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Diagnosis of fetal non-chromosomal abnormalities on routine ultrasound examination at 11–13 weeks' gestation

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KEYWORDS: fetal abnormalities; first-trimester screening; prenatal diagnosis; ultrasound examination

CONTRIBUTION

What are the novel findings of this work?
This study confirms our previous finding that fetal abnormalities essentially fall into three categories in relation to detectability at the 11–13-week scan (always detectable, never detectable or sometimes detectable) and demonstrates improvement in the identification of those that are sometimes detectable, which can be attributed to improved quality of ultrasound equipment and an updated standardized protocol.

What are the clinical implications of this work?
A routine 11–13-week scan, carried out according to a standardized protocol, can identify many severe non-chromosomal fetal abnormalities. However, to maximize prenatal detection of abnormalities, additional scans in both the second and third trimesters are necessary.

ABSTRACT

Objective *To examine the performance of the routine 11–13-week scan in detecting fetal non-chromosomal abnormalities.*

Methods *This was a retrospective study of prospectively collected data from 100 997 singleton pregnancies attending for a routine ultrasound examination of fetal anatomy, performed according to a standardized protocol, at 11–13 weeks' gestation. All continuing pregnancies had an additional scan at 18–24 weeks and 71 754 had a scan at either 30–34 or 35–37 weeks. The final diagnosis of fetal abnormality was based on the results of postnatal examination in cases of live birth and on the findings of the last ultrasound examination in cases of pregnancy termination, miscarriage or stillbirth. The performance of the 11–13-week scan in the detection of fetal abnormalities was determined.*

Results *The study population contained 1720 (1.7%) pregnancies with a fetal abnormality, including 474 (27.6%) detected on the first-trimester scan, 926 (53.8%) detected on the second-trimester scan and 320 (18.6%) detected in the third trimester or postnatally. At 11–13 weeks' gestation, we diagnosed all cases of acrania, alobar holoprosencephaly, encephalocele, tricuspid or pulmonary atresia, pentalogy of Cantrell, ectopia cordis, exomphalos, gastroschisis and body-stalk anomaly and > 50% of cases of open spina bifida, hypoplastic left heart syndrome, atrioventricular septal defect, complex heart defect, left atrial isomerism (interrupted inferior vena cava with normal intracardiac anatomy), lower urinary tract obstruction, absence of extremities, fetal akinesia deformation sequence and lethal skeletal dysplasia. Common abnormalities that were detected in < 10% of cases at 11–13 weeks included ventriculomegaly, agenesis of the corpus callosum, isolated cleft lip, congenital pulmonary airway malformation, ventricular septal defect, abdominal cysts, unilateral renal agenesis or multicystic kidney, hydronephrosis, duplex kidney, hypospadias and talipes.*

Conclusions *A routine 11–13-week scan, carried out according to a standardized protocol, can identify many severe non-chromosomal fetal abnormalities. A summary statistic of the performance of the first-trimester scan is futile because some abnormalities are always detectable, whereas others are either non-detectable or sometimes detectable. To maximize prenatal detection of abnormalities, additional scans in both the second and third trimesters are necessary.*

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INTRODUCTION

Ultrasound examination at 11–13 weeks' gestation is used widely for assessment of gestational age[1], diagnosis of multiple pregnancy and chorionicity[2], screening for fetal aneuploidy[3–5] and diagnosis of fetal non-chromosomal abnormalities[6–8]. Another recent indication that is likely to become widespread is screening for preterm pre-eclampsia because the risk for this pregnancy complication is substantially reduced by the prophylactic administration of aspirin in the high-risk group[9–12].

In a previous study of 45 191 singleton pregnancies undergoing a routine examination of the fetal anatomy between March 2006 and September 2009, we reported that, in relation to the first-trimester scan, fetal non-chromosomal abnormalities can be subdivided into three groups[8]. The first group includes those that should always be detectable, such as acrania, alobar holoprosencephaly, exomphalos, gastroschisis and body-stalk anomaly. The second group includes abnormalities that are potentially detectable depending on, first, the objectives set for such a scan and, consequently, the time allocated for the fetal examination, the expertise of the sonographer and the quality of the equipment used, and, second, the presence of an easily detectable marker for an underlying abnormality, such as increased nuchal translucency thickness (NT), tricuspid regurgitation and abnormal flow in the ductus venosus for cardiac defects, and abnormal posterior fossa for open spina bifida. The third group includes abnormalities that are undetectable because, first, they develop during the second or third trimester of pregnancy, such as fetal tumors, ovarian cysts, microcephaly or ventriculomegaly, second, the phenotypic expression of the abnormality becomes apparent later in pregnancy as a result of physiological changes in the fetus, such as increased urine production unmasking urinary tract obstruction or reflux, increased fetal swallowing unmasking a bowel obstruction, or increased production of lung fluid unmasking congenital pulmonary airway malformation, and, third the defect evolves with advancing gestational age, such as short limbs in achondroplasia, fractured limbs in some types of osteogenesis imperfecta or some cardiac defects, such as coarctation of the aorta and pulmonary or aortic stenosis.

The objective of this study of 100 997 singleton pregnancies undergoing a routine examination of the fetal anatomy between October 2009 and July 2018 was to investigate further the performance of the 11–13-week scan in the detection of fetal non-chromosomal abnormalities.

METHODS

Study population

This was a retrospective study of prospectively collected data from women with a singleton pregnancy attending for a routine hospital visit at 11 + 0 to 13 + 6 weeks' gestation at King's College Hospital, London or Medway Maritime Hospital, Gillingham, UK between October 2009 and July 2018. At this visit, we recorded maternal characteristics and medical history, performed an ultrasound scan to, first, determine gestational age from the measurement of fetal crown–rump length (CRL)[1], second, measure fetal NT as part of screening for trisomies 21, 18 and 13[5], and, third, diagnose any fetal abnormalities[8]. Women were given an estimated individual risk for trisomy and those with a high risk were offered invasive testing for fetal karyotyping or cell-free DNA testing for trisomies 21, 18 and 13[13,14].

In all cases with a continuing pregnancy, a fetal anomaly scan was undertaken at 18–24 weeks' gestation and, in many cases, a scan was also carried out at 30–34 or 35–37 weeks' gestation. We excluded pregnancies with known aneuploidy. Data on pregnancy outcome were collected from computerized records of the delivery ward and neonatal unit or the patient's general practitioner, and all prenatal and postnatal findings were recorded in a fetal database. This study constitutes a retrospective analysis of data derived from routine clinical examination and did not require ethics committee approval.

Ultrasound scans

All ultrasound examinations were carried out according to standardized protocols by sonographers who had obtained The Fetal Medicine Foundation Certificate of Competence in ultrasound examination for fetal abnormalities or by trainees under the supervision of certified sonographers. Most of the sonographers were doctors from different countries undergoing a 2-year training fellowship in fetal medicine, during the first 6–12 months of which they undergo supervised training in first-, second- and third-trimester ultrasound by more senior fellows.

