Journal of Hip Preservation Surgery, 2024, **11**, 176–181
DOI: https://doi.org/10.1093/jhps/hnae010
Advance access publication date: 9 March 2024
Research article

A pilot screening project for the detection of hip dysplasia in young patients

Frederik Berstad Møse[1,2*], Shahin Mohseni[1] and Tomas Borg[1,2]

[1]Department of Orthopedic Surgery, Orebro University Hospital, Orebro 701 85, Sweden and [2]School of Medical Sciences, Orebro University, Orebro 702 81, Sweden

*Correspondence to: F. B. Møse. E-mail: frederik.berstad-mose@regionorebrolan.se

ABSTRACT

Hip dysplasia in young adults is underdiagnosed and can cause pain and discomfort. Progression to osteoarthritis (OA) is common, necessitating total hip arthroplasty at an early age. When discovered early, symptomatic patients can be offered physiotherapy and/or hip-preserving surgery to alleviate pain and decrease the risk of early OA. A pilot project to screen radiograms for hip dysplasia was started across the Swedish region of Örebro Län in January 2019, comparing the incidence of dysplasia before and after initiation of the screening program. All elective conventional radiograms of the hip (age 12–44 years), requested by primary care physicians, were analyzed by consultant radiologists according to a pre-established algorithm to identify hip abnormalities. If the hip radiograms showed dysplastic changes, or other pathological signs, the radiologist advised referral to a specialized Youth Hip Clinic for further work-up and treatment. A total of 1056 radiograms were requested by clinicians during the study periods (601 and 455 during 2018 and 2020, respectively). A total of 457 trauma-related cases were excluded, resulting in 599 available for analysis (348 and 251 during 2018 and 2020, respectively). During 2018, 17 patients (4.9%) received the radiologic diagnosis of dysplasia, compared with 44 patients (17.5%) during 2020 ($P < 0.001$). A three-fold increase of patients diagnosed with hip dysplasia was detected as a result of the implementation of the screening program. The advantage of screening is early referral to an orthopedic department for evaluation and consideration for physiotherapy and/or surgical intervention.

INTRODUCTION

Dysplasia of the hip is a condition defined by poor coverage of the femoral head. Dysplastic hips have an increased risk of secondary osteoarthritis (OA), which is especially devastating in young adult [1–3]. Patients often report daily pain, which may progress with time. Unfortunately, many patients do not receive neither the correct diagnosis nor a suitable treatment due to diagnostic delay across primary care, radiology and orthopedic departments [4]. In Scandinavia, the prevalence of hip dysplasia has been reported in both Denmark (3.3%) and Norway (3.4%) [3, 5]. A retrospective Swedish study found a prevalence of 5.2%. Only 7 of the 98 patients with hip dysplasia in the study were identified correctly by the examining radiologist [4]. The study indicates that dysplasia is often overlooked and that underreporting and underdiagnosing of dysplasia are common.

A pilot project to screen radiograms for hip dysplasia in young adults was started across the Swedish Region of Örebro Län in January 2019. This paper aims to describe the implementation of a radiographic screening program to increase diagnostic accuracy of hip dysplasia.

METHODS

Setting

This pilot project included all patients sent for elective (non-trauma related) radiographic investigation of the hip across the Swedish Region of Örebro Län, which is covered by Örebro University Hospital and its affiliated hospitals in Lindesberg and Karlskoga. The region has 29 primary care centers and slightly more than 300 000 inhabitants and is one of the 21 health care regions in Sweden.

All conventional radiograms of the hip requested by both general practitioners and hospital physicians marked 'routine/elective' within the age bracket of 12–44 years for the years 2018 and 2020 were included in the study. Year 2019 was not included since it was the year when screening was introduced. The lower age bracket was chosen as the tri-radiate cartilage fuses in early adolescence (approximately at 12 years for girls and 14 years for boys) [6]. Before fusion, other radiographic measurements may be of interest and the treatment algorithm may differ. The upper age bracket was selected, as hip preserving surgery is rarely indicated after the age of 40 years, due to the increased risk of total hip arthroplasty (THA) conversion [7].

