Is X-ray screening unnecessary for life in Graf type I children at high risk of DDH?

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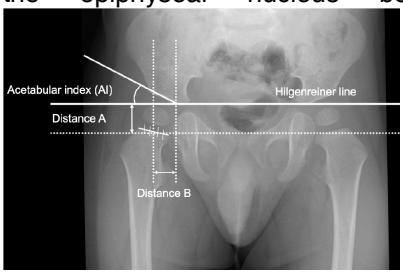
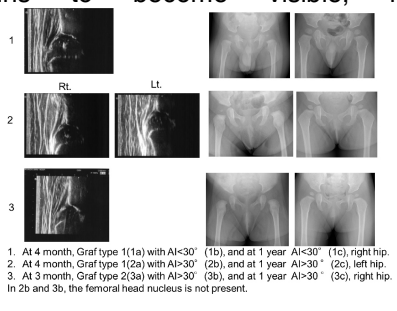
INTRODUCTION: Early diagnosis and treatment of developmental dysplasia of the hip (DDH) are crucial because they enable less invasive and more effective interventions. Despite various screening methods used worldwide, there are still reports of delayed diagnoses and overdiagnoses, which remain contentious issues. Ultrasound examination, as introduced by Graf, allows for early visualization of the hip condition, enabling the detection of dislocations, instability, and dysplasia from a very young age. Currently, ultrasound is considered the global gold standard for DDH screening due to concerns about radiation exposure from other methods. However, previous studies have indicated that some children who initially appear clinically and ultrasonographical normal may later be diagnosed with DDH. This suggests that the diagnostic accuracy of ultrasound screening for DDH has not been fully validated. This study hypothesized that in children at high risk for DDH, there might be cases with normal ultrasound results but abnormal radiographic findings. To test this hypothesis, the present study aimed to examine the prevalence and characteristics of DDH in high-risk children up to 1 year of age.

METHODS: Of the 417 patients who underwent secondary and tertiary DDH screening at our hospital between 2020 and 2022, 44 were over 7 months old at their first visit, 20 were not considered high risk, 25 had changed doctors or moved away, 42 did not consent to the study, and 38 were treated with a Pavlik harness or similar devices, and were excluded from the study. This left 239 infants (478 hips), including 23 boys and 216 girls, who were included and followed up until around 1 year of age. Ultrasound examinations were conducted at the first visit and at 3-6 months of age, while X-rays were taken at 3-6 months and again when the child started walking (approximately 1 year of age). Ultrasound was performed using the Graf method, with only type I considered normal. The X-rays measured the acetabular angle (AI), distance A, and distance B (Fig. 1). Infants with an AI greater than 30° were defined as radiological abnormality.

RESULTS: There were 74 cases (96 hips) diagnosed with an abnormality other than Graf Type I at 3-6 months of age, and 38 cases (51 hips) diagnosed with DDH by X-ray during the same period. Among those diagnosed with DDH at 3-6 months, 19 cases (22 hips) showed normal ultrasound results. Among those diagnosed with DDH on X-ray at 1 year of age, 30 cases (37 hips) were identified, of which 21 cases (56%) had a normal ultrasound at 3-6 months. Despite normal ultrasound findings at 3-6 months, physical examination findings and radiological indices for those with an acetabular index (AI) of ≥30° on X-ray were found to be associated with pelvic positioning, lesser distance A, and the absence or asymmetry in the appearance of the femoral epiphyseal nucleus (Fig. 2). Multivariate analysis further indicated that the absence or asymmetry in the appearance of the femoral epiphyseal nucleus and lesser distance A were significantly influenced this discrepancy. There was a significant correlation between AI at 3-6 months and at the onset of walking ($r = 0.617$, $p < 0.0001$) (Fig. 3).

DISCUSSION AND CONCLUSION: This study identified cases where normal ultrasonographic findings were accompanied by abnormal radiographic findings either at the same time or at 1 year of age. X-ray examination is a crucial diagnostic tool for DDH due to its high reproducibility. Regarding the concern about radiation exposure, past reports indicate that a single X-ray examination is unlikely to pose a significant risk, even in infants. Furthermore, combining ultrasound and X-ray provides more accurate screening for DDH compared to ultrasound alone. Some reports suggest that no additional tests are necessary for high-risk children with normal ultrasound results, while others recommend an X-ray at some point during the follow-up period. Consequently, there is no consensus on the optimal follow-up protocol for children at high risk of DDH. The results of this study suggest that radiographic imaging around 4 months of age, when the epiphyseal nucleus begins to become visible, may be beneficial for high-risk patients.





1. At 4 month, Graf type 1(1a) with AI<30° (1b), and at 1 year AI<30° (1c), right hip.
2. At 4 month, Graf type 1(2a) with AI>30° (2b), and at 1 year AI>30° (2c), left hip.
3. At 3 month, Graf type 2(3a) with AI>30° (3b), and at 1 year AI>30° (3c), right hip.
In 2b and 3b, the femoral head nucleus is not present.