The ultrasound examinations were performed transabdominally using a 3–7.5-MHz curvilinear transducer but, in 2–3% of cases, when there were technical difficulties in obtaining adequate views, a transvaginal scan (3–9 MHz) was also carried out. The time allocated for the ultrasound examination of the fetus was 30 min. All cases of suspected fetal abnormality on the first-, second- or third-trimester scans were examined on the same day by a fetal medicine specialist. Likewise, all cases of suspected fetal cardiac defects were examined by a fetal cardiologist.

First trimester

At 11–13 weeks, we aimed to obtain a transverse section of the head to demonstrate the skull, midline echo and choroid plexuses, a midsagittal view of the face to demonstrate the nasal bone, midbrain and brain stem, transverse views to demonstrate the orbits, upper lip and palate, a sagittal section of the spine to demonstrate the spine and overlying skin, a transverse section of the thorax and use of color Doppler to assess the four-chamber view of the heart and outflow tracts and record blood flow

across the tricuspid valve, and transverse and sagittal sections of the trunk and extremities to demonstrate the stomach, kidneys, bladder, abdominal insertion of the umbilical cord, all the long bones, hands and feet. Examination of the posterior fossa was included in the protocol only after 2011 and this was based on visual assessment rather than measurements of the brainstem and brainstem–occipital bone diameter[15–18].

Fetal echocardiography by a cardiologist was carried out at 11–13 weeks in all cases of fetal NT above the 99th percentile for CRL and at 20 weeks in those with NT between the 95th and 99th percentiles or regurgitation across the tricuspid valve or abnormal flow in the ductus venosus at 11–13 weeks[19–25].

Second trimester

At the second-trimester scan, we aimed to obtain the following views: a transverse section of the head at the level of the cavum septi pellucidi and lateral ventricles; a suboccipitobregmatic view to examine the midbrain, cerebellum and vermis; a midsagittal view of the face to examine the nasal bone and exclude micrognathia; transverse views of the orbits, upper lip and palate; sagittal, coronal and transverse views of the spine; a sweep through the heart in the transverse plane to include the four-chamber view, outflow tracts and three-vessel view; transverse and sagittal sections of the thorax and abdomen to examine the lungs, diaphragm, liver, stomach, bowel, umbilical cord insertion, kidneys, bladder and ureters; systematic examination of upper and lower limbs for length and shape of each bone, position and movement of each joint and examination of both hands and feet, including the digits. Examination of the genitalia was not a compulsory part of the protocol.

Third trimester

The third-trimester scan was aimed primarily at assessing fetal growth, amniotic fluid volume and Doppler measurements in the uterine, umbilical and fetal middle cerebral arteries. The sonographers were instructed to assess the fetal anatomy in the same systematic way as in the second trimester, but it was accepted that, depending on the fetal position, examination of the fetal face, sacrum and extremities may not be possible.

Outcome measures

The final diagnosis of fetal abnormality was based on the results of postnatal examination in cases of live birth and on the findings of the last ultrasound examination in cases of pregnancy termination, miscarriage or stillbirth because, in these cases, postmortem examination was not performed systematically. All neonates at our hospitals are examined by a pediatrician, but certain asymptomatic internal abnormalities are inevitably missed. For example, ventricular septal defects or coarctation of the aorta with patent arterial duct may be missed by early neonatal examination, which does not include echocardiography. However, all children with a cardiac abnormality diagnosed prenatally or postnatally at our centers are examined at a regional pediatric cardiac center which notifies us of any such abnormalities.

Ventriculomegaly was included only if the atrial width during the second or third trimester was $\geq$ 15 mm. Hydronephrosis was considered to be present if there was pelvicalyceal dilatation with an anteroposterior diameter $\geq$ 10 mm in the second trimester or $\geq$ 15 mm in the third trimester. We considered only severe ventriculomegaly and hydronephrosis because the incidence of milder degrees is much higher and their clinical consequences are questionable. In cases of exomphalos with a sac containing only bowel, megacystis, ventriculomegaly and hydronephrosis, a follow-up scan was carried out and cases with spontaneous resolution of the abnormality were considered to be normal. Polydactyly was considered to be present if the extra digit contained bone, and talipes was considered to be present if the fetus required postnatal treatment.

We included all cases of abnormalities of the heart and great vessels but excluded cases of persistent left superior vena cava and aberrant right subclavian artery because these are variants of normal rather than true defects. Cases with coarctation of the aorta, aortic arch hypoplasia and interrupted aortic arch were classified as arch abnormalities. Similarly, cases with Ebstein's anomaly or tricuspid dysplasia were classified as tricuspid valve abnormalities. Cases with at least two different major heart defects were classified as complex.

Association of fetal abnormalities with increased NT

The incidence of fetal NT above the 95th percentile for CRL for each fetal abnormality was determined and compared to that in fetuses without abnormality using the chi-square test with Yates' correction for large sample sizes.

RESULTS

Study population

During the study period, we carried out an ultrasound examination at 11–13 weeks in 101 793 singleton pregnancies with a live fetus and CRL of 45–84 mm. Median maternal age was 31.0 (interquartile range (IQR), 26.6–34.8) years, median maternal weight was 67.5 (IQR, 59.6–78.7) kg, the racial origin of the women was white in 76 036 (74.7%), black in 16 330 (16.0%), South Asian in 4620 (4.5%), East Asian in 2112 (2.1%) and mixed in 2695 (2.7%). At the time of the first-trimester scan, median fetal CRL was 63.8 (IQR, 58.5–69.7) mm and median gestational age was 12.7 (IQR, 12.3–13.2) weeks; the scan was carried out during the 11th week in only 8639 (8.5%) cases. The 11–13-week scans were carried out by 476 sonographers.

