Combination of some findings of two different screening methods in DDH: Presentation of our findings in a large population

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Keywords
- congenital hip dysplasia
- congenital hip dislocation
- developmental dysplasia of the hip
- ultrasonography, methods.

ABSTRACT

The purpose of this study is to establish the diagnostic value of combining using static (Graf) and dynamic (Harcke) ultrasonography methods. Both static and dynamic methods were used only in Graf’s Type 1 and Graf’s Type 2a patients. Groups were classified as normal findings (Group A), follow-up group (Group B) and DDH group (Group C). In Group B patients 17 of 20 hips were followed; 5 of them diagnosed as DDH and classified as Group C after follow up studies. In initial evaluation 14 hips were followed according to the result of Harcke’s. Whereas 18 hips were directed to follow up for their suspicious Graf’s result. When both methods were combined to determine suspicious cases 20 hips were classified as Group B. Twelve hips were directed to follow up in both methods. After 3 months hips were reevaluated and 4 hips were diagnosed to be DDH according to both methods. One hip was diagnosed as DDH by only Graf’s method, it was stable in Hercke’s. Eleven hips were normal for both methods. Static and dynamic methods leads to diagnose DDH easily without repetitions and precludes confusing of methods by leaving β angle measurement of the hip.

Introduction

DDH has 0.5-1.5% incidence. This ratio increases to 34% with positive familial anamnesis (Clarke, 2004). Ultrasonography (US) is a useful imaging technique in follow-up and the diagnosis of the developmental dysplasia of hip (DDH). Technique mostly depends on experience. Determination of DDH may perform by 2 methods on US: Static evaluation of Graf’s morphological method and stability assessment of Harcke’s dynamic method (Graf, 2007; Harcke, 1994).

α and β angles are forming the Graf’s method. α angle consists of intersection between parallel lines of acetabulum, lateral wall of ilium and represents osseous acetabulum. β angle consists of intersection between parallel lines of lateral wall of ilium and cartilaginous roof of the acetabulum. Decrease of α angle to 59 and less and increase of β angle more than 55 degrees directs to development of acetabular dysplasia. Actual importance of β angle is to distinguish Type 2c stable, unstable and Type D hips (Graf, 2007).

Harcke’s dynamic method shows the stability of femoral head in acetabulum. This technique performs by applying stress to the hip with Barlow maneuver. Results are classified as stable and unstable femoral head (Harcke, 1994). Stable and centered hip with normal angle measurements have to accept as normal hip, although unstable hip on dynamic examination with or without normal angle measurements have to accept as pathologic hip on final diagnosis (Harcke, 1994; Koşar et al., 2009).

Bilateral detailed hip US studies may take a long time for a community screening program. Using single method may lead multiple repetitions. Shortening time in US is essential because it may increase the wide community researches for DDH. Selective US studies investigate infants with risk factors have a priority, also screening of whole infants has an
importance on the diagnosis. Unilateral hip imaging because of ipsilateral risk factor is not common in practice. Both static and dynamic methods are separately necessary during hip US examinations, therefore combine using of both methods is essential.

The purpose of this study is to establish the diagnostic value of combine using static (Graf) and dynamic (Harcke) ultrasonography methods.

