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Treatment results of patients with developmental dysplasia of the hip, who were treated with tubingen hip flexion splint

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Abstract

Developmental dysplasia of the hip (DDH) can be treated successfully with early diagnosis and conservative methods. In this study, we evaluated the results of patients with DDH who were treated with Tubingen hip flexion splint (THFS). The results of patients with DDH who were treated with a Tubingen hip flexion splint (THFS) were retrospectively evaluated. 75 hips of 50 patients were evaluated in the study. According to the Tönnis Stage system, 49 of the hips were dysplasia, 18 of the hips were subluxations, and 8 of the hips were dislocations. The mean age at the time of starting the THFS was 3.48 (1.5-5.5) months, and the duration of treatment was 5.5 (3-9) months. Ultrasonographically normal hip (Graf type 1) and/or sufficient acetabular index values with concentric hip reduction and hips without avascular necrosis of the femoral head were considered successful results. Treatment of four patients in this study failed. 3 of these patients were female. 3 of the failed patients had left hip dysplasia, and one had right hip dysplasia. There was no significant relation between hip side and treatment success ($p = 0.638$). None of the patients had avascular necrosis. The overall success rate was 92%. As a result of this study, we observed that THFS is an effective treatment option for DDH treatment.

Keywords: developmental dysplasia of the hip, treatment, tubingen splint, graf

1. Introduction

Developmental dysplasia of the hip (DDH) is a common orthopedic abnormality in infants and young children. DDH is a clinical entity that expresses developmental disorders that may occur before, during, or after birth. The incidence ranges between 1.6 and 28.5 per 1000 live births among different racial groups depending on the definition of the DDH (1).

Early diagnosis and treatment is critical for the DDH treatment. If the diagnosis is not made promptly, it can lead to severe consequences such as hip pain and limping in adulthood. Therefore, early hip reduction is necessary to achieve satisfactory results. Currently, many different methods are available for the treatment of DDH. Maintaining hip reduction is important for the conservative treatment of DDH and many orthoses such as the Frejka pad, the Pavlik harness, the von Rosen brace, the Ilfeld brace, and the Tubingen hip flexion brace can be used for that aim (2).

The Tubingen hip flexion splint (THFS) was first introduced in the 1990s as an alternative to Pavlik harness. The Tubingen splint has an adjustable abduction bar which allows adjustment to the desired abduction angle. THFS provides abduction. In addition to that it provides the advantages of preventing hip adduction and the knee and ankle joints remain free to move. Some studies report that THFS for the early treatment of DDH has the same or better results than the Pavlik harness and causes less avascular necrosis (AVN) (2). THFS has been reported to be an effective treatment modality in infants with DDH (3).

In this study, we aimed to report the results of our DDH patients who were treated with THFS.

2. Materials and Methods

The results of patients diagnosed with developmental hip dysplasia, who presented at the Orthopedics and Traumatology Department of Ondokuz University Faculty of Medicine between July 2014 and April 2017 and treated with Tubingen hip flexion splint were evaluated retrospectively. 75 hips of 50 patients were included.

The same research team examined all of the patients and made diagnosis. THFS was applied within 24 hours after diagnosis. At the diagnosis stage, physical examinations of all patients were performed, Ortolani test, Barlow test, and abduction limitation were evaluated and recorded.

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All patients underwent ultrasonography according to the Graf method for the diagnosis of the DDH. Patients with Graf type 2a and above hips were included in the study. The study did not include patients with myelomeningocele, neuromuscular and collagen connective tissue disease, and teratological hips. Due to the ossification of the femoral head epiphysis in the 4th and 6th months, direct anterior-posterior pelvic radiography was taken in addition to ultrasonography for the patients who were older than four months and whose follow-up exceeded four months. Measurements were made and recorded. On the radiographs, the Shenton-Menard line and the position of the femoral head relative to the Perkin line were carefully evaluated and noted. Acetabular index measurements were noted.

The patient's hips were considered dysplastic, subluxated and dislocated and classified according to the Tönnis staging system. Conversion to Graf 2b for Graf type D and Graf type 2c, 2b or 1 for type 3 and 4 was evaluated by hip ultrasonography at intervals of 2-4 weeks. The relationship of the femoral heads and the acetabulum were evaluated by the acetabular index angle in direct anteroposterior pelvis radiographs for the patients older than six months. Criterias for successful treatment were cases with normal hips detected in ultrasonography; reduction of the femoral heads concentrically to the acetabulum on direct anterior-posterior pelvis radiography (stage 1 according to the Tönnis staging system), sufficient acetabular index value and patients without avascular necrosis. Patients who did not meet this criterias were considered unsuccessful.