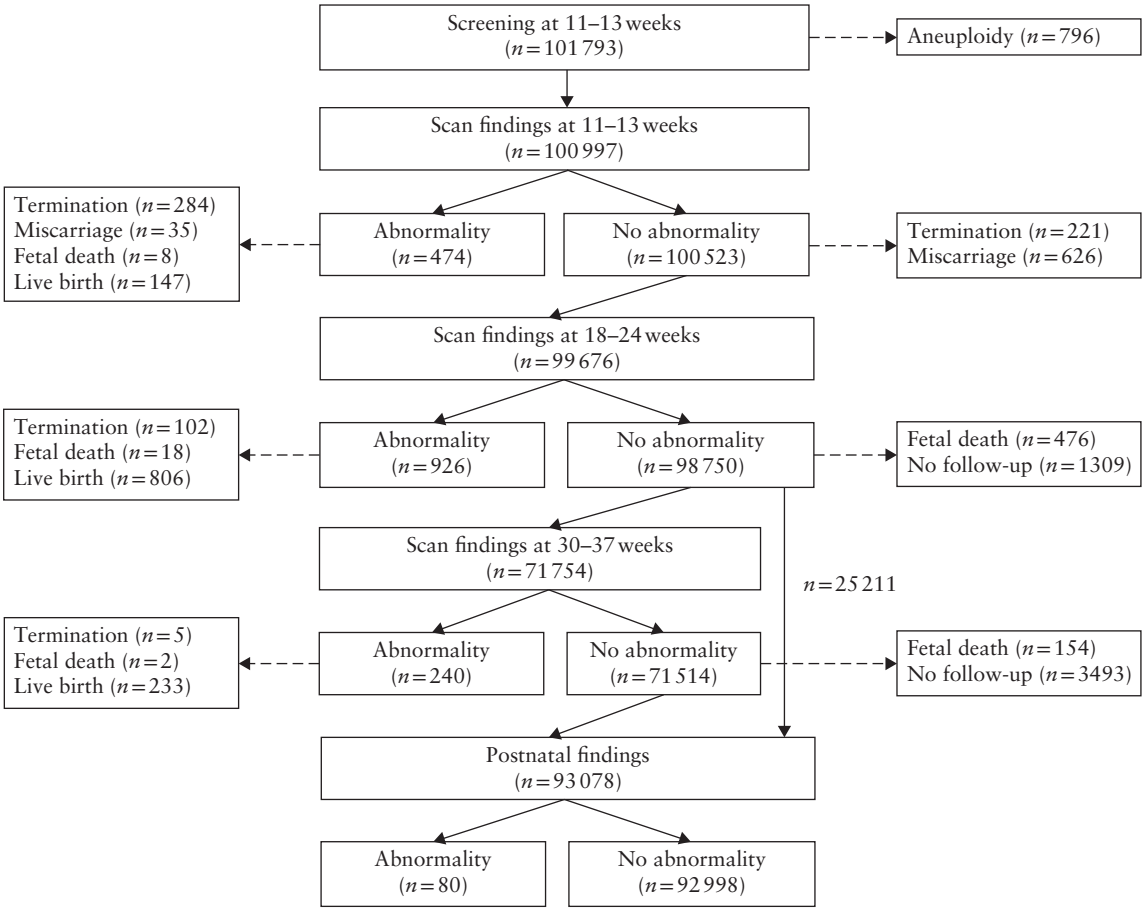

Figure 1 Flowchart of study population of pregnancies undergoing routine ultrasound examinations for non-chromosomal fetal abnormalities.

In 796 (0.8%) of the 101 793 cases, there was a prenatal or postnatal diagnosis of aneuploidy and these cases were excluded from this study (Figure 1). At the 11–13-week scan, we diagnosed an abnormality in 474 (0.47%) of the 100 997 cases; in 847 cases with no detectable abnormality, there was subsequent miscarriage or termination of the pregnancy for psychosocial reasons or genetic abnormality such as hemoglobinopathy or cystic fibrosis. The remaining 99 676 cases had an ultrasound scan at 18–24 weeks' gestation and, on this scan, we diagnosed an abnormality in 926 (0.9%) cases; in 1785 cases with no detectable abnormality, there was subsequent fetal death or loss to follow-up. In 71 754 pregnancies, there was an additional routine scan at either 30–34 or 35–37 weeks and, on these scans, we diagnosed an abnormality in 240 (0.3%) cases; in 3647 cases with no detectable abnormality, there was subsequent fetal death or loss to follow-up. In the 93 078 cases resulting in live birth, neonatal examination demonstrated an abnormality that was not detected prenatally in 80 (0.08%) cases and no defect in 92 998 neonates.

Aneuploidies

In 796 cases, fetal aneuploidy was diagnosed by cytogenetic analysis of chorionic villi, amniotic fluid or neonatal blood. These included 378 cases of trisomy 21, 166 of trisomy 18, 42 of trisomy 13, 29 of triploidy, 56 of monosomy X and 125 cases of other chromosomal abnormalities, including unbalanced translocations, deletions, duplications, inversions and mosaicisms.

Non-chromosomal abnormalities

At the 11–13-week scan, we diagnosed all cases of acrania, alobar holoprosencephaly, encephalocele, tricuspid or pulmonary atresia, pentalogy of Cantrell, ectopia cordis, exomphalos, gastroschisis and body-stalk anomaly and > 50% of cases of open spina bifida, hypoplastic left heart syndrome, atrioventricular septal defect, complex heart defect, left atrial isomerism, lower urinary tract obstruction, absence of extremities, fetal akinesia deformation sequence and lethal skeletal dysplasia (Table 1).

Central nervous system abnormalities

At 11–13 weeks, we diagnosed all cases of acrania, alobar holoprosencephaly and encephalocele, 59% (35/59) of cases of open spina bifida and 13% (2/15) of hypoplastic cerebellum and/or vermis. All other brain abnormalities were diagnosed at the second- or third-trimester scan.

Table 1 Diagnosis of fetal non-chromosomal abnormalities in 100 997 pregnancies undergoing routine ultrasound examinations