Materials and methods

After obtaining institutional review board approval, we conducted a study of all patients who underwent to hip US. 8,200 hips of 4,100 patients imaged on US between July 2007 and August 2010. Patients imaged by US with routine US protocols (AIUM, 2009). The range at which the children were screened is from 4 weeks to 6 months; the mean age was 4 months and 2 days. All patients imaged bilaterally. We include all the patients in a wide range such as unilateral or bilateral hip dislocation, suspicion of subluxation and normal physical examination findings. Our study had a risk group: 2 patients were twins, other 2 had talipes equinovarus. Cleft palate and lip with mega cisterna magna, agenesis of corpus callosum, labial fusion and hepatic simple cyst also existed in patients. One subluxated hip excluded because presence of septic arthritis of the hip had diagnosed, therefore dynamic evaluation was not performed. After the antibiotic therapy, femoral head returned to normal place, therefore DDH was not considered. Experienced radiologist on hip US performed the imaging protocols without any preparation or sedation in a research center. The US studies applied in lateral decubitus position with 5-11 MHz band range linear probe. Static evaluation was performed in transverse and coronal planes with flexion of hip and knee. Femoral head position and coverage considered during examination. Graf static method used for morphological assessment. Femoral head statement in acetabulum, α and β angle measurements observed from all hips. After static imaging, dynamic method used to establish of femoral head stability in acetabulum. Applying stress to the hip by Barlow maneuver in transverse and coronal planes showed stability of femoral head in acetabulum. Dynamic evaluation was not performed to Type 2b-4 in pathologic group (Group C), because additional examination is not required for the diagnosis of DDH. Group C hips were considered abnormal enough to treat and pavlik harness had used on treatment. Type 1 unstable and Type 2a patients followed 3 months (Group B). Patients classified into 3 groups according to US findings. Femoral head centered in acetabulum with complete coverage in Type 1 divided into 2 groups: Type 1 stable (Group A) and Type 1 unstable (Group B). Type 2a hips also divided into 2 groups: Type 2a stable and Type 2a unstable (both in Group B). Type 2b, Type 2c, Type D, Type 3 and Type 4 (Group C) grouped as Graf classification and β angles had measured. Group A accepted as normal. Patients in Group B accepted as follow-up group, therefore recalled 1 month later. We had followed control groups 3 months, if there was not any recovery. Group C was accepted DDH reported as treatment required group, β angle measured on US examinations in Type 2c and Type D (decentered) hips (Table 1). We have observed both α and β angle ratios from all patients. In Graf’s static method, β angle less than 55 degree is in Type 1b. We classified Type 1b hips as normal in Group A. β angle ratio is important especially in Type 2c and D and we have classified these groups in Group C.

One of the main aims of the study was to shorten the screening time in order to increase the acceptance of US as a screening method. We measured the examination times of Graf, Harcke and our combined methods. We did not calculate the examination time in patients that were applied single US method to avoid skewed distribution of patients in the study.

Results

8,149 hips (99.38%) in Type 1 at Graf’s classification and stable on Harcke’s classification were classified as Group A. Twenty hips (0.24%) with Type 1 at Graf’s classification were unstable at Harcke’s classification and all Type 2a patients were classified as Group B. Thirty one hips (0.38%) classified from Type 2b to Type 4 were accepted to be Group C. Group C patients directed to pediatric orthopedics. In Group B patients 17 of 20 hips were followed; 5 of them diagnosed as DDH and classified as Group C after follow-up studies. In initial evaluation 14 hips were followed according to the result of Harcke’s. Whereas 18 hips were directed to follow up for their suspicious Graf’s result. When both methods were combined to determine suspicious cases 20 hips were classified as Group B. Twelve hips were directed to follow up in both methods. After 3 months, hips were reevaluated and 4 hips were diagnosed to be DDH according to both methods. One hip was diagnosed as DDH by only Graf’s method, while it was stable in Hercke’s. Eleven hips were normal for both methods. Our data revealed two more hips to follow up when methods were combined. Hercke’s method missed one hip as DDH after follow up. Combine using of both methods step by step on US screening program is shown on Figure 1 as a radiological steps. We observed that the total time to finished examination was 292.4±28.7 seconds when examination performed separately while it was 214.9±19.4 when performed combined (p<0.001).

