The Impact of The National Screening Program for Developmental Dysplasia of The Hip on Radical Surgical Procedures

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Abstract

Aim: Developmental dysplasia of the hip (DDH) encompasses a broad pathological spectrum from mild acetabular dysplasia to complete hip dislocation and can be treated with simple and non-invasive methods with early diagnosis. In contrast, major surgical interventions may be required in those with late diagnosis, and most heal with sequelae. This study aimed to investigate the effects of the national developmental dysplasia of the hip (DDH) screening program initiated in 2013 on the developmental dysplasia treatment approaches and the number of surgical treatments in Balcalı Hospital of Cukurova University Medical Faculty.

Methods: All patients operated on for DDH in our clinic from 2007 to 2021 were retrospectively reviewed from records, and the number of closed reductions, open reductions, and pelvic osteotomies performed before and after the screening program were analyzed.

Results: Between 2007-2021, 255 surgical and 125 non-surgical procedures were performed under anesthesia in DDH patients. With the national hip screening program, the rate of closed reduction and spica casting increased from 14,8% to 46,3%. The rate of open reduction also increased from 24,1% to 29,4% in this period, and the rate of major surgical procedures with pelvic osteotomy decreased significantly from 61,1% to 24,3%.

Conclusions: In this study, it was observed that after the initiation of the screening program for DDH, major surgical interventions involving pelvic osteotomies were significantly reduced in our clinic, while the rate of closed reduction increased.

Keywords: *Developmental dysplasia of the hip, Screening program, Pelvic osteotomy*

1. Introduction

Developmental dysplasia of the hip (DDH) includes the spectrum of idiopathic abnormal hip developmental disorders with mild acetabular dysplasia, subluxation, or hip dislocation due to capsular laxity and mechanical instability in the growing and developing hip joint [1]. Hip pathologies secondary to neurological, neuromuscular, and syndromic diseases are excluded from this group and are called teratogenic hip dislocation[2]. While in the past years, the term congenital hip dislocation was used, which did not define the developmental aspect of this disorder, today the definition of developmental dysplasia of the hip, which is more descriptive of the disease, is used. Changing the definition of congenital to developmental increases physicians' legal liabilities [3].

While dislocated and subluxated hips can be diagnosed clinically at early stages, the clinical diagnosis of dysplastic hips is comparatively more challenging. Mild dysplasia may never occur or become clinically evident until adulthood, while severe dysplasia is more likely to occur clinically in late infancy or early childhood[4].

Developmental dysplasia of the hip has a multifactorial etiology. There are well-defined risk factors for DDH. These include female gender, being the firstborn, breech presentation, and positive family history [5]. In addition, the traditional method of newborn swaddling in Turkey and eastern societies increases the risk of DDH[6,7].

Developmental dysplasia of the hip can be diagnosed by clinical examination, hip ultrasonography, or an x-ray taken after the 4th month. There is no international consensus on the screening programs for the early diagnosis of DDH. In countries such as the USA and Canada, screening begins with an examination, and ultrasound

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is performed in clinically high-risk groups. On the other hand, universal screening is performed in many European countries[8–11]. While universal ultrasonography screening has disadvantages such as false positivity, overtreatment and cost, some cases can be missed in selective screening[12]. Studies on DDH early diagnosis and treatment programs in Turkey were initiated in 2010 in cooperation with the Ministry of Health and the Turkish Pediatric Association, and family physicians were trained. With the participation of the Turkish Society of Radiology Executive Committee in 2013, it was updated throughout the country and started to be actively implemented. As part of the national screening program, all infants undergo a hip dislocation examination during the neonatal period (3-4 weeks). Infants with positive findings or risk factors are referred to orthopedic and radiology clinics for further evaluation. Hip ultrasound is performed in the first 3-6 weeks of life for infants in this group. The goal is to evaluate infants and provide prompt and appropriate treatment when needed, while minimizing the need for surgery and potential complications associated with hip dislocation[13].

There is a well-known relationship between residual dysplasia and the age at reduction. When patients are diagnosed within the first six months, treatment consists of using a Pavlik harness. For those aged between 6-18 months, closed reduction and spica casting are performed under general anesthesia, whereas in later stages, open reduction and pelvic osteotomies are the preferred methods. If the diagnosis is delayed, the success rate decreases, and it may cause severe long-term health problems, such as early-onset degenerative arthritis. This disease, which is an important cause of disability in the period from childhood to adulthood, is also the cause of 9% of all primary hip replacements and up to 29% of people with this disease under the age of 60 have primary total hip replacement[7,14,15].

