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Assessment of the fetal nasal bone at 11–14 weeks of gestation by three-dimensional ultrasound

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KEYWORDS: first trimester; nasal bone; three-dimensional ultrasound; trisomy 21

ABSTRACT

Objective *To evaluate the benefit of three-dimensional (3D) ultrasound in the examination of the fetal nasal bone at 11–14 weeks of gestation.*

Method *We examined the fetal nasal bone in 120 stored volumes acquired transabdominally with a 3D scanner from singleton pregnancies at 11–14 weeks of gestation. The volume acquisition had been performed following conventional ultrasound examination that had demonstrated presence of the fetal nasal bone. The volumes were obtained with two-dimensional (2D) start images in transverse, coronal mid-sagittal, parasagittal and oblique longitudinal sections of the fetal head.*

Results *In the transverse and coronal sections, a satisfactory image demonstrating presence of the nasal bone was achieved in only three and one, respectively, of the 20 volumes that we obtained. In mid-sagittal sections, the nasal bone was always visible when the angle was within a range of 30–60°, without the need for sectional image analysis. None of the images with an angle* $> 60°$ *or* $< 30°$ *was satisfactory. In the parasagittal sections with the fetal profile at 45°, a good-quality image of the nasal bone was possible in all cases that were examined, irrespective of the distance from the mid-sagittal plane. In the oblique longitudinal sections with the fetal profile at 45°, there were 10 volumes where the 2D start section was at 0–25° from the midline and in all these cases the nasal bone was successfully visualized. In contrast, only 5/20 cases where the 2D start section was at 25–90° from the midline provided a satisfactory image demonstrating the nasal bone. In 5/10 volumes obtained with the fetus facing downwards the nasal bone was visible in both the 2D and 3D images.*

Conclusion *In a 3D volume the extent to which the nasal bone can be demonstrated to be present in a given reconstructed section is entirely dependent on obtaining a good initial 2D view. Copyright © 2004 ISUOG. Published by John Wiley & Sons, Ltd.*

INTRODUCTION

Trisomy 21 is associated with absence of the fetal nasal bone at 11–14 weeks' gestation[1–6]. It has been estimated that in screening for trisomy 21, using a combination of maternal age and fetal nuchal translucency (NT), inclusion of examination of the fetal profile for the presence or absence of the nasal bone could increase the sensitivity from 75% to 93% for a fixed false-positive rate of 5%[1,2]. For examination of the nasal bone, the fetus should preferably be facing up towards the transducer, the image should be magnified so that only the head and the upper thorax are included in the screen, and a mid-sagittal view of the fetal profile must be obtained. The angle between the ultrasound transducer and an imaginary line passing through the fetal profile should be about 45° and the probe should be gently tilted from one side to the other of the fetal nose to demonstrate three distinct lines (Figure 1). The top line represents the skin and the bottom one, usually thicker and more echogenic than the overlying skin, represents the nasal bone, whereas a third line, almost in continuity with the skin but at a higher level, represents the tip of the nose. This specific section is sometimes difficult to obtain and requires well-trained sonographers to perform the scans[3]. Furthermore, in a few cases it may be necessary to wait for several minutes before the fetus moves to the required position.

The aim of the present study was to investigate the potential role of three-dimensional (3D) ultrasound in overcoming two major technical problems in the assessment of the nasal bone: first, the need to obtain a perfect mid-sagittal view and, second, the need for the

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angle between the ultrasound transducer and the fetal profile to be about 45° (Figures 1 and 2).

