NHS

Screening Programmes

Fetal Anomaly

A guide to getting the most from the ultrasound equipment when measuring Nuchal Translucency

Version 2: July 2012

Authorship

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Introduction

Many practitioners undertaking obstetric ultrasound, and measuring nuchal translucency (NT), may face challenges when trying to produce results approaching the Fetal Medicine Foundation (FMF) distribution curve.

This guide provides details of the areas practitioners need to consider and control to get the best from their machines when measuring NT. The guide is intended to be applicable to all ultrasound machines and therefore the terminology used is not machine or manufacturer specific.

There are ten sections in the guide and each one refers to a particular function and how it affects image quality with regard to NT measurement. The sections explained are:

1. Power
2. Gain
3. Zoom
4. Field depth
5. Sector width
6. Dynamic range
7. Focus
8. Harmonics
9. Frequency
10. Post processing

In each section images are used to illustrate the function and its effect. The images are labelled and presented with the pre-manipulation, less desirable image on the left. The post manipulation, more desirable image is on the right.

Key message

As ultrasound machines have developed, the amount of practitioner input required to achieve an acceptable image has reduced; possibly resulting in an increasing reliance on presets and the ultrasound machine's optimisation button. Whilst under average conditions presets provide an appropriate starting point, **the practitioner is still expected to utilise the full range of ultrasound machine functions to make continual adjustments to manually optimise the image.**

Power

The acoustic power is the output from the transducer. Ultrasound is absorbed as it travels through tissue; the absorption is dependent on the tissue type and the depth of the tissue. The power required to achieve a diagnostic image will depend on the body mass index (BMI) of the person being scanned and the orientation of the fetus. The lower the BMI the less power needed.

Excessive amounts of power can cause noise and reverberation in the image, which obscures detail. Once this noise is in the system it cannot be separated from the desirable image signal. Reducing the power leads to a reduction in both brightness and noise. Power is often displayed as a percentage of the machine's limited maximum output. Power is also the main factor affecting the mechanical index (MI) and thermal index (TI) values, which should be kept within recommended limits.[1]

Figure 1: (MI 0.7 TI 0.2) power high

Figure 2: (MI 0.1 TI 0.0) power reduced

In Figure 1(MI 0.7), the nuchal space is narrowed by reverberation and the edges are less clear, making the NT appear much smaller than in Figure 2 where the power is reduced (MI 0.1). The gain setting has not been altered. Increasing the gain slightly will brighten the lines in the right hand image without obscuring the space.

Overall gain and time gain compensation

Gain controls how bright the image appears by altering the amplification applied to the received signal. The operator can alter this with the overall gain control and/or with the time gain control, where gain at certain depths within the tissue is altered. Increasing the gain leads to brighter display of echoes with an increase in image noise and artefact and also a possible loss of contrast.