			Detection			
Defect	*Total*	*NT > 95th percentile*	*First trimester*	*Second trimester*	*Third trimester*	*Postnatal*
Central nervous system						
Acrania	48	0 (0)	48 (100)	0 (0)	0 (0)	0 (0)
Alobar holoprosencephaly	10	2 (20.0)	10 (100)	0 (0)	0 (0)	0 (0)
Encephalocele	15	5 (33.3)*	15 (100)	0 (0)	0 (0)	0 (0)
Open spina bifida	59	6 (10.2)*	35 (59.3)	24 (40.7)	0 (0)	0 (0)
Hypoplastic cerebellum/vermis	15	0 (0)	2 (13.3)	13 (86.7)	0 (0)	0 (0)
Agenesis of corpus callosum	26	2 (7.7)	0 (0)	25 (96.2)	1 (3.8)	0 (0)
Schizencephaly	3	0 (0)	0 (0)	2 (66.7)	1 (33.3)	0 (0)
Septo-optic dysplasia	1	0 (0)	0 (0)	1 (100)	0 (0)	0 (0)
Microcephaly	9	0 (0)	0 (0)	1 (11.1)	8 (88.9)	0 (0)
Severe ventriculomegaly	18	0 (0)	0 (0)	14 (77.8)	4 (22.2)	0 (0)
Arachnoid cyst	14	1 (7.1)	0 (0)	5 (35.7)	9 (64.3)	0 (0)
Brain hemorrhage	2	0 (0)	0 (0)	1 (50.0)	1 (50.0)	0 (0)
Dural venous sinus thrombosis	2	0 (0)	0 (0)	2 (100)	0 (0)	0 (0)
Craniosynostosis	2	1 (50.0)	0 (0)	1 (50.0)	1 (50.0)	0 (0)
Occipital dermoid cyst	1	1 (100)*	0 (0)	1 (100)	0 (0)	0 (0)
Blake's pouch cyst	4	0 (0)	0 (0)	4 (100)	0 (0)	0 (0)
Brain tumor	2	0 (0)	0 (0)	0 (0)	2 (100)	0 (0)
Face						
Anophthalmia/microphthalmia	5	0 (0)	0 (0)	5 (100)	0 (0)	0 (0)
Dacryocystocele	2	0 (0)	0 (0)	0 (0)	2 (100)	0 (0)
Cataract bilateral	1	0 (0)	0 (0)	0 (0)	0 (0)	1 (100)
Cleft lip and palate	52	1 (1.9)	18 (34.6)	34 (65.4)	0 (0)	0 (0)
Cleft lip only	28	1 (3.6)	0 (0)	24 (85.7)	0 (0)	4 (14.3)
Cleft palate only	10	1 (10.0)	0 (0)	0 (0)	0 (0)	10 (100)
Micrognathia	7	0 (0)	1 (14.3)	6 (85.7)	0 (0)	0 (0)
Thorax						
Congenital diaphragmatic hernia	24	6 (25.0)*	7 (29.2)	14 (58.3)	2 (8.3)	1 (4.2)
Congenital pulmonary airway malformation	43	5 (11.2)*	0 (0)	39 (90.7)	4 (9.3)	0 (0)
Congenital high-airway obstruction syndrome	1	1 (100)*	0 (0)	1 (100)	0 (0)	0 (0)
Mediastinal teratoma	1	0 (0)	0 (0)	1 (100)	0 (0)	0 (0)
Pleural effusion	3	0 (0)	0 (0)	2 (67.7)	1 (33.3)	0 (0)
Heart						
Tricuspid atresia	7	2 (28.6)*	7 (100)	0 (0)	0 (0)	0 (0)
Pulmonary atresia	11	4 (36.4)*	11 (100)	0 (0)	0 (0)	0 (0)
Polyvalvular dysplasia	1	1 (100)*	1 (100)	0 (0)	0 (0)	0 (0)
Hypoplastic left heart syndrome	40	15 (37.5)*	37 (92.5)	3 (7.5)	0 (0)	0 (0)
Atrioventricular septal defect	11	8 (72.7)*	10 (90.9)	1 (9.1)	0 (0)	0 (0)
Complex heart defect	25	9 (36.0)*	15 (60.0)	10 (40.0)	0 (0)	0 (0)
Left atrial isomerism	7	3 (42.9)*	4 (57.1)	3 (42.9)	0 (0)	0 (0)
Tetralogy of Fallot	28	5 (17.9)*	11 (39.3)	15 (53.6)	1 (3.6)	1 (3.6)
Arch abnormality	38	13 (34.2)	12 (31.6)	21 (55.3)	4 (10.5)	1 (2.6)
Tricuspid valve abnormality	8	2 (25.0)*	2 (25.0)	3 (37.5)	2 (25.0)	1 (12.5)
Transposition of great arteries	15	2 (13.3)	2 (13.3)	12 (80.0)	0 (0)	1 (6.7)
Double/right aortic arch	32	2 (6.3)	5 (15.6)	27 (84.4)	0 (0)	0 (0)
Aortic stenosis	6	1 (16.7)	0 (0)	4 (66.7)	1 (16.7)	1 (16.7)
Pulmonary stenosis	10	2 (20.0)	0 (0)	7 (70.0)	2 (20.0)	1 (10.0)
Common arterial trunk	1	0 (0)	0 (0)	1 (100)		
Ventricular aneurysm	3	0 (0)	0 (0)	2 (66.7)	1 (33.3)	0 (0)
Arrhythmia	3	0 (0)	0 (0)	1 (33.3)	2 (66.7)	0 (0)
Cardiomyopathy	1	0 (0)	0 (0)	1 (100)	0 (0)	0 (0)
Rhabdomyoma	6	1 (16.7)	0 (0)	1 (16.7)	5 (83.3)	0 (0)
Ventricular septal defect	136	15 (11.0)*	0 (0)	97 (71.3)	31 (22.8)	8 (5.9)
Gastrointestinal tract						
Liver, spleen, gallbladder, mesenteric or adrenal cyst	21	2 (9.5)	0 (0)	12 (57.1)	9 (42.9)	0 (0)
Cloacal abnormality	2	1 (50.0)	2 (100)	0 (0)	0 (0)	0 (0)
Meconium peritonitis	1	0 (0)	1 (100)	0 (0)	0 (0)	0 (0)
Right-sided stomach	1	0 (0)	1 (100)	0 (0)	0 (0)	0 (0)
Esophageal atresia	8	0 (0)	0 (0)	4 (50.0)	2 (25.0)	2 (25.0)
Duodenal atresia	9	0 (0)	0 (0)	1 (11.1)	8 (88.9)	0 (0)
Small-bowel obstruction	6	0 (0)	0 (0)	0 (0)	6 (100)	0 (0)
Hirschsprung's disease	2	0 (0)	0 (0)	0 (0)	0 (0)	2 (100)
Imperforate anus	3	0 (0)	0 (0)	0 (0)	0 (0)	3 (100)

Continued over.

Table 1 *Continued*

Defect	*Total*	*NT > 95th percentile*	*Detection*			
			First trimester	*Second trimester*	*Third trimester*	*Postnatal*
Abdominal wall						
Exomphalos with bowel or liver	44	15 (34.1)*	44 (100)	0 (0)	0 (0)	0 (0)
Gastroschisis	40	2 (5.0)	40 (100)	0 (0)	0 (0)	0 (0)
Bladder exstrophy	2	0 (0)	0 (0)	2 (100)	0 (0)	0 (0)
Genitourinary						
Lower urinary tract obstruction	52	9 (17.3)*	37 (71.2)	11 (21.2)	4 (7.7)	0 (0)
Bilateral renal agenesis	13	2 (15.4)	2 (15.4)	11 (84.6)	0 (0)	0 (0)
Bilateral polycystic kidneys	14	3 (21.4)*	1 (7.1)	10 (71.4)	3 (21.4)	0 (0)
Unilateral pelvic kidney/agenesis	124	10 (10.5)*	3 (2.4)	107 (86.3)	14 (11.3)	0 (0)
Bilateral multicystic kidney	4	1 (25.0)	0 (0)	4 (100)	0 (0)	0 (0)
Unilateral multicystic kidney	58	1 (1.7)	0 (0)	51 (87.9)	7 (12.1)	0 (0)
Severe hydronephrosis	79	3 (3.8)	0 (0)	47 (59.5)	32 (40.5)	0 (0)
Duplex kidney	87	4 (4.6)	0 (0)	69 (79.3)	18 (20.7)	0 (0)
Horseshoe kidney	5	0 (0)	0 (0)	4 (80.0)	1 (20.0)	0 (0)
Unilateral dilated ureter	6	0 (0)	0 (0)	3 (50.0)	3 (50.0)	0 (0)
Unilateral renal cyst	11	0 (0)	0 (0)	7 (63.7)	4 (36.4)	0 (0)
Ovarian cyst	27	0 (0)	0 (0)	0 (0)	27 (100)	0 (0)
Ambiguous genitalia	5	1 (20.0)	0 (0)	4 (80.0)	0 (0)	1 (20.0)
Hematocolpos	2	0 (0)	0 (0)	0 (0)	2 (100)	0 (0)
Hypospadias	26	2 (7.7)	0 (0)	1 (3.8)	0 (0)	25 (96.2)
Rectovaginal fistula	1	0 (0)	0 (0)	0 (0)	0 (0)	1 (100)
Skeleton						
Absent hand, arm, leg or foot	24	1 (4.2)	18 (75.0)	6 (25.0)	0 (0)	0 (0)
Fetal akinesia deformation sequence	11	2 (18.2)	8 (72.7)	3 (27.3)	0 (0)	0 (0)
Lethal skeletal dysplasia	14	8 (57.1)*	10 (71.4)	4 (28.6)	0 (0)	0 (0)
Non-lethal skeletal dysplasia	12	0 (0)	0 (0)	10 (83.3)	2 (16.7)	0 (0)
Abnormal digits	59	4 (6.8)	25 (42.4)	19 (32.2)	3 (5.1)	12 (20.3)
Hemivertebra/scoliosis	12	0 (0)	4 (33.3)	8 (66.7)	0 (0)	0 (0)
Talipes	93	4 (5.4)	2 (2.2)	82 (88.2)	5 (5.4)	4 (4.3)
Tumor						
Sacrococcygeal teratoma	2	0 (0)	1 (50.0)	1 (50.0)	0 (0)	0 (0)
Lymphangioma	4	1 (25.0)	0 (0)	3 (75.0)	1 (25.0)	0 (0)
Testicular mass	1	0 (0)	0 (0)	0 (0)	1 (100)	0 (0)
Thyroid goiter	2	0 (0)	0 (0)	0 (0)	2 (100)	0 (0)
Other						
Body-stalk anomaly	16	5 (31.3)*	16 (100)	0 (0)	0 (0)	0 (0)
Pentalogy of Cantrell	2	2 (100)*	2 (100)	0 (0)	0 (0)	0 (0)
Ectopia cordis only	2	0 (0)	2 (100)	0 (0)	0 (0)	0 (0)
Hydrops fetalis	8	1 (12.5)	0 (0)	7 (87.5)	1 (12.5)	0 (0)
Multiple						
Pulmonary stenosis, microcephaly, micrognathia	1	0 (0)	0 (0)	1 (100)	0 (0)	0 (0)
Tetralogy of Fallot, hemivertebra, talipes	1	0 (0)	0 (0)	1 (100)	0 (0)	0 (0)
Ventriculomegaly severe, cleft lip and palate	1	0 (0)	0 (0)	1 (100)	0 (0)	0 (0)
Diaphragmatic hernia, unilateral renal agenesis	1	0 (0)	0 (0)	1 (100)	0 (0)	0 (0)
Cleft lip and palate, unilateral multicystic kidney	1	0 (0)	0 (0)	1 (100)	0 (0)	0 (0)
Cleft lip and palate, megacystis, radial aplasia	1	1 (100)*	1 (100)	0 (0)	0 (0)	0 (0)
Cleft lip and palate, unilateral renal agenesis	1	0 (0)	0 (0)	1 (100)	0 (0)	0 (0)
Complex heart defect, megacystis	1	1 (100)*	1 (100)	0 (0)	0 (0)	0 (0)
Total	1720	204	474	926	240	80

