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Research Article

Effects of developmental dysplasia of the hip screening program on the treatment strategies: A retrospective study from a tertiary care hospital in the southeast region of Turkey

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ABSTRACT

Objective: The aim of this study was to investigate the effects of the developmental dysplasia of the hip screening program on the treatment procedures in a tertiary health care center.

Methods: We retrospectively reviewed all the DDH patients between 2012 and 2019 from the operating theatre records. The patients were separated based on the year of treatment. The rates of each treatment modality were determined respectively from 2012 to 2019, and Pavlik harness usage of the patients were queried. The changes in the rates of several surgical interventions after the start of screening program were identified.

Results: Between 2012 and 2019, 831 interventions were applied to 711 DDH patients. Closed Reduction (CR) is the least invasive treatment method, and it increased significantly from 20% to 46%. The rate of Open Reductions (OR) also increased from 3% to 9% at this time period, but it was statistically insignificant. Conversely, Pemberton-Salter Osteotomy (PSO) and Dega-Chiari Osteotomy (DCO) rates decreased significantly (41% to 28% and 9% to 0%, respectively). The rate of Pemberton-Salter osteotomy with femoral shortening (PSO-FS) rate decreased insignificantly from 27% to 20%. In patients that used Pavlik harness, the most common intervention was CR (83%). In CR group, the screened newborn rate increased more than two times from 2012 to 2019.

Conclusion: The results of this study have shown that after the initiation of the screening program for DDH, less invasive treatment modalities such as CR and OR interventions increased, and major bony procedures such as PSO, PSO-FS and DCO interventions decreased. Furthermore, as the screening program advanced, CR rate and the use of Pavlik harness rate in CR interventions increased.

Level of Evidence: Level IV, Therapeutic Study

Introduction

Developmental Dysplasia of the Hip (DDH) includes alignment impairment of the hip joint and/or abnormal growth of the femur and acetabulum in newborns.[1] The incidence ranges between 1.6 and 28.5 per 1000 live births among different racial groups and depending on the definition of the DDH.[2] Early diagnosis and treatment are key factors for improved outcome. In this context, different screening strategies are established in many countries.[3,4]

Screening programmes include only clinical examination or a combination of the clinical and ultrasonographic examinations.[5,6] Ultrasonographic examination can be applied universally for all newborns or selectively for only high risk groups.[5] The optimal screening program should decrease the incidence of late presentation of DDH effectively and at the same time should not cause over diagnosis and over treatment.[1] There are several studies comparing different screening strategies, but there is no agreement on the optimum screening program yet.

In Turkey, screening program includes clinical examination and selective ultrasonographic examination. Clinical examination is applied to all newborns by primary care physicians, and risky newborns are examined sonographically. Training of the primary care physicians for the screening program started firstly in 2010. The pilot screening program was started in 2013, and countrywide screening program started in 2014. Then, several updates were done till today.[7] As the screening program in Turkey has been emerged since 2010, we expect some changes in the rates of late presentation and surgical interventions. Cases diagnosed after eight weeks are identified as late presentation.[5] The delay time for late presentation is variable, and it is prolonged in the southeast region of Turkey. As the delay is longer, surgery rates increase and also the invasiveness of the surgeries increases.[8] We do not have the records of the screened infants, so we cannot put forth the exact late presentation and surgery rates. Our aim is to show the effect of the screening program on the treatment procedures in a tertiary health care center. We hypothesised that screening program

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decreased the incidence of late presentation and decreased the invasive treatment rates and increased the less invasive treatment modality rates. Also change in the rates of Closed Reduction (CR) and distinct surgical interventions will show us the difference of no screening and selective screening indirectly.

Materials and Methods

This retrospective study was conducted between January 2012 and December 2019 in Harran University School of Medicine. The study protocol was approved by the local ethics committee (Harran University School of Medicine, 26.03.2020-E14380). Inclusion criteria were the application of CR or surgical treatment with a diagnosis of DDH. Exclusion criteria were a diagnosis of arthrogryposis, neuromuscular disease or any other syndrome related with DDH.

