Comparison between Graf method and pubo-femoral distance in neutral and flexion positions to diagnose developmental dysplasia of the hip

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A B S T R A C T

Purposes: To evaluate whether the pubo-femoral distance (PFD) can be used as an accurate screening test to diagnose developmental dysplasia of the hip (DDH) in an at-risk population compared with the Graf method. Second, to determine whether PFD assessment is feasible and reproducible regardless of the observer's experience.

Materials and methods: IRB approved this retrospective single-institution study. Written informed consent was waived. Between January 2010 and March 2012, 116 neonates at risk for DDH were included. Infants' hips were distributed into two groups according to recommendation for treatment: non-dysplastic (ND; Graf I/IIA; 211 hips; 69 females/37 males) and dysplastic hip (DH; Graf IIB/IIC/III/D/IV; 21 hips; 8 females/3 males). One resident and one experienced radiologist reviewed ultrasonography images performed in the fourth week. To compare the groups, Student's t and Mann–Whitney tests for normally and non-normally distributed covariates were performed. Accuracy of PFD to diagnose DDH was calculated. Intraclass correlation coefficient (ICC) was calculated to assess inter-observer agreement.

Results: Mean PFDs of ND group were 3.09 mm at neutral position and 3.64 mm with the hip flexed. Mean PFDs of DH group were 6.29 mm and 7.59 mm, respectively. Sensitivity, specificity, and accuracy of PFD were 94.4%, 93.4%, and 97.2% (cut-off = 4.6 mm) at neutral position and 94.4%, 89.0%, and 95.5% (cut-off = 4.9 mm) with hip flexed. ICCs were 0.852 and 0.864, respectively.

Conclusions: PFD is comparable with Graf method, enabling physicians to differentiate patients who should undergo treatment from those who should not. PFD can be used as a screening tool for diagnosing DDH with high accuracy, even by inexperienced radiologists.

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1. Introduction

Developmental dysplasia of the hip (DDH) encompasses a spectrum of abnormalities ranging from a stable hip with a mildly dysplastic acetabulum to a complete hip dislocation. Late diagnosis and treatment of DDH might result in premature degenerative joint disorder, functional impairments, chronic pain, and permanent disability. Using only a physical examination, approximately 50% of infants with dislocated hip joints are diagnosed by the end of their first year of life [1]. After screening for hip dysplasia using ultrasonography (US), the rates of open reductions and complications decreased by 46% [2,3].

US is the preferred diagnostic imaging method for DDH screening in patients aged <4 months [4,5]. Graf [6] proposed the primary US screening method for DDH used worldwide, but regional variability exists among ultrasonographic techniques. One source of variability related to the Graf method is that the reliability of assessing hip morphology might be low [7], and this method does not assess hip instability. In addition, a steep learning curve exists for an acceptable application of the Graf method. Harcke [8]

proposed a dynamic US technique to assess hip instability. Currently, a combination of the static technique proposed by Graf and the dynamic technique proposed by Harcke is used [5,9]. In France, a simple and reproducible US screening test [10,11] for DDH was proposed based on measuring the pubo-femoral distance (PFD).

The primary purpose of the current study was to evaluate whether the PFD can be used as an accurate screening test to diagnose DDH in an at-risk population compared with the Graf method. Second, we sought to determine whether PFD assessment is feasible and reproducible regardless of the observer's experience.

2. Materials and methods

2.1. Study design and IRB approval

Institutional Review Board (IRB) approved this retrospective single-institution study. Written informed consent was waived.

2.2. Sample

Between January 2010 and March 2012, 156 neonates at risk for DDH underwent hip US at our institution. Twenty-one participants were excluded for known chromosomal abnormalities, neuromuscular disorders, or both. Nineteen participants were excluded because their exams were not available in the picture and archiving communication system (PACS). In total, 116 neonates (232 hips) were included. Clinical charts were reviewed to assess patients' physical examination, risk factors, and clinical indications for performing hip US. Radiological charts were reviewed for assessing the Graf modified classification [12], alpha and beta-angle values, and results of the dynamic hip US that were considered as the referral standard.

The neonates were divided into two groups according to the recommendation for hip treatment. The non-dysplastic group (ND; 211 hips, 69 females/37 males) was composed of infants with hips of the Graf modified classifications I and IIA, and the dysplastic hip group (DH; 21 hips, 8 females/3 males) was composed of infants with hips of Graf IIC, III, D, and IV. Graf IIB ($n = 0$) was not considered because this classification is defined after 12-week follow-up exams for immature hips [4].