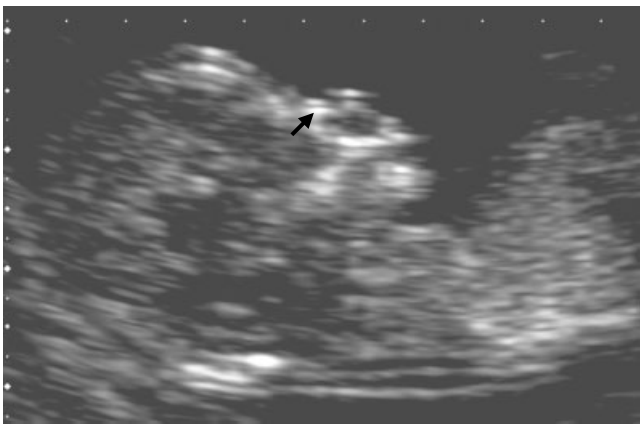

Figure 1 Mid-sagittal view of the profile in a 12-week fetus illustrating presence of the nasal bone (black arrow). The angle between the ultrasound transducer and an imaginary line passing through the fetal profile is about 45°.

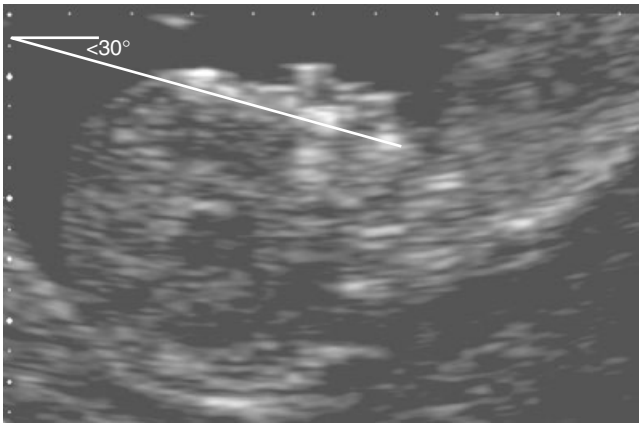

Figure 2 Mid-sagittal view of the profile in a 12-week fetus (as in Figure 1). In this case the angle between the ultrasound transducer and an imaginary line passing through the fetal profile is < 30° and the nasal bone is not visible.

METHOD

This was a prospective study in 69 singleton pregnancies at 11–14 weeks' gestation. The patients attended our unit for first-trimester screening for trisomy 21 by measurement of fetal NT[7]. Demographic characteristics, and measurement of fetal crown–rump length (CRL) and NT, were recorded in a computer database. In all cases selected for this study conventional ultrasound scanning had demonstrated the presence of the fetal nasal bone. The study was carried out during a 2-month period (November–December 2002). Both the two-dimensional (2D) and 3D ultrasound examinations were carried out transabdominally (RAB 4–8 probe, Voluson 730, GE Medical Systems, Milwaukee, WI, USA).

In total, 120 volume acquisitions were performed with the fetus at rest in the following 2D start sections of the fetal head:

1. Transverse sections (Figure 3) with angles of the midline to the vertical ranging from 0° to 180°.
2. Coronal sections (Figure 3) with angles of the midline to the vertical ranging from 0° to 180°.
3. Mid-sagittal sections (Figures 1 and 2) with angles of the fetal profile to the transducer ranging from 0° to 180°.
4. Parasagittal sections (Figure 4) with the fetal profile at 45° and parallel sweeps of the probe at distances of 2–12 mm from the mid-sagittal position.
5. Oblique longitudinal sections (Figure 5) with the fetal profile at 45° and rotation of the 2D start plane from the mid-sagittal one in angles ranging from 0° to 90°.
6. Mid-sagittal sections with the fetal profile at 45° but the fetus facing downwards.

The volume was then displayed in three orthogonal planes (multiplanar display). In the Voluson 730, the plane at which the three orthogonal planes intersect is marked by a marker dot, which can pinpoint the exact spot on the three planes that are being simultaneously displayed (Figure 4). Using this marker dot it was possible