Data are given as *n* or *n* (%). *Significant difference in proportion of fetuses with nuchal translucency thickness (NT) > 95th percentile between those with given abnormality and those without, examined by chi-square test with Yates' correction for large sample size ($P < 0.05$).

Facial abnormalities

At 11–13 weeks, we diagnosed 35% (18/52) of cases of cleft lip and palate and 14% (1/7) of cases of micrognathia, but none of the cases of anophthalmia/microphthalmia, dacryocystocele, cataract, cleft lip only or cleft palate only.

Thoracic abnormalities

At 11–13 weeks, we diagnosed 29% (7/24) of cases of congenital diaphragmatic hernia, but none of congenital pulmonary airway malformation, congenital high-airway obstruction syndrome, mediastinal teratoma or pleural effusion.

Cardiac abnormalities

At 11–13 weeks, we diagnosed all cases of tricuspid or pulmonary atresia, > 90% of cases of hypoplastic left heart syndrome and atrioventricular septal defect, about 60% of cases of complex heart defect and left atrial isomerism (interrupted inferior vena cava with normal intracardiac anatomy), 30–40% of cases of tetralogy of Fallot and arch abnormality, 25% of cases of tricuspid valve abnormality and about 15% of cases of transposition of the great arteries and double or right aortic arch. Cases of aortic or pulmonary stenosis, common arterial trunk, ventricular aneurysm, arrhythmia, cardiomyopathy, rhabdomyoma and ventricular septal defect were first diagnosed on the second- or third-trimester scan or very occasionally postnatally.

Gastrointestinal abnormalities

At 11–13 weeks, we diagnosed both cases of cloacal abnormality and one case each of meconium peritonitis (presenting as an abdominal cyst) and right-sided stomach. All cases of cysts in the liver, spleen, gallbladder, adrenal gland or mesentery, esophageal or duodenal atresia and small-bowel obstruction were diagnosed mostly for the first time in the second or third trimester and cases of Hirschsprung's disease and imperforate anus were first diagnosed postnatally.

Abdominal wall abnormalities

At 11–13 weeks, we diagnosed all cases of gastroschisis and exomphalos, but the cases of bladder exstrophy were first seen in the second trimester.

Genitourinary abnormalities

At 11–13 weeks, we diagnosed 71% (37/52) of cases of lower urinary tract obstruction, a few cases of bilateral or unilateral renal agenesis and polycystic kidneys, but none of multicystic kidneys, hydronephrosis, duplex or horseshoe kidneys, megaureter or renal cysts, which were first diagnosed on the second- or third-trimester scan. Ovarian cysts and hematocolpos were diagnosed mostly for the first time in the third trimester, whereas hypospadias and rectovaginal fistula were diagnosed mostly for the first time postnatally.

Skeletal abnormalities

At 11–13 weeks, we diagnosed > 70% of cases of absence of extremities, fetal akinesia deformation sequence and lethal skeletal dysplasia, about 30–40% of cases of hemivertebra or scoliosis, and polydactyly, oligodactyly, syndactyly or ectrodactyly, but only 2% (2/93) of cases of talipes and none of non-lethal skeletal dysplasia; these were diagnosed mostly during the second- or third-trimester scan and a few cases were first diagnosed postnatally.

Tumors

One of two cases of sacrococcygeal teratoma was diagnosed at 11–13 weeks. All other fetal tumors were detected on the second- or third-trimester scan.

Other abnormalities

At 11–13 weeks, we diagnosed all cases of body-stalk anomaly, pentalogy of Cantrell and ectopia cordis. Eight cases of hydrops fetalis first presented in the second or third trimester; in two of these, the underlying cause was parvovirus B19 infection and the other six were unexplained.

Multiple abnormalities

There were eight cases with fetal abnormalities involving more than one organ system and two of these presenting with megacystis were diagnosed in the first trimester.

Association of fetal abnormalities with increased NT

In the total population of 101 793 cases, there were 4754 (4.7%) with fetal NT above the 95th percentile. The incidence of increased NT was 66% (525/796) in the group with aneuploidy and 12% (204/1720) in those with, and 4% (4025/99 277) in those without, non-chromosomal abnormality.

A significantly higher incidence of increased NT was observed in cases of encephalocele, spina bifida, congenital diaphragmatic hernia, exomphalos, lower urinary tract obstruction, lethal skeletal dysplasia, fetal akinesia deformation sequence, body-stalk anomaly and pentalogy of Cantrell (Table 1). Increased NT was observed in 21.9% (85/389) of fetuses with a cardiac abnormality. Of the 117 cases with a cardiac defect detected in the first trimester, 56 (47.9%) had fetal NT above the 95th percentile.

