Simple or stress sonographic hip screening in the newborn versus simple hip screening at the age of three to four months

Hassan Malkawi, MD, Faris Tadros, MD, Ziad Khasawneh, MD, Bassam Al-Asir, PhD.

ABSTRACT

Objectives: The study was carried out to find the most appropriate age and sonographic method to detect developmental dysplasia of the hip (DDH). Subjects: 4411 newborns and infants were examined clinically and by simple or stress sonography. Design: The study was divided into three parts. In the first part 1823 newborns were examined by simple sonography at birth and followed up monthly until the age of three months. In the second part 1511 newborns were examined by stress sonography and followed-up until the age of three months. In the third part 1077 infants were examined by simple sonography at the age of three to four months. Results: In part one, hip pathology requiring treatment was detected in 85 infants (4.66 per cent). In 34 infants the diagnosis was made at birth while in the remaining 51 infants hip pathology was detected one to three months after birth. In 22 infants of the latter group, hips were initially of type 1b which, according to Graf, will not deteriorate. In the second part, hip pathology requiring treatment was detected in 88 infants (5.6 per cent). In 33 infants hip pathology was detected at birth and in 55 it was detected at one to three months after birth. In the third part, hip pathology requiring treatment was found in 14 infants (1.3 per cent). Conclusion: Simple hip sonography at the age of three months is able to detect all pathological hips and reduce the number of treated infants more than three fold.

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Keywords: Developmental dysplasia of the hip, simple sonography, stress sonography.

Clinical screening programs of the newborn hip proved to be useful, but it did not meet all the expectations, because the late presentation of dislocated hip still occurs.1,2,4,13 Sonographic examination of the hip as introduced and refined by Graf17 allows objective documentation of the hip joint, because it is able to visualize all bony and soft tissue parts of the hip as well as motion of the femoral head in relation to the acetabulum. Although it has been in use for more than one decade, the number of reports dealing with this topic is rapidly increasing.8,14,16,24 Unfortunately, the reports confined to hip screening in the newborn in the English sonographic literature are still limited.8,10,14,16,19 Clarke et al.12 concluded, that sonography can detect hip pathology even in the clinically normal neonates, but their concept of using selective sonographic screening of at-risk babies, has failed to demonstrate a significant reduction in the incidence of late cases. They concluded, that a prospective trial of sonographic screening of all births is required. Graf strongly recommends sonographic hip screening of all newborns, but in his monograph, there are no clear-cut conclusions concerning the validity of sonographic newborn screening programs. In the five reports dealing with this topic,8,10,14,16,19 there is no mention of missed or late cases. The reader may gain the impression that these programs are 10 per cent successful. More than 50 per cent of the new 100 born hips are of type 1b.6,16 Some authors hold the opinion that control examination of these hips at the age of three months is not required.8,16,22 Usually simple sonography is used in screening programs and stress sonography is advised under certain conditions. Szoke et al.19 and Castelein and Sauter20 tested the stability of the hip joint by stress sonograph but they do not specify if it was of value. Saies et al.15 used the Clark technique in stress sonograph and found it of value.11 In an effort to find the most appropriate sonographic method and age to detect developmental dysplasia of the hip (DDH) 4411 newborns and infants were examined clinically and by simple or stress sonography. According to the type of sonography examination and according to the age at which sonograph was performed, the study was divided into three parts. (1) - simple sonography at birth. (2) - stress sonography at birth. (3) - simple sonography at the age of three to four months.

The objective of the study was to answer the following questions: (1) - is sonography able to detect all abnormal hips. (2) - which sonographic method (simple or stress) and at what age is most appropriate and cost effective in detecting DDH.

Patients and methods. There are more than 6000 newborn deliveries each year at the authors' facility (Princess Basma Teaching Hospital, Irbid, Jordan). From August 1988 until February 1989, 3334 newborns

From the Faculty of Medicine, (Malkawi, Tadros, Khasawneh, Asir), Jordan University of Science & Technology, Jordan.

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Correspondence and reprint request to: Dr Hassan Malkawi, Jordan University of Science & Technology, Faculty of Medicine, Irbid, Jordan. Fax No. 962 2 39513.
Table 1 - The number of infants and hips divided according to the severity of hip pathology and the time when the pathology was diagnosed.