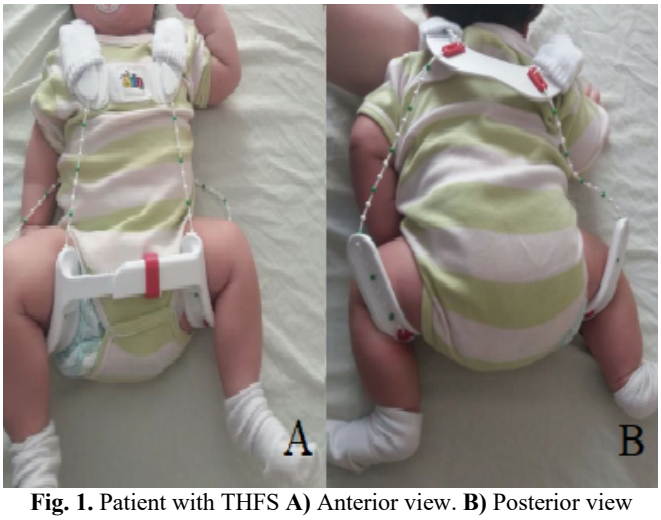

Fig. 1. Patient with THFS **A)** Anterior view. **B)** Posterior view

THFS was applied within 24 hours after obtaining family consent in all patients for whom treatment decision was made. Initially, flexion was set to 90-110 degrees and decreased to 70° as treatment progressed (Fig. 1). The child was allowed to perform 10-15 degrees of passive abduction.

Concentric reduction of the femoral head was confirmed by ultrasonography and/or direct anteroposterior pelvic radiography. Cases that concentric reduction could not be achieved were followed up for two weeks. If reduction was achieved at the end of this period, the treatment continued. In cases where the reduction was not achieved, other treatment methods were used. In patients with reduction achieved, flexion was gradually reduced to 70 degrees. THFS was applied 24 hours a day for at least six weeks in all patients. In cases with stable and adequate acetabular index values on ultrasonography and/or direct anterior-posterior pelvic X-ray, treatment was continued for 14 hours a day (during sleep) for 4-10 weeks, depending on the severity of dysplasia. Controls examination of the patients were planned with gradually increasing intervals until the skeletal maturity was completed.

The obtained data were statistically tested using the program (IBM SPSS Statistics for Windows, Version 21.0. Armonk, NY: IBM Corp, 2012). Fisher's Exact test was used to evaluate success according to values such as gender, side, age at onset of treatment and examination findings. $p<0.05$ was taken as a criterion for statistical significance.

3. Results

In this study, 50 patients (40 female, 10 male; 75 hips) were evaluated. There was a family history for DDH in 8 of the cases, breech presentation in 2 and swaddling in 2 of the cases. 20 patients with 35 DDH hips were the first children of their parents. 49 hips of the patients were evaluated as dysplasia (65.3%), 18 hips were subluxated (24%), and 8 hips were dislocated (10.6%) (Fig 2). The mean duration of treatment with splint was 5.5 (3-9) months. 4 out of 50 patients, the treatment was unsuccessful. 3 of them were female and 1 was male. 3 of the failed patients had left hip dysplasi and 1 had right hip dysplasia. No significant correlation was found between hip side and success (p=0.638).

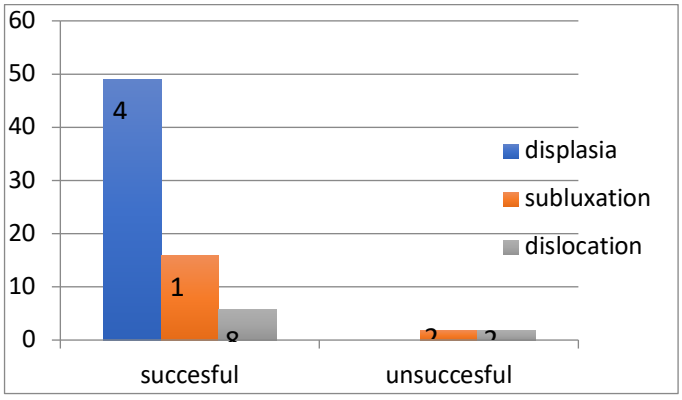

Fig. 2. Graph of success and failure according to hip type of patients

The overall success rate was determined as 92%, considering the number of patients. It was observed that 2 of the 4 unsuccessful patients had type 3 and 2 of them had type 4 irreducible hips according to the ultrasonography results. These patients were referred from another center and the mean age at presentation was 5 (4-5.5) months.

