

## Periacetabular Osteotomy for Painful Non-paralytic Dysplastic Hip Joints in Adults Affected by Poliomyelitis

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**Background:** Few researchers have discussed hip joint dysplasia in adults affected by poliomyelitis. We retrospectively studied the outcomes of hip joint function in poliomyelitic adults who underwent periacetabular osteotomy for the contralateral painful non-paralytic dysplastic hip joints.

**Methods:** Eight female patients with the mean age of 35.9 years underwent periacetabular osteotomy from January 1991 through July 2002. The procedure was performed on eight non-paralytic hip joints via a modified Ollier transtrochanteric approach. Harris hip joint scores and radiographs were used to evaluate the hip joint functions.

**Results:** At a mean of  $9.0 \pm 3.8$  years postoperatively, the modified Harris hip joint scores had improved from  $45.6 \pm 12.9$  points preoperatively to  $75.8 \pm 20.9$  points. Radiographically, the degree of osteoarthritis remained unchanged in seven hip joints and got worse in one. The anterior center-edge (CE) angle increased from  $14.0 \pm 17.5$  to  $30.9 \pm 10.4$  degrees. The lateral CE angle increased from  $-16.0 \pm 11.7$  to  $18.0 \pm 23.3$  degrees. The acetabular index angle improved from  $26.0 \pm 6.9$  to  $11.3 \pm 4.4$  degrees. The acetabular head index increased from  $36.1 \pm 11.7$  to  $63.1 \pm 20.7\%$ . With an outcome system combining modified Harris hip joint scores and radiographic severity of osteoarthritis, six patients had satisfactory results. Coxa valga usually occurred bilaterally with the neck-shaft angle of  $159.1 \pm 15.7$  degrees for the operated non-paralytic hip joints versus  $161.4 \pm 6.7$  degrees for the non-operated paralytic hip joints. Complications included osteonecrosis of the rotated acetabular fragment, acetabulofemoral impingement, a defect on the rotated ilium, and non-union of the superior pubic ramus (one hip joint each).

**Conclusions:** Acetabular dysplasia can be severe in the non-paralytic leg because of coxa valga, leg length discrepancy, and pelvic tilt. Periacetabular osteotomy through a modified Ollier transtrochanteric approach provides extensive correction and relief of symptoms in most painful non-paralytic dysplastic hip joints in adults affected by poliomyelitis.

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**Key words:** poliomyelitis, hip joint dysplasia, pelvic osteotomy

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There have been few reports concerning the management of non-paralytic dysplastic hip joints in adults after poliomyelitis.<sup>(1,2)</sup> Lee et al. reported on a modified triple innominate osteotomy for hip joint instability and limb shortening due to poliomyelitis in 62 adolescent and adult patients.<sup>(1)</sup> At a mean follow-up of 4 years, 59 of the patients (95.2%) had substantial improvement in hip joint stability. Lau et al. reported the results of various pelvic osteotomies for paralytic hip joint instability in poliomyelitis.<sup>(2)</sup>

In patients with poliomyelitis, it is more troublesome when the non-paralytic hip joint is dysplastic and painful. The patient can barely stand because of weakness of the paralytic leg and painful disability of the non-paralytic hip joints. Therefore, it is important to discuss the management of painful non-paralytic hip joint dysplasia in these patients.

Previously, we reported on periacetabular osteotomy through a modified Ollier transtrochanteric approach for treatment of painful dysplastic hip joints.<sup>(3)</sup> We now report on this approach and evaluate the function of the hip joints in adults affected by poliomyelitis.

## METHODS

From January 1991 through July 2002, eight female adults with poliomyelitis underwent periacetabular osteotomy through a modified Ollier transtrochanteric approach for the treatment of painful non-paralytic dysplastic hip joints. Their ages ranged from 33 to 40 years (mean  $\pm$  SD, 35.9  $\pm$  2.6). Five right hips and three left hip joints were involved. No ancillary soft tissue procedures were performed prior to this treatment, because there was no soft tissue imbalance in hip joint flexion-adduction and extension-abduction.<sup>(4)</sup> Muscle imbalance was recorded when the sum of the muscle power of the hip flexors and adductors was three or more Medical Research Council grades greater than the sum of the hip joint extensors and abductors.<sup>(2)</sup> Only patient 2 received corrective osteotomy of the right distal femur at the age of 8 years. This retrospective study was approved by our Institutional Review Board, and all patients signed informed consent to participate.

