Subtrochanteric Valgus Osteotomy With Monolateral External Fixator in Hips for Patients With Severe Cerebral Palsy

MANDAR AGASHE, MS(ORTH); SANG-HEON SONG, MD; XUE-BO TONG, MD; JIN-HO HONG, MD; HAE-RYONG SONG, MD, PHD

Abstract

Subtrochanteric valgus osteotomy has been used for painful hip joint dislocation in patients with severe cerebral palsy. The goal of this study was to evaluate 11 patients (17 hips) with severe cerebral palsy who had chronically dislocated and painful hips treated with subtrochanteric valgus osteotomy using a monolateral external fixator.

A retrospective review was performed of 11 patients (average age, 17.8 years) with severe quadriplegic cerebral palsy with flexion–adduction contractures due to chronically dislocated and painful hips. A subtrochanteric valgus osteotomy with a monolateral fixator was performed in all patients. Patients were analyzed clinicoradiologically, and caregivers were asked about ease of handling, transfers, and perineal care. At an average follow-up of 37 months (range, 14-72 months), all caregivers were satisfied with the surgery and felt that their child was more comfortable and could sit with support for a longer time period and that perineal care, wheelchair mobilization, and transfers were much easier. A total of 11 complications in 7 patients were observed, including pin-tract infections, delayed consolidation, abduction deformity, and hypostatic pneumonia.

The complication rate of subtrochanteric valgus osteotomy was comparable with other methods, and this method had the advantage of shorter surgical time, ease of application, no internal implant with lesser chance of infection or heterotopic calcification, and less intraoperative blood loss with less morbidity.

The authors are from the Institute for Rare Diseases and the Department of Orthopaedic Surgery (MA, X-BT, J-HH, H-RS), Korea University Medical Center, Guro Hospital, Seoul; and the Department of Orthopaedic Surgery (S-HS), Soonchunhyang University Bucheon Hospital, Bucheon, Korea.

The authors have no relevant financial relationships to disclose.

This study was supported by a grant from the Korea Healthcare Technology R&D Project, Ministry for Health, Welfare & Family Affairs, Republic of Korea (A110416).

Drs Agashe, Song, and Tong contributed equally to this work.

Correspondence should be addressed to: Hae-Ryong Song, MD, PhD, Institute for Rare Diseases and Department of Orthopaedic Surgery, Korea University Medical Center, Guro Hospital, 80, Guro-Dong, Guro-Gu, Seoul, 152-703, Korea (songhae@korea.ac.kr).

doi: 10.3928/01477447-20130122-13

Figure: Clinical photograph of a 14-year-old boy with spastic quadriplegic cerebral palsy with severe flexion–adduction contractures of both hips (A). Clinical photograph 7 months postoperatively showing abduction contracture of the right hip (B).
Problems of the hip joint in patients with cerebral palsy are common and range from hips with decreased abduction and a marginally increased Reimer’s migration percentage to dislocations with severe arthritic changes. Hip dislocations are a result of severe flexion and adduction contractures and cause significant pain, resulting in difficulty with transfers and caring for perineal hygiene, which can cause bed sores and infections. The reported incidence of hip dislocation in individuals with cerebral palsy ranges from 2% to 59%. Children with severe cerebral palsy have the highest incidence rates—so much so that some authors feel that hips in those children will almost invariably dislocate. Although the approach of early diagnosis and comprehensive treatment of hip disorders in patients with cerebral palsy has resulted in significant improvement in the long-term prognosis of these hips, a small percentage exists of severely affected individuals who have hips with neglected painful dislocations with severely arthritic femoral heads. The treatment options for these hips are limited and include head and neck resection, proximal femoral resection with muscle interposition, proximal femoral valgus osteotomy, hip arthrodesis, and, rarely, total hip replacement. The pelvic support osteotomy fixed internally has been used by some authors with some success. However, to the current authors’ knowledge, no published data exist regarding the use of an external fixator for stabilization of the osteotomy. Therefore, the authors report their experience with the proximal femoral valgus (and extension) osteotomy using the monolateral external fixator in 17 chronically dislocated and painful hips in patients with severe cerebral palsy.