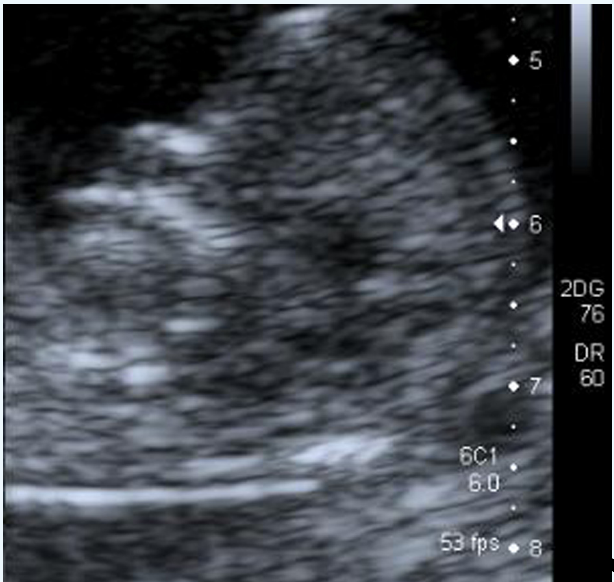

Figure 3: excessive gain

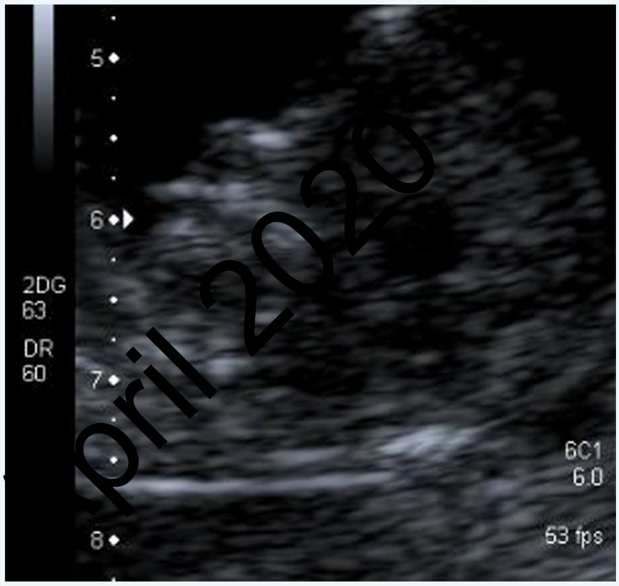

Figure 4: correct gain

The NT appears smaller in Figure 3 than in Figure 4. Excessive gain in Figure 3 thickens the skin line, blurs the edges and obscures the nuchal space. Lower intensity signals are amplified to the point where they are displayed at the same brightness as the stronger ones.

Read and write zoom

In write zoom an area of the potential image is selected and the ultrasound field and processing is restricted to that area. This allows the maximum amount of detail to be acquired for the area of interest and assigned to the image matrix. There may be consequent benefits of frame rate and spatial resolution in the magnified image.

In read zoom an area of the obtained image is selected and magnified. The displayed image rapidly becomes pixelated.

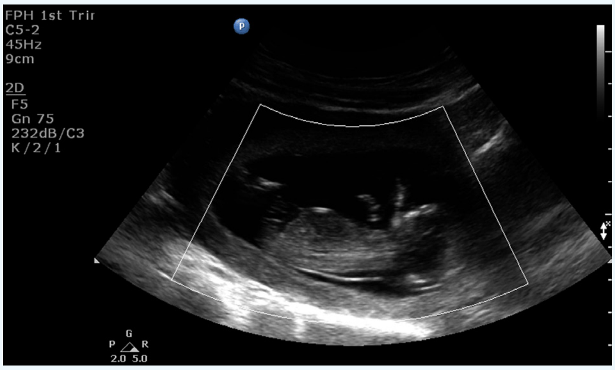

Figure 5: write zoom box in place

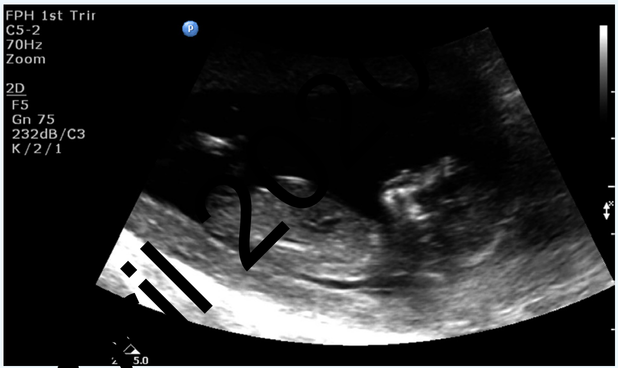

Figure 6: write zoom activated

Both zooms can be used sequentially. However, it is not always clear whether a zoom feature on a system is a write or read zoom and there is no consistent description across systems.