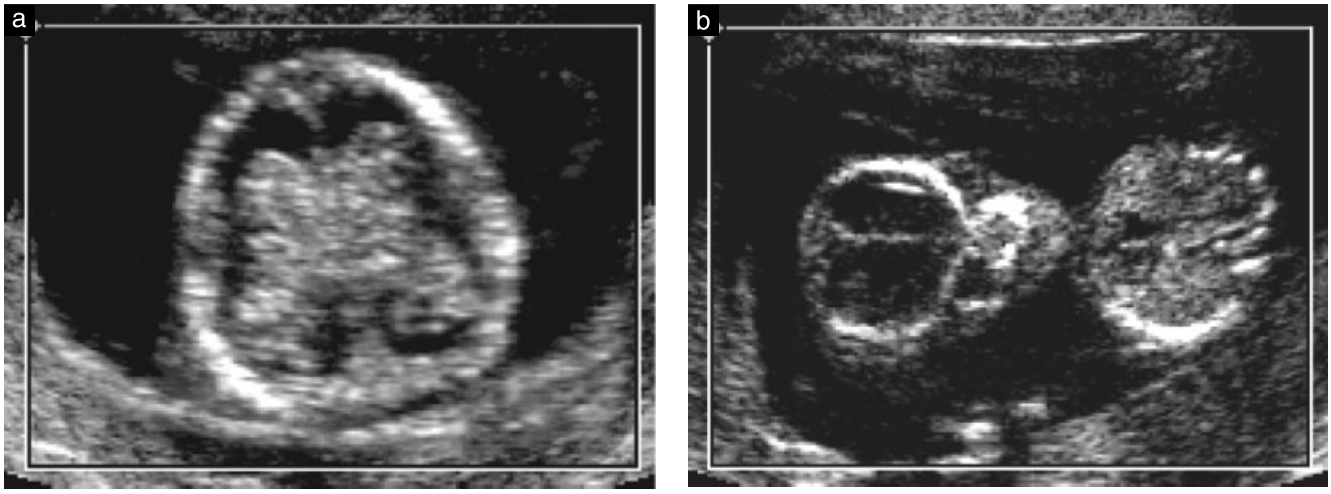

Figure 3 Two-dimensional start sections of the fetal head. Transverse section with the angle of the midline to the vertical at 15° (a) and coronal section with the angle of the midline at 90° (b).

to measure the distance (in the parasagittal sections) and the angle (in the oblique sections) between the 2D start image and the mid-sagittal section of the fetus.

Each plane was examined with the objective of obtaining a mid-sagittal section of the fetal face with the imaginary line passing through the fetal profile being at 45°. Subsequently, the obtained image was examined to determine if the nasal bone could be demonstrated to be present.

RESULTS

The median maternal age was 35 (range, 22–46) years, the median CRL was 68 (range, 50–84) mm and the median gestation was 13 (range, 11–14) weeks. The findings of the 3D examination, according to the section of the fetus, are shown in Table 1. In the transverse and coronal sections, a satisfactory image demonstrating presence of the nasal bone was achieved in only three and one, respectively, of the 20 volumes that we obtained. In mid-sagittal sections, the nasal bone was always visible when the angle was within a range of 30–60°, without the need for sectional image analysis. In contrast, none of the images with an angle > 60° or < 30° was satisfactory. In the parasagittal sections, a good-quality image of the nasal bone was possible in all cases that were examined, irrespective of the distance from the mid-sagittal plane. In the oblique longitudinal sections, there were 10 volumes where the 2D start section was at 0–25° and in all these cases the nasal bone was successfully visualized. In contrast, only 5/20 cases where the 2D start section was

Table 1 Detection rate of the nasal bone, according to the two-dimensional start section of the fetal head, in reconstructed mid-sagittal sections obtained by three-dimensional ultrasound

Section	n	*Nasal bone detected (n (%))*
Transverse	20	3 (15)
Coronal	20	1 (5)
Mid-sagittal 30–60°	10	10 (100)
Mid-sagittal < 30° and > 60°	10	0 (0)
Parasagittal	20	20 (100)
Oblique < 25°	10	10 (100)
Oblique 25–90°	20	5 (25)
Facing down	10	5 (50)