DISCUSSION

Main findings

The main features of this study are: first, prospective collection of data from > 100 000 singleton pregnancies; second, routine first-trimester ultrasound examination with > 90% of the scans carried out during the 12th or 13th week; third, systematic examination of the fetal anatomy according to a standardized protocol and an allocated time period of 30 min; fourth, the scans were conducted primarily transabdominally and by > 470 trainee sonographers; fifth, the examinations were carried out within the framework of a fetal medicine unit in which any suspected abnormality was assessed within the same clinical visit by a fetal medicine expert; sixth, all continuing pregnancies had an ultrasound examination for fetal anatomy at 18–24 weeks and > 70% had an additional scan in the third trimester; seventh, follow-up

was obtained in > 95% of cases; and, eighth, the final diagnosis of fetal abnormality was based on the results of postnatal examination by a pediatrician in cases of live birth and based on the findings of a fetal medicine expert or cardiologist on the last ultrasound examination in cases of fetal death, because, in these cases, postmortem examination was not performed systematically; fetuses with a transient anomaly, including exomphalos with a sac containing only bowel, megacystis, ventriculomegaly and hydronephrosis, were considered to be normal.

The main findings of the study are: first, the overall incidence of fetal non-chromosomal abnormality was 1.7%, including 27.6% detected on the first-trimester scan, 53.8% detected on the second-trimester scan and 18.6% detected in the third trimester or postnatally; second, at the 11–13-week scan, we diagnosed all cases of acrania, alobar holoprosencephaly, encephalocele, tricuspid or pulmonary atresia, pentalogy of Cantrell, ectopia cordis, exomphalos, gastroschisis and body-stalk anomaly and > 50% of cases of open spina bifida, hypoplastic left heart syndrome, atrioventricular septal defect, complex heart defect, left atrial isomerism (interrupted inferior vena cava with normal intracardiac anatomy), lower urinary tract obstruction, absence of extremities, fetal akinesia deformation sequence and lethal skeletal dysplasia; third, common abnormalities that were detected in < 10% of cases at 11–13 weeks included ventriculomegaly, agenesis of the corpus callosum, isolated cleft lip, congenital pulmonary airway malformation, ventricular septal defect, abdominal cysts, unilateral renal agenesis or multicystic kidney, hydronephrosis, duplex kidney, talipes and hypospadias; and, fourth, the incidence of fetal NT above the 95th percentile was higher in those with, than in those without, non-chromosomal abnormality (12% *vs* 4%) and it was particularly high in fetuses with a cardiac abnormality (22%), especially in those detected in the first trimester (48%).

Comparison with findings from previous studies

The findings of this study are consistent with those of our previous report on first-trimester routine ultrasound examination in 45 191 singleton pregnancies, which highlighted that fetal abnormalities essentially fall into three categories in relation to detectability at the 11–13-week scan: always detectable, never detectable or sometimes detectable[8]. There are two major differences in the findings between the current and the previous study, which relate to improved detection and ascertainment of certain abnormalities. There was improved detection of open spina bifida (59% *vs* 15%), major cardiac defect (52% *vs* 34%) and cleft lip and palate (35% *vs* 5%); these improvements can be attributed to the better quality of the ultrasound machines and incorporation in our standardized protocol of the midsagittal section of the brain for examination of the posterior fossa, color Doppler for examination of the four chambers of the heart and outflow tracts, and transverse views of the face to demonstrate the upper lip and palate.

In the current, compared to our previous, study[8], there was an increased overall incidence of fetal abnormalities (1.7% *vs* 1.1%) which is likely to be the consequence of improved ascertainment. For example, there was an increase in the incidence of cleft lip and/or palate (from about 1 in 2300 to 1 in 1100), ventricular septal defect or double/right aortic arch (from about 1 in 2300 to 1 in 600), congenital diaphragmatic hernia or congenital pulmonary airway malformation (from about 1 in 3200 to 1 in 1500), esophageal atresia, duodenal atresia or small-bowel obstruction (from about 1 in 15 000 to 1 in 4400), unilateral renal agenesis or pelvic kidney (from about 1 in 7500 to 1 in 800), other urinary tract defects (from about 1 in 700 to 1 in 200), and abdominal cysts, ovarian cysts or hypospadias (from 0% to about 1 in 1400). To some extent, such increased ascertainment is the consequence of, first, the higher expectation in the last 10 years for diagnosis of abnormalities such as ventricular septal defects or right aortic arch and unilateral renal agenesis or pelvic kidney, and, second, the introduction of a routine third-trimester scan and diagnosis of abnormalities such as bowel obstruction and ovarian cysts which are not usually detectable on the routine second-trimester scan; many of these abnormalities are also undetectable during a routine neonatal examination.

The value of the first-trimester scan in detecting fetal abnormalities has been assessed in several previous studies, many of which were included in our previous publication[8]. For this comparison, we selected only nine studies that included examination of at least 5000 pregnancies; in seven there were between 5000 and 10 000 pregnancies, in one there were 13 723 and in the other there were 17 973[26–34]. The reported incidence of fetal abnormalities varied between 1% and 3% and the first-trimester detection rate varied between 13% and 79%. The studies differed in terms of protocol for the ultrasound scan and outcome measure, which included all or only major abnormalities with or without chromosomal defects; additionally, there was large variation between studies in the definition of major abnormalities. These limitations preclude meaningful comparisons concerning the performance of the first-trimester scan.

Strengths and limitations

The main strength of our study is the examination of a large number of pregnancies attending for routine assessment in the first-, second- and third-trimesters of pregnancy using standardized protocols and appropriately trained sonographers in units with expertise in fetal medicine and fetal cardiology. In our study, we included all abnormalities detected prenatally or in the neonatal period and demonstrated wide variation in detection rates during the first trimester, illustrating the futility of summary statistics for overall detection rates of defects.

The main limitation of this and most previous studies investigating the effectiveness of routine ultrasound examination in the prenatal diagnosis of fetal abnormalities relates to ascertainment of such abnormalities. Although

in our centers all neonates are examined by pediatricians, it is possible that asymptomatic abnormalities of internal organs could be missed. Similarly, we assumed that all phenotypically normal neonates were chromosomally normal.

Another potential limitation relates to the general applicability of our results because the routine ultrasound examinations were carried out within the framework of fetal medicine units with readily available expertise. Consequently, in a routine ultrasound department, some of the abnormalities we detected could have been missed.

Conclusions

This study has highlighted the types of fetal abnormalities that should be detectable during a routine first-trimester scan based on a standardized protocol with allocation of adequate time to allow systematic examination of the fetal anatomy. This study has also demonstrated that, first, the overall performance of the scan is to a great extent dependent on the type of target abnormalities and the available infrastructure for ascertainment of such abnormalities, and, second, to maximize prenatal detection of abnormalities, additional scans in both the second and third trimesters[35] are necessary.

