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ORIGINAL PAPER

Duration of immobilization after developmental dysplasia of the hip and open reduction surgery

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Abstract

Background There is no consensus about the duration of post-operative immobilization in the treatment of DDH (developmental dysplasia of hip). Our aim in this study is to compare between two post-operative immobilization protocols for patients undergoing open reduction.

Materials and methods Thirty-eight hips in 32 patients assigned to group A were immobilized in hip spica for four weeks followed by abduction brace application which was gradually weaned through the periods of several months and 29 hips in 24 patients assigned to group B immobilized in hip spica for 12 weeks without further bracing. Both groups were surgically reduced using anterior approach between the ages of 12–24 months.

Results There were non-significant statistical difference between both groups as regards clinical and radiological outcome but there is significant statistical difference as regards AVN (avascular necrosis) on follow-up between both groups. The rate of AVN cannot be related to the method of immobilization, as there are many factors can lead to AVN of the hip as immobilization in an extreme position and tight reduction.

Conclusion Group A post-operative immobilization protocol is safer and associated with less complications and more comfortable to the patient and parents than that used in group B. Early removal of hip spica cast and application of hip abduction brace does not increase the rate of re-dislocation.

Level of Evidence Level III Retrospective comparative study

Keywords Open reduction · Developmental dysplasia of hip · Hip Spica

Introduction

Developmental dysplasia of the hip (DDH) is one of the most complex three-dimensional (3D) deformities and is a leading cause of premature arthritis requiring total hip replacement [1]. The choice of the type of surgical procedure for surgeons in DDH mainly depends on the understanding of the morphologic insufficiencies of acetabulum and femur [1, 2].

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After age of 12 months, open reduction through anterior approach is often required in the treatment of DDH to remove obstacles to reduction and achieve a stable joint [3–5]. It is indicated for children who failed to achieve a stable concentric reduction by closed methods [6]. At this age, closed reduction is not preferred as significant proportion of patients will need additional surgery [4].

Hip spica cast is routinely used post-operatively to maintain the hip joint in the new stable position and give the chance to the released and repaired soft tissue (joint capsule plication) that is performed during open reduction to heal [3].

Hip spica cast is an inconvenient and uncomfortable type of plaster and difficult to keep it clean and dry. It may lead to some complications like skin ulceration and breakdown when there are unprotected sharp edges. Prolonged casting may cause joint stiffness, osteopenic fractures, and contractures. Prolonged extreme positions of immobilization are reported to be one of the causes of osteonecrosis [7, 8]. Rare problems as superior mesenteric artery syndrome, peroneal nerve palsy,

and decubitus ulcers were also mentioned as complications of spica immobilization [9–11].

There is no collective agreement about the exact safe and best duration of post-operative immobilization in the treatment of DDH; also, no any report mentioned that its early removal as a risk factor for redislocation. It was found that spica duration is widely variable and ranged from two weeks to eight months [12, 13].

In our study, we compare between two groups of patients with different duration of hip spica cast immobilization after open reduction of DDH as regards the long-term clinical and radiological outcomes.

Material and methods

This is a retrospective comparative study between 2 groups with two different methods of immobilization after open reduction of hip dislocation in cases of DDH. All operations on the two groups were done by first author by the same technique of open reduction.

Fifty-six patients (67 hips) with developmental dysplasia of the hip either unilateral or bilateral aging between one and two years (mean age 16 months) who had open reduction through anterior approach were included in this study. All cases have no previous attempts of closed reduction nor bracing as they are diagnosed late mostly after starting weight bearing after age of one year.

There are divided into two groups with two different protocols of post-operative immobilization (Table 1).

The first group (group A) included 32 patients (38 hips). Twenty-one were females with 11 males; six of them were bilateral while 26 were unilateral. In those patients, the spica was removed after four weeks followed by abduction brace application for 18 hours/day for one month then 14 hours/day for one month then ten hours/day for one month then eight hours/day for eight to ten months.

Gradual withdrawal of bracing over long duration will help remodeling of the bone and growth of bone in the right direction of hip containment.

Also, the early removal of cast and hip abduction brace application give more comfort to the patient and family and less cost because the cast for 12 weeks needs cast change under general anesthesia after six weeks.

Table 1 Demographic data of patients of study

Group A	Group B
32 patients (38 hips)	24 patients (29 hips)
26 unilateral	19 unilateral
6 bilateral	5 bilateral
21 females	16 females
11 males	8 males
13–19 months (16 months)	14–18 months (16 months)

While the second group (group B) included 24 patients (29 hips), 16 females and eight males, bilateral affection was seen in five patients and the others were unilateral. In this group, spica cast was removed after 12 weeks then start ambulation with no brace [14, 15].

