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Original Research Article

Effectiveness of abduction orthoses in the management of developmental hip dysplasia: a comparative retrospective study

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ABSTRACT

Background: Developmental dysplasia of the hip (DDH) is a disorder marked by abnormal hip alignment or structure, often calling for orthopedic treatment. The purpose of this research was to compare the Aro and Milgram splints, two types of orthopedic splints, for use in treating diabetic foot disease.
Methods: Between three and four months of age, 53 patients were identified with hip dysplasia in a retrospective observational analysis. Beginning at six months of age, patients received treatment with either the aro splint or the milgram splint. At six and twelve months after the start of therapy, radiographic measures of the acetabular angle were made. Statistical analysis was done to assess the efficacy of the two splints and compare treatment results.
Results: The aro and milgram splints both reduced acetabular angles, and there was no discernible difference between them in terms of reaching the ideal angle. Most patients needed to get therapy for around five months to achieve the ideal angle. With both splints, there were notable decreases in acetabular angles, even though some patients were unable to achieve this angle. Eighty-one percent of the patients were female, which is consistent with established DDH demographics.
Conclusions: These findings suggest that both splints can lower acetabular angles and treat hip dysplasia in DDH patients. Both the aro and milgram splints lower acetabular angles and reverse hip dysplasia in DDH patients. Using either splint may enhance hip stability and function. Both splints are effective DDH therapeutic alternatives, according to these results.

Keywords: Developmental hip dysplasia, Orthopedic splints, Aro splint, Milgram splint, Acetabular angle

INTRODUCTION

Developmental dysplasia of the hip (DDH) is a pathological condition in which there is a compromise in the normal hip structure or alignment of the coxofemoral joint.[1] This is caused by congenital, degenerative and hereditary disorders, which leads to an alteration in the harmonic functioning of the joint, making it unstable.

The hip joint is stabilized by a fibrous joint capsule and key supporting ligaments, including the iliofemoral, pubofemoral, and ischiofemoral ligaments, which ensure that the articulating bones remain connected during hip movements.[2] The acetabulum, formed by the ischium, ilium, and pubis, contains essential components, including the round ligament and the acetabular labrum, which contribute to articular stability.

In the normal development of the hip, the femoral head must remain within the acetabulum, ensuring proportional growth. However, in hip dysplasia, the femoral head is displaced, resulting in disproportionate growth of the joint components and instability. The precise cause of displacement is still under investigation, but there are

known factors that contribute to femoral head displacement, including mechanical forces applied against the fetal thigh, which can be observed in firstborns due to increased uterine pressure.[3] Another potential cause is decreased amniotic fluid, which limits the mobility of the fetal legs and predisposes to femoral head displacement. This condition is more prevalent in females and is more commonly observed on the left side.

In order to manage these conditions, it is essential to recall that the acetabular angle, which originates from the triradiate cartilage and extends to the anteroinferior iliac spine, is typically around 30° at birth. However, by one year of age, this angle should have reduced to approximately 20°.[4] This reduction can be achieved through the use of the Pavlik harness until the age of six months, after which the ring splint or Milgram splint can be employed.[3]

The milgram splint and the hoop splint are orthopedic devices utilized to correct hip dysplasia in children older than six months.[5] The objective of these devices is to achieve a neutral position of the hips, thereby ensuring that the femoral head remains within the acetabular cavity. The distinguishing feature of the aros splint is its more rigid construction, while the milgram splint is more flexible. In children with hip dysplasia, the choice of splint depends on the specific condition.

After six months of age, there is debate regarding the best course of therapy; spontaneous remission of DDH is improbable.[6] Abduction orthoses are often employed for this patient group since treating patients with Pavlik harnesses is difficult once the child is six months old. Nevertheless, there is not enough data in the literature to justify the use of these devices, especially in kids whose hips are stable but dysplastic.[7] When comparing part-time bracing to observation alone, Gans et al found that part-time bracing produced superior outcomes.[8] The usefulness of full-time bracing for residual acetabular dysplasia (RAD) and the influence of prior Pavlik harness use on the outcome of abduction orthosis therapy were assessed in the research by Yılmaz et al.[9] The existing literature on the use of ring splints or milgram splints is limited, and there is a paucity of information on the differences between the two types of devices. Therefore, it was deemed necessary to prepare this article, which presents the results of a study comparing the use of each type of abductor device in a cohort of patients.