Received 11 October 2023

Table I. *Radiographic markers of dysplasia, retroversion and FAIS chosen for screening*

Markers for dysplasia	***Markers for retroversion***	***Markers for FAI***
CE angle	Posterior wall sign	Cam morphology
Sharp's angle	Crossover sign	Pincer
AI angle	Ischial spine sign	Alpha angle

Ethical approval

Ethical approval was obtained from the Ethical Authority of Sweden (Dnr 2021-04210). The prevalence of hip dysplasia diagnosed by radiograms before the start of screening (2018) and after the introduction of the pilot program (2020) was compared. The year 2019 was omitted to allow for introduction lag when implementing the new routine.

Radiological screening

The radiology department was included in the planning and initiation phase. Literature was reviewed from various institutions internationally and collated into a firm algorithm (Table I, Fig. 1). A test period with constant dialogue between key personnel across orthopedics and radiology was essential for a smooth transition. Thereafter, the screening program was left unchanged until the end of the study period. There was no change in the qualification of the radiologists involved between the two study periods. The radiology department was able to add the more structured analysis of the radiograms, without increasing the time required for radiogram analysis. This was done by using a firm algorithm and a pre-filled form in the locally available picture archive and communication systems (PACS) and by using the hip dysplasia tool available (Fig. 2) (Sectra, IDS7). Since no additional work or imaging was carried out in regard to the introduction of the screening program, there was no negative economic impact on implementation.

All patients had standing radiograms performed including an anteroposterior (AP) pelvis to account for the functional inclination of the pelvis during weight-bearing [8]. Internal evaluation of the radiation dosage when using standing radiograms showed an effective dose of 0.2 mSv, which was deemed acceptable. Furthermore, a false lateral (Billing C) was included to identify cam morphology on the femoral neck. Markers for dysplasia and acetabular version were annotated in the PACS.

As the cornerstone of dysplasia diagnosis, the lateral center-edge angle (CE angle) was chosen as it is a measurement with low inter- and intra-observer variance and shows the relationship between the center of rotation of the femoral head and the lateral border of the sourcil [9, 10]. To indicate version of the acetabulum, a triad of markers were chosen: the posterior wall sign (PWS) to indicate the center of rotation of the femoral head in relation to the posterior wall of the acetabulum; the cross-over sign (COS), to indicate the relationship between the anterior and posterior wall of the acetabulum; and finally the ischial spine sign (ISS) to indicate a retroversion of the innominate bone as a whole [11]. To supplement this measurement, the Sharp's angle and the acetabular index (AI) were also digitally annotated on the radiograms, but not included in the written report to the referring clinician. The Sharps angle describes the inclination of the acetabulum independent of the position of the femoral head, while the AI indicates the inclination of the weight-bearing segment of the acetabulum (sourcil) [12, 13].

After double reading of radiograms with final approval by a consultant in skeletal radiology, the primary care physician received a recommendation to further refer the patient to the

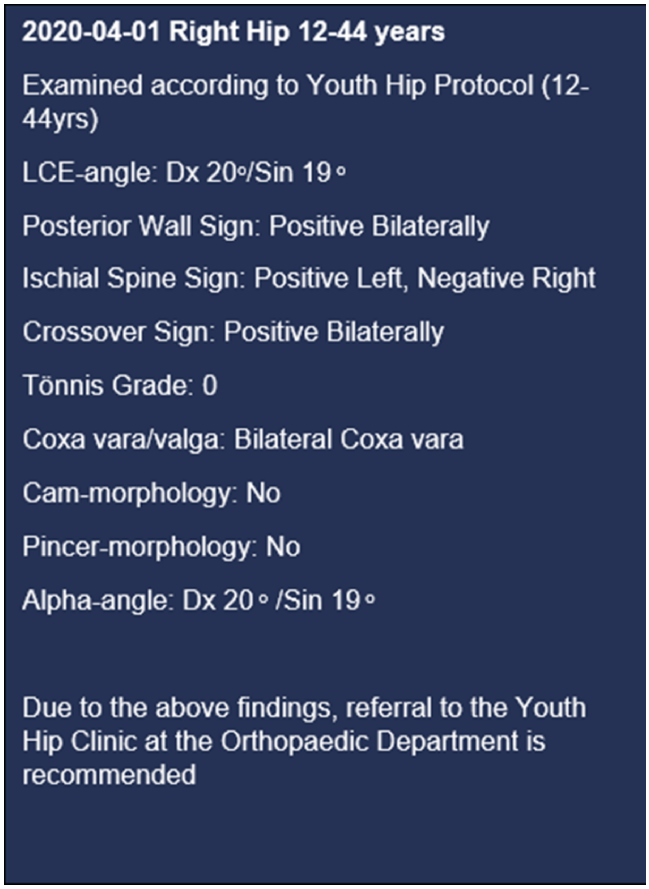

Fig. 1. Example of a recommendation from the radiology department.