The indications for periacetabular osteotomy were symptoms secondary to acetabular dysplasia or hip instability that had not responded to at least 6

months of conservative treatment including nonsteroid anti-inflammatory drugs, less weight bearing or walking with crutches. The procedure was contraindicated for young patients in whom the acetabular triradiate cartilage was still open with growth potential of more than 1 year, for patients who were older than 50 years with severe acetabular dysplasia and osteoarthritis. Clinically, leg length discrepancy, symptoms of acetabular rim syndrome and modified Harris hip joint scores were recorded.<sup>(5,6)</sup> Each radiographic evaluation included a supine antero-posterior radiograph of the pelvis and a false-profile radiograph of the hip joints.<sup>(7)</sup> A standing or spot scanograph was taken for leg length discrepancy measurements and weight-bearing status of the hip joints was evaluated using the standing scanograph. Radiographic measurements included the anterior center edge angle, the lateral center-edge angle, the acetabular index of the weight-bearing zone, the acetabular head index, lateral subluxation, and the status of the Shenton's line.<sup>(7,8-11)</sup> The neck-shaft angle of the proximal femur, pelvic level and evidence of scoliosis from a thoracolumbar spine or whole spine radiograph were also recorded. The degree of acetabular dysplasia was graded according to the Severin classification.<sup>(8)</sup> The severity of the osteoarthritis was staged radiographically according to the criteria of Tonnis.<sup>(9)</sup>

## Surgical procedures

The detailed operative technique was described in a previously published paper.<sup>(3)</sup> The technique utilized a U-shaped skin incision and greater trochanteric osteotomy, and allowed excellent visualization enabling the surgeon to perform the periacetabular osteotomy without penetrating the joint. The periacetabular osteotomy was performed using a curved osteotome, designed to approximately correspond to the circumferential curvature of the acetabulum. The osteotomy began anterosuperiorly and superolaterally, with the radius of the curve osteotome at least 1.5 centimeters larger than the radius of curvature of the acetabulum. The antero-inferior portion of the osteotomy connected the previous line and was on the protuberance of iliopubic bone. Posteriorly the osteotomy line bisected the space between the greater sciatic notch and the joint space. After retraction of the quadratus femoris, the curved osteotome extended anteriorly to cut the pos-

teroinferior part of the acetabulum. The most inferior part of the acetabulum was then fractured or cut directly without penetrating the hip joint. The acetabular fragment was then displaced to the desired direction under direct vision to gain adequate coverage of the femoral head according to the preoperative radiographs of the hip joint. Two or three cortical screws and / or Kirschner wires were inserted from the anterior inferior iliac spine toward the sacroiliac joint to transfix the rotated acetabular fragment to the ilium. The bone graft was impacted into the space created between the rotated fragment and the ilium. The greater trochanter was reattached to the original site with two 4.5-mm cancellous or cortical screws. The Kirschner wires were imbedded subcutaneously with the wound closed over suction drains.

Postoperative rehabilitation included bed rest for 7 days. The patients underwent quadriceps and hip joint-abductor strengthening exercises. The patients were discharged in an average of 10 days postoperatively. The Kirschner wires were usually removed 8 weeks after the operation. Crutch-walking with partial weight bearing was started 1 week to 10 days postoperatively, and full weight-bearing is allowed at 3 to 4 months after surgery.

The patients were assessed at 1, 2, 4, 6, and 12 months postoperatively, and then annually thereafter. At each follow-up, modified Harris hip joint scores and radiographs of the pelvis and the hip joints were obtained. With use of an outcome system combining

the modified Harris hip joint scores and radiographic severity of osteoarthritis,<sup>(5,6)</sup> the results were graded as excellent, good, fair, and poor.<sup>(3)</sup> An excellent or good result was considered a satisfactory outcome, and a fair or poor result was considered an unsatisfactory outcome. The conditions of the hip joint, scoliosis, and pelvic tilt were also evaluated to analyze the long-term effects of poliomyelitis on adults.