This study aims to investigate the effect of the Turkish National Hip Screening Program on the procedures performed for DDH in our clinic and to show the decrease in the rate of radical surgical procedures with early diagnosis.

2. Materials and methods

This retrospective study was conducted between June 2007 and June 2021 at the Department of Orthopedics and Traumatology, Faculty of Medicine, in Çukurova University Balcalı Hospital. Ethics committee approval was obtained from the non-interventional clinical research ethics committee of Çukurova University Faculty of Medicine with decision number 121 and number 54 dated April 8, 2022. Patients who underwent anesthesia for the treatment of developmental dysplasia of the hip were identified through the surgery records. Patients who had been treated with a Pavlik harness were excluded from the study due to insufficient outpatient records. Records before 2007 were also excluded due to inadequate surgical documentation. Patients who had undergone surgery for teratogenic hip dislocation, such as arthrogryposis multiplex congenita and meningomyelocele, were also excluded from the study.

As a result, 380 patients were included in the study. The patients were divided into three groups pelvic osteotomy, open reduction, and closed reduction. The pelvic osteotomy group included Salter osteotomy, Pemberton osteotomy, Steel osteotomy, and Dega osteotomy. Radical reduction including femoral shortening osteotomy was performed when necessary in the patient who underwent pelvic osteotomy. An anterior approach was performed in all patients in the open reduction group. Percutaneous adductor tenotomy was performed in the closed reduction group if necessary. Arthrography was not applied. A hundred and twenty-seven patients had bilateral DDH. In cases where patients underwent different procedures on both hips, the patient was included in the group that underwent the more extensive surgery. Additionally, patients were categorized based on the year of their surgery.

Although there are some exceptions, infants with DDH are typically treated with the Pavlik harness up to six months of age, followed by closed reduction from six to twelve months, open reduction from twelve to eighteen months, and pelvic osteotomies from 18 months onwards. Following all surgical procedures, hip spica casting is administered to patients under fluoroscopy.

The national DDH screening program in Turkey mandates clinical examinations for all newborns, with selective sonography performed only on those with risk factors. Risk factors for prenatal sonography include family history (first and second-degree relatives), first-born female, multiple pregnancies, amniotic fluid anomalies, breech presentation, congenital foot deformities, plagiocephaly, scoliosis, pelvic tilt, limited hip abduction, congenital torticollis, and swaddling. If there are no risk factors, newborns are examined by primary care physicians at the 6th week of birth. In case of hip instability or any positive risk factor in this examination, babies are referred to the radiology department for ultrasonographic examination.

2.1. Statistical Analysis:

Categorical variables were expressed as numbers and percentages, whereas continuous variables were summarized as mean and standard deviation. Chi-square test was used to compare categorical variables between the groups. All analyses were performed using IBM SPSS Statistics Version 20.0 statistical software package. The statistical level of significance for all tests was considered to be 0.05. SPSS referance: IBM Corp. Released 2011. IBM SPSS Statistics for Windows, Version 20.0 Armonk, NY: IBM Corp.

3. Results

Of the 380 patients included in the study, 127 (33.4%) had bilateral and 255 (66.6%) had unilateral DDH. The number of female patients was 305 (80%) and male patients was 75(20%). 255 (%67) patients underwent surgical treatment, of which 152 (%40) were pelvic osteotomy and 103 (%27) were open reduction. Of the 152 pelvic osteotomies, 47 were Salter, 25 were Pemberton, 5 were Dega, 68 were radical, and 7 were Steel. Closed reduction was performed in 125 (%33) patients (Table 1).

Table 1

Distribution of closed reduction, open reduction and radical surgical procedures by years

	CR	OR	Salter	Pemberton	Dega	Radical	Steel
2007		1	16			10	
2008	2	5	6			10	
2009	3	4	4			7	
2010	1	5	7			4	
2011	4	7	5	3		3	
2012	2	8	2	3	1	2	1
2013	12	9		9	2	4	
2014	12	10		8		10	
2015	18	9	2	2		4	4
2016	9	16				1	1
2017	14	6	2			1	1
2018	8	11	3			6	
2019	15	6				4	
2020	15	2			1	1	
2021	10	4			1	1	
	125	103	47	25	5	68	7