We retrospectively reviewed all DDH patients from the operating theatre records. The patients were separated based on the year of treatment. The rates of each treatment modality were determined, respectively, from 2012 to 2019. Our cohort included the patients who were treated with CR or surgically. To put forth the rates of the screened patients among this cohort, we called all of the parents by phone and asked to the accessible parents whether their child had been screened for DDH and whether Pavlik harness had been applied to their child after the diagnosis of DDH.

The patients were treated with distinct methods; CR, open reduction (OR), OR plus Pemberton or Salter Osteotomy (PSO), OR plus PSO with Femoral Shortening (PSO-FS) and Dega or Chiari Osteotomy (DCO). CR and the surgical interventions were applied under general anesthesia. We applied pelvipedal cast after all interventions.

In our general practice, CR is applied to the patients between 0 and 6 months of age in case of a failed Pavlik harness treatment and to the patients between 6 and 18 months of age. In case of a failed CR, OR is applied. After 18 months, innominate osteotomies like PSOs are applied with or without OR, and in need, femoral osteotomy is added. DCOs are applied in the complicated and older aged patients.

In Turkey, according to the national DDH screening program, all neonates are examined clinically, and at risk neonates are selectively examined sonographically. After birth, all the neonates are questioned about risk factors before discharging from hospital. If the neonates are in the risky group, they are referred to the radiology department for ultrasonographic examination. Risk factors are: having first or second degree relatives having DDH, being first born female neonate, multiple pregnancies, amniotic fluid anomalies, breech posture, having foot deformities, plagiocephaly, scoliosis, pelvic obliquity, hip abduction restriction, congenital torticollis and swaddling. If there are no risk factors, the neonates are examined by primary care physicians at 41th day of birth. In case of having hip instability or any positive risk factor at this examination, infants are referred to the radiology department for ultrasonographic examination.[7]

Statistical analysis

Segmented regression analysis were done using 4.7th version of the Joinpoint software, which have an access in the National Cancer Institute website (https://surveillance.cancer.gov/joinpoint/). To calculate the hospital application tendency and the number of exchange points, segmented regression model was used. Maximum three joint point (subgroups) within 9 years were allowed to test that an apparent change in trend is statistically significant. Annual Percent Change (APC) values and 95% confidence intervals were calculated. Years (2012 to 2019) were independent variables, and the numbers of applications were dependent variables in the regression model. Logarithmic transformation was applied to the application numbers. To determine the most appropriate model, least squares method was used. For estimation of regression parameters, Grid Search method was used. Additionally, to determine the segment numbers, permutation test and Bayesian Information Criteria were used.

Results

Of the 711 patients included in the study, 325 (45.7%) had bilateral and 386 (54.3%) had unilateral (148 right-20.8% and 238-33.5% left) DDH. The number of female patients was 562 (79%). The median age of the patients was 18 months (minimum 3, maximum 132 months).

Eight hundred and thirty one discrete interventions were applied to study patients. Between the years 2012 and 2019, 263 CR, 42 OR, 308 PSO, 178 PSO-FS and 40 DCO interventions were applied (Table 1).

The annual number of the CRs between the years 2012 and 2019 is presented in Table 1. APC was 12.5. Annual rates increased significantly ($P < 0.05$) between 2012 and 2019 from 20% to 46% (Figure 1).

For ORs, APC was 20.7 and annual rates increased insignificantly ($P = 0.100$) between 2012 and 2019 from 3% to 9% (Figure 2).

The annual number of the PSOs is presented in Table 1. APC was −6.8. The annual PSO rates decreased significantly between 2012 and 2019 from 41% to 28% (Figure 3).

HIGHLIGHTS

- Early diagnosis and treatment are key factors for improved outcome in DDH.
- Pavlik harness is the first choice treatment in early diagnosis of DDH.
- In Turkey, screening program for DDH increased Pavlik harness usage rate, accordingly decreased major surgery rate.