In our study, 25 patients had bilateral, 19 patients had isolated left hip, 6 patients had isolated right hip dysplasia. Successful results were obtained in all 25 patients with bilateral involvement. It was determined that 3 of the 4 failed patients

had left hip involvement and 1 had right hip involvement. There was no statistically difference between the right and left hips in terms of the success of the treatment ($p>0.05$). The success rate was 94.7% according to the number of hips treated. The failure rate was found to be higher in hips that were found to be dislocated and/or types 3 and 4 on ultrasonography compared to the others. Femoral head aseptic necrosis did not occur in any of the patients during the follow-up period. Closed reduction and pelvipedal cast were applied to 4 patients who failed reduction.

In the last controls for 3 of our treated patients, stage 1 according to Tönnis criteria, normal on ultrasound, but minimal acetabular dysplasia was present in the final control radiographs, while hip maturation was completely normal in all the remaining 43 patients. Case examples of this study are presented in Fig. 3.

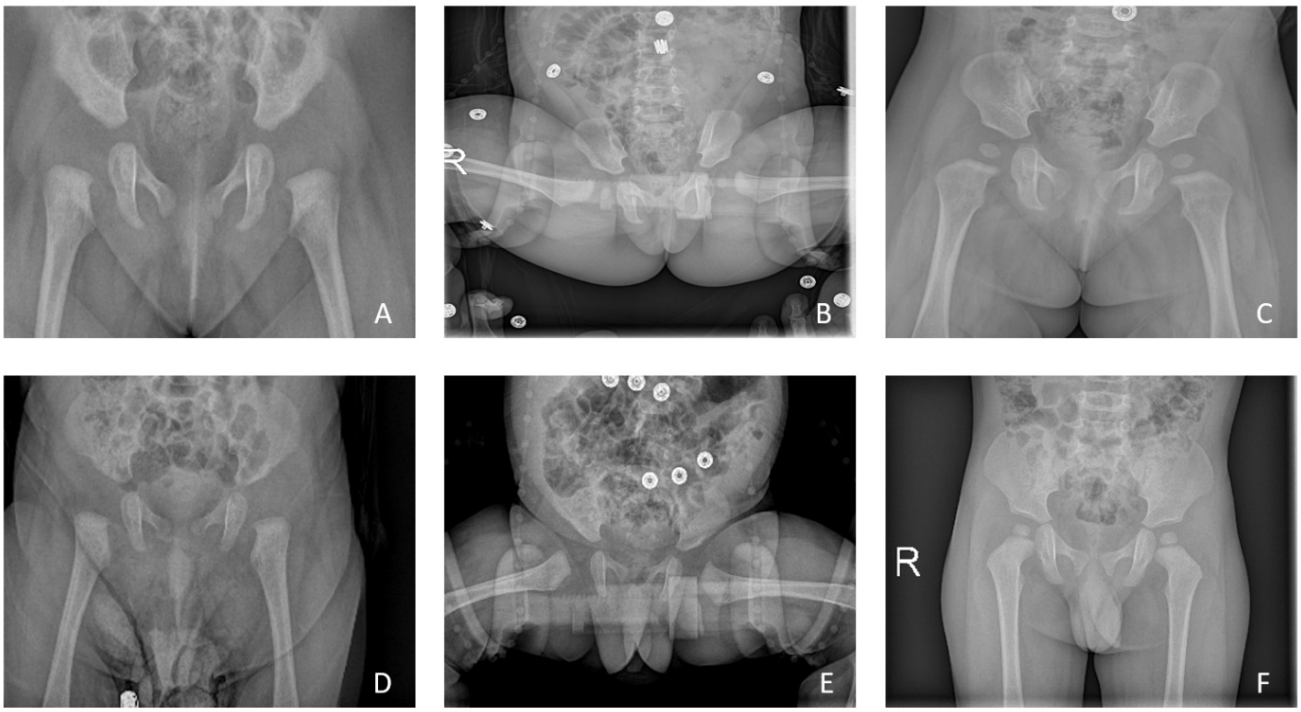

Fig. 3. Case examples of this study. A) First hospital admission (4 months) radiography. B) After applying the Tubingen hip flexion-abduction splint. C) 9th-month control radiography. D) Another patient, first hospital admission (4 months) radiography. E) After applying the Tubingen hip flexion-abduction splint. F) 19th-month control radiography

4. Discussion

Developmental dysplasia of the hip (DDH) is a disease which can be successfully treated with early diagnosis and conservative methods. The primary goal in treating developmental dysplasia of the hip is to achieve the concentric reduction by keeping the hip in flexion and abduction and maintaining this condition without avascular necrosis of the femoral head (4).