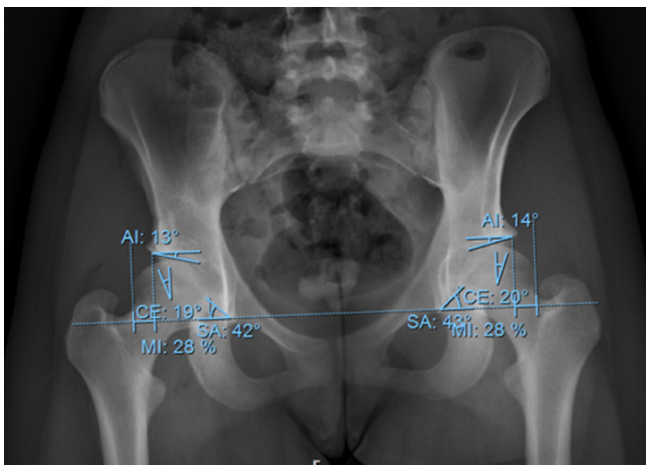

Fig. 2. Example of measurements using dysplasia tool (IDS7).

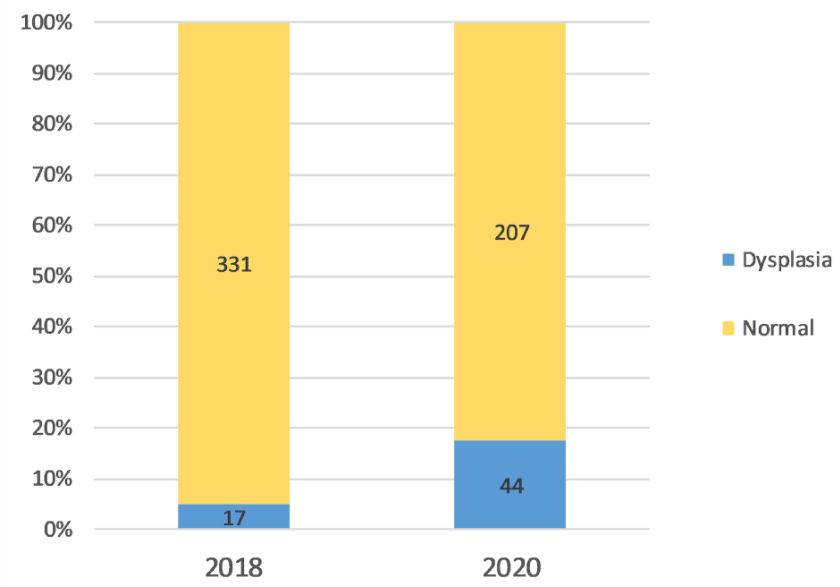

Fig. 3. Comparison of hip dysplasia identified in radiograms during 2018 and 2020.

Young Hip Clinic (YHC) at Örebro University Hospital if deviating morphology was identified (Fig. 1). The YHC consists of orthopedic consultants with sub-specialization in pelvic and acetabular surgeries and a team of physiotherapists with a focus on hip pathology. An evaluation of the patient history, symptomatology and radiograms formed the basis for considering hip preserving surgery or physiotherapy.

Statistics

Independence of observation and homogeneity of the variance between the two periods was assumed. As both periods contained categorical variables, it was analyzed using the Fisher's chi-square test to investigate statistical significance, which was set to a *P*-value of less than 0.05.

RESULTS

A total of 1056 hip radiograms were requested by clinicians during the study periods, 601 during 2018 and 455 during 2020, respectively. A total of 457 trauma-related cases were excluded, resulting in 599 available for analysis, 348 and 251 during 2018 and 2020, respectively.