## RESULTS

The data for each patient are presented in Tables 1 and 2. The modified Harris hip joint scoring system was separated into three main categories (pain, function, and range of motion) for further analysis (Table 1). The function category included limp, use of walking support, walking distance, stair-climbing, sitting, putting on socks, tying shoes, driving an automobile, and absence of deformity. At a mean of 9 years and 4 months (range, 4 to 15 years) after the operation, the mean pain score improved from  $13.8 \pm 5.2$  points preoperatively to  $34.4 \pm 12.4$  points postoperatively. The mean functional score improved from  $25.1 \pm 9.6$  points preoperatively to  $34.0 \pm 9.8$  points postoperatively. The mean score for range of motion was  $6.8 \pm 1.2$  points preoperatively and  $7.4 \pm 0.5$  points postoperatively. The mean total Harris hip joint score improved from  $45.6 \pm 12.9$  points to  $75.8 \pm 20.9$  points.

Radiographically, the mean anterior center-edge

**Table 1.** Clinical Data on the Adults after Poliomyelitis

Case	Gender	Side	Age (yr)	Duration of Follow up (yr)	Modified Harris Hip Score (points)								LLD (cm)	Pelvic tilt	Scoliosis	
					Pain		Function*		Range of motion		Total					
					Pre-op	Follow up	Pre-op	Follow up	Pre-op	Follow up	Pre-op	Follow up				
1	F	R	33	15	20	45	39	42	6	8	65	95	5	-	-	
2	F	L	35	14	10	40	30	39	7	7	47	86	17	+	+	
3	F	R	36	10	20	40	24	32	6	8	50	80	2	-	-	
4	F	R	33	8	10	10	16	11	8	7	34	28	1.5	-	-	
5	F	L	34	8	10	40	8	37	5	7	23	84	1	†	†	
6	F	L	37	7	10	20	24	39	8	7	42	66	5.5	-	+	
7	F	R	39	6	20	40	30	37	6	7	56	84	10.5	+	+	
8	F	R	40	4	10	40	30	35	8	8	48	83	2	-	+	
Average			$35.9 \pm 2.6$	$9.0 \pm 3.8$	$13.8 \pm 5.2$	$34.4 \pm 12.4$	$25.6 \pm 9.6$	$34.0 \pm 9.8$	$6.8 \pm 1.2$	$7.4 \pm 0.5$	$45.6 \pm 12.9$	$75.8 \pm 20.9$	$5.6 \pm 5.6$			

\*: Function includes limp, use of walking support, walking distance, stair-climbing, sitting, putting on socks, tying shoes, driving an automobile, and absence of deformity; LLD: Leg length discrepancy; †: improved after surgery.

**Table 2.** Radiographic Data on the Adults after Poliomyelitis

Case	Dysplasia (Severin class)	Degree of osteoarthritis (Tonnis grade)		Ant. center-edge angle (deg)		Lat. center-edge angle (deg)		Acetabular index angle (deg)		Acetabular head index (%)		Femur neck-shaft angle (deg)	
		Pre-op	Follow up	Pre-op	Follow up	Pre-op	Follow up	Pre-op	Follow up	Pre-op	Follow up	R	L
		1	IV	1	1	-	25	-8	35	32	10	43	72
2	IV	2	2	-	38	-18	32	22	12	35	77	174	174*
3	V	2	2	6	28	-12	-4	24	15	30	44	162*	174
4	V	2	2	40	10	-20	-27	21	17	30	23	147*	155
5	IV	2	2	5	40	-40	41	33	10	17	88	161	164*
6	IV	1	2	25	36	0	18	15	12	50	64	165	156*
7	IV	2	2	18	40	-12	34	26	12	52	75	143*	138
8	V	2	2	-10	25	-18	15	35	2	32	62	155*	150
Average				14.0±17.5	30.9±10.4	-16.0±11.7	18.0±23.3	26.0±6.9	11.3±4.4	36.1±11.7	63.1±20.7		

\*: operated non-paralytic site

angle improved from  $14.0 \pm 17.5$  degrees preoperatively (excluding two patients who did not have suitable false-profile radiograph for preoperative measurement of the anterior center-edge angle) to  $30.9 \pm 10.4$  degrees postoperatively. The mean lateral center-edge angle improved from  $-16.0 \pm 11.7$  degrees to  $18.0 \pm 23.3$  degrees. The mean acetabular index angle improved from  $26.0 \pm 6.9$  degrees to  $11.3 \pm 4.4$  degrees. The mean acetabular head index improved from  $36.1 \pm 11.7$  to  $63.1 \pm 20.7\%$ . The degree of osteoarthritis remained unchanged in seven hip joints (87.5%), and got worse in one (12.5%).