The objectives of this study were to evaluate the effectiveness of two types of orthopedic splints, the ring splint and the milgram splint, in treating developmental dysplasia of the hip (DDH). The study aimed to compare the outcomes of these splints in terms of their ability to correct hip dysplasia, assess changes in the acetabular angle on radiographic imaging as a measure of treatment success, and analyze differences in treatment response between male and female patients.

METHODS

A retrospective observational study was conducted at San Francisco de Quito General Hospital to investigate the effectiveness of two types of orthopedic splints in the treatment of developmental dysplasia of the hip from the period of January 2022 to January 2023. Patients diagnosed with hip dysplasia between 3 and 4 months of age, who were prescribed treatment with orthopedic splints starting at 6 months of age, were selected. Purposive sampling was used in the study as it aimed to evaluate a special type of orthopedic splint in a special type of patient.

Inclusion criteria

Fifty-three patients who met the inclusion criteria, diagnosed with hip dysplasia and treated at the Hospital General San Francisco, were included.

Exclusion criteria

Patients who did not complete treatment with orthopedic splints or who had other concurrent orthopedic conditions were excluded.

The sample size of 53 was calculated based on the availability of eligible participants that met the specific criteria in a specific time frame. Patients were treated with two types of orthopedic splints: the ring splint and the milgram splint. Radiographic measurements of the acetabular angle were taken at 6 and 12 months after initiation of treatment with the orthopedic splints. Initial radiographs were compared with subsequent radiographs to evaluate the effectiveness of treatment in correcting hip dysplasia.

Strict ethical guidelines were followed by the study, and the ethics committee of San Francisco de Quito General Hospital reviewed and approved the criteria. Informed consent was obtained from the participants and guardians, they were informed about the objectives of the research and usage of their data in future for research purposes. Also, participant's confidentiality was maintained through pout the study.

Statistical analysis

Descriptive analysis was employed to summarize the demographic characteristics of the patients and the distribution of the types of orthopedic splints utilized. A chi-square analysis was conducted to evaluate the association between splint type and acetabular angle improvement. Additionally, the averages of reduced acetabular angles between the two treatment groups were compared. A p value of $p<0.05$ was considered statistically significant.

The results were analyzed in terms of frequency and contingency tables, with relevant statistical analyses also presented. The clinical implications of the findings were

discussed, and recommendations for clinical practice based on the results obtained were provided.

RESULTS

Fifty-three patients with hip dysplasia diagnosed between 3 and 4 months of age at the Hospital General San Francisco were analyzed, for which anteroposterior radiographic plates of the pelvis in a neutral position were requested. Our study began at 6 months, after the use of the Pavlik harness for a variable period of 1 to 3 months. At 6 months the aro splint or milgram splint is suggested to continue the treatment, this choice was made by the treating physician in agreement with the parents of the patients based also on the cost of the orthopedic device.

Initially, the number of patients who used the different treatments was evaluated. In female patients, 67.4% used the aro splint and 32.6% the milgram splint, while in male patients 60% used the aro splint, and 40% the milgram splint. As previously known, dysplasia occurs mostly in women, which is why 43 (81.1%) patients were female and 10 (18.9%) were male (Table 1).

Table 1: Frequency table.

Sex	Splint type	Frequency	Percent	Valid percent	Cumulative percent
Male	Aro	6	60.000	60.000	60.000
	Milgram	4	40.000	40.000	100.000
	Total	10	100.000		
Female	Aro	29	67.442	67.442	67.442
	Milgram	14	32.558	32.558	100.000
	Total	43	100.000		

The acetabular angle was analyzed at 6 months and then at 12 months after treatment with the different splints. A total of 35 patients used the aro splint, of which 13 (37.1%) reached the optimal angle and 22 (62.9%) failed to reach this value. On the other hand, 18 patients used the milgram splint as treatment, of which 8 (44.4%) reached the optimal angle and 10 (55.6%) failed to reach the corresponding degrees (Table 2). A p value of 0.607 was obtained, which does not establish a significant difference (Table 3).