Table 1. Numbers and Rates of the Interventions Between 2012 and 2019

		Intervention				
		Closed Reduction	Open Reduction	Pemberton–Salter	Femoral Shortening	Chiari–Dega
		Count-Rate	Count-Rate	Count-Rate	Count-Rate	Count-Rate
Year	2012	20–20%	3–3%	41–41%	27–27%	9–9%
	2013	17–21%	2–3%	37–45%	20–24%	6–7%
	2014	20–22%	3–3%	40–43%	22–24%	7–8%
	2015	32–29%	1–1%	50–45%	16–15%	11–10%
	2016	31–36%	3–3%	32–37%	15–17%	6–7%
	2017	28–31%	6–7%	38–41%	18–20%	1–1%
	2018	44–37%	15–13	29–25%	30–25%	0–0%
	2019	70–46%	9–6%	42–28%	30–20%	0–0%
Total	2012–2019	263–100%	42–100%	308–100 %	178–100%	40–100%

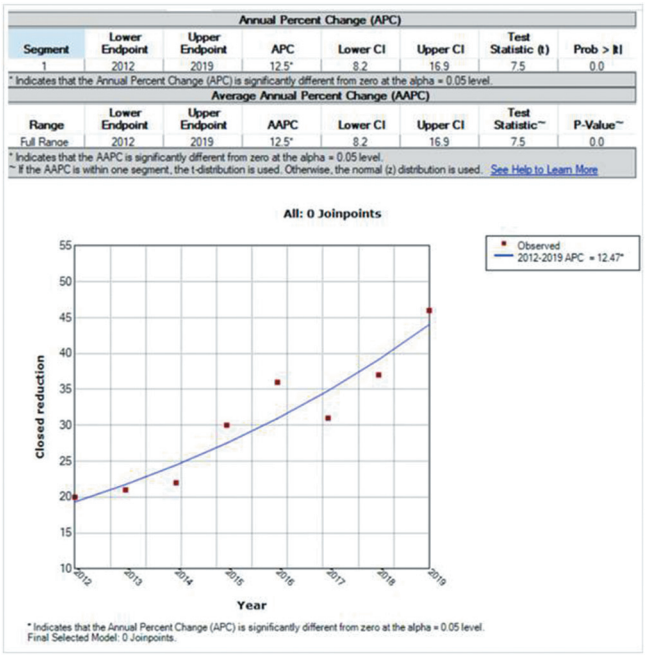

Figure 1. CR annual rate increased significantly ($P < 0.05$) between 2012 and 2019. APC is 12.5 (a,b).CR, Closed Reduction; APC, Annual Percent Change.

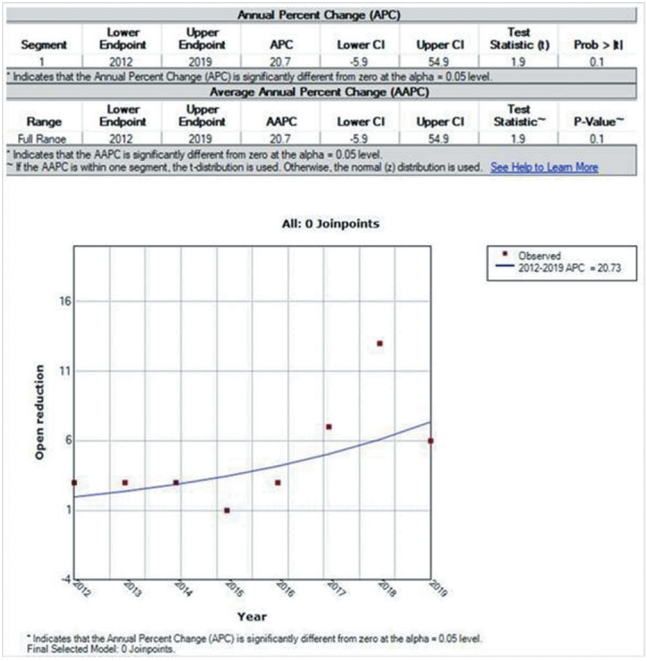

Figure 2. OR annual rate increased insignificantly ($P = 0.1$) between 2012 and 2019. APC is 20.7 (a,b). OR, Open Reduction; APC, Annual Percent Change.

