

Unilateral Versus Bilateral Peri-ilial Pelvic Osteotomies Combined With Proximal Femoral Osteotomies in Children With Cerebral Palsy: Perioperative Complications

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Abstract: The purpose of this study is to evaluate if bilateral peri-ilial pelvic osteotomies (PIPO) combined with proximal femoral varus derotation osteotomies (VDRO) influenced postoperative complications in children with spastic quadriplegia. Bilateral and unilateral hip subluxation or dislocation secondary to spasticity was present in 29 and 61 patients, respectively. The children were divided into 2 groups: group 1 were to be performed a surgery for unilateral PIPO associated with bilateral VDRO, and group 2 were to be performed a surgery for bilateral PIPO and VDRO. The average age of patients at initiation of surgery was 11.7 years (range, 5–20 years) for group 1 and 10.7 years (range, 5–19 years) for group 2. The hospital stay was similar for group 1 and 2 ($P = 0.797$), which was 9 days. In group 1, 11 (18%) of 61 children needed an average of 2 days (range, 1–7 days) in the intensive care unit postoperatively, and 4 of these 11 patients were reintubated because of respiratory problems. In group 2, 6 (20%) of 29 children were transferred to the intensive care unit postoperatively for an average of 2 days (range, 1–4 days) and 3 of these 6 children were reintubated because of respiratory problems. In conclusion, respiratory problems and anemia were the most common early postoperative complications, which occur with a similar rate in children with spastic quadriplegia who underwent bilateral or unilateral peri-ilial pelvic osteotomy(ies) combined with proximal femoral osteotomies. We believe that bilateral hip procedures including PIPO, proximal femoral osteotomies, and soft-tissue release can be performed safely in 1 stage and, based on this data, the staged procedure would probably have the same risk as the first procedure.

Key Words: cerebral palsy, peri-ilial pelvic osteotomy, femoral osteotomy, complications

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The incidence rate of hip dislocation and subluxation is high in children with cerebral palsy, which has been reported between 10%¹ and nearly 80%.² In younger children

(<8 years), adductor muscle release is recommended to prevent hip dislocation; however, dislocation or subluxation of the hip occurs despite muscular release.^{3,4} The common pathologies in these children are an increased femoral anteversion and insufficiency of the anterior, superior, or mainly posterior acetabular wall.^{5,6} One-stage proximal femoral and pelvic osteotomies associated with muscular release have been recommended in older children with hip dislocation secondary to spasticity to address these bony deformities.^{7–11} Stasikelis et al¹² performed a 1-stage procedure if there was bilateral hip dislocation because bilateral hip surgeries increased blood loss in the operation and caused an increased risk of postoperative complications. In literature, the complications rates for bilateral and unilateral peri-ilial pelvic osteotomies (PIPO) combined with proximal femoral osteotomies have not been compared. Therefore, the goal of this study is to determine if bilateral PIPO combined with proximal femoral osteotomies influenced postoperative complications in children with spastic quadriplegia.

METHODS

For inclusion in this study, the subjects must be children who had spastic quadriplegia, hip subluxation or dislocation secondary to spasticity, and underwent bilateral proximal femoral osteotomies combined with either unilateral or bilateral PIPO. The indication for bilateral pelvic osteotomies was bilateral acetabular dysplasia. Hip subluxation or dislocation often associated with pain, sitting intolerance, and impaired perineal care were the main indications for operation. Ninety consecutive patients (119 hips) met the inclusion criteria. Bilateral and unilateral hip subluxation or dislocation was present in 29 and 61 patients, respectively. The children were divided into 2 groups: group 1 were to be performed a surgery for unilateral PIPO associated with bilateral varus derotation osteotomy (VDRO), and group 2 were to be performed a surgery for bilateral PIPO and VDRO. A contralateral site proximal femoral VDRO was performed in children with unilateral hip problems to avoid asymmetry and leg length discrepancy.

The average age of patients at initiation of surgery was 11.7 years (range, 5–20 years) for group 1 and 10.7 years (range, 5–19 years) for group 2. The average follow-up time was 33 months (range, 15–80 months) for group 1 and 41 months (range, 18–90 months) for group 2.