We use the conventional 1 and one-half spica cast. Two most important points need to be considered during casting are that an expert assistant or the surgeon must keep the operated limb in the safe and reduced position and meanwhile trochanteric molding should be done on the operated hip which is the keystone of the casting.

Patients with neurological, teratological dislocation, or those having hip dislocation associated with syndromes were excluded from the study. Patients lost in the follow-up before or shorter than six to eight years were excluded from the study.

Also, we included only cases between one and two years in this study to exclude other cases which needed femoral shortening or pelvic osteotomy to keep the group homogenous and decrease the variables.

Surgical technique

Under general anesthesia, open reduction was done through anterior approach via a bikini incision. The dissection was blunt in the plane between abductor and flexor muscles of the hips. The straight and reflected heads of the rectus femoris were released followed by iliopsoas tenotomy at lesser trochanter. Then, the capsule was opened and removal of the hypertrophic ligamentum teres and hypertrophic fat pad inside the hip were performed. After cleaning of the acetabulum, the femoral head was reduced; the reduction was assessed and confirmed by intra-operative X-ray. Proper capsular repair with plication was done followed by insertion of two K-wires passing extra-articular from the greater trochanter to the ilium under image control just to maintain position until hip spica was done and then wires were removed.

In group A, after four weeks, the spica was removed under general anesthesia associated with examination of hip stability and application of abduction brace. While in group B, the spica retained for 12 weeks with no brace application after its removal.

The patients were followed clinically and radiographically for eight to 16 years after operation (the mean duration of follow up is 11.5 years for group A and 12 years for group B). All patients in both groups were evaluated by the same methods. At the latest follow-up, the clinical evaluation was made using McKay criteria which divide patients into four groups: excellent, good, fair, and poor according to stability and pain of the hip also, limping and range of movement of the hip [16]. Severin [17] radiographic classification system was used for radiological assessment of the hip which classifies it into seven groups: normal, mild, dysplastic, sublaxed, head articulate with second acetabulum, redislocated, and arthritic.

All radiographs were assessed for the degree of avascular necrosis (AVN) according to Kalamchi and MacEwen's grading system which classifies it into four overlapping groups according to how much of the proximal femur involved [16].

Results

Clinical assessments after final follow-up according to McKay criteria [16]

Thirty-one hips (81.6%) showed excellent results and 18.4% (7 hips) scored as good in group A. While in group B, 86.2%(25 hips) rated as excellent outcome and 13.8% (4 hips) considered as good. Non-significant statistical difference is noticed (*P*-value = 0.612).

Radiographic assessments after final follow-up according to Severin classification [17]

In group A, 31 hips (81.6%) scored as Ia, grade Ib seen in 15.8% (6 hips), and one hip (2.6%) rated as grade II.

In group B, grade Ia was present in 20 hips (69%), grade Ib in seven hips (24.1%), and two hips (6.9%) ended with grade II.

The statistical difference is non-significant (*P* value = 0.449).

Avascular necrosis (AVN) after final follow-up

Six hips in group A (15.8%) were complicated by avascular necrosis (AVN) three of those graded as type I and the other three hips showed type II avascular necrosis according to Kalamchi and MacEwen classification [18].

While group B showed avascular necrosis in 48.3% of hips, six hips showed type I (AVN) and 8 hips graded as (AVN) type II with significant statistical difference between the two groups (*P* value = 0.015).

Complications after removal of spica cast

Three hips in group B were complicated by stiffness of hip joints which improved by physical therapy and two hips in the same group developed skin ulceration managed by daily dressing.

No complications have been seen in group A. The statistical difference is significant (*P* value = 0.029).

Discussion

There is a controversy about the enough duration of hip spica cast immobilization after open reduction in management of DDH. No study has been found comparing the results of these variable immobilization protocols.

In our study, we compare between two different protocols of post-operative immobilization. From the study, our results showed that no significant clinical and radiological difference between short and long duration immobilization protocols but showed that long duration of spica immobilization is associated with higher rate of avascular necrosis and increased incidence of post-operative complications like skin ulceration and joint stiffness.

The rate of AVN cannot be related to the method of immobilization, as there are many factors can lead to AVN of the hip as immobilization in an extreme position and tight reduction.

There are several studies of open reduction of DDH through anterior approach with different protocols of post-operative immobilization period; there results are summarized in Table 2.

Akagi et al. [4] used hip spica cast for four weeks post-operative. There results showed no significant difference in the rate of avascular necrosis in comparison to patient of group A in our study but there is a higher incidence of unsatisfactory radiographic results; six hips showed Severin class III and two hips of Severin class IV.