<table>
<thead>
<tr>
<th>Hip pathology and the time when it was diagnosed</th>
<th>No. of infants</th>
<th>No. of hips</th>
</tr>
</thead>
<tbody>
<tr>
<td>I. Dislocated hips</td>
<td></td>
<td></td>
</tr>
<tr>
<td>A - Diagnosed at birth</td>
<td>34</td>
<td>43</td>
</tr>
<tr>
<td>B - Diagnosed after birth</td>
<td>38</td>
<td>59</td>
</tr>
<tr>
<td>1 - With a cause for monthly follow-up</td>
<td>25</td>
<td>41</td>
</tr>
<tr>
<td>2 - Without a cause for follow-up</td>
<td>13</td>
<td>18</td>
</tr>
<tr>
<td>II. Dysplastic hips (type IIb), diagnosed at the age of 3 months.</td>
<td>13</td>
<td>20</td>
</tr>
<tr>
<td>Total</td>
<td>85</td>
<td>122</td>
</tr>
</tbody>
</table>

delivered consecutively in the maternity unit were included in the first two parts of this study. All babies were examined in the first 12 hours after birth. They were re-examined at the age of three months. Hips with risk factors (positive family history, breech presentation, congenital generalized laxity, oligohydramnios, club foot and other congenital anomalies), sonographically unstable hips and hips under treatment were followed-up monthly, while type II hips were followed-up only at the age of three months as recommended by Graf. In the third part of the study, 1077 unscreened infants were examined in the period from June 3rd until December 2nd 1989. All infants were three to four months old with an average age of 3.4 months. Using Graf’s technique and classification, all babies were examined first sonographically and after that, clinically, so that the baby would remain calm at least during the sonographic examination. Sonographic examination was conducted with a real time linear scanner Sonoline SL, (Siemens, Erlangen, Germany), using 7.5 MHz transducer. For infants older than two months, a 5MHz transducer was used.

**Technique of simple sonography.** Infants were placed in the locating device (as per Graf) in a lateral position with the examined hip in slight flexion and medial rotation. With contact gel applied to the area of the greater trochanter, the transducer, held by the right hand, was positioned over the trochanter in frontal plane parallel to the body long axis without tilt (Fig.1). The standard plane was found by rotating the transducer around the central acetabular axis. After recording the standard plane, both angles α and β, were recorded. The left hip is usually examined first.

**Technique of stress sonography.** With the baby and transducer in the same position as in simple sonography, the examiner grasps the infant’s left leg with his free left hand, positioning his fingers on the slightly flexed and adducted knee and the thumb on the sacrum. When examining the right hip the position of the fingers and thumb is reversed (Fig.2). The femoral head is then pushed in the dorsocranial direction by pushing the knee in this direction while the hip is adducted. The hip is considered unstable when β angle in stress sonography is ≥ 90° (Fig. 3). It was found in the first part of this study that newborn hips with β angle ≥ 90° dislocate, irrespective of α angle value. For this reason β angle ≥ 90° was chosen. Babies with hip pathology were treated by Pavlik harness and at the conclusion of the treatment, they were examined clinically, sonographically and reotngenographically to search for hip pathology including avascular necrosis of the femoral head. Treated babies and those with risk factors were re-examined at the age of one year. Normal children except those included in the third part of the study, were not examined at the age of one year. The author’s facility is the only facility in the area, where DDH cases are referred and treated. So far no case of DDH was referred from these screened children.

**Results. Part 1. Simple sonography at birth.** In this part of the study, 1823 newborns (844 females and 979 males were examined sonographically and clinically (Table 1.) Hip pathology necessitating treatment was found in 85 infants (4.66 per cent). In 13 infants (20 hips) of them, with hip dysplasia (Type IIb hips) were found at the age of three months. In 4 of them, hip pathology was expected.
because their hips were initially of type IIa. In the remaining 9, hip pathology was not expected because their hips were initially of type Ib, which according to Graf should not deteriorate. In the remaining 72 infants, 102 dislocated hips were found. In 34 infants hip pathology was diagnosed at birth and in 38 it was diagnosed one to three months after birth. In 25 infants of the latter group, hip pathology was expected as they were from the group of patients with either risk factors or their hips were initially of type IIa. The dislocation in the remaining 13 infants was not expected, as there was no cause for follow-up and their initial hips were type IIb, which according to Graf should not deteriorate.