DDH is a disease with multifactorial etiology. Positive family history and breech presentation are the most common risk factors for DDH (5).

In the study by Pavone et al. (6) published in 2015, 10,274 hips of 5137 infants in the first three months of life in Italy were examined. As a risk factor, a breech presentation was found in 10.09% of patients, and positive family history was found in 7.12% of patients. In our study, five patients (10%) had a positive family history, and 2 (4%) patients had a breech presentation. Köse et al. (5) reported that positive family history was the most common risk factor. According to this study, DDH occurred in 1.34% of 4173 babies swaddled in Central Anatolia. Swaddling was detected in 2 (4%) of our patients. Despite many studies conducted over the years, the swaddling of babies is still common in our country, as seen in this study. Therefore, it continues as a risk factor.

In our study, the success rate was 94.7%. One of the factors affecting the treatment process is the Graf stage at the beginning of the treatment. Van de Sande et al. (7) reported 73% success rate for Graf type 3 and 30% success for Graf type 4. it is seen that the success rates are low especially in Graf type 4 patients. Sluijs et al. (8) stated that prolonged treatment was useless in Graf type 4. Walton et al. (9) reported that the patients they treated with the Pavlik bandage were unsuccessful in all of the dislocated and irreducible patients and that the Pavlik bandage was not an effective treatment method for this group. In the study of Seidl et al. (10) forty-nine of the fifty patients (98%) were successfully treated, and the only patient who failed was a child with type 4 hip. In this study, the failure rate was found to be higher in hips that were found to be Graf type 3 and 4. Similar to literature, we suggest that as the stage increases, the success rate decreases.

Among the researchers who started early treatment, Bin et al. (11) reported the mean age of starting treatment as five days, Atalar et al. (12) as eight weeks, and Uçar et al. (13) as 14.8

weeks. In some other studies, treatment was started at an average age of 4 months, similar to our research (4, 14). When we compare the studies performed with Tubingen hip flexion-abduction splint with our research, although we have a later onset age, similar success rates (92%) were observed, so we think there is no significant relationship between the age of onset of treatment.

Proximal femoral avascular necrosis rates have been reported between 2.38% (15) and 20% (16) in patients treated with the Pavlik bandage. It has been suggested that more than 110 degrees of flexion are the leading cause of avascular necrosis. The major factor for avascular necrosis in DDH treatment is forced abduction and flexion (17, 18). During treatment with THFS, abduction is adjustable with the rigid part of the splint between legs. In our study, we adjusted the splint so that 10° to 15° of passive abduction was possible.

In the literature, hip flexion was adjusted between 80 and 110 degrees in studies with a Pavlik bandage (11, 12, 19), and it is consistent with our study. In our study, flexion was set to 90-110 degrees and gradually decreased to 70° as treatment progressed to prevent avascular necrosis of the femoral head. Atalar et al. (12) stated that less than 90 degrees of flexion will direct the femoral head to the acetabulum's superior and is unsuitable for reduction.

It has been stated that parental compliance is essential for the treatment with Tubingen to be successful (10). In our study, attention was paid to family harmony, detailed information was given, and the appropriate use of the splint was ensured. And quadriceps muscle function were examined at every follow-up visit.

In our study, femoral nerve palsy and avascular necrosis of the femoral head was not reported during the Tubingen splint treatment, and no skin problems were encountered.

Grill et al. (15) noted that the straps preventing adduction caused a skin problem, negatively affecting the family and child harmony.

It has been stated that parental compliance is essential for the treatment with Tubingen to be successful (10). In our study, attention was paid to family harmony, detailed information was given, and the appropriate use of the splint was ensured.

THFS allows free movement of the knees and ankles and it is easy to use, practical, family-friendly, and easy to clean thanks to its plastic structure. As a result of this study, the Tubingen hip flexion-abduction splint is an effective and successful method for treating developmental dysplasia of the hip.

Conflict of interest

The authors declared no conflict of interest.

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None to declare.

Authors' contributions

Concept: İ.B., Design: İ.B., D.K., Data Collection or Processing: H.Ç., Analysis or Interpretation: E.S., Literature Search: A.Ç., Writing: İ.B., A.Y.

Ethical Statement

Approval was obtained from Ondokuz Mayıs University Clinical Research Ethics Committee, the study started. The ethics committee decision date is 20/07/2017 and the number of ethical committee decisions is 2017/260.

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