*CR: closed reduction, **OR: open reduction*

Table 2

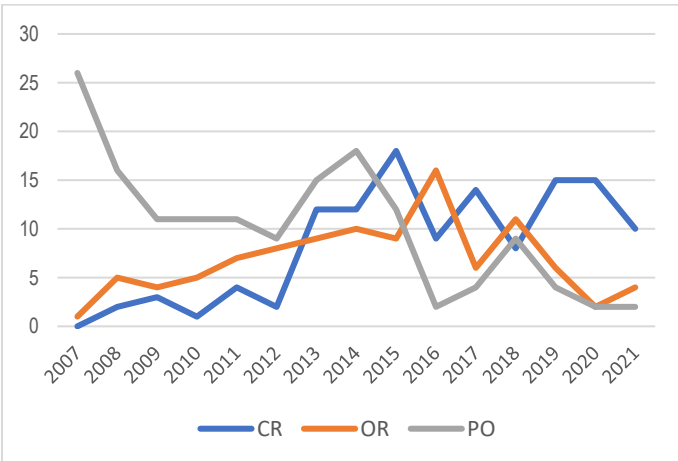
Crosstabulation of procedures by year

			Years		Total
			2007-2013	2014-2021	
Procedures	CR	Count	24a	101b	125
		% within procedures	19,2%	80,8%	100,0%
		% within years	14,8%	46,3%	32,9%
	OR	Count	39a	64a	103
		% within procedures	37,9%	62,1%	100,0%
		% within years	24,1%	29,4%	27,1%
	PO	Count	99a	53b	152
		% within procedures	65,1%	34,9%	100,0%
		% within years	61,1%	24,3%	40,0%
Total		Count	162	218	380
		% within procedures	42,6%	57,4%	100,0%
		% within years	100,0%	100,0%	100,0%

*Each subscript letter denotes a subset of years categories whose column proportions do not differ significantly from each other at the ,05 level. *CR: closed reduction, **OR: open reduction, ***PO: pelvic osteotomies*

Figure 1

Change of procedures over the years



**CR: closed reduction, **OR: open reduction, ***PO: pelvic osteotomies*

Between the years 2007-2013 (before screening): 24 closed reductions, 39 open reductions, and 99 pelvic osteotomies were performed. Between the years 2014-2021 (after screening): 101 closed reduction, 64 open reduction, and 53 pelvic osteotomy were performed (Figure 1). Closed reduction and open reduction rates increased significantly from 14.8% to 46.3% and from 24.1% to 29.4%, respectively. Pelvic osteotomy rate decreased significantly from 61.1% to 24.3%. While closed reduction was 19.2% of all procedures in the years before 2014, this rate increased significantly to 80.8% after 2013. On the contrary, while patients who underwent pelvic osteotomy were 65.1% of all patients before 2014, this rate decreased significantly to 34.9% after 2013 (Table 2).

4. Discussions

Considering the successful outcomes observed in our clinical practice and the decrease in major surgical interventions, it is necessary to accept the effect and success of the Turkish National DDH Screening Program in our region and clinic.

Early diagnosis provides easier treatment options to achieve and maintain reduction, increases the potential for acetabular and femoral remodeling, and reduces the risk of complications and treatment costs. Delayed diagnosis reduces treatment success, increases treatment costs and can cause long-term disability [2,16,17].

Screening for DDH is controversial. There are no internationally agreed guidelines or standards. Universal screening, which is the USG screening of all newborns, or selective screening, which is the examination and screening in the presence of risk factors, can be performed. In Austria and Germany, there is a universal sonographic hip joint screening program for newborns [18–20]. In Norway and France, there are universal clinical and selective sonographic hip screening programs[10,11]. In the USA it has been advocated that breech presentation and family history in females and breech presentation in males may be selectively screened[21]. There is no international consensus on which method should be preferred in terms of efficiency and cost. Studies comparing universal and selective ultrasound have found no significant difference in the criteria for subluxation - dislocation or acetabular dysplasia - degenerative changes. [11,22].

Universal clinical and selective ultrasound screening for DDH in Turkey started in 2010 with the training of family physicians and regional practices and was updated and implemented nationwide in 2013. Due to the developmental nature of the disease, neglect or delay in diagnosis creates medicolegal problems for the physician who screens and refers according to risk factors. We believe that these medico-legal issues point family physicians to the universal ultrasound screening program in Turkey. Ultrasound screening is crucial for the diagnosis of DDH although there is still disagreement about who should undergo ultrasound screening and when because the disease is not easy to diagnose in the early stages. If diagnosed early, it is easier to treat, cheaper, and less invasive, and critical hip disorders can be prevented[23].

