcomes of total hip arthroplasty in patients with cerebral palsy and to compare outcomes with those of matched patients with a diagnosis of osteoarthritis.

Methods: Over a 24-year period, 39 patients undergoing a total hip arthroplasty with a diagnosis of cerebral palsy were identified. The cohort included 26 male patients (67%), and the mean patient age was 49 years. The mean follow-up was 7 years. Patients with cerebral palsy were matched 1:2 with a group of patients undergoing total hip arthroplasty for osteoarthritis.

Results: There was no difference in the rate of reoperation, implant survival, or complications, specifically dislocation. Prior to the surgical procedure, all patients had severe or moderate pain, and postoperatively no patient had moderate or severe pain. Twenty-three patients had an improvement in their ability to independently walk, and all preoperative hip flexion contractures were corrected (n = 9). There was also a significant improvement (p < 0.0001) in functional Harris hip scores.

Conclusions: This study refutes previous evidence showing increased risk of complications following total hip arthroplasty in patients with cerebral palsy. Total hip arthroplasty is a durable treatment option and provides clinically important pain relief and functional improvement in patients with cerebral palsy.

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

Patients with cerebral palsy often develop hip subluxation due to flexion and adduction contractures of the hip, coxa valga, and increased femoral anteversion. Such deformity leads to symptomatic arthrosis, further limiting their ability to walk, stand, and sit. Hip preservation procedures may have a role early on in the disease process, but once joint arthrosis occurs, additional treatment is required to optimize pain relief and function.

Total hip arthroplasty is considered one of the most successful procedures for the treatment of hip arthrosis. However, the reported use of total hip arthroplasty in patients with cerebral palsy is controversial because of concerns for dislocation, aseptic loosening, infection, and other complications. Recently, studies have shown good outcomes at long-term follow-up, with limited complications among patients with cerebral palsy. Although these series have shown a satisfactory outcome in the setting of cerebral palsy, to our knowledge, there has been a paucity of data comparing the outcome of total hip arthroplasty in patients with cerebral palsy with that in patients with uncomplicated osteoarthritis. The purpose of this study was to compare revision, reoperation, and complication rates following primary total hip arthroplasty in patients with cerebral palsy with those in a matched cohort with uncomplicated osteoarthritis.

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Materials and Methods

Following institutional review board approval, we used our institutional total joint registry to examine all patients undergoing primary total hip arthroplasty over a 24-year period (1990 to 2013). This registry prospectively captures data regarding patient and implant survival, complications, and patient-reported outcomes utilizing a standardized data collection form at standardized time points, including questions assessing pain and function.

Indications to perform a total hip arthroplasty in patients with cerebral palsy included radiographic evidence of hip osteoarthritis, failure of nonoperative treatments for hip pain, the ability to walk either independently or with the use of gait aids, and hip joint contractures that were correctable. Contraindications to total hip arthroplasty included the inability to walk and hip joint contractures that were not correctable.

The primary outcomes of interest included revision surgical procedure (subsequent removal or exchange of any components), reoperation on the affected hip for any reason, and complications, including infection, dislocation, periprosthetic fracture, deep venous thrombosis, wound dehiscence, hematoma, and heterotopic ossification formation. Radiographs were reviewed to determine the acetabular component abduction angle and version on anteroposterior pelvic and cross-table lateral radiographs.

Cerebral Palsy Cohort

Forty-one (0.18%) of 22,077 total hip arthroplasties were performed in patients with a diagnosis of cerebral palsy. Two patients were removed because they had not obtained 2 years of clinical follow-up, leaving a cohort of 39 patients. The cohort (Table I) included 26 male patients (67%) with a mean age of 49 years (range, 21 to 74 years) and a mean body mass index (BMI) of 24.9 kg/m² (range, 18.3 to 32.3 kg/m²). Prior to the surgical procedure, all patients were capable of walking with the use of assistive devices, and the Gross Motor Function Classification System (GMFCS) level for the patients was I in 3 patients, II in 18, III in 12, and IV in 6. Eight patients mainly functioned from a wheelchair base immediately prior to the surgical procedure because of pain and functional debility from their arthrosis; however, they were able to walk short distances with a walker.

All patients had radiographic evidence of end-stage osteoarthritis leading to substantial pain and debility. Prior to the surgical procedure, a comprehensive nonoperative treatment program failed to mitigate the pain in all patients. Likewise, the operative risks, benefits, complications, and alternatives, including femoral head ressection and continued nonoperative treatment, were discussed with the patients and also the patients’ families or guardians. As such, informed consent was obtained from the patient (n = 34 [87%]) or the patient’s guardian (n = 5 [13%]). All patients who had their consent signed by a guardian had a GMFCS level of III or IV.