The average mean age was 34 years (SD 10.4) in 2018 and 31 years (SD 10.7) in 2020. There was a female predominance in 2018 (211 female and 137 male), whereas it was evenly divided in 2020 (126 female and 125 male). The indications for referral for radiology were diverse. General queries such as 'arthritis?', 'pathology?', 'skeletal abnormality?' and 'something abnormal?' were common. The indications for referral were not noticeably different between the two time periods.

When comparing the two time periods, we found a substantial increase of hips diagnosed with dysplasia after introduction of the screening (Fig. 3). During 2018, 17 of 348 (4.9%) radiograms with hip dysplasia were identified compared with 44 of 251 (17.5%) radiograms in 2020 ($P < 0.001$). There was no statistical difference in the diagnosis of hip dysplasia between genders ($P = 0.862$).

A striking difference was observed regarding terminology during the two periods. During 2018, only 2 of 17 radiograms in which the radiologist observed signs of dysplasia were marked by objective terminology. The remaining 15 used diffuse and varied descriptions, such as 'pathological joint bowl' or 'steep acetabulum'. In the two instances where the joint was objectively measured, Sharp's angle was used in one case and the CE angle in another case. During 2020, only two radiograms had diffuse terminology. All dysplastic hips were identified clearly, and 36 of 44 used the standardized measurement algorithm described giving a clear verdict that the findings warranted referral to the YHC (Table II).

In total, 64 patients were referred to the YHC after implementation of the new screening algorithm due to hip abnormalities for further evaluation during 2020. The time from referral to the orthopedic clinic to an appointment at the YHC was acceptable, within the 3 months guaranteed by the Swedish health care service. A total of six patients (9.4%) referred to the YHC met criteria for PAO surgery, whereas the rest were offered non-operative treatment and scheduled for follow-up. Indication criteria for PAO at YHC are patients with hip dysplasia experiencing substantial daily hip pain without radiographic signs of OA and joint instability, detected either clinically or by comparing the rotational center of the femoral head in neutral and abduction.

DISCUSSION

The authors present the implementation of a screening program for early detection of hip dysplasia. As a result of the screening

Table II. *Summary of radiology reports identifying hip dysplasia, 44 hips identified in 30 patients found in 2020 screening*

	LCE angle		*PWS*		*ISS*		*COS*		*Tönnis grade*		
Patient	***Right***	***Left***	***Right***	***Left***	***Right***	***Left***	***Right***	***Left***	***Right***	***Left***	***Radiology report when 'deviating' from the algorithm***
6	23	19	N	N	N	N	N	N	0	0	
13	#	#	#	#	#	#	#	#	#	#	Steep acetabulum
18	24	30	N	N	N	N	N	N	0–1	0–1	
25	#	#	#	#	#	#	#	#	#	#	Subluxation of the hip with degenerative changes
31	10	40	Y	N	Y	Y	Y	N	0–1	0–1	
40	#	#	#	#	#	#	#	#	#	#	Hip dysplasia, as before
55	30	22	N	Y	N	N	N	N	1	1	
76	#	#	#	#	#	#	#	#	#	#	Mild hip dysplasia
82	#	#	#	#	#	#	#	#	#	#	Mild right side hip dysplasia and substantial hip dysplasia left
99	14	20	N	N	N	N	N	N	1	0	
101	24	26	N	N	N	N	N	N	0	0	
104	#	#	#	#	#	#	#	#	#	#	As before, shallow acetabulum
110	28	25	N	N	N	N	N	N	0	0	
120	25	25	N	N	Y	N	N	N	1	0	
122	21	23	N	N	N	N	N	N	0	0	
124	22	20	#	#	#	#	#	#	0	0	
132	27	24	N	N	N	N	Y	N	0	0	
133	23	37	N	N	N	N	N	N	0–1	0	
159	22	36	N	N	N	N	N	N	0	0	
170	#	#	#	#	#	#	#	#	#	#	Left hip dysplasia
171	11	19	Y	Y	N	N	Y	Y	0	0	
172	25	31	N	N	Y	Y	Y	N	0	0	
181	17	21	N	N	N	N	N	N	0	0	
184	#	#	#	#	#	#	#	#	#	#	Dysplasia
210	22	23	N	Y	N	N	N	N	0	0	
225	24	32	N	N	N	N	N	N	0	0	
235	28	34	Y	Y	N	Y	N	N	0	0	
237	23	26	N	N	N	N	N	N	0	0	
241	25	'Severe'	N	#	N	N	N	N	0	2	
249	19	26	N	N	N	N	N	N	0	0–1	
252	24	23	Y	N	Y	N	N	N	0	3	

#not documented.

program, a significant increase in the yearly incidence (from 4 to 17%) of dysplasia could be detected.