**Materials and Methods**

After institutional review board approval, a retrospective review was performed of all patients with severe cerebral palsy with chronically dislocated hips treated by a pelvic support osteotomy with monolateral fixator between January 2002 and July 2009 at the authors’ institution. The indication for surgery was any patient with spastic quadriplegic cerebral palsy with severe flexion–adduction contractures of both hips with chronically dislocated femoral heads. Patients with only adduction contractures with salvageable femoral heads were treated with multiple muscle releases or botulinum toxin injections, as indicated. It was difficult to quantify the amount of flexion–adduction contracture necessary for performing an osteotomy by soft tissue release only. It was a combination of several factors: an adduction–flexion contracture of at least 10° that was not correctible even under general anesthesia, chronically dislocated arthritic femoral heads, and a history of difficulty in perineal and nursing care.

A total of 11 patients (17 hips) underwent proximal femoral valgus osteotomy. This was a consecutive series of patients, and only this method was performed for the indicated patients during the specified period. Seven men and 4 women with a mean age of 17.8 years (range, 12-33 years) were included. According to the validated Gross Motor Functional Classification System, three patients were grade IV and 8 were grade V. All patients were spastic quadriplegic, with muscle tone being spastic in 8 and dystonic, athetoid, and mixed in 1 each. All patients were bedridden or required a restrained wheelchair for assisted ambulation. All patients had severe cognitive impairment. Preoperatively, medical management for spasticity and convulsion control was adequately controlled using baclofen, as well as antiepileptics such as phenytoin. These medications were continued postoperatively.

Active range of motion could not be accurately tested in these patients; therefore, passive range of motion was used to quantify the effect of surgery. All patients had a flexion–adduction contracture with an average adduction deformity of 20° (range, 10°-30°), with further adduction up to 30° (range, 20°-40°), and an average flexion deformity of 30° (range, 20°-60°), with further passive flexion up to a maximum of approximately 90° (range, 60°-100°).

All surgeries were performed by the senior author (H.R.S.). The indication for surgery was a chronically dislocated, painful hip with arthritic changes in the femoral head. Caregivers for all patients had significant problems with patients’ positioning and transfers and difficulty in perineal care and wheelchair mobilization due to severe flexion-adduction contractures. The caretakers were asked about the degree of pain and comfort the patient was feeling; nonverbal features such as grimacing, posturing, or an increase in spasticity were taken as indicators for pain. Preoperatively, caregivers were asked about the maximum sitting time and the need for any modification in wheelchairs or other devices due to the severe contractures. Detailed informed consent of the caregivers was obtained preoperatively. The need for concomitant surgeries, such as muscle- and tendon-lengthening procedures, osteotomies, or tendon transfers, was also evaluated. A thorough preoperative anesthetic workup was performed before each patient was taken to the operating room.

**Surgical Technique**

Intraoperatively, the required muscle and tendon lengthening was performed before beginning the osteotomy for ease of positioning. Accordingly, adductor tenotomies were performed in all patients, hamstring lengthening in 6, and tendoachilles lengthening in 2. Intramuscular recession of rectus femoris and psoas tenotomy was performed in 4 patients in whom the flexion deformity of the hip was severe. A subtrochanteric valgus osteotomy (as described by Inan and Bowen and Inan et al) was then performed with a few modifications. Because the patients were nonambulatory and bedridden, the
second varizing and lengthening osteotomy in the distal third of the femur (as described by Ilizarov and Rozbruch et al) was not indicated.

While the patient was in the supine position, a single Schanz pin was inserted in the proximal fragment of the femur at an angle determined to be the angle of the osteotomy (Figure 1A). The exact angle of the osteotomy (similar to the one calculated for ambulatory patients for the Ilizarov hip reconstruction) could not be calculated due to severe restriction of joint motion due to severe spasticity. Therefore, the angle was taken as that resulting in adequate abduction of the distal fragment. Accordingly, the average angle of the osteotomy was 50.3° (range, 45°-85°). The level of the osteotomy was marked as the point on the femur that corresponded with the ischial tuberosity while the limb was in full adduction. Three parallel Schanz pins were then inserted into the middle third of the femur perpendicular to the femoral shaft. Two additional Schanz pins were then inserted parallel to each other (A). The monolateral fixator frame is then mounted on these pins to maintain the angulation of the osteotomy (B).