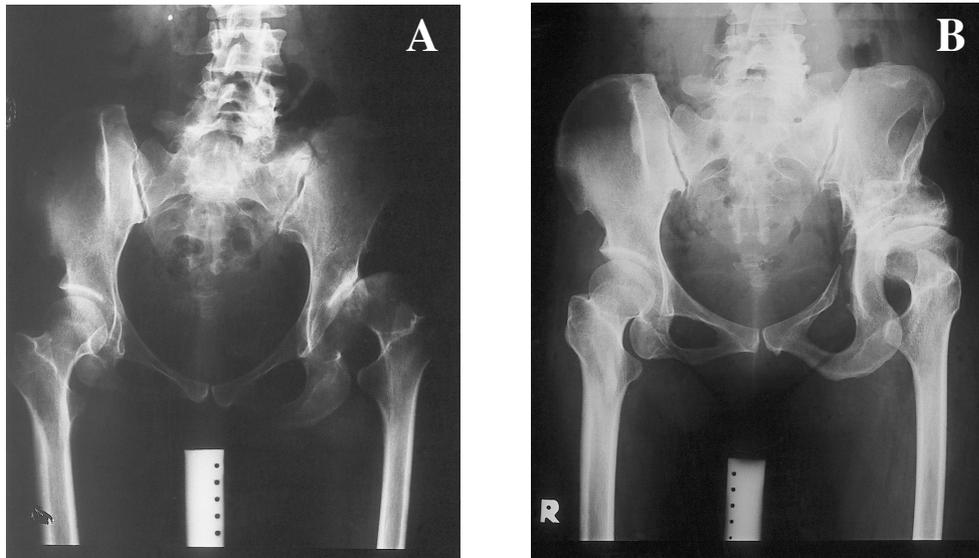
With the use of an outcome system combining the modified Harris hip joint scores and radiographic severity of osteoarthritis,<sup>(5,6)</sup> one patient had an excellent result, five patients had good results (75% satisfactory results), and two patients had poor results (25% unsatisfactory results). The unsatisfactory results were due to osteonecrosis of the rotated acetabular fragment in a patient with alcoholism (patient 4); and inadequate coverage or inappropriate rotation due to incomplete cut at the anteroinferior or posteroinferior portion of the osteotomy (patient 6). All of the patients had severe acetabular dysplasia with lateral center-edge angle of less than 0 degree and needed extensive acetabular correction (Fig. 1).

The mean neck-shaft angle of the paralytic hip joints was  $161.4 \pm 6.7$  degrees and was  $159.1 \pm$

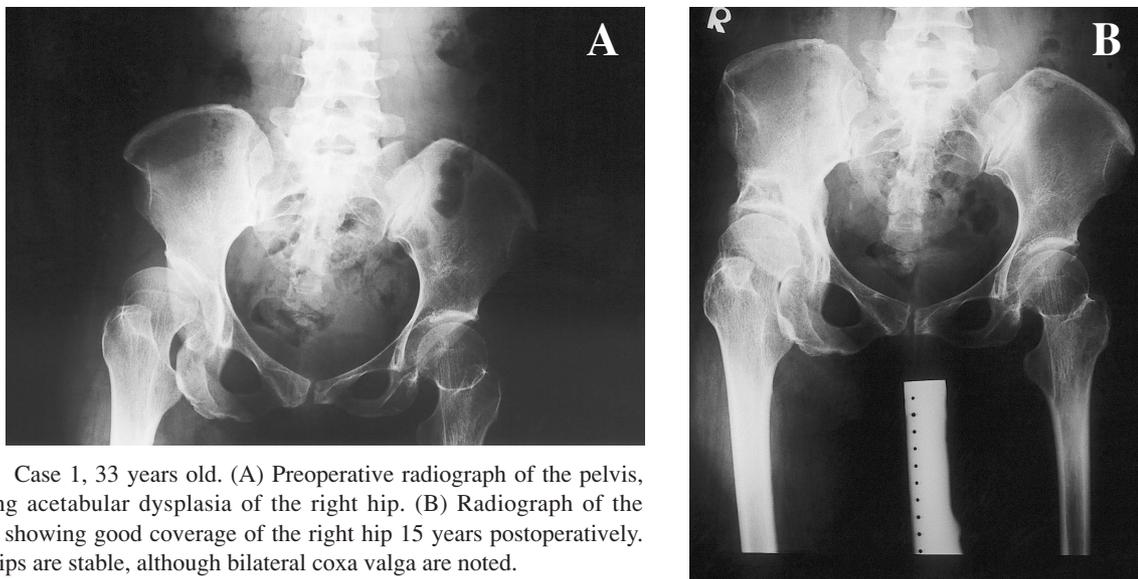
$15.7$  degrees in the non-paralytic hip joints. Coxa valga with an increase of the femoral neck-shaft angle  $\geq 20\%$  normal level or  $\geq 150$  degrees was noted in 13 hip joints (Table 2).<sup>(2)</sup> The index periacetabular osteotomy was performed on six hip joints with coxa valga, and a satisfactory result was obtained in five hip joints (Fig. 2). Of the two hip joints without coxa valga (patients 4 and 7), one had an unsatisfactory result and the other had a satisfactory result.