Traditionally, the treatment of hip dysplasia in young adults has been conservative and many patients did not receive the correct diagnosis. A lack of knowledge of the condition leads to under-diagnosis and under-treatment. Consequently, the risk of OA development increases and the patient may eventually need to undergo THA. THA at a relatively young age increases the risk of implant wear or loosening and need for additional surgical procedures.

When discovered early, symptomatic hip dysplasia can be treated by re-orienting the acetabulum to a more favorable position for load transfer reducing the risk for early THA. The authors' method of choice is the Ganz peri-acetabular osteotomy (PAO) using a mini-invasive transsartorial approach described by Söballe [14, 15].

Computer tomography (CT) has been used to quantify dysplasia. In the setting of radiographic screening, the increased radiation dose and the difficulty in accounting for pelvic tilt render this method difficult to advocate [16, 17].

In the Swedish setting, it has been a challenge to identify patients with hip dysplasia early, i.e. before the development of incipient OA. A Tönnis grade of greater than 1 has been shown to increase the risk for conversion to THA after PAO [7]. Patients with hip dysplasia are often identified too late, when the window for a successful PAO has closed due to secondary OA. Upon clinical interview, a history of hip pain in teenage years is often reported, which in retrospect may be due to undiagnosed hip dysplasia. Delays in diagnosis and referral have been reported to produce inferior outcomes [18].

The experienced physiotherapy team at the YHC is an essential part of complete patient care. Patients with borderline dysplasia or functional retroversion may do well with a conservative approach. Ongoing studies, such as PreserveHip, are underway to explore this option [19]. During the course of the YHC, all isolated retroverted hips were initially offered physiotherapy. None of these patients have, after undergoing physiotherapy, met the clinical criteria for surgical intervention with reverse PAO or arthroscopic rim trimming.

To the authors' best knowledge, this is the first implementation of a structured screening program for hip dysplasia in young adults. This article describes a practical amendment of clinical practice. A three-fold increase in the incidence of the radiological diagnosis of hip dysplasia was seen after implementation. A fair assumption is that false-negative radiogram interpretation decreased after implementation of the screening program.

Another success of the program was the expediency by which general practitioners referred the patients on the YHC. As the treatment of dysplasia is multi–faceted, we believe that the creation of a multidisciplinary referral center for initial evaluation is essential for quality care.

LIMITATIONS

The study coincided with the Covid-19 pandemic. Some patients may have stayed away from the healthcare sector leading to underreporting of the true incidence of hip dysplasia. Despite this, the radiograms identified with dysplasia were higher in both absolute and relative terms during 2020.

The study is retrospective in nature, and possible group differences are not accounted for. Furthermore, a certain confirmation bias might have been present in 2020 due to the ongoing screening program. Nevertheless, a small adjustment in in-house radiology routines resulted in a significant increase in hip dysplasia incidence without the need for all-encompassing educational programs across primary care and hospital practitioners to spread awareness of the condition.

One limitation is using only AP pelvic radiograms in classifying hip dysplasia. The false profile view would highlight deficient anterior coverage more clearly; however, in order to simplify the screening process, we chose to focus on AP radiograms which indirectly show poor anterolateral coverage.

The authors suggest that the differences detected in the incidence of hip dysplasia in 2018 compared with 2020 (before and after implementation of the screening program) were due to suboptimal radiological reporting and that recommended referral to a specialized center (YHC) was not routine.

CONCLUSION

A three-fold increase of patients diagnosed with hip dysplasia was detected as a result of the implementation of a screening algorithm. The advantage of screening is early referral to an orthopedic department for evaluation and consideration of physiotherapy and/or surgical intervention. We recommend this screening method to be tested in other centers experiencing difficulties with delayed diagnosis of hip dysplasia.

DATA AVAILABILITY

The data underlying this article cannot be shared publicly due to the privacy of individuals who participated in the study. The data will be shared on reasonable request to the corresponding author.