The osteotomy was performed using the multiple drill-hole method, and the 2 sets of Schanz pins were brought parallel to each other, giving the required amount of valgus to the osteotomy site (Figure 2A). The Schanz pins were then connected to the compact monolateral fixator (Figure 2B). Manipulation of the osteotomy site was performed using a small Hohmann’s spike and elevating the fragments at the osteotomy site to give it the required extension.

At this point, the monolateral fixator clamps were loosened temporarily to allow for some mobility. Once extension was confirmed in the osteotomy, the clamps were tightened and 1 more Schanz pin each in the proximal and distal segment was placed for added stability. The positions of the pins and the osteotomy were monitored intraoperatively by fluoroscopy and postoperatively by radiographs (Figure 3). A similar procedure was performed on the contralateral hip in bilateral cases either in the same surgery or 7 days after the primary surgery, depending on the patient’s level of anesthetic fitness.

Postoperatively, the patient was given an abduction pillow and began graded passive hip and knee range of motion exercises. These exercises, although limited due to the severe spasticity involved, consisted of assisted passive abduction and flexion-in-abduction until tolerated and were started approximately 1 week postoperatively after pain decreased. An exact quantification of the amount of physiotherapy given was not possible due to the varied types of contractures involved, as well as the severe joint contractures already present in these patients. The caregivers were given instructions about pin-tract care, daily range of motion exercises, and prevention of pressure sores. Pain-relieving and spasticity-control medications were given continuously during the postoperative period for better comfort. The patients were discharged 4 to 5 days after the last surgery (ie, after the second surgery in staged bilateral cases).

The fixator was removed in the clinic with mild oral sedation when the callus showed full corticalization in 3 cortices (when the pixel value ratio was equal to 1), after which patients were given an abductor brace to use for approximately 3 months. Patients were asked to follow up every 2 weeks during the time when the fixator was applied, every 3 months for the first year, and then yearly thereafter. At every yearly follow-up, caregivers were given a visual analog scale to complete (scale range, 1 to 10, with 1 as the least pain and 10 as the most pain) regarding the amount of pain and discomfort the patient was having, as well as the difficulty
in perineal care, transfers, and wheelchair ambulation.

In these patients, it was difficult to exactly determine and quantify their functional gains postoperatively. Hence, relatively subjective factors, such as maximum continuous sitting time and change or improvement in wheelchair ambulation, were also analyzed. The details were completed in follow-up charts, which were available for analysis for the current study.

Statistical Analysis

Data were entered in Microsoft Excel 2007 (Microsoft Korea, Seoul, Korea) and analyzed using SAS version 9.2 software (SAS Institute Inc, Cary, North Carolina). Pre- and postoperative visual analog scores were compared using Student’s t test, and a P value less than .05 was significant.

RESULTS

A total of 11 patients (17 hips) were analyzed. Average age at surgery was 17.8 years (range, 12-33 years), and mean follow-up was 37 months (range, 14-72 months). Average hospital stay was 10.09 days (range, 4-14 days). Mean blood loss was 63 mL (range, 50-100 mL), and mean operative time was 94.5 minutes (range, 60-120 minutes), excluding the time for anesthesia and including the time required for closure. Among the 6 patients who underwent bilateral surgery, surgery was performed in the same surgery in 4 patients and in a staged manner (1 week apart) in 2 patients; the 2 patients who underwent staged surgeries were poor anesthetic risks and were 2 of the earliest patients undergoing surgery.

Mean operative time was 45 minutes (range, 30-58 minutes) for patients undergong a single surgery (including the patients who underwent staged surgeries) and 112 minutes (range, 110-120 minutes) for patients undergoing bilateral surgery. Average time with the fixator in situ was 9.1 weeks (range, 6-16 weeks), with an average time to complete union of 13 weeks (range, 10-18 weeks). Hip range of motion improved postoperatively. Preoperative adduction deformity was converted into an abduction deformity, which was a much more physiological deformity for perineal and nursing care, with an average abduction deformity of 16° (median, 10°; range, 0°-80°), with further abduction up to 40° (range, 30°-100°). The flexion deformity of the hip decreased due to the mild extension given to the osteotomy and because of the rectus and psoas release to an average of 20° (range, 10°-25°), with further flexion up to 90° (range, 70°-100°).

