The role of ultrasound in obstetrics

Nicky Roberts

Basky Thilaganathan

Abstract

Advances in ultrasound technology and new developments in the field of screening for pregnancy disorders have led to a change in the clinical application of ultrasound in the routine care of low-risk pregnant women. In parallel, there has been an increased tendency to inappropriately use this technology. This review highlights the validated uses of ultrasound in obstetrics, such as pregnancy dating, screening for aneuploidy, diagnosis of fetal abnormality and placental localisation. Knowledge of the scientific basis of the role of ultrasound means less unnecessary intervention in normal pregnancies and more appropriately timed intervention in pathological pregnancies.

Keywords pregnancy; ultrasound; dating; screening; diagnosis; Down's syndrome; preterm delivery; pre-eclampsia; growth restriction; multiple pregnancy; placenta praevia

Introduction

Ultrasound has been in clinical use in obstetrics since 1978. With advances in technology, there have been improvements in resolution, allowing better imaging of the fetus. This, together with new developments in the field of screening for pregnancy disorders, has led to a change in the clinical application of ultrasound in the routine care of low-risk pregnant women. Techniques such as pulsed wave and colour Doppler imaging have improved the monitoring of small for gestational age fetuses and help to differentiate fetuses that are well, from those that are not. This has led to less interference in normal pregnancies and more appropriately timed intervention for fetuses in genuine trouble.

The use of ultrasound in obstetrics may be broadly classified as elective or reactive. Elective or planned use implies scanning to detect potential problems in an otherwise seemingly uncomplicated pregnancy (screening), whereas reactive use is the application of ultrasound to help in the management of a clinical problem such as suspected fetal growth restriction.

Nicky Roberts *MRCOG is a Clinical Fellow in the Fetal Medicine Unit, St George's Hospital, London, UK.*

Basky Thilaganathan *PhD MRCOG is Reader in Obstetrics and Director of Fetal Medicine, Fetal Medicine Unit, St George's Hospital NHS Trust, London, UK.*

Elective use of ultrasound

Pregnancy dating

Nagele's rule predicts the mean length of gestation to be 280 days from the last menstrual period (LMP). The problems of calculating gestational age based on menstrual history are well recognised. Even if menstrual dates are considered certain or reliable, this method tends to lead to an overestimation of gestational age compared with ultrasound. Also, gestational age distributions are negatively skewed; hence, the mean value is not representative of the 'typical' length of pregnancy, and there have been proposals that the modal value (283 days) should be used instead. These factors result in a much wider error margin in LMP dating compared with ultrasound dating in the first half of pregnancy. For women who present in the second trimester, gestational age can be assessed by ultrasound measurement of biparietal diameter or head circumference, and this has an error deviation of about ± 7 days. The first trimester is a period of rapid growth and gestational age is by far the strongest variable affecting fetal size, with the result that crown–rump length measurement is even more accurate (Figure 1).

The UK National institute for Clinical Excellence guideline on antenatal care recommends that all pregnant women should be offered an early ultrasound examination to determine gestational age (in lieu of LMP). This ensures consistency of gestational age assessments, improves the performance of screening for Down's syndrome, and reduces the need for induction of labour after 41 weeks. Scans should ideally be performed at 10–13 weeks and should use the crown–rump length measurement to determine the gestational age.

Accurate pregnancy dating is especially important at the extremes of pregnancy. The likelihood of survival following extreme premature delivery increases steeply from about 40% at 24 weeks to more than 80% at 28 weeks. When assessing gestation, a few days variation in either direction has an impact on the baby's chances and hence on the advice given to parents and on clinical management decisions. At the other end of the spectrum, as many as 70% of pregnancies presumed to be post-term (>294 days) by menstrual dates are not post-term by scan dates. This suggests that most inductions for post-term pregnancy could be avoided on the basis of ultrasound estimation of gestational age alone.

In terms of prenatal screening, both nuchal translucency and biochemical test levels (serum α-fetoprotein (α-FP) and β-human chorionic gonadotropin (β-hCG)) vary with gestational age. Erroneous dating therefore leads to incorrect risk assessment, unnecessary referrals and increased maternal anxiety.

Multiple pregnancy

Twins account for about 1% of all pregnancies; two-thirds are dizygotic and one-third monozygotic (identical). In dizygotic pregnancies, each zygote develops with its own chorion (dichorionic). Monozygotic pregnancies may also be dichorionic, or there may be sharing of the same placenta (monochorionic) and even fetal organs (conjoined). Chorionicity and amnionicity depends on how soon the single embryonic mass splits after fertilisation. The perinatal mortality rate in twins is around six times higher than in singletons, and the increased mortality is about 3–4 times higher in monochorionic than dichorionic twin pregnancies, regardless of zygosity. Perinatal statistics actually underestimate the importance of monochorionic placentation in fetal death, since the highest rate

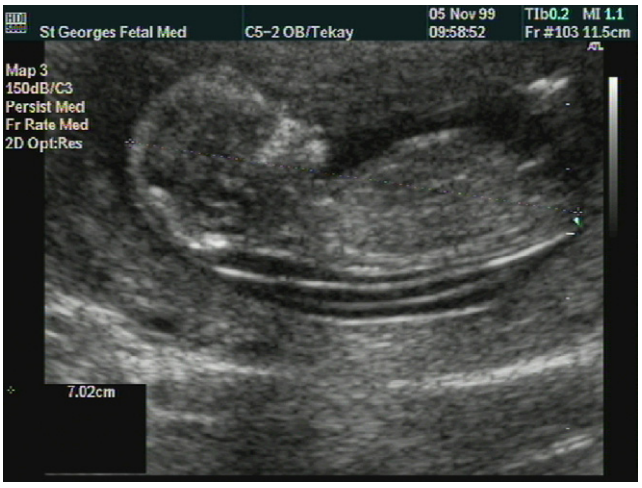

Figure 1 First trimester ultrasound showing measurement of the crown–rump length.