Zionts and McEwen [19], Bulut, et al. [20], and Clarke et al. [21] were sharing the same duration of spica immobilization after open reduction which was six weeks. When we compared their results with the patients of group A of our study, we found that some patients in these three studies showed unsatisfactory radiographic results (Severin class III and more) which are not present in group A of our study and 50% of patients in Clarcke et al. (22) study had AVN which is similar to group B of our study.

Matsushita et al. [22] used hip spica for eight weeks post-operative. There is no significant difference in their results when they are compared with previously mentioned studies. Only 3% showed fair clinical results with no poor results and the remaining 97% were clinically excellent and good. Only 16% show unsatisfactory radiographic results (Severin class III and more).

Szepesi et al. [23] recommended immediate post-operative functional flexible immobilization. A Pavlik harness was used till the age of ten months and abduction splint was used for older children, the device can be removed for one to two hours per day after one month to improve the mobility of the joint. After three months, standing was permitted and according to acetabular development the device is gradually removed until it worn at night only. This treatment was continued until the radiological appearance of full acetabular development that is usually done within six months to one year. Only less than 4% of patients were considered radiographically unsatisfactory (Severin grade III or more) and seven hips (14%) were complicated by AVN and rated as Kalamchi type II.

The authors of this study advocated their post-operative functional bracing protocol and attributed it as the key step in obtaining favourable results. They believed that the main two factors that stimulate joint development are the absence of rigid fixation and use of devices that helps to prevent

Table 2 Review of results of different studies

Studies	Year	No. of cases (hips)	Age (months)	Follow up (years)	McKay clinical result	Severin Radiographic results	Kalamchi AVN	Immobilization
Group A Our study	2016	32 patients (38 hips)	12–24	11.5	E: 31 G: 7	Ia: 31 hips Ib: 6 hips II: 1 hips	AVN:6 hips I = 3 hips I*I* = 3 hips	4 weeks
Group B our study	2016	24 patients (29 hips	12–24	12	E: 25 G: 4	Ia**:** 20 hips Ib: 7 hips II: 2 hips	AVN: 14 hips I: 6 hips II = 8 hips	12 weeks
Zionts and McEwen [4]	1986	5 hips	24.4 Range (19–31)	7.6	E: 5	I: 4 hips III: 1 hip	–	6 weeks
Akagi et al. [19]	1998	20 patients 22 hips	14 range (5–26)	(1 3–20)	–	I: 2 hips II: 12 hips III: 6 hips IV: 2 hips	AVN: 7 hips I: 1 II: 3 III: 3	4 weeks
Bulut et al. [20]	2013	13 patients	20–24	(3–4.2)	E: 9 G: 3 F: 1	I: 6 II: 5 III: 2	–	6 weeks
Clarke et al. [21]	2005	22 hips	4–16	at least 3 years	–	I: 12 II: 3 IV:2 VI: 1 4 are ungraded	AVN:11 I: 8 II: 0 III: 2 IV: 1	6 weeks Spica + 6 weeks of broom stick plaster
Matsushita et al. [22]	1999	24 patient 31 hips	3–25	17.8	E: 24 G: 6 F: 1	I:14 hips II: 12 hips III: 4 hips IV: 1 hips		8 weeks
Szepesi et al. [23]	2013	49 hips	6–24	16–20	–	I: 12 II: 3 IV:2 VI: 1 4 are ungraded	II: 7 hips	Functional bracing either Pavlik harness of abduction splint

excessive soft tissue stretching which may lead to circulatory problem; the other factor is that using of devices ensures concentric reduction and allows early spontaneous motion in the functional position.

Since there is no negative effect has been seen after decreasing the duration of postoperative spica but instead, longer duration of spica found to be associated with higher rate of complications, we recommend group A post-operative immobilization protocol and consider it as safe and successful in the management of DDH.

Our limitations in this study are all operations done by single surgeon not multicenter, the number of cases in each group is not sufficient to reach a firm conclusion so that the volume of sampling of this comparative study is low and not sufficient to reach to firm conclusion, young age, and we do not know if incidence of osteoarthritis or dysplasia will be different after skeletal maturity. The retrospective study design and absence of randomization are also considered as a limitation of the study and also absence of representative radiological imaging data to differ between two groups pre- and postoperatively and in final follow-up.

Conclusion

A hip spica for four weeks is enough period of immobilization after open reduction of DDH and safer than long period as it decreases hip stiffness and risk of avascular necrosis of head of femur. Also, a four week spica cast gives short duration and more comfort to the family and the child with the same clinical and radiological outcome as long duration.

Compliance with ethical standards

Conflict of interest The authors declare that they have no conflict of interest.

Ethical approval This article does not contain any studies with human participants or animals performed by any of the authors.

Ethical committee This study was accepted from ethical committee inAin Shams University.

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