The rate of PSO-FSs was decreased from 27% to 20% between 2012 and 2019, but the decline rate was not significant ($P = 0.400$) (Table 1) (Figure 4). APC was −2.7.

The annual number of the DCOs is presented in Table 1. APC was −37.9. Annual rates decreased significantly between 2012 and 2019 from 9% to 0% ($P < 0.05$) (Figure 5).

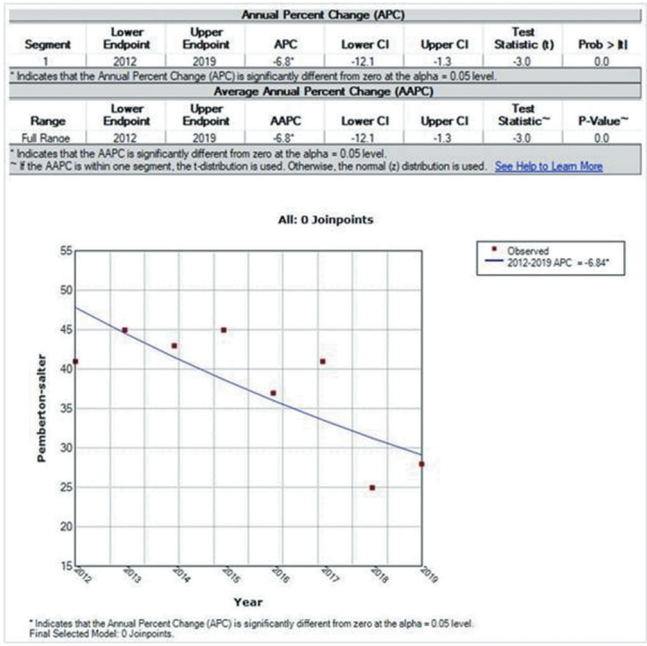

Figure 3. PSO annual rate decreased significantly ($P < 0.05$) between 2012 and 2019. APC is −6.8 (a,b). PSO, Pemberton–Salter Osteotomy; APC, Annual Percent Change.

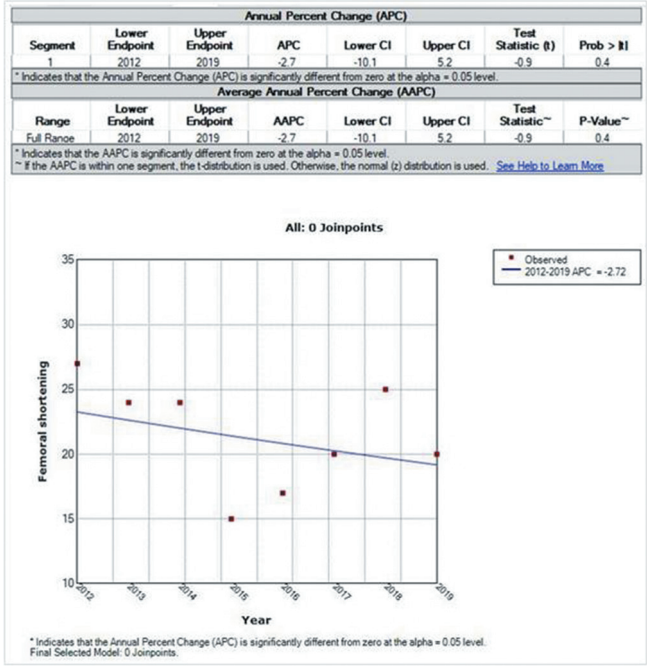

Figure 4. PSO-FS annual rate decreased insignificantly ($P < 0.05$) between 2012 and 2019. APC is −2.7 (a,b). PSO: Pemberton–Salter Osteotomy; APC, Annual Percent Change.

APC for CRs, PSOs and DCOs remained the same over 9 years, so no joint point was found statistically significant.