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REFERENCES

1. Robinson HP, Fleming JE. A critical evaluation of sonar crown rump length measurements. *Br J Obstet Gynaecol* 1975; **82**: 702–710.
2. Sepulveda W, Sebire NJ, Hughes K, Odibo A, Nicolaides KH. The lambda sign at 10–14 weeks of gestation as a predictor of chorionicity in twin pregnancies. *Ultrasound Obstet Gynecol* 1996; **7**: 421–423.
3. Nicolaides KH, Azar GB, Byrne D, Mansur CA, Marks K. Nuchal translucency: ultrasound screening for chromosomal defects in the first trimester of pregnancy. *BMJ* 1992; **304**: 867–869.
4. Snijders RJ, Noble P, Sebire N, Souka A, Nicolaides KH. UK multicentre project on assessment of risk of trisomy 21 by maternal age and fetal nuchal-translucency thickness at 10-14 weeks of gestation. Fetal Medicine Foundation First Trimester Screening Group. *Lancet* 1998; **352**: 343–346.
5. Nicolaides KH. Screening for fetal aneuploidies at 11 to 13 weeks. *Prenat Diagn* 2011; **31**: 7–15.
6. Johnson SP, Sebire NJ, Snijders RJ, Tunkel S, Nicolaides KH. Ultrasound screening for anencephaly at 10–14 weeks of gestation. *Ultrasound Obstet Gynecol* 1997; **9**: 14–16.
7. Souka AP, Snijders RJ, Novakov A, Soares W, Nicolaides KH. Defects and syndromes in chromosomally normal fetuses with increased nuchal translucency thickness at 10–14 weeks of gestation. *Ultrasound Obstet Gynecol* 1998; **11**: 391–400.
8. Syngelaki A, Chelemen T, Dagklis T, Allan L, Nicolaides KH. Challenges in the diagnosis of fetal non-chromosomal abnormalities at 11–13 weeks. *Prenat Diagn* 2011; **31**: 90–102.
9. O'Gorman N, Wright D, Syngelaki A, Akolekar R, Wright A, Poon LC, Nicolaides KH. Competing risks model in screening for preeclampsia by maternal factors and biomarkers at 11–13 weeks' gestation. *Am J Obstet Gynecol* 2016; **214**: 103.e1–12.
10. Tan MY, Wright D, Syngelaki A, Akolekar R, Cicero S, Janga D, Singh M, Greco E, Wright A, Maclagan K, Poon LC, Nicolaides KH. Comparison of diagnostic accuracy of early screening for pre-eclampsia by NICE guidelines and a method combining maternal factors and biomarkers: results of SPREE. *Ultrasound Obstet Gynecol* 2018; **51**: 743–750.
11. Wright D, Tan MY, O'Gorman N, Poon LC, Syngelaki A, Wright A, Nicolaides KH. Predictive performance of the competing risk model in screening for preeclampsia. *Am J Obstet Gynecol* 2019; **220**: 199.e1–13.
12. Rolnik DL, Wright D, Poon LC, O'Gorman N, Syngelaki A, de Paco Matallana C, Akolekar R, Cicero S, Janga D, Singh M, Molina FS, Persico N, Jani JC, Plasencia W, Papaioannou G, Tenenbaum-Gavish K, Meiri H, Gizurarson S, Maclagan K, Nicolaides KH. Aspirin versus placebo in pregnancies at high risk for preterm preeclampsia. *N Engl J Med* 2017; **377**: 613–622.
13. Gil MM, Accurti V, Santacruz B, Plana MN, Nicolaides KH. Analysis of cell-free DNA in maternal blood in screening for aneuploidies: updated meta-analysis. *Ultrasound Obstet Gynecol* 2017; **50**: 302–314.
14. Gil MM, Revello R, Poon LC, Akolekar R, Nicolaides KH. Clinical implementation of routine screening for fetal trisomies in the UK NHS: cell-free DNA test contingent on results from first-trimester combined test. *Ultrasound Obstet Gynecol* 2016; **47**: 45–52.
15. Chaoui R, Benoit B, Mitkowska-Wozniak H, Heling KS, Nicolaides KH. Assessment of intracranial translucency (IT) in the detection of spina bifida at the 11–13-week scan. *Ultrasound Obstet Gynecol* 2009; **34**: 249–252.
16. Chaoui R, Nicolaides KH. From nuchal translucency to intracranial translucency: towards the early detection of spina bifida. *Ultrasound Obstet Gynecol* 2010; **35**: 133–138.
17. Chaoui R, Nicolaides KH. Detecting open spina bifida at the 11–3-week scan by assessing intracranial translucency and the posterior brain region: mid-sagittal or axial plane? *Ultrasound Obstet Gynecol* 2011; **38**: 609–612.
18. Lachmann R, Chaoui R, Moratalla J, Picciarelli G, Nicolaides KH. Posterior brain in fetuses with open spina bifida at 11 to 13 weeks. *Prenat Diagn* 2011; **31**: 103–106.
19. Hyett J, Perdu M, Sharland G, Snijders R, Nicolaides KH. Using fetal nuchal translucency to screen for major congenital cardiac defects at 10–14 weeks of gestation: population based cohort study. *BMJ* 1999; **318**: 81–85.
20. Hyett JA, Perdu M, Sharland GK, Snijders RSM, Nicolaides KH. Increased nuchal translucency at 10–14 weeks of gestation as a marker for major cardiac defects. *Ultrasound Obstet Gynecol* 1997; **10**: 242–246.
21. Huggon IC, Ghi T, Cook AC, Zosmer N, Allan LD, Nicolaides KH. Fetal cardiac abnormalities identified prior to 14 weeks' gestation. *Ultrasound Obstet Gynecol* 2002; **20**: 22–29.
22. Matias A, Huggon I, Areias JC, Montenegro N, Nicolaides KH. Cardiac defects in chromosomally normal fetuses with abnormal ductus venosus blood flow at 10–14 weeks. *Ultrasound Obstet Gynecol* 1999; **14**: 307–310.
23. Maiz N, Plasencia W, Dagklis T, Faros E, Nicolaides K. Ductus venosus Doppler in fetuses with cardiac defects and increased nuchal translucency thickness. *Ultrasound Obstet Gynecol* 2008; **31**: 256–260.
24. Chelemen T, Syngelaki A, Maiz N, Allan L, Nicolaides KH. Contribution of ductus venosus Doppler in first-trimester screening for major cardiac defects. *Fetal Diagn Ther* 2011; **29**: 127–134.
25. Pereira S, Ganapathy R, Syngelaki A, Maiz N, Nicolaides KH. Contribution of fetal tricuspid regurgitation in first-trimester screening for major cardiac defects. *Obstet Gynecol* 2011; **117**: 1384–1391.
26. Whitlow BJ, Chatzipapas IK, Lazanakis ML, Kadir RA, Economides DL. The value of sonography in early pregnancy for the detection of fetal abnormalities in an unselected population. *Br J Obstet Gynaecol* 1999; **106**: 929–936.
27. Saltvedt S, Almstrom H, Kublickas M, Valentin L, Grunewald C. Detection of malformations in chromosomally normal fetuses by routine ultrasound at 12 or 18 weeks of gestation – a randomised controlled trial in 39,572 pregnancies. *BJOG* 2006; **113**: 664–674.
28. Chen M, Lee CP, Lam YH, Tang RY, Chan BC, Wong SF, Tse LH, Tang MH. Comparison of nuchal and detailed morphology ultrasound examinations in early pregnancy for fetal structural abnormality screening: a randomized controlled trial. *Ultrasound Obstet Gynecol* 2008; **31**: 136–146.
29. Hildebrand E, Selbing A, Blomberg M. Comparison of first and second trimester ultrasound screening for fetal anomalies in the southeast region of Sweden. *Acta Obstet Gynecol Scand* 2010; **89**: 1412–1419.
30. Jakobsen TR, Søgaard K, Tabor A. Implications of a first trimester Down syndrome screening program on timing of malformation detection. *Acta Obstet Gynecol Scand* 2011; **90**: 728–736.
31. Grande M, Arigita M, Borobio V, Jimenez JM, Fernandez S, Borrell A. First-trimester detection of structural abnormalities and the role of aneuploidy markers. *Ultrasound Obstet Gynecol* 2012; **39**: 157–163.
32. Iliescu D, Tudorache S, Comanescu A, Antsaklis P, Cotarcea S, Novac L, Cernea N, Antsaklis A. Improved detection rate of structural abnormalities in the first trimester using an extended examination protocol. *Ultrasound Obstet Gynecol* 2013; **42**: 300–309.
33. Vayna AM, Veduta A, Duta S, Panaitescu AM, Stoica S, Buinoiu N, Nedelea F, Peltecu G. Diagnosis of fetal structural Anomalies at 11 to 14 Weeks. *J Ultrasound Med* 2018; **37**: 2063–2073.
34. Kenkhuis MJA, Bakker M, Bardi F, Fontanella F, Bakker MK, Fleurke-Rozema JH, Bilardo CM. Effectiveness of 12–13-week scan for early diagnosis of fetal congenital anomalies in the cell-free DNA era. *Ultrasound Obstet Gynecol* 2018; **51**: 463–469.
35. Ficara A, Syngelaki A, Hammami A, Akolekar R, Nicolaides KH. Value of routine ultrasound examination at 35–37 weeks' gestation in diagnosis of fetal abnormalities. *Ultrasound Obstet Gynecol* 2019. DOI: 10.1002/uog.20857.