The data acquired from the charts included (1) sex; (2) age; (3) operative time; (4) blood loss; (5) intraoperative

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complications; (6) duration of intensive care unit (ICU) stay; (7) postoperative reintubation; (8) hospital stay; (9) early postoperative complication, which occurred during the hospital stay; and (10) surgical wound infection, which was classified as superficial or deep. Patients with an additional bony procedure or soft-tissue procedure in the knee, tibia, or upper extremity at the same time as hip surgery (13 patients in group 1 and 15 patients in group 2) were not included in statistical analysis of operative time or blood loss. The patients who had concomitant surgery in group 1 were as follows: 8 patients who had adductor release with or without iliopsoas release; two who had rectus transfer; one who had a distal tibial osteotomy; and two who had subtalar arthrodesis with gastrocnemius release. The patients who had concomitant surgery in group 2 were as follows: 9 patients who had adductor release with or without iliopsoas release; two who had rectus transfer; two who had a distal tibial osteotomy; and two who had subtalar fusion with gastrocnemius release. The duration of ICU stay was recorded if the patient stayed in the unit for more than 12 hours. Hospital stay was recorded from the first postoperative day to the day of discharge from the hospital. Problems during hospital stay were recorded as early complications.

The percentage of coverage of the femoral head as described by Reimers,¹³ the acetabular angle by Sharp,¹⁴ and the femoral neck-shaft angle were measured on the anteroposterior radiographs of the pelvis taken preoperatively and at follow up, with the patella pointing forward. Subluxation was defined if there was an uncoverage of the femoral head between 33% and 99% according to Reimers index; dislocation was defined if the migration percentage was 100% or greater. Radiographs were analyzed for nonunion. Delayed union was defined as the absence of a callus bridging in 2 radiographic planes (anteroposterior and lateral) at 3 months postoperatively; nonunion was at 8 months postoperatively.

Surgical Procedure

The combined hip procedure includes VDRO, PIPO, and soft-tissue release performed in 1 stage.¹⁰ Proximal femoral exposure was done through lateral incision. Under fluoroscopy control, transverse femoral osteotomy at the level of lesser trochanter was done by saw. After the shortening of the distal femoral segment (length, 1–2 cm), concentric reduction of the femoral head was documented with image intensifier; if a reduction could not be obtained, a capsulotomy was performed through the lateral incision and femoral osteotomy site. Afterward, PIPO was made through an anterior bikini incision. When the hip capsule was identified, an osteotomy was done under fluoroscopy control just above the acetabulum in a curved fashion over the anteromedial, anterolateral, and posterior aspects of the pelvis. The osteotomy site was then levered open and pieces of tricortical iliac crest bone graft obtained from the bone bank were placed as wedges into the open osteotomy.¹⁰ The femoral osteotomy was then stabilized by using the AO blade plate technique.¹⁵ After completing the surgical procedure, concentric reduction of the femoral head and hip motion were controlled. Hip spica cast immobilization was not used in any patient. Postoperative mobilization was allowed as

patient tolerated and started by physical therapy on postoperative day 1.

Statistical significance was evaluated with the use of an independent *t* test to compare operation time, blood loss, and hospital stay between groups. Statistical significance was set at $P < 0.05$.

RESULTS

The average operation time for group 1 was shorter than that for group 2 (2.7 and 3.3 hours, respectively; $P < 0.001$). The average blood loss was also statistically different between groups ($P < 0.001$): 360 ± 215 mL (range, 70–1000 mL) for group 1 and 580 ± 286.7 mL (range, 200–1800 mL) for group 2. The hospital stay was similar between groups 1 and 2 ($P = 0.797$), which was 9 days (group 1 range, 3–35 days; group 2 range, 5–16 days). In group 1, 11 (18%) of 61 children needed an average of 2 days (range, 1–7 days) in the ICU postoperatively, and 4 of these 11 patients were reintubated because of respiratory problems. In group 2, 6 (20%) of 29 children were transferred to the ICU postoperatively for an average of 2 days (range, 1–4 days), and 3 of these 6 children were reintubated because of respiratory problems. The preoperative and postoperative radiographic measurements, including Reimers index, acetabular index, and femoral neck-shaft angle, are shown in Table 1.