We reached 379 of the 711 patients who were called and asked for Pavlik harness usage. Four hundred and forty one discrete interventions were applied to these 379 patients. Of the 441 interventions, 184 (42%) were CRs, 30 (7%) were ORs, 168 (38%) were PSOs, 50 (11%)

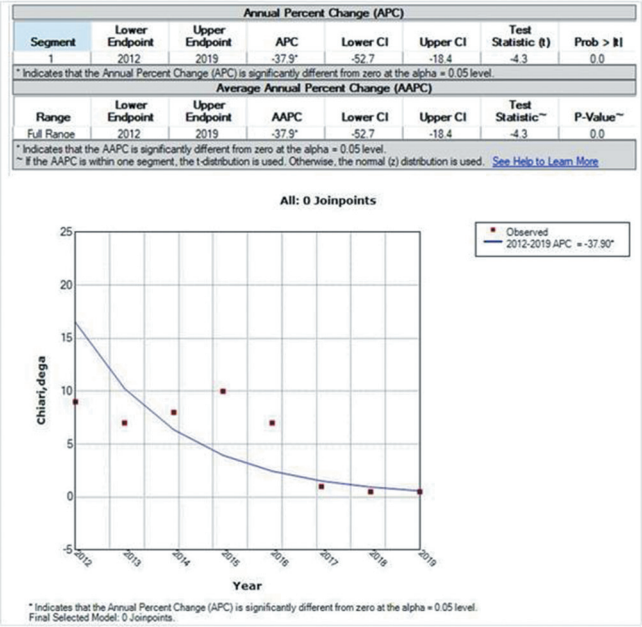

Figure 5. DCO annual rate decreased significantly ($P < 0.05$) between 2012 and 2019. APC is −37.9 (a,b). PSO, Pemberton–Salter Osteotomy; APC, Annual Percent Change.

were PSO-FSs and 9 (2%) were DCOs. One hundred of the 379 patients and 27% (117/441) of the interventions had Pavlik harness usage history. Among these 117 interventions, 97 (83%) of them were CR, 7 (6%) of them were OR and 13 (11%) of them were PSO.

Pavlik harness usage rate in the CR group at 2012 was 29%. APC was 16 and harness usage rates increased significantly ($P < 0.05$) and reached to 68% at 2019 (Figure 6). In OR group, 7/30 (23%) of them

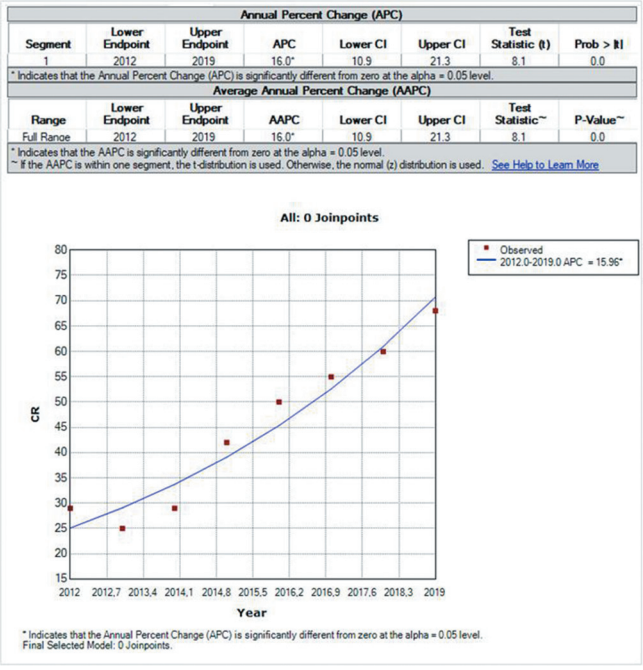

Figure 6. Pavlik bandage usage rates in CR group increased significantly ($P < 0.05$) between 2012 and 2019. APC is 16 (a,b). CR, Closed Reduction; APC, Annual Percent Change.