Ten patients had a previous acetabular or femoral osteotomy. The surgical procedures were performed by high-volume adult reconstruction subspecialty surgeons, using their preferred surgical approach. Surgical procedures were augmented with a tendon release (adductor [n = 7] or psoas [n = 2]), acetabular constraint (dual-mobility [n = 5] or lipped liner [n = 2]), and acetabular structural support (femoral head augmentation [n = 4]). Harris hip scores were calculated prior to the surgical procedures and at the time of the most recent clinical follow-up.

Patients were randomly matched 1:2 to a group of patients undergoing total hip arthroplasty for osteoarthritis over the same time period, using the institutional joint registry and removing all patients with a diagnosis other than primary osteoarthritis. The outcome of the patients was not known at the time of matching. All patients had at least 2 years of clinical follow-up, and the outcome and complications of the patients were not known at the time of matching, leaving a cohort of 15,687 patients.

Matching criteria included sex, age, date of the surgical procedure within 3 years, and BMI within 3 kg/m². All patients were followed longitudinally to the time of implant revision or death. Because of the small number of patients in the cerebral palsy cohort, we were not able to match patients on the basis of other confounding variables such as smoking status, diabetes, and implant fixation.

In the matched comparison group, there were 52 male patients and 26 female patients, with a mean age of 49 years (range, 21 to 74 years) and a mean BMI of 25.6 kg/m² (range, 16.2 to 30.5 kg/m²) at the time of the surgical procedure. There was no difference in the mean BMI (p = 0.18) and the surgical approach used (p = 0.16 for both anterolateral and posterior approaches). All patients in the study had an uncemented acetabular component. There was a significantly greater proportion (p < 0.0001) of cemented femoral components in the patients with cerebral palsy (44%) compared with those patients without cerebral palsy (8%). There was no difference (p = 0.56) in the mean femoral head size between the cerebral palsy cohort (32 mm [range, 22 to 40 mm]) and the osteoarthritis cohort (32 mm [range, 22 to 44 mm]). Radiographically, there was significantly increased mean acetabular anteversion (p = 0.03) in

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*The values are given as the mean, with the range in parentheses. †The values are given as the number of patients. NA = not applicable.
patients with cerebral palsy at 34° (range, 15° to 48°) compared with those with primary osteoarthritis at 29° (range, 12° to 48°). Likewise, there was no difference (p = 0.70) in the mean acetabular abduction angle between patients with cerebral palsy at 37° (range, 20° to 55°) and those with osteoarthritis at 38° (range, 28° to 55°).

Postoperatively, the patients were advised on standard total hip arthroplasty precautions. They were mobilized with the assistance of physical therapy on the first postoperative day. Weight-bearing restrictions were based on the individualized preferences of the operating surgeon depending on the fixation of the femoral components. Also, in selected cases, a neurologist was consulted for recommendations on modifications of spasticity medications and the potential need for botulinum toxin A treatments. The mean follow-up in each group was 7 years (range, 2 to 20 years).

**Statistical Analysis**
Continuous variables were compared using unpaired Student t tests. Fisher exact tests were used to compare categorical variables between groups. Kaplan-Meier methodology was employed to make overall survival estimates, and comparisons between the cerebral palsy group and the osteoarthritis group were made with use of log-rank tests. Significance was set at \( p < 0.05 \).

**Results**
At a mean postoperative time of 3 years (range, 4 months to 8 years), revision surgical procedures occurred in 5 patients with cerebral palsy. Indications for revision included acetabular aseptic loosening (n = 2), recurrent instability with a well-fixed acetabular component (n = 2), and deep infection (n = 1). The mean implant survival for primary total hip arthroplasty in patients with cerebral palsy was 92% at 2 years, 88% at 5 years, 81% at 10 years, and 81% at 15 years (Fig. 1-A). With a hazard ratio (HR) of 1.14 (95% confidence interval [CI], 0.35 to 3.23; \( p = 0.80 \)), there was no difference in overall implant survival compared with that of patients with a diagnosis
of osteoarthritis, in which the mean implant survival was 97% at 2 years, 95% at 5 years, 90% at 10 years, and 68% at 15 years. When the effect of the GMFSC level on revision was assessed, there was no difference ($p = 0.65$) in implant survival based on the patients’ scores (Fig. 1-B).