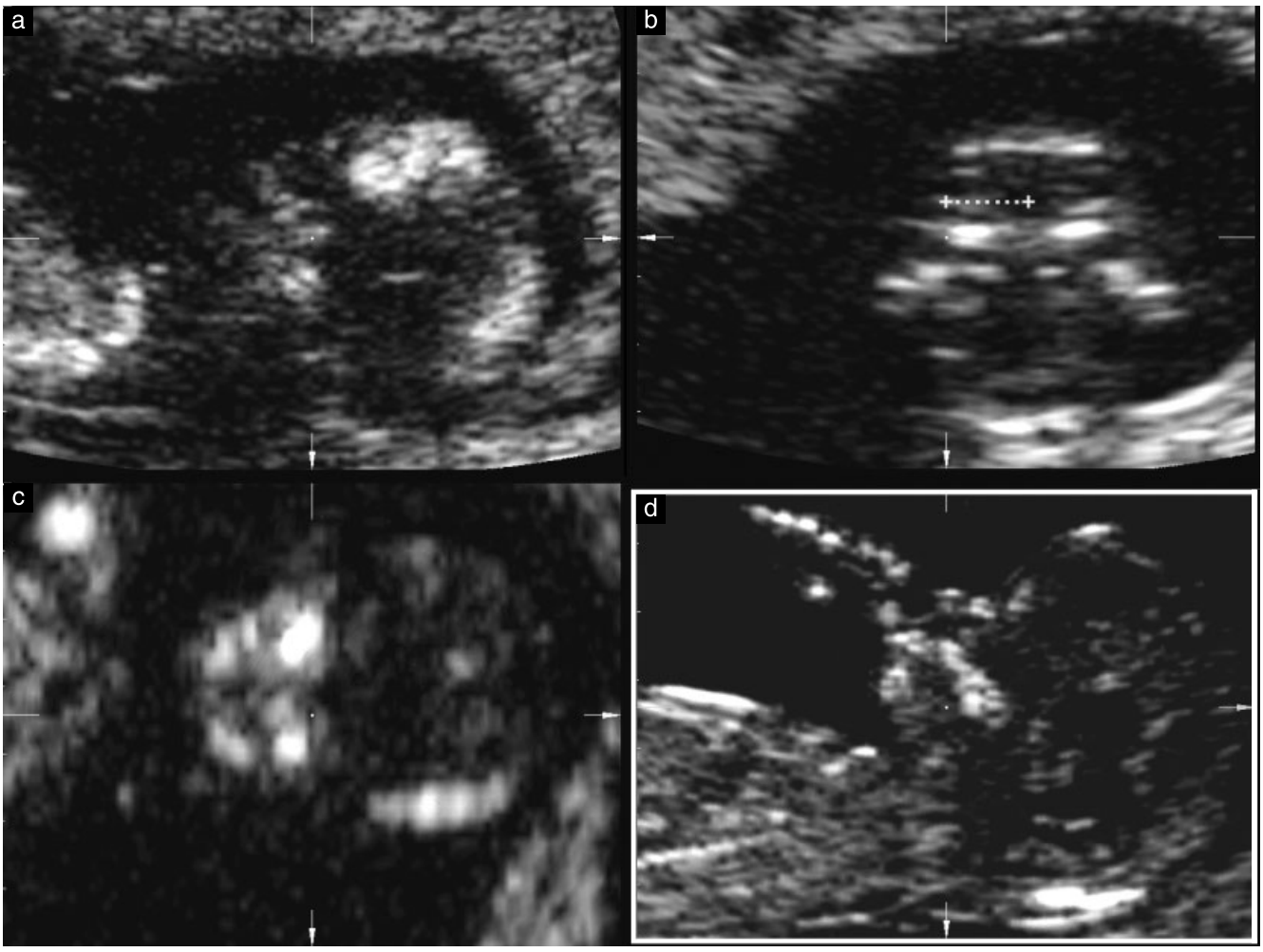

Figure 4 Simultaneous display of three orthogonal planes: parasagittal 2D start section (a); transverse plane, in which the distance of the parasagittal plane from the mid-sagittal one can be measured (b); coronal plane (c). Image (d) is the reconstructed mid-sagittal plane demonstrating presence of the nasal bone.