Of the eight contralateral paralytic hip joints that were not operated on, five hip joints were stable without subluxation (patients 1, 2, 5, 7 and 8) (Fig. 3) and three hip joints (patients 3, 4, and 6) were unstable. All these, eight hip joints were asymptomatic or minimally symptomatic. The predisposing factors to paralytic hip joint instability included acetabular dysplasia, muscle imbalance, and coxa valga. One of the eight patients (12.5%) had the paralytic hip joint on the high side of the pelvis. The effect of pelvic tilt on the stability of the paralytic hip joint existed only when the paralytic hip joint was on the high side of the pelvis.

Leg length discrepancy was noted in all eight patients with the mean of  $5.6 \pm 5.6$  cm (range, 1 to 17 cm). Pelvic tilt of more than 10 degrees (on supine radiograph) was noted in three patients (patients 2, 5 and 7) and improved postoperatively in one (patient 5). Lumbar scoliosis was noted in five



**Fig. 1** Case 5, 34 years old. (A) Preoperative radiograph of the pelvis, showing severe acetabular dysplasia of the left hip, pelvis tilt, and scoliosis. (B) Radiograph of the pelvis, showing good coverage of the left hip with non-union of the superior pubic ramus 7 years postoperatively. The pelvis tilt and scoliosis improved after hip stabilization.



**Fig. 2** Case 1, 33 years old. (A) Preoperative radiograph of the pelvis, showing acetabular dysplasia of the right hip. (B) Radiograph of the pelvis, showing good coverage of the right hip 15 years postoperatively. Both hips are stable, although bilateral coxa valga are noted.

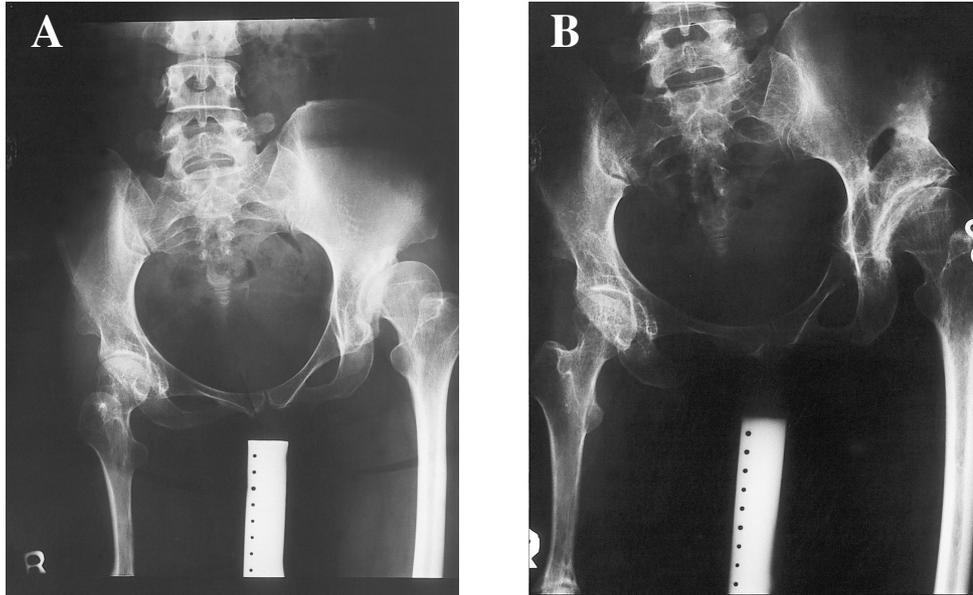
patients (patients 2, 5, 6, 7, 8) and improved postoperatively in one (patient 5).

