Four-point Molding: A New Cast Molding Technique for Closed Reduction Treatment of Developmental Dysplasia of the Hip

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Background: *In order to achieve added stability in a hip spica cast and decrease unnecessary open reduction, the authors have devised a new hip spica cast molding technique that has been named, "Four-point molding technique". Our aim was to evaluate the efficacy of this technique, in terms of its ability to deliver a stable, concentric reduction of the hip.*
Material and Method: *The authors retrospectively reviewed the patients, aged 6-24 months, that were diagnosed with DDH and who had undergone closed reduction with a hip spica cast. The authors used the four-point molding technique on all patients. The authors evaluated radiographs for redislocation during the 12 weeks of cast treatment and followed-up to 1 year after hip spica cast removal. 15 children (15 hips) who were treated over a14-year period were included in the present study to determine the success rate of this procedure.*
Results: *From 1996-2010, there were 15 unilateral DDH patients who were treated with the four-point molding technique. The average age of the patients at the time of the reduction was 17 months (age range: 8-23 months). The treatment was 86.6% successful in 13 children (95% CI 0.62-0.96). The average duration in the hip spica cast was 12.5 weeks. Mean follow-up was 23.1 months. Two children were unable to be concentrically reduced with sufficient stability with closed reduction and therefore required open reduction and osteotomy.*
Conclusion: *Four-point molding is simple, gives good result, and with low complications. The authors propose this technique for use in closed reduction treatment for DDH.*

Keywords: *DDH, Closed reduction, Hip spica cast, Four-point molding technique*

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Developmental dysplasia of the hip (DDH) treatment depends largely on patient age. The objective of DDH is to provide a stable anatomical reduction with normal hip development, thus achieving a long lasting (preferably lifetime stable), fully functioning, and pain-free hip. Currently, hip reduction with spica cast applied is the preferred treatment for DDH children more than 6 months of age and for children for whom the Pavlik harness has failed. The pathological changes of dysplastic hip are 95% reversible with simple treatment at an early age. If the diagnosis is delayed, the obstacles to reduction become increasingly difficult to overcome and the recovery of the acetabulum after reduction less predictable. A secondary procedure such as a femoral or acetabularosteotomyis often performed because acetabular development may be inadequate after closed or open reduction alone is performed.

The success of closed reduction has been reported as variable, from 42% to 92%[4,6-13], due to obstacle structures in the hip joint that made reduction impossible on the first casting attempt or that may cause dislocation in the cast. The operation is performed in independent walking-age children, under general anesthesia and with arthrogram. To maintain the reduced hip is a very important factor and a well-molded spica cast is the key to the success of this treatment. To date, there have been very few reports that describe spica cast molding techniques that best maintain the reduced hip. In order to achieve full-time stability in the hip spica cast and avoid unnecessary open reduction, the autors have devised a new hip spica cast molding technique that the authors have called, "four-point molding technique". Our aim was to evaluate the efficacy of this technique, in terms of its

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ability to deliver a stable, concentric reduction of the hip.

Material and Method

This was a retrospective cohort study using patient hospital chart and radiographic data of all DDH patients from 1996-2010. The inclusion criteria included any child aged 6-24 months that was treated by closed reduction with hip spica cast that was applied using the four-point molding technique. Exclusion criteria included incomplete patient information, incomplete radiographic data, and patients who had received previous treatment. Traction before closed reduction is the method used in all cases to increase the success rate of closed reduction treatment and to decrease rates of avascular necrosis (AVN). The authors reviewed the medical records and radiographs at presentation, after closed reduction under general anesthesia with hip spica cast, and at follow-up until success or failure was determined. The primary outcome was the stable and concentric reduction; secondary outcomes were duration in cast and casting complications.

Four-point cast molding technique and chronology

Closed reduction was performed in the operating room under general anesthesia. Reduction was performed in the flexion and abduction position of the hip without any force applied. Arthrography was performed to determine the anatomical reduction and any underlying causes preventing reduction. The hip safe zone was determined. In cases with narrow open or closed adductor, a tenotomy was performed.