In group 1, 1 hip had iatrogenic femoral neck fracture at the tip of the blade plate. This complication was revealed on the radiographs taken at the second postoperative day. The patient was treated with repeated open reduction and dynamic hip screw after removal of the blade plate. Bone healing was achieved in 9 weeks. One femoral fracture at the distal screw

TABLE 1. Patient Demographics

	Unilateral PIPO (n = 61)	Bilateral PIPO (n = 29)	P
Age, yrs (mean, range)	11.7 (5–20)	10.7 (5–19)	0.203
Sex, n			
Female	47	16	—
Male	24	13	—
Operative time, hrs (mean, range)	2.7 (1.8–4)	3.3 (2.3–4.5)	0.001
Blood loss, mL (mean, range)	360 (70–1000)	580 (200–1800)	0.001
Hospital stay, days (mean, range)	9 (3–35)	9 (5–16)	0.797
Radiographic measurements			
Reimers index*			
Subluxation (33%–99%)	57	41	—
Dislocation (100%)	4	17	—
Acetabular index (degrees)			
Preoperative	56 (31–75)	55 (38–70)	—
Postoperative	38 (20–60)	38 (20–65)	—
Femoral shaft-neck angle (degrees)			
Preoperative	155 (90–180)	156 (125–180)	—
Postoperative	112 (85–145)	115 (90–130)	—

*Index according to hip number.

of the blade plate was observed on the third postoperative week. This patient was treated with open reduction and replacement of the blade plate with a longer one. Union was obtained in 7 weeks.

In group 1, 18 early complications occurred (Table 2). Respiratory problems (n = 6) were the most common complication. Pneumothorax was diagnosed in 2 patients from radiographs. The reasons for pneumothorax were hyperventilation in 1 patient and the use of central venous catheter in the other patient. These patients were treated by placement of a chest tube. Reintubation was required in 3 patients on the first postoperative day because of the decreasing O₂ saturation related to obstructive airway disease. Atelectasis and pleural effusion developed in 1 reintubated patient. The patient was treated with placement of a chest tube and intravenous fluids, and total parenteral nutrition was recalculated. Two patients required urgent gastrostomy because of feeding problems and distention. Hypotension and low hemoglobin level (<7 mg/dL) were detected in 5 patients immediately after operation, and an urgent blood transfusion was begun. Normal blood pressure was achieved after blood transfusion. A surgical wound infection at the femoral osteotomy site developed in 5 hips (3 superficial and 2 deep). Superficial infections were treated with oral antibiotics and local wound care; deep infections were treated with surgical drainage, debridement, and intravenous antibiotics. After this treatment, 1 patient had persistent infection; blade plate was removed and debridement repeated. Stabilization was achieved in 1 patient by casting for 6 weeks. There was no sequela of infection at last control.

In group 2, 13 early complications occurred (Table 2). Respiratory problems occurred in 4 patients. Pneumothorax was diagnosed in 1 patient from radiographs taken on the

second postoperative day. The reason for pneumothorax was hyperventilation; the patient was treated with placement of a chest tube. In 3 patients, decreased O₂ saturation related to obstructive airway disease developed on the first postoperative day, requiring reintubation. Gastrointestinal bleeding on the first postoperative day was defined in 1 patient and treated with urgent endoscopic repair. Low blood pressure and low hemoglobin level were identified in 4 patients and successfully treated with blood transfusion. A surgical wound infection at the femoral osteotomy site developed in 4 hips (2 superficial and 2 deep). Superficial infections were treated with oral antibiotics and local wound care; deep infections were treated with surgical drainage, debridement, and intravenous antibiotics. One patient had persistent infection; the blade plate was removed and debridement repeated. Stabilization for the patient was not needed because of adequate bone healing. There was no residual infection at last control. Early complication rates between the 2 groups (unilateral vs. bilateral) were similar ($\chi^2_1 = 2.04, P = 0.153$).

Hip redislocation/subluxation developed in 1 hip from each group. The posterior hip resubluxation in group 1 occurred 3 weeks postoperatively, secondary to insufficient reconstruction of the posterior acetabular wall. The Reimers index was 54% at the last control. The hip redislocation in group 2 developed a secondary to deep wound infection at the third postoperative week. Immobilization and abduction brace was placed for 6 weeks. The redislocation of the hip was determined at follow-up, and VDRO associated with PIPO was repeated to achieve hip reduction.

Delayed union in 2 femoral osteotomy sites occurred in group 1, and nonunion in 1 femoral osteotomy site developed in group 2. All 3 patients were treated with reapplication of the blade plate, debridement of the bone end, and bone grafting. Bone healing was obtained in 3 months for all hips.