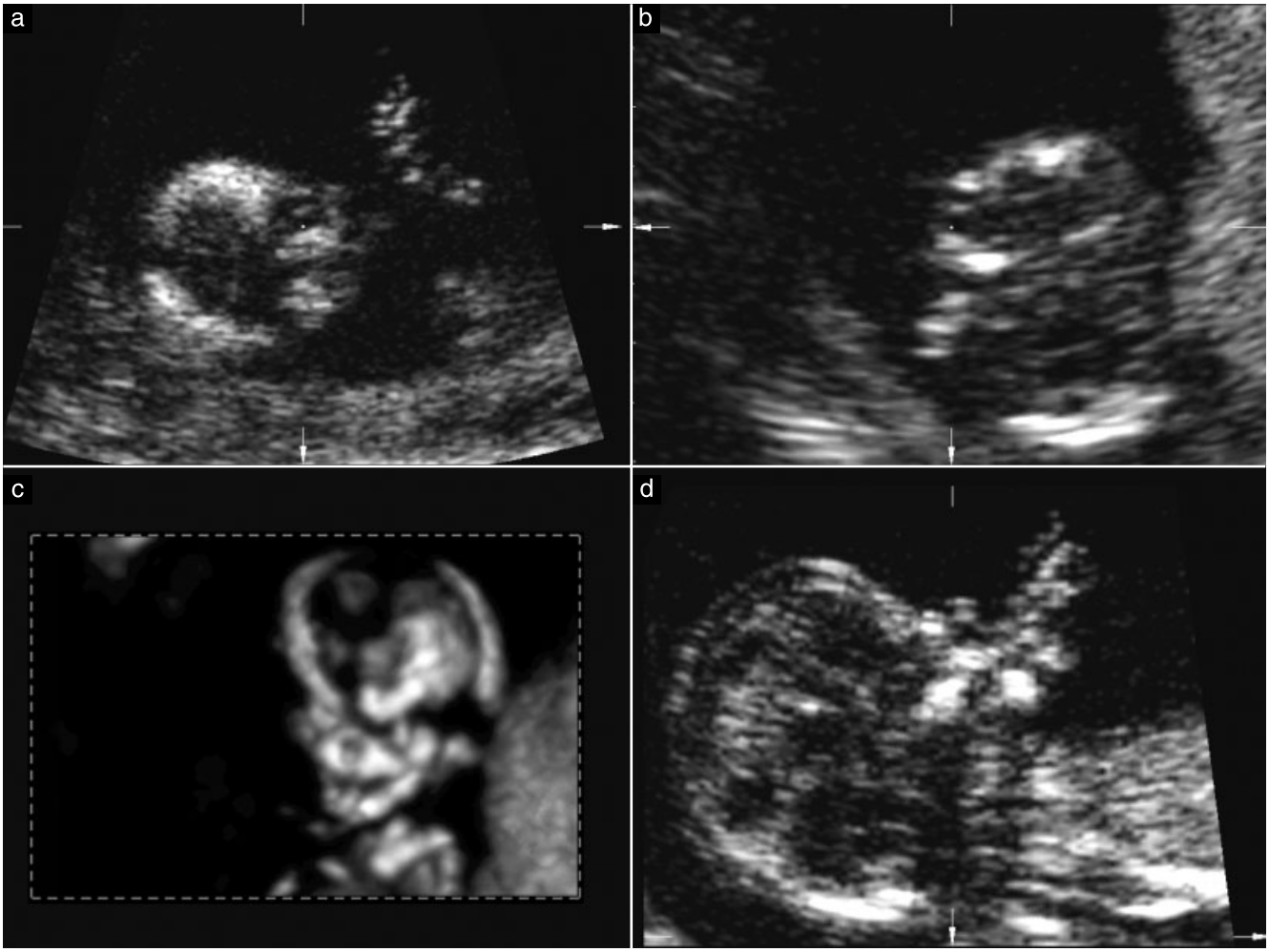

Figure 5 Simultaneous display of: oblique longitudinal 2D start section (a); transverse plane, in which the angle from the midline can be assessed (b); three-dimensional image rendering of the fetal face (c). Image (d) is the reconstructed mid-sagittal plane in which the nasal bone can be demonstrated.