There were no additional reoperations in the patients with cerebral palsy, with all reoperations occurring because of failure of one or both total hip arthroplasty components. The overall reoperation-free survival for primary total hip arthroplasty in patients with cerebral palsy was 92% at 2 years, 88% at 5 years, 81% at 10 years, and 81% at 15 years. At an HR of 0.94 (95% CI, 0.30 to 2.55), there was no increased risk of reoperation ($p = 0.91$) in patients with cerebral palsy compared with patients with osteoarthritis, in whom the reoperation-free survival was 94% at 5 years, 87% at 10 years, 57% at 20 years, and 43% at 25 years.

Complications occurred in 8 patients with cerebral palsy, with multiple complications in 1 of these patients, at a mean postoperative time of 2 years (range, 1 month to 8 years) and included dislocation (n = 3), acetabular component loosening (n = 2), wound dehiscence (n = 1), deep infection (n = 1), heterotopic ossification (n = 1), and deep venous thrombosis (n = 1). There was no difference (HR, 0.84; $p = 0.69$) in the risk of postoperative complications between patients with cerebral palsy and those with osteoarthritis. Specifically, there was no increased risk of dislocation (odds ratio [OR], 2.0; $p = 0.66$), infection (OR, 1.0; $p = 1.0$), or acetabular component loosening (OR, 1.0; $p = 1.0$) in patients with cerebral palsy (Table II). In comparing the patients who had dislocation with those who did not, there was no difference in the mean abduction angle (35° compared with 37°; $p = 0.56$) or mean acetabular anteversion (28° compared with 34°; $p = 0.24$).

Prior to the surgical procedure, all patients had severe or moderate pain, and this proportion was significantly reduced postoperatively to no patients ($p < 0.0001$). Preoperatively, 9 patients in the cerebral palsy group had a hip flexion contracture of ≥15°, which was corrected in all patients following the surgical procedure. Furthermore, 22 patients had an improvement in their ability to independently walk as judged by progression to less cumbersome gait aids or no need for gait aids (Fig. 2). Compared with the preoperative status (10%), there was a significant improvement ($p < 0.0001$) in the proportion of patients who were independent ambulators following total hip arthroplasty (56%). In patients with cerebral palsy, the mean preoperative Harris hip score was 36 points (range, 14 to 58 points), which improved to 78 points (range, 55 to 98 points) ($p < 0.0001$). Although there was a significant improvement in the postoperative Harris hip score, patients with cerebral palsy had a significantly lower mean postoperative Harris hip score ($p = 0.0001$) compared with patients with osteoarthritis, whose mean Harris hip score was 92 points (range, 44 to 100 points).

**Discussion**

Total hip arthroplasty has been shown to relieve pain and to restore function in patients with osteoarthritis of the hip. Although symptomatic hip arthritis is common in patients with cerebral palsy, to our knowledge, there have been limited outcome data in this patient population. Surgeons have historically been reluctant to perform this procedure in patients with cerebral palsy because of concerns of dislocation and early prosthetic failure. The purpose of this study was to examine total hip arthroplasty outcomes in patients with cerebral palsy from a single institution and

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**Fig. 2**
Following total hip arthroplasty in patients with cerebral palsy, all patients were ambulatory. Although a majority of patients required some form of gait aid preoperatively and postoperatively, 22 patients were able to independently walk.
to compare their outcomes with those in patients with osteoarthritis.

Historically, total hip arthroplasty in the setting of cerebral palsy has been associated with a theoretical risk of complications such as aseptic loosening, dislocation, and infection, even though several reports indicate that the majority of patients experience improvement in pain. In a study by Buly et al., the authors noted significant pain relief in all patients, but 2 of their patients sustained dislocation related to malpositioned components, with an overall implant survivorship of 86%. In a more recent study by Raphael et al., the authors noted excellent pain relief and improved function, with a 10-year implant survivorship of 85%. This is similar to the outcome of our study, in which the 10-year implant survivorship was 81%.

We identified 2 cases of aseptic loosening, both of the acetabular component. It is thought that patients with cerebral palsy are at increased risk of acetabular loosening related to soft-tissue imbalances and contractures that lead to increased stress and potential component loosening. This is further highlighted in the study by Schroeder et al., in which the authors noted a higher rate of acetabular component loosening in patients with cerebral palsy, without an adductor release at the time of total hip arthroplasty. In our series, most patients did not have an adductor tendon release, and of the 2 patients with acetabular loosening, 1 had had an adductor release. Although the current study did not show an increased risk of aseptic loosening, the general lack of data in the literature makes it difficult to translate the clinical relevance of this theoretical concern.