It can be difficult to scan when the image field has been reduced. Whilst scanning in real time use the write zoom to magnify the image, as demonstrated in Figures 5 and 6. If necessary use the read zoom to magnify the image further to obtain your measurement, as demonstrated in Figure 7. Image magnification should be such that the fetal head and upper aspect of the fetal heart should occupy the whole screen.[2]

Figure 7: read zoom increased

Field depth

Excessive field depth results in the machine displaying irrelevant deeper structures. It reduces the frame rate and may lead to a compromise in the quality of the image.

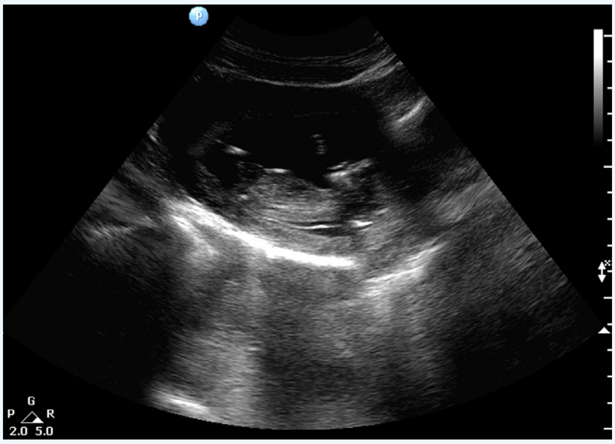

Figure 8: excessive depth

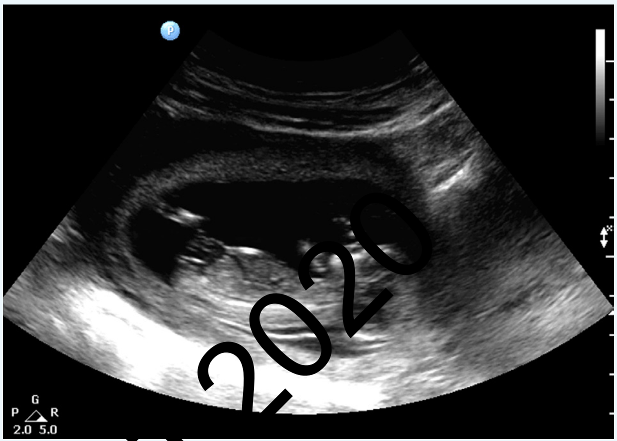

Figure 9: correct depth setting

Figure 8 demonstrates excessive field depth, reduce the depth as demonstrated in Figure 9 and make the structures you are interested in fill the screen.

Sector width

Sector width is one of the factors which may affect lateral resolution. In some cases reducing the sector width may permit a higher lateral line density, reducing the number of interpolated pixels, thereby improving the image quality.

Figure 10: excessive sector width

Figure 11: appropriate sector width

Not all machines reduce the sector width when write zoom is used. As well as improving the use of the image matrix, using read zoom, reducing sector width and field depth will also improve temporal resolution and increase the frame rate.

Dynamic range

Refers to how the range of received signal strength is displayed from maximum brightness to darkness. This may also be referred to as compression or contrast. The effect of compression or contrast controls on the image may vary between different manufacturers depending on what additional factors, other than dynamic range, are included in the processing.

Figure 12: low contrast

Figure 13: high contrast

Figure 12 demonstrates when the dynamic range is set too high (DR 65) the image has a low contrast and appears flatter and there are more shades of grey. The edge of the skin line is more clearly defined in Figure 13 with the lower dynamic range (DR 40) giving greater contrast, fewer shades of grey with increased black and white.

The skin appears thickened in Figure 13, if the skin thickness cannot be restored by reducing the gain, a higher DR would be more appropriate. The ideal setting on this machine lies somewhere between these two images.

Focus

The focus is the area within the beam where lateral spatial resolution is at its optimum. The focus level indicator has been circled in Figures 14 and 15.