ACKNOWLEDGEMENTS

The authors would like to thank all involved in the screening program in the Orthopedic department, radiology department and primary care centers.

FUNDING

No external funding.

CONFLICT OF INTEREST STATEMENT

None declared.

REFERENCES

1. Cooperman DR. How good is the evidence linking acetabular dysplasia to osteoarthritis? *J Pediatr Orthop* 2019; **39**: S20–2.
2. Murphy SB, Ganz R, Müller ME. The prognosis in untreated dysplasia of the hip. A study of radiographic factors that predict the outcome. *J Bone Joint Surg Am* 1995; **77**: 985–9.
3. Jacobsen S, Sonne-Holm S. Hip dysplasia: a significant risk factor for the development of hip osteoarthritis. A cross-sectional survey. *Rheumatology* 2005; **44**: 211–8.
4. Leide R, Bohman A, Wenger D *et al*. Hip dysplasia is not uncommon but frequently overlooked: a cross-sectional study based on radiographic examination of 1,870 adults. *Acta Orthop* 2021; **92**: 575–80.
5. Engesaeter IØ, Laborie LB, Lehmann TG *et al*. Prevalence of radiographic findings associated with hip dysplasia in a population-based

cohort of 2081 19-year-old Norwegians. *Bone Joint J* 2013; **95-B**: 279–85.
6. Dimeglio A. Growth in pediatric orthopaedics. *J Pediatr Orthop* 2001; **21**: 549–55.
7. Lerch TD, Steppacher SD, Liechti EF *et al*. One-third of hips after periacetabular osteotomy survive 30 years with good clinical results, no progression of arthritis, or conversion to THA. *Clin Orthop Relat Res* 2017; **475**: 1154–68.
8. Troelsen A, Jacobsen S, Romer L *et al*. Weightbearing anteroposterior pelvic radiographs are recommended in DDH assessment. *Clin Orthop Relat Res* 2008; **466**: 813–9.
9. Wiberg G. Studies on dysplastic acetabula and congenital subluxation of the hip joint with special reference to the complication of osteoarthritis. Stockholm: Exp., Norstedt; 1939.
10. Carreira DS, Emmons BR. The reliability of commonly used radiographic parameters in the evaluation of the pre-arthritic hip: a systematic review. *JBJS Rev* 2019; **7**: e3.
11. Tannast M, Hanke MS, Zheng G *et al*. What are the radiographic reference values for acetabular under- and overcoverage? *Clin Orthop Relat Res* 2015; **473**: 1234–46.
12. Sharp IK. Acetabular dysplasia. *J Bone Joint Surg Br Vol* 1961; **43-B**: 268–72.
13. Kleinberg S. The acetabular index in infants in relation to congenital dislocation of the hip. *Arch Surg* 1936; **32**: 1049–54.
14. Troelsen A, Elmengaard B, Søballe K. A new minimally invasive transsartorial approach for periacetabular osteotomy. *J Bone Joint Surg Am* 2008; **90**: 493–8.
15. Ganz R, Klaue K, Vinh TS *et al*. A new periacetabular osteotomy for the treatment of hip dysplasias. Technique and preliminary results. *Clin Orthop Relat Res* 1988; **232**: 26–36.
16. Tannast M, Fritsch S, Zheng G *et al*. Which radiographic hip parameters do not have to be corrected for pelvic rotation and tilt? *Clin Orthop Relat Res* 2015; **473**: 1255–66.
17. Tachibana T, Fujii M, Kitamura K *et al*. Does acetabular coverage vary between the supine and standing positions in patients with hip dysplasia? *Clin Orthop Relat Res* 2019; **477**: 2455–66.
18. Kennedy JW, Brydone AS, Meek DR *et al*. Delays in diagnosis are associated with poorer outcomes in adult hip dysplasia. *Scott Med J* 2017; **62**: 96–100.
19. Reimer LCU, Jakobsen SS, Mortensen L *et al*. Efficacy of periacetabular osteotomy followed by progressive resistance training compared to progressive resistance training as non-surgical treatment in patients with hip dysplasia (PreserveHip)—a protocol for a randomised controlled trial. *BMJ Open* 2019; **9**: e032782.