After the reduction, a spica cast was extended to the ankle on the involved side and to just proximal to the knee on the uninvolved side. The hips were positioned at 100 degrees of flexion and 60 degrees of abduction, while the surgeon applied the spica cast using the "four-point cast molding technique".

Four-point cast molding is characterized by gentle molding over the left and right greater trochanter areas, the pubic symphysis, and the sacral area (Fig. 1-3).

The duration of immobilization in the hip spica cast was 12 weeks, with subsequent abduction splinting after the spica cast was removed.

A successful procedure was characterized by a stable reduction of the femoral head into the acetabulum after 12 weeks in a hip spica cast.

Results

The present study evaluated 15 patients (1 male, 14 females) who were clinically treated by the research authors from 1996-2010. All of the patients were diagnosed with unilateral DDH. One walking-age child presented with a limping gait due to leg length discrepancy; another presented with a decreased ability to abduct his/her hip. The average acetabular index of

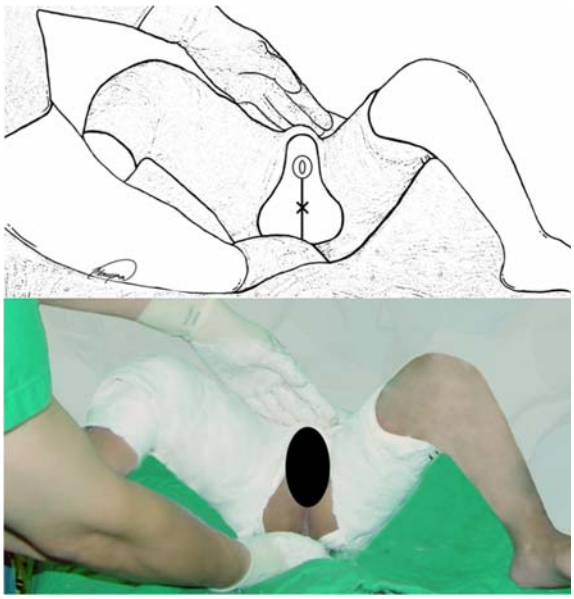

Fig. 1 Shows molding above the pubic symphysis and underneath sacral area.

Fig. 2 Shows molding over both the left and right greater trochanter areas.

Fig. 3 Shows four-point molding hip spica cast.

the affected hip prior to treatment was 29.8 (range 20-45, SD 7.8). The average age was 17 months (range 8-23). The four-point molding technique variation of the hip spica cast treatment was successful in 13 of 15 cases (86.6%, 0.62-0.96 of 95% CI). The average duration in the hip spica cast of the successful group was 12.5 weeks (range 11-20). For 2 of the children, closed reduction was unsuccessful. At 3 and 10 weeks in the hip spica cast, the first required open reduction with hip spica cast and the other converted to open reduction, femoral varusderotation osteotomy, Salter pelvic osteotomy, and hip spica cast. There was one early complication; skin breakdown in the groin area. This condition was cured with antibiotic ointment only, with no interruption or discontinuation in casting (Table 1).

Discussion

Developmental dysplasia of the hip (DDH) is a congenital disorder with a reported incidence of about 1-2 per 1000 live births[1,2]. The most essential target of treatment for DDH is to obtain and maintain anatomical reduction, with closed reduction being one of the most desirable treatment options, given the high-levels of function experienced by patients aged 6-24 months who were treated using this method[1,2,6,9,10,12].

This series had a high success rate, in terms of the ability to achieve a stable concentric reduction of the hip using closed reduction. The literature has reported variable success rates in closed reduction and spica casting for DDH treatment. Kahle[16] reported a 57% success rate - 27 of 47 hips. There were 23% (11 patients) aged less than 6 months and 30% (14 patients) aged over 1 year. Their data suggest that older patients may have a higher failure rate in achieving a stable closed reduction. Zionts and MacEwen reported on 42 children between 1-3 years of age who underwent a

