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Original Article

Verification of hip reduction using anterior ultrasound scanning during Pavlik harness treatment of developmental dysplasia of the hip

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ABSTRACT

Aim: Ultrasound scanning (USS) is used for diagnosis and surveillance in developmental dysplasia of the hip (DDH). Lateral coronal scanning is performed with the hip flexed, in neutral adduction. In this position an unstable hip may dislocate, failing to demonstrate a reducible hip, leading to abandonment of harness treatment. Anterior ultrasound permits imaging of the flexed abducted hip in harness. This study evaluates the role of anterior & lateral USS in determining duration of treatment and reduction in DDH.

Method: Between 1997 & 2010, 233 patients requiring harness treatment received lateral USS, with dislocated & dysplastic hips re-imaged fortnightly. From 2005, anterior USS was used additionally to assess reduction in harness.

Results: One-hundred and eighteen patients (167 hips) received lateral USS, 115 (160 hips) received both. In the lateral cohort, 103 (140 hips) were treated successfully, mean duration 66.2 days (95% CI 60.2–72.1), with 15 (26 hips) failures (15.5%), mean 30 (CI 95% 19.3–40.6). In the anterior cohort, 107 (150 hips) were treated successfully, mean 53.3 (95% CI 49.8–56.7), with 8 (10 hips) failures (6.25%), mean 35.3 (CI 95% 25.5–44.9). Children receiving an anterior USS had a shorter duration of treatment ($p = 0.011$) and no difference in failures ($p = 0.21$).

Conclusions: A reduced duration of treatment for Graf 3 hips was observed. Anterior ultrasound allows earlier recognition of hips that fail to stabilize, via two observed modes of failure; failure of hip reduction and failure to stabilize after reduction.

1. Introduction

Following on from our institutions previous work identifying the "ischial limb" as a reliable sonographic marker of the central and deepest portion of the cartilaginous acetabulum during anterior ultrasound of the hip,[1] in addition to the regional anatomy originally described by Dahlström-et al,[2] we set out to review our own results with the technique.

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Anterior, dynamic and real-time ultrasound are terms used to describe techniques of scanning separate from that originally described by Graf[3] in the coronal plane capturing static images of the hip. Clarke et al[4] described a method of obtaining two-dimensional planar views of the hip using two lateral images to construct a three-dimensional representation of patho-anatomy termed real-time ultrasound. Dahlström et al[2] described a purely anterior dynamic technique, with the transducer centred over the femoral head & parallel to the femoral neck. Suzuki et al[5] described imaging both hips simultaneously from the front (anterior) in extension and flexion-abduction.

The Graf US technique is performed with a laterally applied transducer on the neutrally adducted hip in 90 degrees of hip flexion and slight internal rotation. In this position an unstable hip will invariably dislocate and Graf standard plane imaging alone may not verify that concentric hip reduction is being achieved, leading to premature abandonment of harness treatment. Furthermore lateral USS gives poor quality imaging of the abducted hip in more rigid splints. This lead the senior author to adopt and develop a technique of dynamic anterior ultrasound, performed with the child supine in harness, hips flexed and abducted, transducer centred over the femoral head (Fig. 1), using the relationship of femoral head to ischial limb as a sonographic marker of reduction, as described in our previous paper.[1]

The research questions during this study using anterior ultrasound imaging as an adjunct to standard lateral scanning were:

1) Can anterior ultrasound scanning aid identification of successful hip reduction in an abduction orthosis?
2) Can this technique demonstrate failure of hip reduction?
3) Does this imaging method improve Pavlik harness success rates and outcome?

Fig. 1 – Photograph of child undergoing anterior ultrasound scanning in Pavlik harness. Note the position of the transducer, placed anterior to the hip joint, centred on the femoral head. The transducer is held parallel to a plane drawn across the front of the pubic symphysis.

2. Method

Our regional surveillance protocol for infantile hip dysplasia since 1997 has been through a consistent selective US screening policy. Those with risk factors, positive family history and breech presentation during third trimester or at delivery are scanned at 6 weeks of age. Those children with an abnormal neonatal or six week examination are scanned as soon as practical after recognition. Hip instability according to clinical findings was assessed in every child by the primary examiner and subsequently the senior author at initial scanning clinic. The results were not recorded consistently in all cases, and therefore for the purposes of study we have not included this. Children with a completely normal scan (Graf 1) were discharged. Those with minor dysplasia and deemed to be stable (Graf 2a) were not treated in Pavlik and rescanned until confirmed normal (Graf 1). Those with instability, (Graf 2a unstable) abnormal scans (critical range dysplasia Graf 2c or decentered/dislocated Graf 3 and 4 hips) were treated accordingly, initially in a Pavlik harness and rescanned at weekly or fortnightly intervals in a dedicated hip treatment clinic.

Anonymised details of children with abnormal scans were included in the DDH database comprising; gender, laterality, location of birth (hospital site), maternal age, delivery, birth weight, ethnicity, family history, congenital anomalies, abnormality of examination/reason for referral and risk factors for DDH. Crucially, the child's age at the time of presentation, initial scan, diagnosis, Graf classification, subsequent management, surveillance and duration of treatment were also recorded. Institutional approval was obtained, as was parental consent to scanning & treatment.

In 2005, the senior author introduced the technique of anterior USS in addition to standard lateral USS. Lateral ultrasound scanning necessitates removal of the limb from the abduction orthosis, risking loss of reduction in the unstable hip whereas anterior USS can be undertaken in-situ. Given these concerns, anterior USS was used additionally to monitor reduction & depth of hip location.

Between October 1997 and August 2010, two hundred and seventy six consecutive patients presented to our service and were found to have DDH on ultrasound scanning and underwent treatment in a Pavlik harness. In all patients, hip reduction in harness was monitored through ultrasound scanning.

2.1. *Lateral scan cohort*

Between 1997 and 2005 standard lateral US scanning was used as the sole method to monitor for hip reduction in 145 patients. Twenty seven patients from this cohort were excluded due to incomplete follow-up details.

2.2. *Anterior scan cohort*

Since 2005 anterior USS was used additionally to verify hip reduction in 131 patients. Within this cohort, 15 patients were excluded from study as their anterior USS was not performed