**Part 2. Stress sonography at birth.** In this part 1511 newborn (751 females and 760 males) were included (Table 2). Hip pathology requiring treatment was found in 88 infants [5.8 per cent]. In 33 infants, 47 dislocated hips were diagnosed at birth, while in the remaining 55 infants (72 pathological hips) the diagnosis was made one to three months after birth. All of them were from a group of 560 infants with a cause for follow-up. Therefore the percentage of followed-up infants was 37 per cent of the total number and in almost 10 per cent of these followed-up infants hip pathology necessitating treatment was found. In 11 infants of the 55, 13 dysplastic hips (type IIb) were diagnosed at the age of three months, 3 hips in three infants were initially of type IIa and 10 hips in 8 infants were initially, type Ib). In the remaining 44 infants, 59 dislocated hips were diagnosed (in 39 infants the diagnosis was made at the age of one month, in four at the age of two months and in one at the age of three months). Their initial hip types were: type Ib 41 hips and IIa 18 hips. The cause for follow-up in the 55 infants were: risk factors in 13, sonographic hip instability in 15, IIa hip type in five and their combination in 22 infants. The total number of infants with SHI was 252 (16.67 per cent of the total number). In 175 of them SHI was combined with other risk factors, while in the remaining 77 [5 per cent of the total number], SHI was pure without other risk factors. Therefore the incidence of unstable hips (pure or combined with other factors) which progressed to dislocation was 12.69 per cent. If only pure instability is considered, then the percentage will be slightly less than 20 per cent. Hips which were sonographically stable at birth or which stabilized in the first two months remained so at the final check-up at the age of three months. In this part of the study, 90 per cent of the unstable hips stabilized at the age of one month.

**Part 3. Simple sonography at the age of three to four months.** In this part, there were 1077 infants (517 females and 560 males). Hip pathology requiring treatment was found in 20 hips in 14 infants (1.3 per cent). There were two dysplastic hips (type IIb) in 2 patients, and 18 dislocated hips. All of them were treated with Pavlik
harness as was mentioned earlier. The average duration of
treatment was 2.9 months (range six weeks to four
months). The treatment was successful in all of them. No
avascular necrosis was seen in the treated group.

Discussion. Three parts of the study emerged from an
effort to find the most appropriate age and sonographic
method, which is most effective in detecting all abnormal
hips and at the same time is cost effective. In the first two
parts of the study we followed exactly Graf's program in
sonographic hip screening in the newborn [the first
sonographic examination should be carried out during the
first month of life, monthly follow-ups should be
performed in high risk babies and those requiring treatment
and routine final examination should be carried out for all
infants at the age of three months].

In the first part of the study the hips of 85 infants
required treatment and only in 34 infants (40 per cent) was
hip pathology diagnosed at birth, while in 51 it was
diagnosed one to three months after birth. In 29 infants
from the latter group (34 per cent), hip pathology was
anticipated, as there was a cause for their follow-up. In the
remaining 22 infants (26 per cent) the diagnosis was not
expected and they would have been missed, because their
hips were initially of type Ib, and there was no cause for
their follow-up. They were detected thanks to the routine
final check-up at the age of three months. From this it is
obvious that type Ib hips in the newborn may deteriorate to
become not only dysplastic but also dislocated. This,
contradicts Graf's statement that type Ia and Ib hips do not
deteriorate but remain age appropriate throughout their
further development. In this part of the study, one
important observation was made: In 15 hips in 11
newborns, the initial β angle was ≥90°, although α angle
was more than 50° (in six newborns it was between 52 to
59 and in 9 it was more than 60°), and all of them became
dislocated. From this, it was concluded that every hip with
β angle ≥ 90° should be considered dislocated irrespective
of its α angle value.