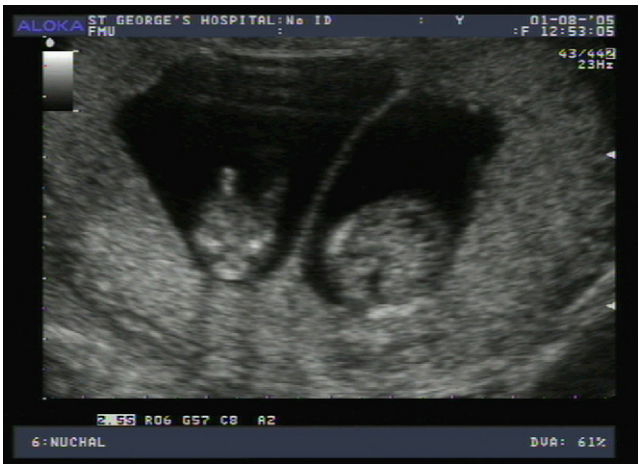

Figure 2 Lambda (left) representing dichorionic placentation in a twin pregnancy.

of mortality is before 24 weeks of gestation due to twin-to-twin transfusion syndrome (TTTS). Any effort to reduce this excess loss can be achieved only through early identification of monochorionic pregnancies by ultrasound examination in early pregnancy and the development of appropriate methods of surveillance and intervention during the second trimester.

Chorionicity can be determined by ultrasonography and relies on the assessment of fetal gender, number of placentas and the characteristics of the inter-twin membrane. Different-sex twins are dizygotic and therefore dichorionic, but in about two-thirds of twin pregnancies the chorionicity cannot be determined in this way, as the fetuses are of the same sex. Similarly, if there are two separate placentas, the pregnancy is dichorionic, but if the two placentas are adjacent to each other, it is often difficult to differentiate them.

The best way to determine chorionicity is by an ultrasound examination at 6–9 weeks of gestation, when in dichorionic twins there is a thick septum between the chorionic sacs. After 9 weeks, this septum becomes the inter-twin membrane, but it remains thick and easy to identify at the base of the membrane as a triangular tissue projection. This, when visible, is known as the lambda sign. With the introduction of first-trimester scanning at 11–14 weeks, ultrasonographic examination of the base of the inter-twin membrane for the presence or absence of the lambda sign provides a reliable distinction between dichorionic and monochorionic pregnancies (Figure 2).

TTTS is thought to occur in about 15% of monochorionic twins and is not usually detectable before 16 weeks of gestation. TTTS describes a wide range of problems that can occur in monochorionic twins as a result of unequal sharing of placental blood through inter-twin vascular anastomoses. Ultrasound features in the donor include fetal growth restriction, an empty bladder and anhydramnios. In contrast, the recipient usually has normal growth velocity, a large bladder, polyhydramnios and, when TTTS is severe, hydrops. Untreated severe TTTS before 26 weeks is associated with perinatal mortality of up to 90% and a high risk of disability in the survivors. A large, multi-centre randomised study has shown that fetoscopic laser coagulation of inter-twin anastomoses is a more effective first-line treatment than serial amnioreduction in cases of severe TTTS at less than 26 weeks.

Placental site

Placental implantation in the lower uterine segment (placenta praevia) is an uncommon but serious complication of pregnancy. A low-lying placenta is often diagnosed (15–20% of cases) following mid-trimester ultrasonography. The prevalence of clinically evident placenta praevia is estimated to be approximately 4–5 per 1000 pregnancies (Figure 3).

The diagnosis of placenta praevia is based on the findings of the ultrasound examination before the occurrence of symptoms. It is well established that the use of transvaginal ultrasound is superior to transabdominal ultrasound in defining the relationship of the placental edge to the internal cervical os. Also, the use of ultrasound has changed the classification of placenta praevia to 'minor' and 'major'. A minor placenta praevia (low-lying placenta) is one that lies in the lower uterine segment more than 2 cm from the internal os. A major placenta praevia occurs when the placental edge overlaps or is within 2 cm of the internal cervical os in late pregnancy.

If the placenta is overlapping or reaching the internal cervical os at the time of the anomaly scan, repeat ultrasonography should be arranged in late pregnancy to exclude placenta praevia. If the placental edge is not reaching the internal os, repeat scanning in later pregnancy is unnecessary. If the placental edge is located within 2 cm of the internal cervical os (major praevia) at term, a caesarean section should be performed. When the distance is more than 2 cm (minor praevia), an attempt at vaginal delivery is appropriate but precautions should be taken to manage post-partum haemorrhage.

Screening

Chromosomal aneuploidy: Down's syndrome accounts for about one-third of cases of severe mental disability and is the most common pattern of malformation in humans. Prenatal diagnosis currently relies on assessment of risk followed by invasive testing in those deemed to be at high risk. For many years, the basis of screening for trisomy 21 has been maternal serum biochemistry or first-trimester nuchal translucency. The traditional classification of high risk uses the highest 5% of risk for the screen-positive group. At this risk cut-off, the detection rate for trisomy 21 varies from