Table 1. Clinical data of the fifteen children in this study

Case	Sex	Side	Age at Time of Reduction (months)	Acetabular Index at Time of Reduction		Duration in Hip Spica Cast (weeks)	Casting-related	Complications Reintervention
				Affected side	Unaffected side			
1	F	R	22	23	13	12	No	
2	F	L	21	24	16	12	No	
3	M	L	23	20	13	3	No	Open reduction
4	F	R	15	41	23	12	No	
5	F	L	15	26	26	12	No	
6	F	L	18	31	17	20	Skin breakdown	
7	F	R	13	33	30	12	No	
8	F	R	20	45	19	11	No	Open reduction with FVDO pelvic osteotomy
9	F	L	14	33	21	10	No	
10	F	L	22	20	18	12	No	
11	F	R	16	39	27	12	No	
12	F	R	8	26	12	12	No	
13	F	L	16	29	29	12	No	
14	F	R	23	36	22	12	No	
15	F	L	9	22	17	12	No	
		Mean	17	29.8	20.2			

closed reduction and adductor tenotomy. They reported a success rate of 75%.[4] Schoenecker *et al* reported that 15 of 19 hips (79%) in children aged 18 to 21 months and 8 of 19 hips (42%) in children aged 22 months or older were successfully closed reduced[7]. Asim Am reported that out of 8 hip patients with an average age of 11 months, 4 hips (50%) were successful[13]. Malvitz and Weinstein (6) showed that long-term overall hip function and radiographic appearance was improved, the younger the age of the patient at the time of reduction. The series by DeRosa and Feller[14] showed that 88% of children achieved stable hip reductions, with 72% of those patients aged 6 months of age or younger; once again suggesting that younger patients tend to achieve higher levels of success with closed reduction. Race and Herrings reported a closed reduction success rate of 68% (40 of 69) in patients under the age of 2, with 26% (15 of 69) requiring a subsequent open procedure. Race and Herring recommended that early initial reduction was the best prognostic[3]. Joseph[15] reported a 78% (40 of 51) closed reduction success rate with 27% (14 of 51) requiring subsequent open reduction; 56% (33 of 69) developed AVN, as diagnosed by radiograph.

Many researchers have attempted to increase success rates of close reduction by developing additional techniques, like the previous use of traction before reduction; however, some have not been adopted as standard treatment[5,8,9]. Greater trochanter molding is a popular technique[2,9], though there have been mixed results and an additional procedure is required after closed reduction. In this report, we present a new technique that we have named, "four-point molding". This technique is equal in spica casting duration, but results show it can improve the success rate of the closed reduction method. A key limitation of our study was the limited number of cases. This data can be used in a future prospective randomized controlled trial for developing a spica cast index. Closed reduction and hip spica cast, applied using the four-point molding technique, has shown improved results and low complication rates when applied by experienced orthopaedic surgeons. The authors support the use of this technique in closed reduction with hip spica cast in DDH patients.

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Potential conflicts of interest

None.

References

1. Weinstein SL. Developmental hip dysplasia and dislocation. In: Morrissy RT, Weinstein SL, editors. Lovell and Winter's pediatric orthopaedics. Philadelphia: Lippincott William & Wilkins; 2006: 987-1037.
2. Tachdjian MO. Congenital dysplasia of the hip. In: Tachdjian MO, editor. Pediatric orthopaedics. Philadelphia: W. B. Saunders; 1990: 247-549.
3. Race C, Herring JA. Congenital dislocation of the hip: an evaluation of closed reduction. J Pediatr Orthop 1983; 3: 166-72.
4. Zionts LE, MacEwen GD. Treatment of congenital dislocation of the hip in children between the ages of one and three years. J Bone Joint Surg Am 1986; 68: 829-46.
5. Fish DN, Herzenberg JE, Hensinger RN. Current practice in use of prereduction traction for congenital dislocation of the hip. J Pediatr Orthop 1991; 11: 149-53.
6. Malvitz TA, Weinstein SL. Closed reduction for congenital dysplasia of the hip. Functional and radiographic results after an average of thirty years. J Bone Joint Surg Am 1994; 76: 1777-92.
7. Schoenecker PL, Dollard PA, Sheridan JJ, Strecker WB. Closed reduction of developmental dislocation of the hip in children older than 18 months. J Pediatr Orthop 1995; 15: 763-7.
8. Gogus MT, Aksoy MC, Atay OA, Acaroglu RE, Surat A. Treatment of congenital dislocation of the hip. Results of closed reduction and immobilization in the hip spica cast. Turk J Pediatr 1997; 39: 499-503.
9. Vitale MG, Skaggs DL. Developmental dysplasia of the hip from six months to four years of age. J Am Acad Orthop Surg 2001; 9: 401-11.
10. Aksoy MC, Ozkoc G, Alanay A, Yazici M, Ozdemir N, Surat A. Treatment of developmental dysplasia of the hip before walking: results of closed reduction and immobilization in hip spica cast. Turk J Pediatr 2002; 44: 122-7.
11. Murray T, Cooperman DR, Thompson GH, Ballock T. Closed reduction for treatment of development dysplasia of the hip in children. Am J Orthop (Belle Mead NJ) 2007; 36: 82-4.
12. Aksoy MC. Closed reduction in the treatment of developmental dysplasia of the hip. Acta Orthop Traumatol Turc 2007; 41 (Suppl 1): 25-30.