at 25–90° provided a satisfactory image demonstrating the nasal bone. In all 10 cases with the fetus facing downwards, mid-sagittal sections were obtained with the fetal profile at 45°. In 5/10 of these cases the nasal bone was visible by both 2D and 3D ultrasound. In the other five cases the nasal bone could not be seen either by 2D or 3D imaging because of shadowing by the occipital bone ($n = 2$) or absence of the acoustic window provided by amniotic fluid between the fetal face and the posterior uterine wall or placenta ($n = 3$).

DISCUSSION

In the examination of the fetal nasal bone at 11–14 weeks' gestation, 3D ultrasound makes it possible to obtain a perfect mid-sagittal view of the fetal face and to rotate the fetal profile to any desired angle. However, the extent to which the nasal bone can be demonstrated to be present in a given reconstructed section is entirely dependent on the 2D start section of the volume acquisition. This is not surprising because the 3D volumes are obtained while the probe is sweeping 2D scans between the margins of the volume to be acquired. In this way each pixel (the smallest 2D picture unit) is placed in its correct position in the voxel (the smallest 3D picture unit).

In the examination of the fetal nasal bone, when the 2D start section is transverse or coronal the percentage of cases in which it is possible to demonstrate the nasal bone in the reconstructed true mid-sagittal section is very low. Similarly, in cases in which the 2D start section is mid-sagittal but the angle between the ultrasound transducer and an imaginary line passing through the fetal profile is $< 30°$ or $> 60°$, it is not possible to demonstrate the nasal bone in the reconstructed image achieved by rotation of the fetal profile around its vertical axis to achieve the desired 45°. It is important to appreciate that the quality of the static image in any reconstructed section does not improve by mere rotation on its vertical axis. Consequently, the inability to examine the nasal bone by 2D scanning because the fetal head is hyperextended or very flexed cannot be overcome by obtaining a 3D volume.

The same is true when the fetus is facing down and away from the transducer. In this situation it is possible to visualize the nasal bone both by 2D and 3D imaging only if a perfect mid-sagittal section is obtained and the angle

between the transducer and the fetal profile is between 30° and 60°. However, it is always preferable to wait for fetal movements and rotation to the facing-up position because this avoids the shadowing caused by the occipital bones. In addition, when the fetus faces posteriorly there is often no intervening amniotic fluid to separate the fetal face from the uterine wall or placenta. Such technical problems cannot be overcome by a mere 180° rotation of either a 2D or a 3D image.

The main value of 3D scanning in the assessment of the fetal nasal bone is in achieving a satisfactory reconstructed mid-sagittal section when the 2D start section is parasagittal or slightly oblique. However, this is possible only if in the 2D start section the angle between the ultrasound transducer and an imaginary line passing through the fetal profile is between 30° and 60°. An alternative to the use of 3D scanning in such situations is to wait for spontaneous fetal movements that within a few minutes would alter the fetal position making it possible to examine the fetal profile by conventional 2D imaging.

In 3D ultrasound it is possible to obtain a perfect mid-sagittal section because of the ability to display three orthogonal planes simultaneously. Consequently, 3D scanning may be useful in cases where in 2D scanning the nasal bone cannot be visualized and there is uncertainty as to whether this is the consequence of true absence of the bone or failure to obtain a perfect mid-sagittal view. However, in the present study we examined the usefulness or the possible limits of 3D technology in the assessment of the fetal nasal bone after previous confirmation of its presence by 2D scanning. Our findings suggest that routine application of 3D scanning for the nasal bone in screening for trisomy 21 is likely to be associated with a very high false-positive rate. Essentially, if the sonographer does not appreciate that the ability to examine the nasal bone is critically dependent on obtaining a good 2D image then the nasal bone will be classified as being absent in many cases in which the 2D start section is transverse or coronal and when the angle between the ultrasound transducer and the fetal profile is $< 30°$ or $> 60°$.

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