Comparison Between Static and Dynamic Spica Cast for Closed Reduction Cases of DDH: A Short-Term Follow-Up

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KEYWORDS

DDH, static spica, dynamic spica, Erbil

ABSTRACT

Background: developmental dysplasia of the hip (DDH) is a typical childhood disease that, if left untreated, can lead to early-onset osteoarthritis. Closed reduction and spica casting are the first line of treatment for infants aged 6-18 months. Static and dynamic spica casts are the two primary treatment method used in practice, but the evidence is mixed as to which method provides the best outcomes.

Methods: This prospective, randomized, controlled trial compared static and dynamic spica casting in 98 DDH patients from Kurdistan, Iraq. Patients were divided into dynamic and static groups. The hip was follow-up ed by using radiographic parameters such as the acetabular index and Tonnis grade. Treatment success was defined as a favorable hip outcome after one year.

Results: There was no significant difference in treatment success between the groups, with 68% of patients in both groups achieving normal hip modification. However, the dynamic cast group had significantly better acetabular indices at 3, 6, and 12 months, and all of them were done under general anesthesia (GA), better hygiene, better caring and more comfortable parents with less cost.

Conclusions: Static and dynamic spica casting have similar short-term clinical success rates for DDH, but dynamic casting produces better radiographic outcomes, especially in infants younger than 1. Longer-term studies are needed to determine possible radiographic improvement and whether dynamic type translate into better clinical outcomes since its more comfortable for parent, with less cost.

1. Introduction

Developmental dysplasia of the hip (DDH) is one of the most common congenital musculoskeletal disorders, with an incidence of 1-2 per 1000 live births. It encompasses a wide spectrum of anatomical abnormalities of the hip joint, ranging from mild instability to complete dislocation. If left untreated, DDH can result in early-onset osteoarthritis, decreased range of motion, limb length discrepancy, and abnormal gait patterns. The primary purposes of treatment are achieving a concentric reduction of the femoral head within the acetabulum and facilitating appropriate hip joint growth. The standard first medicine for babies aged 6-18 months is closed reduction and spica casting. Two preliminary categories of spica casts are employed in medical practice: static and dynamic casts. Static spica casts are used to immobilize the hip joint at a predetermined degree of flexion and abduction, while dynamic spica casts provide a progressive and controlled range of movement. (1-2)

Several studies have compared static and dynamic casting for DDH. Sankar et al. found no significant differences in reduction maintenance or need for additional interventions (3), but noted an improved range of motion in the dynamic group six weeks post-removal. Frank et al. (4) observed no radiographic differences but better clinical outcomes with dynamic casting. Conversely, another study by Sankar et al. reported higher rates of reduction loss in the dynamic group (5). A recent meta-analysis by Mulpuri et al. concluded that both casting methods achieve similar early outcomes, though dynamic casts may improve range of motion (6) .

The usefulness of spica casting likely depends on multiple characteristics, including age at presentation, severity of dysplasia, quality of reduction, and casting technique. (7-8). The most significant importance is strictly adhering to the appropriate technique, irrespective of the casting used. Ensuring molds reach beyond the iliac crest and below the foot is crucial to avoid pistoning effectively. (9) Most analyses consider outcomes within the first year after casting. Longer follow-up into childhood remains limited but critical to assessing joint developments. (10)

Static and dynamic spica casting are both effective for initial DDH treatment. Dynamic casting may

offer better short-term acetabular development, hygiene, cost, and compliance. However, comparative studies show no clear superiority, suggesting technique may be more important than cast type. Further research, especially in regions like Kurdistan with late presentations and low compliance, is needed to determine long-term effectiveness.

2. Methodology

Study design and setting: the current study designed as prospective randomized controlled study. This study was done on 100 patient age below 18month at the pediatric department from two different healthcare centers namely Erbil Teaching Hospital and Helena Centre for Handicapped Children in Erbil-Kurdistan Iraq, and carried out during the beginning of July 2021 to the end of December 2023. A total of 98 DDH cases were examined in the study in which divided randomly into two groups first known as fall spica group and second was dynamic spica group.