Discussion

Our study showed that although both DDH detection methods are accurate enough as a screening method, combination of both methods may provide better selection of groups for follow up and Graf’s method performed after normal Harcke diagnosed one more abnormal hip. The data that led us to create Group B is to avoid over diagnosis and related overtreatment among infancy group. It is more appropriate to evaluate hips with US after 4 weeks age to exclude false results by maternal hormonal effects on the ligaments or muscles. Therefore we also followed these patients weekly to the end of 3 months. US has become a more routine and reliable method of examining the infants hip, over the last 20
years (Jellicoe et al., 2007; Bar-on et al., 1998; French and Dietz, 1999). Therefore, many US methods exist to classify the appearance of the infant’s hip (Rosendahl and Toma, 2007; Synder et al., 2006; Bellah, 2001; Wientroub and Grill, 2000). These methods have proven feasible, and the accuracy and the clinical validity of the US have been addressed in numerous papers (Roovers et al., 2005; Rosendahl et al., 1994; Holen et al., 2002; Bellah et al., 1999; Riboni et al., 2003; Harcke and Grissom, 1990). The static and dynamic US methods are more favorable among them (Rosendahl et al., 1992; Finnbogason et al., 2008). Which is more reliable method (static or dynamic) is still controversial because many previous reports confirmed that sonographically unstable hips can have normal morphology (Milcan et al., 2004; Roposch and Wright, 2007; Vandevenne et al., 2009).

Graf method requires measurements of angles. This way may take a long examination time on community screening programs. The radiologists may complain from the difficulties and/or long time of investigations especially in screening of all infants. In a community screening it would be wise to divide the patients into normal, i.e. Graf type 1, which receive no further imaging and abnormal, all other children, which will be referred to (preferably a pediatric) radiologist for additional investigations. This way the subclassification of abnormal findings would not be of importance for the initial screening technician. The ultrasonographer depended screening programs, which act upon this concept, are in place (Roovers et al., 2005). This approach requires many redundant repetitions for the patients and may cause late diagnosis. A new radiology programme accepted by all of the radiology community is required. Our combined approach is radiologists depended screening program. This view has an instant entire diagnosis, prevents redundant repetitions and also has an advantage on to avoid delayed treatment; thus, it is possible to prevent the event of familiar anxious about their child.

<table>
<thead>
<tr>
<th>Group</th>
<th>Type 1a stable</th>
<th>Type 1a unstable</th>
<th>Type 2a stable</th>
<th>Type 2a unstable</th>
<th>Total</th>
</tr>
</thead>
<tbody>
<tr>
<td>Group A</td>
<td>8149 (%99.38)</td>
<td>-</td>
<td>-</td>
<td>-</td>
<td>8149 (%99.38)</td>
</tr>
<tr>
<td>Group B</td>
<td>-</td>
<td>2 (%0.02)</td>
<td>6 (%0.07)</td>
<td>12 (%0.15)</td>
<td>-</td>
</tr>
<tr>
<td>Group C</td>
<td>-</td>
<td>-</td>
<td>-</td>
<td>31 (%0.38%)</td>
<td>-</td>
</tr>
<tr>
<td>Total</td>
<td>8149 (%99.38)</td>
<td>2 (%0.02)</td>
<td>6 (%0.07)</td>
<td>12 (%0.15)</td>
<td>8200 (%100)</td>
</tr>
</tbody>
</table>

Table 2. Results of Group B follow-up studies.

<table>
<thead>
<tr>
<th>Group B</th>
<th>Number of Hips</th>
</tr>
</thead>
<tbody>
<tr>
<td>Before follow-up</td>
<td>17 (100%)</td>
</tr>
<tr>
<td>After follow-up: Normal Findings</td>
<td>12 (71%)</td>
</tr>
<tr>
<td>After follow-up: Pathological findings</td>
<td>5 (29%)</td>
</tr>
</tbody>
</table>

US examination is the most reliable method in diagnosis and provides informations about soft tissues such as joint capsule, labrum and nonosseous parts of femoral head and acetabulum. Static method may reveals subluxation and luxation, although stability of femoral head in acetabulum may evaluated by dynamic imaging method (Roposch and Wright, 2007; Soboleski and Babyn, 1993). Femoral head coverage ratio by acetabulum is the other method. This ratio may demonstrated while calculation of α and β angle degrees by the operator in static method. Various US imaging methods lead confusing the concepts and overlapping the imaging findings. Koşar et al. compared the morphologic and...
dynamic US methods. They classified the hips as normal, abnormal and follow-up or treated hips. Their study sought to ascertain whether every hip that is morphologically normal is stable in dynamic examination and whether every hip that is dynamically unstable is abnormal (Koşar et al., 2009).