2.3. Ultrasonographic examination

US was performed in a GE Logiq® 5 machine with a high-frequency linear transducer (10-L or 12-L transducers). All neonates at risk for DDH underwent a hip US during the fourth week of life. Following standard guidelines [5,9], the techniques proposed by Graf [6] and Harcke [13,14] with dynamic maneuvers [8] to assess hip stability were performed for all neonates. Residents in the third year of radiology training performed the US examinations under the supervision of one of the four radiologists experienced in pediatric hip US from our institution. Images were collected and saved in PACS for analysis.

2.4. Image analyses

Two observers independently, retrospectively, and blindly evaluated the reference images in a randomized fashion: one senior musculoskeletal radiologist with seven years of experience in neonatal hip US (O.S.Z.N., senior observer) and one radiology resident (V.F.D., junior observer) in the third year of his training program. Images were reviewed in a random order to avoid a learning bias. The observers were unaware of each other's results, the clinical data of the participants, or the radiological reports of the exams.
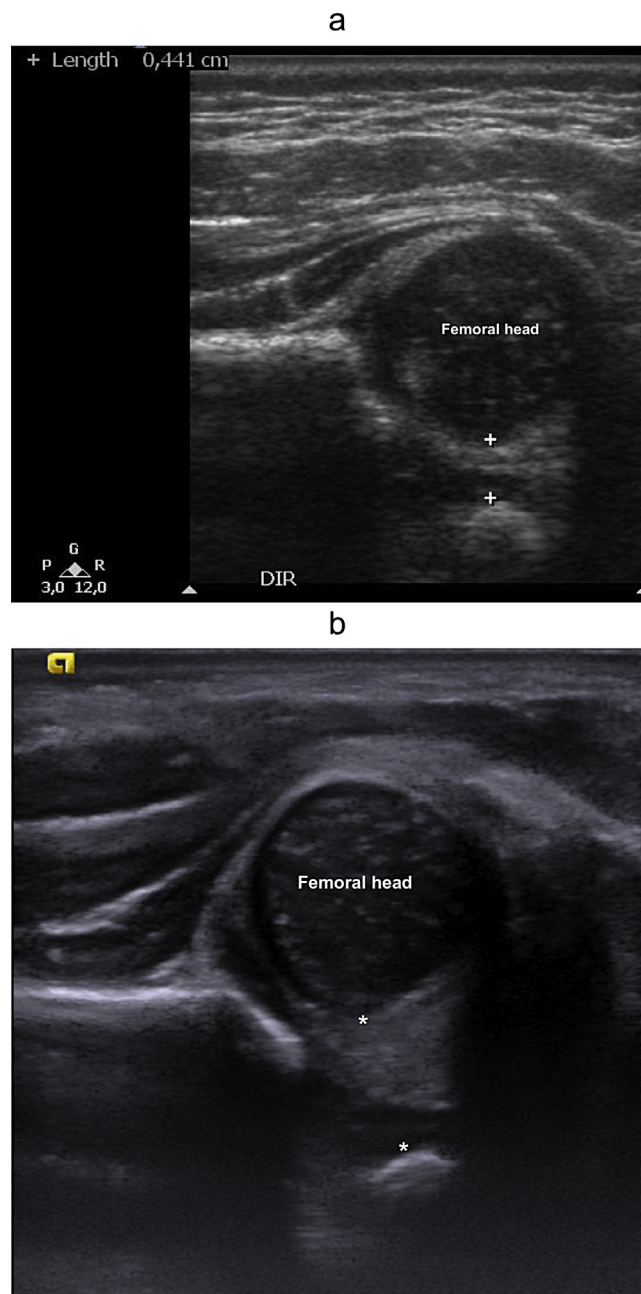
Fig. 1. Ultrasonography of a normal hip (a) and a dysplastic hip (b), coronal view through the mid acetabulum according to Graf. The pubo-femoral distance was 4.4 mm in (a) and 9.0 mm in (b).

Alpha and beta angles, the Graf modified classification, and the PFD were assessed. Alpha and beta angles were measured according to the technique proposed by Graf [6]. The PFD was defined by measuring the distance between the lateral aspect of the pubic bone over the acetabular incisure and the medial surface of the cartilaginous epiphysis of the femoral head [10]. The PFD was measured using the coronal view (Fig. 1), both from a neutral position and with approximately 90° hip flexion, without rotation, adduction or abduction.

2.5. Statistical analysis

The data were checked for normal distributions using the Shapiro–Wilk test prior to the main statistical analyses. Data were represented as means ± standard deviations (SDs) or medians and