Eleven complications were observed in 7 patients. Complications were divided into major and minor based on whether the complications changed or delayed the eventual outcome or required another surgery. Accordingly, 6 minor complications occurred in the form of pin-tract infections, which were treated with local antibiotics and dressings, and 5 major complications occurred in the form of delayed consolidation of the regenerate in 2 patients and significant skin ulcerations that required minor debridement, hypostatic pneumonia requiring prolonged intensive care admission and intravenous antibiotic therapy, and abduction contracture of the hip with persistent mild hip pain in 1 patient each.

The abduction contracture of the hip with persistent mild hip pain occurred in a 12-year-old boy with spastic quadriplegia, a Gross Motor Functional Classification System grade V (Figure 4A), and severe flexion-adduction contractures of both hips with bilateral dislocated hips (Figure 4B). After fixator removal 7 weeks postoperatively, the caregivers, although satisfied with the ease of handling and transfers, noticed valgus posturing of the right hip (Figure 4C) and pain on moving the hip, as indicated by grimacing and posturing. The probable reason for such an occurrence was most likely inadvertent damage to the obturator nerve during adductor tenotomy or an increased valgus angle given to the proximal osteotomy. On
radiological examination, the valgus angle was 85° and the lesser trochanter was impinging against the acetabulum (Figure 4D), which was most likely the reason for his hip pain on movement. The caregivers were advised of the need for further realignment of the osteotomy, but they were not ready for another surgery at that time.

Average maximum continuous patient sitting time was approximately 30 minutes preoperatively, which improved to approximately 120 minutes postoperatively at last follow-up. The families of all patients had added some modifications to the wheelchairs, such as additional straps or central cushions, to prevent adduction contractures during wheelchair ambulation preoperatively. All caregivers perceived improvement in wheelchair transport postoperatively, and all except 1 discarded the use of these additional modifications. All caregivers were satisfied with the surgery, with all but 1 caregiver stating that they would consent to the procedure again if need be. The 1 caregiver who refused did so due to the financial implications, as well as the relatively longer process of recuperation needed, although he felt that his ward had benefitted from the surgery.

Transfers were made more comfortable for all patients, and caregivers felt their wards were more comfortable sitting and could sit for a longer time than they could preoperatively. Because the children were nonambulatory and verbally nonresponsive, no functional score could be applied to them. The visual analog score for pain improved from a preoperative mean of 8.36±0.97 to a postoperative mean of 3.27±1.28. This difference was statistically significant according to Student’s t test, with a P value less than .0001 considered statistically significant.

A brief outline of the results is provided in Table 1.

**DISCUSSION**

Conducting proximal femoral osteotomy as a salvage procedure for dislocated hips in patients with severe cerebral palsy was first described in a review by Samilson et al.19 McHale et al8 reported good results in their series of 6 hips in children with severe cerebral palsy who were treated with femoral head resection and valgus osteotomy. However, the use of this procedure for this condition is not widespread, with few reports appearing in the literature.8,20 Critics of this procedure felt that it did not provide adequate pain relief and was associated with several complications.20 Only recently has interest been rekindled in this procedure. Leet et al20 compared the results of the McHale et al8 procedure with the results of femoral head resection with muscle interposition. All but 1 patient in their series was a severe quadriplegic. The McHale et al8 procedure was performed in 11 patients (17 hips), whereas Leet et al20 performed femoral head resection with muscle interposition in 16 patients (23 hips). At an average follow-up of 3.4 years, pain was reduced in both groups, but more so in the valgus osteotomy group. Length of hospital stay was shorter, postoperative migration was less pronounced, and medical complications were lower in this group. Although an external fixator had been used to stabilize the osteotomized hips in 5 patients treated using the McHale et al8 procedure, a detailed analysis of this group and their complications had not been put forth. Also, the study was a retrospective telephone questionnaire-based study, which may have led to a decreased perception of complications.20