Table 2: Comparison of optimal angle achievement with different splints.

Splint type	Optimum angle		
	No	**Yes**	**Total**
Aro	22	13	35
Milgram	10	8	18
Total	32	21	53

Table 3: Chi-squared test.

Chi-squared tests	Value	df	P value
X^2	0.265	1	0.607
N	53		

However, several patients started with extremely high angles and managed to decrease significantly but did not reach the optimal angle (Figures 1 and 2). Due to this aspect, the degrees decreased were analyzed, which were 292 degrees, 199 with hoop splint and 93 with milgram splint, the average of the milgram splint was 5.16 and of the hoop splint 5.69 (Table 4).

Finally, the treatment time in months was analyzed in both groups and it was found that the greatest number of patients in both the aro splint and the milgram splint had approximately 5 months to reach the optimal angle (Table 5).

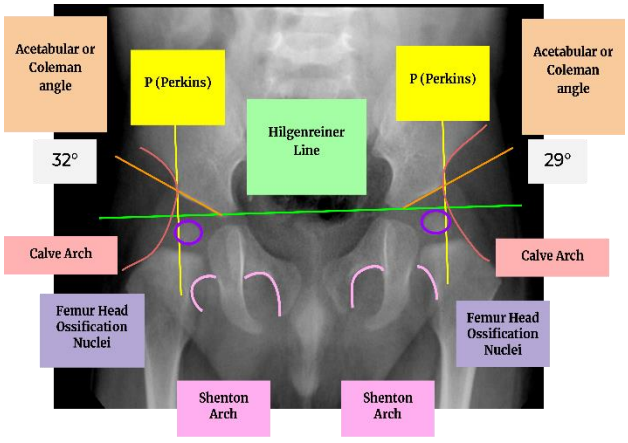

Figure 1: The accompanying X-ray corresponds to one of the study participants whose acetabular angles were measured using several standard techniques. These included the Shenton angle, the Calve angle, the Hilgenreiner line, the acetabular or Coleman angle, the P or Perkins line, as well as the Putin quadrants. The acetabular angle was found to be 40 and 42 degrees, respectively, at six months.

Table 4: Comparison of reduced acetabular angles with different splints.

Splint	Reduced angles	Average	Frequency
Aro	199	35	5,69
Milgram	93	18	5,16
Total	292	53	5,50

Table 5: Comparison of treatment time to reach optimal angle.

Slint type	Treatment time (months)						Total
Milgram	8	7	3	3	11	3	35
Aro	5	2	1	1	7	2	18
Total	13	9	4	4	18	5	53

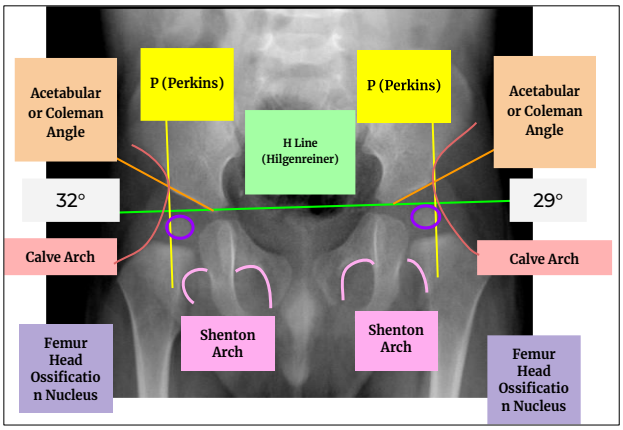

Figure 2: Same patient after six months of treatment with a milgram splint.

The angles obtained after treatment were 32 and 29, respectively. While not reaching the optimal angle, there is a clear decrease compared to the initial radiograph.