Our aim was not to compare the methods; we used both Graf and Harcke methods in the research of disease (Table 3). In our study, we did not calculate the acetabular coverage ratio of the femoral head. In our combined approach method, it is also possible to evaluate the femoral head coverage ratio. This way may also consider the coverage ratio of femoral head by acetabulum in future studies.

The significance of US examination on the diagnosis is advanced to clinical or roentgenogram evaluation. Screening program with the use of US may lead the early detection of disease (Clarke, 2004). There is no consensus on this topic, although the first 6 weeks age is the appropriate time for screening program. Clinical suspicions or risk existence have to direct instant US examination. 6-week-old is the mean age for screening on routine. Late diagnosis of the disease may lead many irreversible damages on patients. Screening programs show the decrease of serious conventional treatment cause of early diagnosis; therefore US may help to detect the silent hip dysplasias. Misdiagnosis has a poor reputation. Late diagnosis rate of missed group is similar to patients without screening by US methods. Screening programs may lead increased faulty on diagnosis, although hip US is mandatory for early diagnosis (Graf, 2007; Harcke, 1994; Rosendahl and Toma, 2007; Synder et al., 2006; Roovers et al., 2005; Riboni et al., 2003).

Roovers et al. study did show that screening at the age of three months, compared to one and two months, significantly decreased the number of type 2a and above with respectively 95.3% and 84.4%. In those cases parents would unnecessarily been made anxious about the outcome of their child. This is an important factor that we, as radiologists, sometimes seem to forget (Roovers et al., 2005).

The unstable hips with normal morphology may stabilize on follow-up studies, therefore static evaluation is important criterion on diagnosis (Koşar et al., 2009). Rosendhal et al. study revealed 91% rate of unstable hips in normal morphology appearance and 49% normal morphology in unstable types (Rosendhal et al., 1992).

Koşar et al. study found 8.42% ratio follow-up due to instability in 472 hips of Type 1 and 10% ratio follow-up in 52 of Type 2a morphology (Koşar et al., 2009). They studied clinical suspected hips with/without risk factors for DDH and showed similar follow-up rates. In our study follow-up group consist of 20 hips (0.24%) in Type 1 unstable, Type 2a stable and unstable classifications (Group B). Group B was found 39% in both pathology suspected hips (Group B and C). Type 2a hips were constituted of 10% in pathologic types. Follow-up ratio was 0.2% in whole screening program. Our study has mild low ratios according to Kosar et al. study because we have imaged not only DDH suspected but also normal hips. We believe our lower ratio is depending on wide community screening of all infants.

Type 3 morphology may develop on follow-up studies in unstable Type 1 class. This late DDH incidence was reported in many studies. The ratio is between 0.14-0.17% (Koşar et al., 2009; Roovers et al., 2005). Our study suggested unstable Type 2a class has an increased ratio in DDH.

We used both static and dynamic methods in researching of DDH on the same time and defined the radiological steps on patient management. We have observed β angle measuring of the hip is not necessary in our classification. Using
both static and dynamic methods leads to diagnose DDH easily without repetitions and preclude on confusing of methods without measuring β angle of the hip. This suggestion decides to use a new screening program with less US examination time. We decide that using our classification will lead to shorten the US examination time and be helpful especially in future community screening programs.

Graf and Harcke methods are independent techniques to evaluate DDH with their own sensitivity and specificity. Many radiologists rely on their personal experience; they are tending to prefer a fast and reliable technique and avoid increasing the screening time with additional measurements or assessments. This is however, in contrast to clinical practice. Which method is the gold standard? In Europe, most centers are only using the Graf approach and even several national screening programs are based on this method, although United States prefer Harcke method. Present day, there is no universal consensus on this topic. Different countries prefer different techniques. Using these methods separately leads ambiguity and increases the examination time and the repetitions. This study states that the combined approach of both Graf and Harcke methods is necessary to evaluate DDH. Combined approach with the switches to another is the one common method. Thus, examination time will decrease according to separate usage.

References