Hogan et al13 reported a series of 24 severely spastic patients with unstable hips who were treated using the Hass subtrochanteric valgus osteotomy. The authors did not perform resection of the femoral head in these patients. At an average follow-up of 44 months, the majority of patients were doing well. Ease of transfers and diaper changes and duration of sitting were significantly improved, as was the general satisfaction level of the caregivers. However, this series had a significantly high complication rate, with 63% of the patients having at least 1 compli-
cation, including implant infection, hardware failure, and heterotopic ossification. Although these complications are known to occur in severely affected patients, they are cause for concern and improvement. Compared with the Hogan et al2 series, the current series had only 5 major complications. The current authors experienced no implant infection, hardware failure, or heterotopic ossification, likely due to the increased periosteal stripping and soft tissue trauma associated with a small incision osteotomy, as well as the fact that internal fixation was not used.

The current series reports the mid-term outcomes for 11 patients (17 hips) with cerebral palsy who were severely quadriplegic who were treated using proximal femoral valgus osteotomy fixed with a monolateral fixator. The caregivers of all patients were satisfied with the results of surgery and reported improvement in perineal care, diaper changes, and transfers. The visual analog scale for pain showed significant improvement from the preoperative values. Operative time was short, and minimal blood loss was observed due to the small incision required to perform the osteotomy. Less soft tissue and periosteal stripping were used in this method, and no patient reported heterotopic ossification as a result. Also, because no implant was in situ, little chance existed of deep-seated bony infection, which was always a cause for concern in this group of patients, who have recurrent infections, such as urinary tract infections and hypostatic pneumonia.2,3,8,20

This procedure had complications, although a majority was minor. This subset of patients has been known to have several surgical complications regardless of the procedure performed. In a wide range of series describing procedures such as pelvic support osteotomies, hip arthrodesis, resection arthroplasty, and prosthetic interposition arthroplasty in patients with severe cerebral palsy, the reported complication rate was between 27% and 88%.8,20 In the current series, with 7 patients having at least 1 complication, the complication rate was 63%, which falls into the range described in the literature. A brief overview of the major series describing the treatment of dislocated hips in cerebral palsy is provided in Table 2.

Pin-tract complications were seen in 6 patients but were grade 1 in 5 patients. The distal-most pin of the proximal set of pins was the most commonly infected; it was manipulated the most while performing the osteotomy. This problem was seen more commonly in the first few cases, after which the authors began making a larger incision while inserting that pin, as well as taking care to ensure that skin did not pucker around it. All pin-tract infections healed uneventfully with dressing and oral antibiotics.

It is difficult to quantify the outcomes in patients with cerebral palsy with quadriplegia and total body involvement. Although various attempts have been made to measure the outcome measures in these patients, most notably by Goldberg21 in 1991, most other authors5,20 have measured postoperative results by using subjective measures, such as caregiver-
perceived visual analog scores, grimacing, and ease of diaper changes and perineal care. The current authors have used similar methods to quantify pre- and postoperative results.

The limitations of this study include the small group of patients, the unblinded and noncomparative nature of the treatment modality, and the relatively short follow-up. The method of results analysis through the caregivers was also nonstandardized and nonvalidated. As a result, it is difficult to compare the results of different methods of treatment in this group of patients using the current method.

**CONCLUSION**

The authors demonstrated that subtrochanteric valgus osteotomy relieves pain significantly, increases sitting time and comfort, and makes perineal care easier and transfers simpler in patients with severe cerebral palsy. The use of the monolateral fixator, which is compact and sturdy, helps in reducing operative time and intraoperative blood loss and significantly decreases the chances of serious surgical complications, such as internal implant infections and heterotopic ossification. Thus, this method can be an effective tool in the treatment of patients with nonsalvageable, arthritic, and painful hips.

The authors present a method of treatment of a difficult problem in patients with severe cerebral palsy, in whom many medical issues are inherent. Although this method has some complications, they are comparable with other series that have previously reported on these patients. Also, exact objective quantification of outcomes is difficult in these patients with concomitant severe developmental issues. Additional long-term, multicentric studies will help physicians understand the exact locus standard of this method.

**REFERENCES**