Complications included osteonecrosis of the rotated acetabular fragment, inadequate coverage or inappropriate rotation due to incomplete cut at the anteroinferior or posteroinferior portion of the osteotomy, acetabulofemoral impingement, a defect

on the rotated ilium, and non-union of the superior pubic ramus in one hip joint each.

## DISCUSSION

Although paralysis occurs early in poliomyelitis, dysplasia or subluxation of the hip joint develops



**Fig. 3** Case 2, 35 years old. (A) Preoperative radiograph of the pelvis, showing acetabular dysplasia of the left hip, paralysis of the right hip, lumbar scoliosis and pelvic tilt. She had a leg length discrepancy of 17 cm. (B) Radiograph of the pelvis, showing good coverage of the left hip fourteen years postoperatively. The paralytic right hip remained stable regardless of a coxa valga when the patient was 49 years old.

insidiously and is often unnoticed; by the time surgical intervention is needed, most patients are in their teens. There have been few reports about the long-term situations of the hip joints in adults affected by poliomyelitis.<sup>(1,2,12)</sup> Lee et al. reported triple innominate osteotomy for hip joint stabilization after poliomyelitis in 62 adolescent and adult patients with an average age of 22.3 years.<sup>(1)</sup> Lau et al reported surgical treatment on 39 patients who had subluxation or dislocation of the hip joint after poliomyelitis. The average age at operation was 13.4 years. They demonstrated the key factors for success were muscle balance, femoral neck shaft and anteversion angles, and acetabular geometry.<sup>(2)</sup> Our patients probably were the oldest group reported, with the mean age of  $35.9 \pm 2.6$  years at the time of operation.

As demonstrated by Brookes and Wardle,<sup>(13)</sup> the development of the femur is influenced by muscle pull. Coxa valga (increase of femoral neck - shaft angle of 20% or more than 150 degrees) occurs in patients with poliomyelitis because the iliopsoas muscle is stronger than the weak gluteus medius and minimus.<sup>(14)</sup> Loss of hip joint abductor power causes retardation of the growth from the greater trochanteric apophysis. Disparity of relative growth

from the capital femoral epiphysis and the greater trochanteric apophysis causes increasing valgus deformity and anteversion of the femoral head. We think the reason for coxa valga in non-paralytic hip joints is the pelvic balancing effect. Irwin reported a symmetrical and triangular relationship between different muscle groups (hip joint abductor muscles, lateral trunk muscles),<sup>(15)</sup> bone levers, and weight-bearing thrusts. During walking the abductors of the hip joint on the weight-bearing side pull downward on the pelvis and the lateral trunk muscles on the opposite side pull upward. When the lateral trunk muscles on the opposite side elevate the pelvis, the lateral trunk muscles on the weight-bearing side must provide counterfixation which in turn depends on the abductors of the opposite hip joint for counterfixation. Thus with each step the femur on the weight-bearing side is the central point of action for this coordinated system of fixation and counterfixation. Each part of the system depends on the others for proper pelvic balance during walking.<sup>(15,16)</sup> In order to keep balanced pelvic level, the hip joint abductors power of the non-paralytic leg also becomes weak, which causes retarded growth of the greater trochanter and consequent coxa valga.

Because the femur is the central point of the action for the coordinated system of fixation and counterfixation among the muscle groups, bone levers and weight-bearing thrusts, prolonged and severe pelvic imbalance may alter the morphology of the femoral shaft (Fig. 3).<sup>(16)</sup> In addition, the leg length discrepancy and pelvic tilt render the non-paralytic hip joint the high side of the pelvis,<sup>(17,18)</sup> which is in a functional valgus position.<sup>(19)</sup> Both the structural and functional coxa valga aggravate the hip joint dysplasia on the non-paralytic side. Acetabular dysplasia can be severe in the non-paralytic leg because of the coxa valga, leg length discrepancy, and pelvic tilt. Extensive acetabular correction is necessary to achieve good coverage. No correction of the coxa valga was performed in any of our eight patients. Six patients had satisfactory results. The data delineate that the coxa valga, although it is one of the causes for hip joint instability, does not preclude good results after periacetabular osteotomy.

The results of our observations agree with those of Lee et al.<sup>(1)</sup> who reported triple innominate osteotomy for hip joint stabilization in 62 poliomyelitic patients with only one additional procedure of femoral derotation osteotomy. Furthermore varus osteotomy of the proximal femur might weaken the hip joint abduction mechanism to aggravate a limp that already presented preoperatively. No additional femoral lengthening was performed in these patients because the patients had been accustomed to their body figures. We were also concerned about the benefits of lengthening the short, weakened legs in adults with poliomyelitis.