In addition to acetabular loosening, soft-tissue imbalances associated with cerebral palsy potentially increase the risk of dislocation. The rate of dislocation following total hip arthroplasty for patients in the setting of cerebral palsy has been reported to be up to 14% compared to 2% to 5% in patients with cerebral palsy with those with osteoarthritis, with a dislocation rate of 7.7% in the cerebral palsy group and 3.8% in the osteoarthritis group; however, the sample size could have been underpowered to detect a difference. In the group of patients who sustained a dislocation, 2 underwent a subsequent revision for multiple dislocations. At the time of these revision surgical procedures, the acetabular components were believed to be in appropriate positioning; as such, only the constraint of the acetabular component was increased.

Functional assessment following total hip arthroplasty in the setting of cerebral palsy is difficult because many patients with cerebral palsy cannot be standardized to the current total hip rating systems. The spasticity of cerebral palsy limits range of motion, and ambulatory distance is often limited even in the setting of a “normal” hip joint in patients with cerebral palsy, forcing patients to walk with gait aids or for only short distances. Because these are major components of standard hip scores, such as the Harris hip score, this bias may explain why Harris hip scores were worse for patients with cerebral palsy. Currently, health-related quality-of-life measures such as the Caregiver Priorities and Child Health Index of Life with Disabilities (CPCHILD) are prospectively used to evaluate improvements in quality of life following surgical procedures; however, this instrument is completed by the caregiver. Despite the limitation that there is not a validated retrospective metric to evaluate functional outcome in patients with cerebral palsy undergoing a total hip arthroplasty, our results were in line with previous studies, as we noticed similar improvements in pain and all patients were able to walk following the surgical procedure, with 56% of patients walking without a gait aid.

The hip is a major factor influencing the walking ability of children with cerebral palsy, with 75% of children with cerebral palsy developing hip displacement. The GMFCS has been shown to be related to the amount of hip displacement, with early surgical hip reconstruction shown to provide reduction of pain in children with cerebral palsy. Reconstructive surgical procedures have been shown to improve long-term functional ambulation; however, a percentage of patients will develop repeat subluxation and pain. A recent study by DiFazio et al. showed significant improvements in the prospectively captured CPCHILD scores in nonambulatory patients with cerebral palsy undergoing hip reconstructions, but that study was limited to 2 years of follow-up. The results of our current series show that even in the setting of a previous osteotomy, older patients with painful hips can have restoration of their functional ambulation following a total hip arthroplasty.

Component positioning is essential to a successful outcome of total hip arthroplasty, and, because of the flexion and adduction contractures of the hip, subluxation, coxa valga, and increased femoral anteversion commonly encountered in patients with cerebral palsy, component positioning can be difficult. To compensate for the increased femoral deformities, there was an increased use of cemented femoral components in patients with cerebral palsy compared with patients with osteoarthritis. Similar to a study by Sochart and Porter, we noted durable results of this form of femoral fixation in patients with a proximal femoral deformity in hip dysplasia. In addition to femoral modifications, in patients with cerebral palsy, the acetabular component was placed with more anteversion to reduce the risk of dislocation.

We acknowledge that there were important limitations to the present study. Because our data were examined retrospectively, they limited the analysis that we were able to perform and we were unable to comment on the number of patients who were candidates for total hip arthroplasty but decided not to undergo the procedure or how many patients were candidates for a total hip arthroplasty but underwent another procedure. However, the prospective nature of our registry database helped to reduce recall bias in the study. Furthermore, given our relatively small number of patients with cerebral palsy, we were unable to examine the influence of other confounding comorbidities. We compensated for this...
limitation by performing a random matched cohort analysis with twice as many patients with osteoarthritis. It was also possible that the study was underpowered to detect differences in patient outcomes. Also, the use of the Harris hip score to measure outcome in patients with cerebral palsy had not been validated.

In summary, total hip arthroplasty provides clinically important pain relief and functional improvement for patients with cerebral palsy. The results of this study show that patients with cerebral palsy should expect a similar outcome in terms of implant survival and postoperative complications compared with patients with a diagnosis of primary osteoarthritis. We believe that total hip arthroplasty is a durable treatment option for patients with cerebral palsy and hip pain, with a majority of patients retaining their implants over the course of their lives and functioning at a level similar to, if not better than, their preoperative status. Currently, we consider total hip arthroplasty in patients with cerebral palsy who have clinical and radiographic findings that would warrant a total hip arthroplasty, are able to walk either independently or with the use of gait aids, and are willing to take on the potential risks and complications of a surgical procedure.

References