In a screening program, it is too expensive and time
consuming to re-examine all infants at the age of three
months. An alternative was to perform stress sonography
in the newborn and to follow-up cases with sonographic
hip instability in addition to high risk cases and cases with
type IIa hips. By this, the number of followed-up infants in
the second part of the study was reduced to almost one
third of the total number. Hip instability was present in 252
infants. In 175 infants it was combined with other risk
factors and they would have been followed for these
factors. In only 77 infants (5 per cent of the total number),
hip instability was pure without other risk factors. In other
words, the number of infants with pure sonographic
instability which were added to the followed-up cases was
only 77 infants or 5 per cent of the total number. It should
be noted that almost 20 per cent of them became
dislocated, although the percentage of all unstable hips
which progressed to dislocation was 12.7 per cent. It
should be noted also that 90 per cent of the unstable hips
were stabilized at the age of one month. All hips which
were sonographically stable at birth or stabilized in the first
two months, remained so at the final check-up at the age of
three months. The number of treated infants in the second
part of the study was 88 or 5.8 per cent. This is higher than
the percentage in the first part which was 4.7 per cent or in

Graf's statistical data in which it was 5.22 per cent. This
evidence proves that stress sonography which, in a way, is
similar to Barlow provocation test, increases the
percentage of treated infants. As advised by Graf, the
infants in the first two parts of the study were not
followed-up after the age of three months. The authors'
facility (Princess Basma Teaching Hospital) is the referral
facility in the area, where cases of hip dislocation are
referred and treated. So far no case of dislocation was
referred after six years from the final follow-up of the
latest infant, when all children were at the walking age.
The third part of the study was performed, because it
seemed that the percentage of treated infants in the first
two parts was high. Muscle tonus in the newborn is
decreased possibly due to weakness of the muscles and
influence of hormones. The muscle tonus stabilizes usually
at the age of one month or later. As was mentioned
earlier 90 per cent of the unstable hips stabilized at the age
of one month and 10 per cent at the age of two and three
months. For this reason also the age of three to four
months was chosen in the third part of the study.

Delaying the screening after the age of three months
reduced the percentage of treated infants four-fold
compared with newborn screening. This explains why the
percentage of dysplastic hips which were treated in the
first two parts of the study 0.71 per cent of screened
infants, while it was only 0.18 per cent in the third group.
The infants in the third part of the study were followed-up
to the age of one year and no case of DDH was detected
after the initial examination. The last question to answer
is: what are the consequences on treatment if the diagnosis
is delayed to the age of three to four months. In this part of
the study the duration of treatment averaged 2.9 months.
In the first and second part of the study where sonographic
screening of the newborn hip was performed in the first 12
hours of life the duration of the treatment averaged 1.6
months. In another study, where the average age of the
infants was six months the duration of the treatment
averaged 4.2 months. It is obvious that the duration of
treatment is age-related and the earlier the treatment the
shorter the duration. The duration of the treatment in the
third part increased 2.5 folds compared with the duration
in the newborn age.

The treatment with Pavlik harness was successful in all
cases. The treated infants were checked at the age of one
year. No avascular necrosis of the femoral head or other ill
consequences resulted from the treatment. It is concluded
that sonographic hip screening at the age of three months
is able to detect all pathological hips and reduce the
number of treated infants more than three fold and the
treatment can still achieve good results in spite of more
than a two fold increase in the duration of treatment
compared with newborn age. From all three parts of the
study it may be concluded that:

1. Type Ib hip in the newborn without risk factors may
deteriorate to become not only dysplastic but also
dislocated.
2. Every hip with β angle ≥ 90° in the newborn should
be considered dislocated irrespective of its α angle
value.
3. Sonographic hip screening in the newborn is valid and
is able to detect all abnormal hips if a second
examination at the age of three months is performed.
4. The incidence of sonographic hip instability alone was 5 per cent and in combination with other risk factors it was 16.67 per cent.
5. The hips in 12.69 per cent of their infants with sonographically unstable hips became distorted.
6. Hips which were sonographically stable at birth or which stabilized during follow-up, remained so in the final check-up.
7. Ninety per cent of the sonographically unstable hips stabilized at the age of one month.
8. Follow-up of infants with sonographic hip instability in addition to those with risk factors and IIa hip types is able to detect all abnormal hips and reduce the number of followed-up cases to one third of the total.
9. The percentage of treated infants in stress sonography is high (5.8 per cent) and is higher than in simple sonography by more than one percent (4.7 per cent in simple sonography).
10. The conclusion therefore is that: sonographic hip screening at the age of three months is able to detect all pathological hips and reduce the number of treated infants (1.3 per cent) more than three fold compared with sonographic hip screening in the first day of life. The treatment can still achieve good results without ill consequences in spite of more than two fold increase in its duration compared with newborn age. Sonographic hip screening at the age of 3 months is most appropriate and cost effective.

References