Although osteoarthritis in adults may be treated with total hip joint arthroplasty, the unstable gait and risk of falling down in poliomyelitic patients may preclude a long-term survival of a prosthesis. In addition, even in a joint that already has some degree of mechanically based osteoarthritis, reduction of the contact stress may reduce the severity of the osteoarthritis.<sup>(20-23)</sup> Periacetabular osteotomy via our approach affords good correction for all directions under direct vision.

Of the eight paralytic hip joints that were not operated on, five hip joints were stable and three hip joints were unstable. A paralytic hip joint will remain stable if there is no muscle imbalance or acetabular dysplasia, regardless of the coxa valga. The three non-operated unstable hip joints were only

a little or non-symptomatic. Few symptoms of the paralytic unstable hip joints were also noted in our other patients. From a review of the literature and our experience on poliomyelitic patients and spastic hip joint dislocation in patients with cerebral palsy,<sup>(2,4,24)</sup> we believe that muscle balance is important for hip joint stability but recommend that hip joints with flaccid paralysis may not necessarily be treated if there is no symptom or muscle imbalance when the patients are adolescents or adults.<sup>(2,4,17,24)</sup> The weak point of the study is the limited number of patients, because there have been no new patients affected by poliomyelitis in recent decades. However, the observation on our patients provides valuable information about this decreasing but important disorder.

In conclusion, the dysplasia of the non-paralytic hip joint can be severe due to the coxa valga, leg length discrepancy, and pelvic tilt. Complete freedom of the acetabular fragment is necessary to correct severe acetabular dysplasia. Periacetabular osteotomy through a modified Ollier transtrochanteric approach allows for extensive correction and provides improved femoral head coverage and relief of symptoms in most painful non-paralytic dysplastic hip joints in adults affected by poliomyelitis.

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# 利用髖臼切骨術來治療小兒麻痺患者非癱瘓側之髖臼發育不良

林子平 郭繼陽 陳松雄 巫瑞文 黃濤 周文毅

**背景：** 很少文獻報導提及對於小兒麻痺患者之髖臼發育不良該如何處理。我們回溯性地探討利用髖臼切骨術，治療小兒麻痺成人患者非癱瘓側之髖臼不良其髖關節功能之結果。

**方法：** 在 1991 年 1 月至 2002 年 7 月間，共計八位女性病人接受此手術，平均年紀 35.9 歲，手術進行是採用改良過的 Ollier transtrochanteric approach 來進行。評估髖關節功能包括 Harris hip scores 和影像學檢查。

**結果：** 在平均  $9.0 \pm 3.8$  年的術後追蹤中，modified Harris hips score 從術前  $45.6 \pm 12.9$  分變成術後  $75.8 \pm 20.9$  分。在影像檢查中，有七個髖關節關節炎的程度不變，有一個則變差。Anterior CE angle 從  $14.0 \pm 17.5$  度變成  $30.9 \pm 10.4$  度，lateral CE angle 從  $-16.0 \pm 11.7$  度變成  $18.0 \pm 23.3$  度，acetabular index angle 從  $26.0 \pm 6.9$  度變成  $11.3 \pm 4.4$  度，acetabular head index 從  $36.1 \pm 11.7\%$  變成  $63.1 \pm 20.7\%$ 。利用 modified Harris hip scores 及影像檢查來分析結果，六位病人達到滿意效果。股骨頸外翻通常雙側都會發生，股骨頸-幹的角度在開刀的非癱瘓側是  $159.1 \pm 15.7$  度，在沒開刀的癱瘓側則是  $161.4 \pm 6.7$  度。併發症則包括旋轉的髖臼骨頭壞死，髖臼和股骨的衝撞，旋轉後髌骨缺損，上恥骨枝的骨頭不癒合。

**結論：** 對於非癱瘓側而言，髖臼發育不良會因股骨頸外翻，雙腳不等長及骨盆傾斜而加劇。利用 modified Ollier transtrochanteric approach 進行髖臼切骨術，可以大幅矯正小兒麻痺成人患者非癱側的髖臼發育不良，並有效解決大多數患者之疼痛。  
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**關鍵詞：** 小兒麻痺，髖臼發育不良，髖臼切骨術

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