Method and data collection: The study involved 98 hips divided into two groups: one group underwent three months of full spica casting, and the other had six weeks of full spica followed by six weeks of dynamic spica casting. The spica casting procedures were performed by a team comprising a doctor and two assistants. Each procedure lasted about 15 minutes and involved using three fiberglass casts for dynamic spica and six for static spica. The reduction of the hip was done using the Ortolani maneuver, and a broomstick was applied by an assistant. In the static spica group, the cast also included the abdomen and hips, with closed reduction under general anesthesia, and sometimes with adductor tenotomy in the operating theatre. The duration of casting and any harness use was recorded. Follow-up evaluations at 3, 6, and 12 months included assessing the acetabular index (AI) and tonnis grade, with an AI of less than 30 indicating healthy acetabular development. Outcomes were categorized as normal hips, dislocated hips, hips with Avascular Necrosis (AVN), or hips requiring surgery for residual dysplasia.

Data management and statistical analysis: Data were collected using a specifically designed questionnaire and then entered into Microsoft Excel (Excel 2016) for initial organization. Analysis was performed using the Statistical Package for Social Sciences (SPSS) version 28. The results were analyzed and compared across different patient variables, with a significance level set at ≤ 0.05. Data were presented as rates, ratios, frequencies, and percentages in various tables and figures. Statistical analyses included the t-test and Chi-square tests to evaluate the data.

Inclusion criteria: The inclusion criteria for the study were idiopathic unilateral or bilateral Developmental Dysplasia of Hip (DDH) and cases more than 2 months old regardless of their gender.

Exclusion criteria: cases with syndromic, paralytic hips, those with skeletal dysplasia were excluded from the study.

Ethical considerations: This study was submitted to the Research Protocol Ethics and Scientific committees at Hawler medical university or. This study was explained for each patient's parents and a verbal consent was obtained from each parent. Confidentiality and anonymity of data were ensured.

3. Results and Discussion

DDH was presented in total of 100 cases that half (50%) of them were static spica and the other half (50%) treated with dynamic spica, the majority (90%) of children were females, 41% of DDH resulted in right (bilateral), 39% of the affected site was left and only 5% of the disease formed in right ,most (79%) of nucleus was present, only 10% of babies had history of harness treatment, adductor tenotomy procedure was done to 22% of the cases, most (68%) of cases turned to normal babies after treatment, 20% of them faced residual displacement of acetabulum and finally re-dislocation occurred to only 4% of cases. See Table 1 and Figure 1.

Table 1: Study group, adductor tenotomy and treatment outcome.

Variables	Categories	Frequency	Percent

Study groups	Static spica	50	50
	Dynamic spica	50	50
Sex	Male	10	10
	female	90	90
Site	Right (bilateral)	41	41
	Left (bilateral)	39	39
	Right (unilateral)	5	5
	Left (unilateral)	15	15
Nucleus present	yes	79	79
	no	21	21
Pervious treatment with harness	yes	10	10
	no	90	90
adductor tenotomy	yes	22	22
	no	78	78
Treatment outcome	Normal	68	68
	Re-dislocation	4	4
	Avascular necrosis	8	8
	Residual displacement of acetabulum.	20	20
Total		100	100%

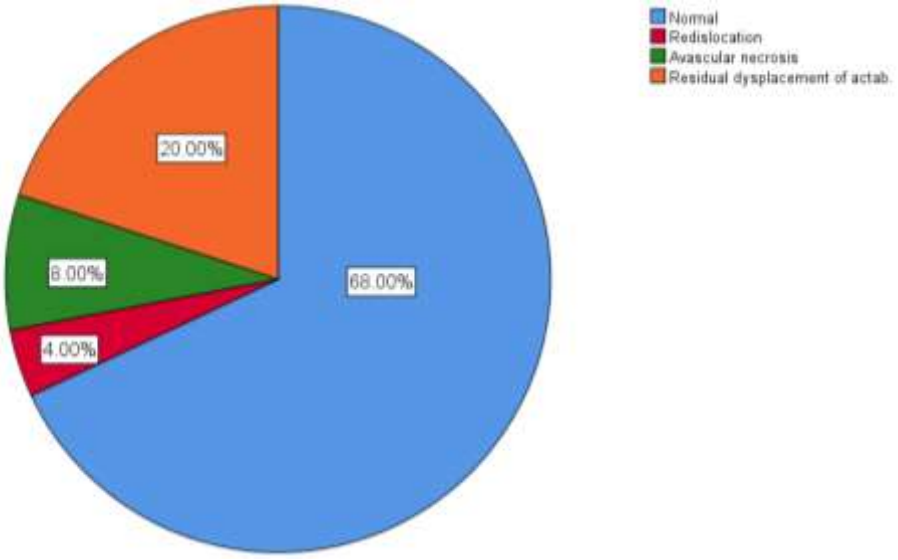

Figure 1: Treatment outcome.