DISCUSSION

Developmental dysplasia of the hip is an orthopedic condition with relative frequency in newborns, which can result in malformation of the hip joint if not adequately treated. The therapeutic approach to correct this condition has been the subject of debate and study over time. In particular the use of orthopedic splints such as the Pavlik harness, milgram splint, and ring splint, among others.[10] These have been widely considered as an effective method for the non-invasive treatment of hip dysplasia in patients from 6 months of age, since up to this age the Pavlik harness is the best therapeutic measure.[11] The use of splints aims to correct the position of the hip and allow adequate development of the joint. However, the effectiveness and comparison between different types of splints in the correction of hip dysplasia have been issues of particular importance in determining the best therapeutic option. Therefore, it is concluded that the use of abduction orthoses in patients older than 6 months of age is the treatment of choice in residual acetabular dysplasia.[12]

Two different types of splints were used in our study, but the results showed no significant difference in the ability to bring patients to the optimal acetabular angle between the ring splint and the milgram splint. Approximately one-third of patients in both groups reached the optimal angle, while a similar proportion failed to achieve this goal. Although a higher proportion of patients using the aro splint than the milgram splint were unable to achieve the ideal angle, this difference was not statistically significant. These findings imply that, at least in terms of acetabular angle reduction, both splints are equally effective in treating DDH.

Notably, several patients showed considerable decreases in acetabular angles after therapy with either splint, even if they did not attain the ideal angle. This result emphasizes how crucial it is to keep an eye on patients' development in addition to reaching the ideal angle. Significant acetabular angle improvements may still lead to improved hip stability and function, which are important outcomes in the therapy of DDH, even if the ideal angle is not reached.[13]

Two noteworthy studies provide pertinent insights when comparing the results of this study to previous research. Yılmaz et al looked into the effects of prior Pavlik harness use on abduction orthosis therapy as well as the efficacy of full-time bracing in cases of RAD.[9] Their findings showed a substantial decrease in acetabular index (AI) values after hip abduction orthosis therapy, with no discernible difference in AI development between patients who had previously had Pavlik treatment and those who had not. This is consistent with what we found in our trial, which shows that both splints efficiently decrease acetabular dysplasia independent of prior treatment techniques.

Similarly, the effectiveness of abduction orthosis in treating primary acetabular dysplasia (AD) was assessed by Yüksel et al.[14] Their research showed that therapy with abduction orthosis resulted in considerable improvements in AI values, highlighting the need of early intervention in patients of primary AD. It's interesting to note that within the first six months of therapy, dysplastic hips improved more in AI than non-dysplastic hips. This result is similar with the faster improvement we saw in our trial during the first stage of treatment.

The research also looked at how long it took to get both splints to the ideal position. It's interesting to note that most patients in both groups needed around five months to get this result. This shows that, regardless of the kind utilized, there may be a constant period for finding meaningful changes in acetabular angles using orthopedic splints. Clinicians may better manage patient expectations and enhance treatment plans by having a better understanding of the average length of therapy.

In addition, the research confirmed previous findings by emphasizing the prevalence of DDH in female patients. This emphasizes how crucial it is to identify problems connected to DDH early on in a baby's infancy and take appropriate action to reduce the risk.

The statistical data in this article gives us to understand that both the hoop splint and the milgram splint are viable options in the treatment of developmental hip dysplasia both being abduction methods giving the option that each physician can freely choose either of the two their preferences and the specific conditions of each patient, one

of these is the price, which is higher for the acquisition of the milgram splint so many physicians take this into account given the conditions in which the population of Ecuador is.

Limitations

It should be noted that the relatively small sample size and the retrospective nature of the study may limit the generalizability of the results. Furthermore, the lack of randomization in the allocation of orthopedic splint types may introduce bias into the analysis.

CONCLUSION

According to the study, individuals with DDH may effectively reduce acetabular angles and repair hip dysplasia by using either the aro or milgram splint. Acetabular angles were significantly reduced with either splint therapy, and most patients reached optimum angles around five months after starting treatment. Crucially, the efficiency of the two splints did not significantly vary from one another. These results highlight the therapeutic usefulness of both splints as effective DDH treatment choices, giving physicians freedom in selecting the best tool depending on unique patient preferences and features. To validate these results and improve therapy regimens for DDH patients, further investigation including bigger cohorts and randomized controlled trials is necessary, considering the retrospective design of the study and its relatively small sample size.

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