Table 2. Pavlik Bandage Usage Rates per Year per Intervention. CR Seems to Be Significantly Related with Pavlik Bandage Usage and Screening

	Intervention				
Year	CR	OR	PSO	PSO-FS	DCO
2012	29%	0.00	10%	0.00	0.00
2013	25%	0.00	0.00	0.00	0.00
2014	29%	0.00	0.00	0.00	0.00
2015	42%	0.00	4%	0.00	0.00
2016	50%	67%	7%	0.00	0.00
2017	55%	50%	10%	0.00	0.00
2018	60%	10%	6%	0.00	0.00
2019	68%	20%	12%	0.00	0.00

CR, Closed reduction; OR, Open reduction; PSO, Pemberton or Salter osteotomy; PSO-FS, Pemberton or Salter osteotomy with femoral shortening; DCO, Dega or Chiari osteotomy.

had Pavlik harness history. In this group, APC was 103.1 and harness usage rates increased significantly ($P < 0.05$) from 2012 to 2019. In PSO group, Pavlik harness history was present in only 8% of the interventions. APC was 31.9, and Pavlik harness usage rates increased insignificantly ($P = 0.2$) between 2012 and 2019 (Table 2). In PSO-FS and DCO groups, there were no Pavlik harness usage history, so we could not analyze any APC value in these groups.

Discussion

Between 2012 and 2019, especially after the year 2015, CR rate increased significantly and invasive bony procedures; PSO and DCO rates decreased significantly in our institution. The rates of OR and PSO-FS did not change significantly.

Positive Pavlik harness history for each intervention reflects the screened population. In patients that used Pavlik harness, the most common intervention was CR. In CR group, the screened newborn rate increased more than two times from 2012 to 2019. The number of OR and PSO interventions was low, so the value of these groups analyzes were weak. In the PSO-FS and DCO groups, there were no Pavlik harness usage history (Tables 1 and 2).

In our district, screening rate was 3.8% in 2013 and increased up to 93% in 2019.[9] The CR rate and Pavlik harness usage rate (especially for CR interventions) increased synchronously with the screening program during this time period. When all the interventions are examined, it can be seen that the use of Pavlik harness and CRs are closely related to the screening program. Thus, these two parameters can be used for the evaluation of the success of the screening program indirectly.

Timing of diagnosis determines the modality of treatment in DDH. As the diagnosis delays, the need for late treatment, which is related with long-term gait disturbances and arthritis, increases.[5,9,10] For early diagnosis of DDH, neonatal screening programs had been applied in Europe since 1950s with clinical examination only. But clinical examination alone did not reduce the rates of delayed diagnosis and surgery sufficiently.[11] Afterwards, ultrasonographic examination was added to screening programs universally for all newborns or selectively for only risky newborns.[12,13] Nowadays, there are many controversies about the screening programs. Do the screening programs decrease the late presentation and surgery rates? Do the screening programs increase the diagnosis rates? Do the increased diagnosis rates cause unnecessary treatments and complications? If there is no screening program, do the surgery and late presentation rates increase?

To overcome these controversies, several studies were conducted. Rosendahl et al. conducted a study including 11,925 newborn infants who

were screened only with clinical examination or universal sonographic examination or selective sonographic examination. They reported that there is a nonsignificant reduction in the rates of late presenting DDH in the children screened by universal and selective sonographic examination compared to clinical examination alone.[10] They also reported higher treatment rates for children who were screened by universal sonographic examination compared to selective sonographic examination and clinical examination alone.[10] In this study, there were no children treated surgically in the universal sonographic screened group. Two children among the clinical examination group and one child among the selective screened group were treated surgically. Therefore, there were no statistical significant difference between any of the groups in means of surgical treatment.[10] Holen et al. compared clinical examination with universal ultrasound and clinical examination with selective ultrasound groups and reported that there were no significant differences in rates of treatment, surgery and late diagnosis.[14] Rosendahl et al. and Holen et al. advocated a selective ultrasonographic examination with high-quality clinical screening.[10,14] Laborie et al. reported that a universal strategy with higher treatment rates did not seem to cause higher rates of avascular necrosis.[12] The US Preventive Services Task Force (USPSTF) do not recommend screening for DDH to prevent adverse outcomes for infants who do not have obvious hip dislocations or other abnormalities evident without screening.[3]