Results of Table 2 indicate that mean age ± Std. Deviation of participants was 10.85 ± 5.73 months, average Tonnis grade (TG) before reduction ± S.D of patients was 1.98 ± 1.37 grade followed by mean TG at 6 weeks ± S.D of them was 1.07 ± 0.32 grade, mean AI before reduction

± S.D of cases was 35.26 ± 2.90˚, average AI after 6 weeks ± S.D of samples sizes was 31.88 ± 2.32˚, mean AI after 3 months ± S.D of babies was 30.70 ± 2.29˚, and finally average AI after 6 months ± S.D of patients was 29.94 ± 2.17˚.

Table 2: Mean age, Tonnis grade and AI results of patients.

Variables	**N**	**Range**	**Minimum**	**Maximum**	**Mean**	**Std. Deviation**
Age in month	100	30	0	30	10.85	5.73
Tonnis grade before reduction	100	4	0	4	1.98	1.37
Tonnis grade at 6 weeks	100	2	0	2	1.07	0.32
AI before reduction	100	10	30	40	35.26	2.90
AI after 6 weeks	100	10	26	36	31.88	2.32

AI after 3 months	100	10	26	36	30.70	2.29
AI after 6 months	100	10	26	36	29.94	2.17
AI after one year	100	10	26	36	29.58	2.15

Table 3 shows that there was a non-significant statistical association between study groups and treatment outcome, static and dynamic spica showed no significant association interfering treatment outcome and p-value was 0.905.

Table 3: Association between study groups and treatment outcome.

Variable	**Categories**	**Group**		**p-value**
		Static spica	**Dynamic spica**	
Treatment outcome	Normal	34 (68%)	34 (68%)	0.905
	Re-dislocation	2 (4%)	2 (4%)	
	Avascular necrosis	3 (6%)	5 (10%)	
	Residual displacement of acetabulum	11 (22%)	9 (18%)	
	Total	50	50	
		100%	100%	

Outcomes of Table 4 reveal that there was no significant statistical difference between study groups and Tonnis grade before reduction, TG at 6 weeks, AI before reduction and AI after 6 weeks and p-value was > 0.05. There was a significant statistical difference between study groups and age in month, static spica group were older with (mean of 12.22 months) compared to dynamic spica group with (mean of 9.48 months). There was a significant statistical difference between study groups and AI after 3 months, AI after 6 months and AI after one year, dynamic spica group had higher angle measurement in comparison to static spica babies. t-test was significant and p-value was <0.05.

Table 4: Comparison of age, TG and AI between static and dynamic groups.

Parameter	Study group	N	Mean	Std. Deviation	p-value	t-test
Age in month	Static spica	50	12.22	6.692	0.016	Significant
	Dynamic spica	50	9.48	4.229		
TG before reduction	Static spica	50	1.88	1.452	0.471	Non-significant
	Dynamic spica	50	2.08	1.307		
TG at 6 weeks	Static spica	50	1.02	.319	0.125	Non-significant
	Dynamic spica	50	1.12	.328		
AI before reduction	Static spica	50	35.74	3.069	0.099	Non-significant
	Dynamic spica	50	34.78	2.675		
AI after 6 weeks	Static spica	50	31.72	2.491	0.494	Non-significant
	Dynamic spica	50	32.04	2.157		
AI after 3 months	Static spica	50	30.08	2.248	0.006	Highly significant
	Dynamic spica	50	31.32	2.199		
AI after 6 months	Static spica	50	29.36	1.998	0.007	Highly significant
	Dynamic spica	50	30.52	2.206		
AI after one year	Static spica	50	29.16	2.024	0.050	Significant
	Dynamic spica	50	30.00	2.213		

There was a significant statistical difference in TG during time, before reduction TG accomplished higher score in cases with (mean of 1.88) reverse to after 6 weeks the grade was lower and resulted in slight narrowing with (mean of 1.02). There was statistically significant difference in AI results, mean AI before reduction of cases was higher (35.74˚) in comparison to mean AI after one year was (29.16˚).

t-test was highly significant and p-value was <0.001. See Table 5.