13. Asim AM, Saw A, Nawar M. Treatment of developmental dysplasia of the hip: short and mid-term outcome. Malaysian Orthop J 2011; 5: 17-20.
14. DeRosa GP, Feller N. Treatment of congenital dislocation of the hip. Management before walking age. Clin Orthop Relat Res 1987; 77-85.
15. Joseph K, MacEwen GD, Boos ML. Home traction in the management of congenital dislocation of the hip. Clin Orthop Relat Res 1982; 83-90.
16. Kahle WK, Anderson MB, Alpert J, Stevens PM, Coleman SS. The value of preliminary traction in the treatment of congenital dislocation of the hip. J Bone Joint Surg Am 1990; 72: 1043-7.

การเข้าเฝือกสะโพกในผู้ป่วยเด็กที่มีภาวะหัวสะโพกหลุดแต่กำเนิดโดยวิธีกดสี่จุด

ดวงใจ ลี้ประกอบบุญ, กมลพร แก้วพรสวรรค์, พีระจิตร เอี่ยมโสภณา

ภูมิหลัง: *การศึกษานี้มีจุดประสงค์เพื่อศึกษาผลของการรักษาผู้ป่วยเด็กที่มีภาวะหัวสะโพกหลุดแต่กำเนิด ที่รับการจัดข้อสะโพกแบบปิดเข้าเฝือกลำตัวและขาโดยวิธีกดสี่จุด*

วัสดุและวิธีการ: *โดยการศึกษาแฟ้มผู้ป่วยและภาพรังสีย้อนหลัง โดยผู้ป่วยเด็กทั้งหมดที่นำมาศึกษามีภาวะหัวสะโพกหลุดแต่กำเนิด ได้รับการรักษาด้วยวิธีและเทคนิคการเข้าเฝือกด้วยวิธีกดสี่จุด ความสำเร็จของการรักษาได้จากการการวิเคราะห์ภาพถ่ายรังสีและกระดูกหัวสะโพกเข้าที่ดีโดยการรักษาวิธีนี้เพียงวิธีเดียว*

ผลการศึกษา: *ตั้งแต่ พ.ศ. 2539-2553 มีผู้ป่วยเด็กทั้งหมด 15 ราย ที่ได้รับการรักษาจัดข้อสะโพกแบบปิดและเข้าเฝือกด้วยวิธีกดสี่จุดพบว่ามีผู้ป่วย 13 ราย (ร้อยละ 86) ที่ประสบความสำเร็จในการรักษาโดยวิธีนี้ใช้เวลาในการเข้าเฝือกนานเฉลี่ย 12.5 สัปดาห์ ผู้ป่วยเด็ก 2 คนที่ล้มเหลวได้รับการรักษาผ่าตัดจัดข้อสะโพกรวมถึงการผ่าตัดกระดูกให้หัวสะโพกเข้าที่*

สรุป: *การเข้าเฝือกลำตัวและขาโดยวิธีกดสี่จุดร่วมกับการจัดข้อสะโพกแบบปิด ในการรักษาผู้ป่วยเด็กที่มีภาวะหัวสะโพกหลุดแต่กำเนิด เป็นวิธีที่ได้ผลสำเร็จดี สามารถทำได้โดยไม่ยุ่งยากซับซ้อนและภาวะแทรกซ้อนน้อย*