In group 1, heterotopic ossification developed in 4 patients (6%) but none of them caused limitation of hip. In group 2, heterotopic ossification developed in 4 patients (6 hips [10%]). Only 1 patient who had bilateral heterotopic ossification after deep surgical wound infection had severe limitation of hip motion. To achieve hip motion, total hip arthroplasty was performed 1 year postoperatively.

DISCUSSION

Several acetabular procedures have been described for reconstruction of acetabular dysplasia in children with cerebral palsy.⁷⁻¹¹ However, recent studies showed that posterior acetabular insufficiency leading to instability at the hip is different from congenital dislocation of the hip. For this reason, Dega-type pelvic osteotomies became popular to address this problem. In our institution, PIPO (Dega-type osteotomy) has been used since 1989 and successful results have been reported previously.¹⁰

One-stage procedure was favored for cerebral palsy. However, the maximum number of surgical procedures can change according to the surgeon's experience and the hospital circumstances. Stasikelis et al¹² performed a 1-stage procedure for bilateral hip dislocation and found that longer cast time seemed to be associated with a higher risk of

TABLE 2. List of Complications

	No. Cases of Unilateral PIPO (n = 61)	No. Cases of Bilateral PIPO (n = 29)
ICU (%)	11(18%)	6 (20%)
Intubation (%)	3 (5%)	4 (14%)
Early complications		
Respiratory	6	4
Gastrointestinal problems	2	1
Anemia	5	4
Surgical wound infections		
Superficial	3	2
Deep	2	2
Late complications*		
Redislocation/Resubluxation	1	1
Lose of reduction	1	0
Delayed union	2	0
Nonunion	0	1
Heterotopic ossification	4	6
Residual acetabular dysplasia	2	1

*According to hips number.

complication. Nowadays, bilateral hip surgery including a soft-tissue release, VDRO, and pelvic osteotomy are performed for bilateral hip dislocation.^{9-12,16,17} In our study, longer operation time and higher blood loss because of bilateral VDRO and PIPO did not increase the risk of early complications.

In this study, respiratory problems were the most common cause that extended the duration of ICU stay, requiring reintubation. These complications were commonly related to anesthetic complications consisting of hyperventilation, use of central venous catheter, and obstructive airway disease occurring postoperatively in our series. We concluded that preoperative preparation of patients and appropriate anesthetic intervention might reduce early complication risks regardless of the use of either unilateral or bilateral PIPO.

Anemia occurred in both groups, although operation time and blood loss were greater in group 2. All patients were followed closely after operation and successfully treated with blood transfusion. There were no serious complications due to anemia. We advise close follow-up after both unilateral and bilateral hip surgery.

Hip dislocation or subluxation has been reported to be as high as 26% after VDRO and 12% after combination of VDRO and pelvic osteotomy at long follow-up.¹⁸ In the present study, we evaluated only early postoperative dislocation/subluxation; insufficient reconstruction of the acetabulum and deep infection seemed to be important factors for causing early hip dislocation/subluxation. Immobilization by body cast after bony procedure was advocated to maintain hip reduction.^{12,18,19} We did not perform cast immobilization to maintain reduction and allowed early mobilization as soon as the patient tolerated. No redislocation/subluxation secondary to early mobilization was observed; therefore, we suggest early hip motion after VDRO combined with PIPO.

Krum and Miller²⁰ showed that the incidence of heterotopic ossification was significant after soft-tissue release around the hip and that the severity of heterotopic ossification might be aggravated by performing a concomitant spine surgery. Although the incidence rate of heterotopic ossification after bony procedures around the hip, such as femoral and pelvic osteotomies, is still unknown, it rarely develops in patients who have cerebral palsy.²¹ In this study, the incidence rate of heterotopic ossification in children treated with unilateral PIPO was slightly higher than that of bilateral PIPO. However, limitation of hip motion occurred only when heterotopic ossification developed with infection.

In conclusion, respiratory problems and anemia were the most common early postoperative complications, which occurred with similar rate in children with spastic quadriplegia who underwent either bilateral or unilateral PIPO combined with proximal femoral osteotomies. We believe that bilateral hip procedures including PIPO, proximal

femoral osteotomies, and soft-tissue release can be performed safely in 1 stage and, based on this data, the staged procedure would probably have the same risk as the first procedure.

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