Table 5: Comparison of TG and AI in static spica group

Static group		Mean	N	Std. Deviation	p-value	t-test
	TG before reduction	1.88	50	1.45	<0.001	Highly significant
	TG at 6 weeks	1.02	50	0.31		
	AI before reduction	35.74	50	3.06	<0.001	Highly significant
	AI after one year	29.16	50	2.02		

Table 6 reveals that there was a statistical difference in TG result, TG had higher (mean of 2.08) before reduction compared to after 6 weeks the grade was lower with (mean of 1.12). There was statistically significant difference in AI results, mean AI before reduction of infants was higher (34.78˚) reverse to mean AI after one year was (30˚). t-test was highly significant and p-value was <0.001

Table 6: Comparison of TG and AI in dynamic spica group.

Dynamic group	Mean	N	Std. Deviation	p-value	t-test
TG before reduction	2.08	50	1.30	<0.001	Highly significant
TG at 6 weeks	1.12	50	0.32		
AI before reduction	34.78	50	2.67	<0.001	Highly significant
AI after one year	30.00	50	2.21		

Discussion

This study compared static versus dynamic hip spica casting for developmental disorders of the hip (DDH), finding no significant differences in treatment outcomes, with 68% effectiveness in both groups. However, the dynamic group, younger by an average of 9.48 versus 12.22 months (p=0.016), showed better acetabular index (AI) improvements at 3, 6, and 12 months [11,12].

The AI measures acetabulum steepness, and in the dynamic spica group, it showed significant improvements at 3 months (31.32 vs. 30.08, P=0.006), 6 months (30.52 vs. 29.36, P=0.007), and 12 months (30.00 vs. 29.16, P=0.05) compared to static casting. Studies confirm dynamic bracing yields better radiographic outcomes in infants under one year due to effective acetabulum reconstruction from micro-motion. Both groups had similar initial severity and significantly improved tonnis grade after six weeks [13].

Approximately 68% of patients achieved normal hip outcomes with no difference between treatment groups, fitting within the typical 60-90% success rate for DDH treatments [13]. The 4% redislocation rate aligns with previous findings [14], and complications like avascular necrosis (8%) and residual dysplasia (20%) are consistent with reported ranges [11,15-16]. While dynamic bracing improved radiographic outcomes in infants under one year, it did not increase overall treatment success compared to static casting. Long-term studies suggest radiographic improvements correlate with better hip function and longevity(17-19).

This study on DDH treatment found that both static and dynamic casting with closed reduction yielded similar short-term success rates of around 70%. However, dynamic bracing significantly enhanced acetabular development in infants under one year. The study's limitations include its small size and brief follow-up. Extensive randomized trials with larger cohorts and longer follow-ups of 5-10 years are necessary to determine if the superior radiographic results from dynamic bracing lead to better long-term clinical outcomes and fewer secondary surgeries. Further research should also explore the reasons behind treatment failures and complications. Overall, dynamic bracing may be preferable for infants under one year to optimize hip growth, though both methods are viable for treating DDH.

4. Conclusion and future scope

In conclusion, this investigation found similar short-term clinical success between static and dynamic spica casting for DDH. However, dynamic casting had better radiographic outcomes, which may be duo to the micromotion that present when the hip is in dynamic spica, longer follow-up is needed to determine whether these radiographic improvements translate into better clinical outcomes. Limitations include a small sample size and a short follow-up period.

Conflicts of Interest

The authors declare that they have no relevant financial or non-financial interests to report.

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Ethical approval

This study received ethical approval from the Ethics committee of Hawler medical university under the protocol number 6

Informed consent

Before the commencement of data collection, all participants were given detailed information about the purpose of the study, procedures, potential risks and benefits for participants were assured of the confidentiality of their data and were clearly informed of their right to withdraw from the study at any time regardless of the consequences. Written informed consent was obtained from all participants.

Authors' Contributions

Berivan Ibrahim Aqrawi was involved in investigation, conceptualization, methodology, data curation, and writing the original draft and Zainab Abdul wahab Muhamad Rida was involved in visualization, editing, validation, and supervision.

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Data Availability

The data used to support the findings of this study are included in the article. Raw data are available from the corresponding author upon request.

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