Breech presentation, oligohydramnios, family history, firstborn, female sex and primiparity were confirmed as risk factors for DDH. It has been reported that women are 2-7 times more likely to have DDH compared to men[5,24]. Furthermore, it has been reported that up to 75% of DDH patients are women[25] . Consistent with the literature in our study, 80% of the patients were female. Estrogen in the maternal and fetal circulation causes ligament laxity and increases the risk of DDH in females. At the same time, the higher number of estrogen receptors in DDH patients compared to controls supports the role of hormones in the development of DDH[26].

In the first months after birth, a concentrically reduced femoral head in the acetabulum is usually sufficient for acetabular development. As the infant grows older, the potential for normal development of the dysplastic acetabulum decreases, and the prevalence of acetabular dysplasia increases with age at hip reduction [27]. Up to 19% residual dysplasia may occur even in patients successfully treated with a Pavlik harness[28]. In infants diagnosed with DDH after 6 months of age, or who have failed Pavlik harness treatment for hip reduction, the next step in the treatment algorithm is closed reduction and hip spica casting. In patients treated with closed or open reduction, residuel dysplasia rate increases by 22% to 33%, respectively, and this rate increases significantly in pelvic osteotomies[29,30]. While only 7% of the procedures performed in our clinic before 2010 were closed reduction and spica casting, this rate increased to

40% after the screening program. The rate of pelvic osteotomies decreased from 75% to 30% during this period.

In patients with persistent acetabular dysplasia, pelvic and femoral osteotomies may be indicated to provide normal development of the acetabulum and prevent or minimize the risk of adult coxarthrosis. Although the timing of osteotomy is not accurately defined, the variation in age and acetabular index may help us predict the development of acetabular dysplasia in adulthood. Femoral osteotomies are designed to reorient the femoral head by increasing derotation and varus to stabilize and stimulate acetabular development. Furthermore, experimental studies have shown that these procedures also increase acetabular volume[31,32]. Pelvic osteotomies are designed to increase femoral head coverage in the acetabulum, maintain concentric reduction, and reduce the risk of developing degenerative hip arthritis. But this risk cannot be eliminated. Thomas et al. reported that 23.8% of patients treated with Salter's osteotomy required total hip arthroplasty (THA) 40 years after acetabuloplasty [33]. Similarly, Steppacher et al. stated that after 20 years of follow-up of patients with pelvic osteotomy, 38% of patients needed THA[34]. In our study, the rate of pelvic osteotomy among procedures performed for DDH decreased from 75% to 30%.

The requirement of surgical intervention for DDH in Germany has decreased from 1 per 1000 live births to 0.26 per 1000 live births since the start of the national screening program[20]. In Austria, the benefit of the universal screening program was associated with a lower rate of surgical interventions for DDH[19]. 5-year surveillance data in Germany reported that about 0.14 (55%) of 0.26 surgical procedures per 1000 live births were for cases diagnosed early by the ultrasound screening programme.[20] This group may represent some patients who would not benefit from early conservative treatment.

There were some limitations in our study. Data on patients treated with Pavlik harness were absent. In addition, we did not have national data. Data were limited to the patient population in the Eastern Mediterranean region of Turkey. We did not evaluate the long-term outcomes and dysplasia rates of the procedures. Our aim in the study was not to compare screening programs but to evaluate the effect on surgical procedures.

5. Conclusions

In our study, although there was no significant decrease in the number of procedures performed in the operating room after the selective screening program, there was a significant decrease in the number and rate of pelvic osteotomies. The significant achievement of the national screening program is the earlier diagnosis of patients and the reduction in the rate of major surgical procedures.

Statement of ethics

This study was conducted in accordance with the ethical principles of the Declaration of Helsinki and was approved by Cukurova University Faculty of Medicine Ethics Committee. (2022-121-54)

Conflict of interest statement

Author declare that they have no financial conflict of interest with regard to the content of this report.

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Author contributions

Concept/Design, Data acquisition, Data analysis and interpretation, Drafting manuscript, Critical revision of manuscript and Final approval and accountability: BK, ÖSB, VCK, AM, MB, CÖ

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