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Diagnóstico de anomalías fetales no cromosómicas en la ecografía de rutina a las 11–13 semanas de gestación

RESUMEN

Objetivo Examinar el desempeño de la ecografía de rutina a las 11–13 semanas en la detección de anomalías fetales no cromosómicas.

Métodos Esta investigación fue un estudio retrospectivo de datos recogidos prospectivamente de 100 997 embarazos con feto único que acudieron a un examen ecográfico de rutina de la anatomía fetal, realizado de acuerdo con un protocolo estandarizado, a las 11–13 semanas de gestación. Todos los embarazos que continuaron se sometieron a una exploración adicional a las 18-24 semanas y 71754 se sometieron a una exploración a las 30-34 o a las 35-37 semanas. El diagnóstico final de la anomalía fetal se basó en los resultados del examen postnatal en los casos de nacimientos vivos y en los hallazgos del último examen ecográfico en los casos de interrupción del embarazo, aborto o éxitus fetal. Se determinó el rendimiento de la exploración de las 11–13 semanas en la detección de anomalías fetales.

Resultados La población del estudio contenía 1720 (1,7%) embarazos con una anormalidad fetal, entre ellos 474 (27,6%) detectados en la exploración del primer trimestre, 926 (53,8%) detectados en la del segundo trimestre y 320 (18,6%) detectados en el tercer trimestre o postnatalmente. A las 11-13 semanas de gestación, se diagnosticaron todos los casos de acrania, holoprosencefalia alobar, encefalocele, atresia tricúspide o pulmonar, pentalogía de Cantrell, ectopia cordis, onfalocele, gastrosquisis y anomalía del pedículo embrionario y >50% de los casos de espina bífida abierta, síndrome del hemicardio izquierdo hipoplásico, comunicación auriculoventricular, defecto cardíaco complejo, isomerismo de la aurícula izquierda (vena cava inferior interrumpida con anatomía intracardíaca normal), obstrucción del tracto urinario inferior, ausencia de extremidades, secuencia de deformación de la acinesia fetal y displasia esquelética letal. Las anomalías comunes que se detectaron en <10% de los casos a las 11–13 semanas incluyeron ventriculomegalia, agenesia del cuerpo calloso, labio leporino aislado, malformación congénita de las vías respiratorias pulmonares, comunicación interventricular, quistes abdominales, agenesia renal unilateral o riñón multiquístico, hidronefrosis, duplicidad renal, hipospadias y pie zambo.

Conclusión Una exploración rutinaria a las 11–13 semanas, realizada de acuerdo con un protocolo estandarizado, puede identificar muchas anomalías fetales no cromosómicas graves. Un resumen estadístico del desempeño de la exploración del primer trimestre es inútil porque algunas anomalías son siempre detectables, mientras que otras no lo son o solo lo son a veces. Para maximizar la detección prenatal de anormalidades, se necesitan exploraciones adicionales tanto en el segundo como en el tercer trimestre.

妊娠 11-13 周常规超声检查胎儿非染色体异常的诊断

摘要

目标：针对常规的 11-13 周胎儿非染色体异常扫描检测，审视相关表现。

方法：这是一项回顾性研究，前瞻性收集了 100 997 例单胎妊娠数据。这些单胎妊娠孕妇在妊娠 11-13 周时，按照标准化方案接受了胎儿解剖的常规超声检查。全体持续妊娠孕妇在 18-24 周接受了额外的扫描，71 754 例孕妇在 30-34 周或 35-37 周接受了一次扫描。胎儿异常的最终诊断基于产后检查结果（若为活产婴儿），或上次超声检查结果（若为终止妊娠、流产或死产）。11-13 周扫描在胎儿异常诊断中的表现有了结论。

结果：研究人群中有 1720（1.7%）例胎儿异常妊娠病例，包括孕早期扫描时发现的 474（27.6%）例、孕中期扫描时发现的 926（53.8%）例、以及妊娠晚期或产后发现的 320（18.6%）例。妊娠 11-13 周时发现所有受试者都患有肢端、前脑无裂、脑膨出、三尖瓣或肺动脉闭锁、五角肌、心脏异位、外淋巴结、腹裂和体柄异常，发现 50%以上的受试者患有开放性脊柱裂、左心发育不全综合征、房室间隔缺损、复合性心脏缺损、左房异构（心内解剖正常的下腔静脉中断）、下尿路梗阻、四肢缺失、胎儿畸形序列及致死性骨骼发育不良。妊娠 11-13 周在不足 10%的受试者中发现的常见异常包括脑室扩大、胼胝体发育不全、孤立性唇裂、先天性肺气道畸形、室间隔缺损、腹腔囊肿、单侧肾发育不全或多囊肾、肾积水、双肾、尿道下裂和足内翻。

结论：根据标准化方案进行的 11-13 周常规扫描，可以发现许多严重的非染色体胎儿异常。对孕早期扫描结果进行汇总统计是徒劳无益的，因为有些异常在任何情况下都可以检测出来，其他异常则无法检测（但有时又可以检测）。为尽量发现产前异常，有必要进行额外的孕中期和妊娠晚期扫描。