Present DDH screening studies do not reflect the factual situation of Turkey exactly. Because before the year 2010 there were no studies about the national screening program for DDH in Turkey, only the newborns who admitted to pediatrics and orthopedics clinics were examined for DDH. After training period of family practitioners, pilot screening program started in 2013 and countrywide program started in 2014.[11] By the year 2014, screening program has improved with new updates and experiences. Therefore, we cannot clarify the status of the DDH screening program of Turkey with these studies.

Shorter et al. reported that there are several studies and recommendations about many of the scenarios of screening programs, but there is no study about no screening versus screening with any method.[5] Our records started in 2012 and included the screened and the non-screened populations. So this study represents the process of a non-screened population to a screened population in means of CR and surgery rates. CR and surgical intervention rates reflects the success of screening method. Changes in the rates of interventions between 2012 and 2019 indicate the effect of screening program in this time period and indirectly compares non-screening and screening with clinical examination plus selective ultrasonographic examination.

According to USPSTF, screening is useful only for infants having obvious hip dislocations or other abnormalities evident without screening.[3] In Turkey, the main problem was missed diagnosis of the obvious hip dislocations. In our district, in the southeast region of Turkey, most of the children neither had been screened nor examined by a physician for DDH until the walking age. Thus, patients with DDH were usually admitted after walking age with limping, limb length discrepancy and trendelenburg gait. Late presentation rate was very high, and the delay time of presentation was very prolonged. This situation caused high rates of surgeries and increased rate of major surgeries. Therefore, the most evident benefit of screening for DDH is to detect patients earlier and prevent major surgeries.[6,15,16]

In this study, our aim was not to put forth the most suitable screening method. Our aim was to assess the effect of the screening to the treatment procedures in a tertiary health center. In our district with the screening program, the rate of late presentation of obvious DDH patients decreased, and the delay time of late presentations shortened. As a result, major surgery rates decreased and less invasive intervention rates increased. For mild DDH cases, we cannot make any comments about late presentation, we need randomized controlled trials for such a result.

There were some limitations in our study. We did not have the records of all patients before CR or any of the surgical procedure. Our center is the major reference center in our district. Patients are referred to our center directly by family practitioners and by secondary hospitals after unsuccessful treatment procedures. We called parents and asked whether their child were examined by family practitioner and use Pavlik harness or not and accepted the parents declaration true. In present study, our aim was not to compare the nonscreening and clinical examination plus ultrasonographic examination. We did not present direct results about the screening program. We just presented the effects of screening program in means of CR and several surgical interventions. A well-organized, multidisciplinary prospective study including family practitioners, pediatricians, orthopaedic surgeon and radiologists should be conducted to put forth the outcomes of the screening program exactly. Beside the limitations, we had an important advantage; all the patients were operated in our institution. The type of the surgeries were decided at weekly department meetings; therefore, there were no distinct clinical or surgeon preference.

As a conclusion after the initiation of the screening program for DDH, less invasive treatment modalities like CR and OR interventions increased and major bony procedures like PSO and DCO interventions decreased. Also, as the screening program advanced, CR rate and the use of Pavlik harness rate in CR interventions increased.

Ethics Committee Approval: Ethics committee approval was received for this study from the Local Ethics Committee of Harran University, School of Medicine (26.03.2020-E14380).

Informed Consent: N/A.

Author Contributions: Concept - C.B., B.S.; Design - C.B., B.S.; Supervision - S.S.; Materials - S.S.; Data Collection and/or Processing - Z.S.; Analysis and/or Interpretation - Z.S.; Literature Review - C.B., M.A.A., B.V.Ç.; Writing - C.B., M.A.A., B.V.Ç.; Critical Review - B.S., C.B., M.A.A., B.V.Ç.

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