Figure 14: incorrect focus position

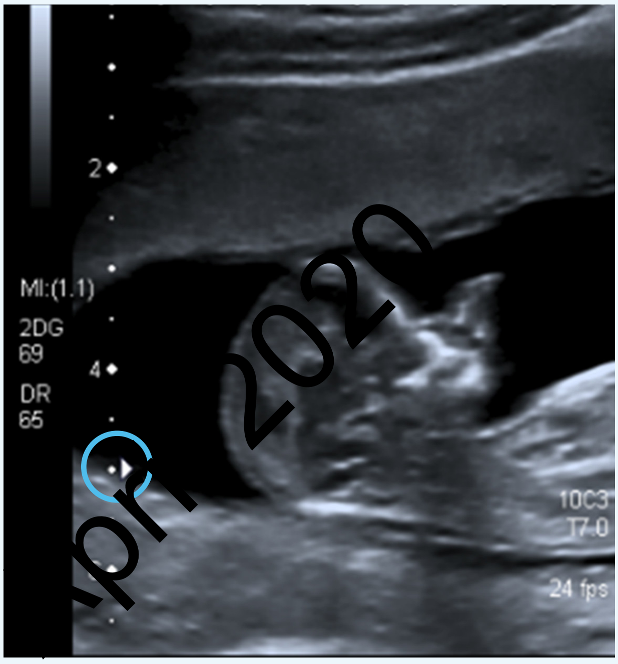

Figure 15: correct focus position

Using a single focus at or just below the level of the NT as in Figure 15 gives the best image to measure the NT.

Harmonic imaging (HI)

HI uses echoes from frequencies other than the primary transmission frequency to produce images with reduced noise, improved spatial resolution and a reduced dynamic range. There are a range of techniques used to combine fundamentals and harmonic images which may vary between systems and manufacturers. Many manufacturers use a harmonic image as a default.

The use of harmonics tends to thicken the skin line reducing the apparent nuchal space leading to under measurement.

Figure 16: HI on

Figure 17: HI off

Manipulation of other factors such as power and gain will reduce the skin thickness restoring the appearance of the nuchal space. This problem can be avoided by not using harmonics unless absolutely necessary.

NT measurements should be taken in the same way whether images were obtained with or without the use of HI.

Frequency selection

The choice of transmit frequency selection will be dictated by maternal habitus. Higher frequency improves spatial resolution, at the expense of penetration. With newer high frequency transducers it is possible to visualise the subcutaneous layers of the nuchal space. At lower frequencies these structures may only be apparent as blurring along the skin edge. By adjusting the image parameters described in the rest of this document a consistent image can be achieved. In some systems there is no separate frequency control. The frequency may be altered by the operator changing other controls such as penetration or resolution.

Post processing

There are many different algorithms and filters which may be applied to the raw image before it is displayed. Edge enhancement, speckle reduction, adaptive processing, noise reduction, image processing, grey maps and chroma all have a role to play in achieving an optimised image.

Figure 18: Edge enhancement off

Figure 19 Edge enhancement on

Figure 19 with edge enhancement on provides an improved quality image to measure the NT.

Even if these are not settings which are commonly utilised, they are worth exploring with your applications specialist if your images have a tendency to become pixelated or noisy at certain combinations of zoom and harmonics etc.

Summary

This guide has provided some useful suggestions on how to optimise the image to achieve high quality NT measurements. Taking a moment to optimise the image settings is time well spent. Familiarising yourself with the various controls on your machine and using them more frequently will improve the image produced and contribute to more accurate NT measurements. This will in turn improve the quality of the Trisomy 21 screening service provided to women in England. It is also worth remembering that these principles can be transferred into other areas of ultrasound scanning.

References

[1] British Medical Ultrasound Society (BMUS) (2009) Guidelines for further details of safe ultrasound exposure levels: www.bmus.org/policies-guides/BMUS-Safety-Guidelines-2009-revision-pdf.

[2] NHS FASP (2010) NHS nuchal translucency training and support manual for combined screening for Trisomy 21: manual for sonographers: www.fetalanomaly.screening.nhs.uk/sssresources – manual for sonographers pdf.

This information has been produced on behalf of the NHS Fetal Anomaly Screening Programme.

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