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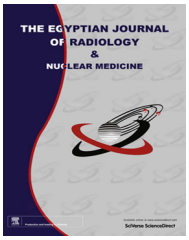

ORIGINAL ARTICLE

Abnormalities of fetal rib number and associated fetal anomalies using three dimensional ultrasonography

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KEYWORDS

Ribs;
Three-dimensional imaging;
Fetal ultrasonography;
Congenital abnormality

Abstract *Aim:* To determine incidence of abnormal number of fetal ribs and its association with other fetal anomalies using 3D ultrasonography.
Materials and methods: A prospective study conducted on 188 singleton pregnant women searching for fetal anomalies including the incidence of abnormal number of fetal ribs and other anomalies. Static 3D volumes with volume contrast imaging using spine map were used. Rendered images were displayed and the ribs were counted.
Results: 173 fetuses (92%) were having normal number of ribs. Fifteen fetuses (8%) were found to have abnormal number of ribs; ten fetuses (5.3%) had 11 ribs. On the other hand five fetuses (2.7%) had supernumerary 13 ribs. Eight fetuses (4.2%) were having abnormal number of ribs with no associated anomalies (isolated abnormal number). Seven fetuses (3.7%) in this study had associated anomalies.
Conclusion: Abnormal number of fetal ribs more to be an isolated finding (4.3%) but it may also be seen with other anomalies (3.7% in this study). 3DUS is useful for scanning the fetal ribs in the mid trimester of the pregnancy for early detection of associated genetic aberrations.

1. Introduction

Fetal malformations are variable regarding their types and severity. According to recent statistics, fetal anomalies occur in about 2–3% of the new born in the developed countries (1).

Fetal thoracic anomalies are relatively less common and most of them could be detected by the standard prenatal two dimensional (2D) ultrasound examinations especially after the recent technical improvements in 2D equipments and their color Doppler applications (2–3).

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A wide range of fetal rib abnormalities are present involving their shape, length and number in addition to fractures and unusual articulation of the ribs (4). The abnormal ribs may be an isolated entity or often a part of congenital disorder or other syndromes e.g. trisomy 21 with unilateral agenesis of the 12th rib (5–6). Ultrasound is still the method of choice and most often used in screening the anomalies of growing fetus, as it is cheap, available and non- invasive (7) The advent of three-dimensional ultrasound (3DUS) technology, allowed easier assessment of both morphological and pathological characteristics of fetal ribs in vivo. The whole body could be visualized and volume reconstruction could be done (8–10). On the other hand, the volume contrast imaging (VCI) technique used with 3D sonography had improved both bone and soft tissue contrast while the reformatting coronal plane has been applied to count the number of the Ribs (11–13).

2. Materials and methods

A prospective study was conducted on 188 consecutive singleton low risk pregnant women searching for fetal anomalies including the incidence of abnormal number of fetal ribs either isolated or co-incidence with other anomalies.

Research Ethics Committee approval and informed consent were obtained. Patients were referred in the period between Aug. 2012 and Sept. 2013 for either routine prenatal examination or for further assessment of fetal anomalies. All women volunteered to undergo 3DUS after being fully informed with the study protocol, technique and time of examination. Inclusion criteria were singleton pregnancy and a match between the ultrasound calculated fetal gestational age and the gestational age calculated based on the Last Menstrual Period (LMP) of the patient. Exclusion criteria were diabetic mothers, fetal growth retardation or over growth and oligohydramnios.

Table 1 The associated anomalies and their ratios.

System	Malformations *n* (%)	Type of anomalies
Urinary system	4 (40%)	MCDK (2) PUJO (1) P. urethral valve (1)
CNS	3 (30%)	Anencephaly (2) Ventriculomegaly (1)
GIT	1 (10%)	Jejunal atresia (1)
Others	2 (20%)	Clubfoot (1) Omphalocele (1)
Total	10	(10)

2.1. Fetal 3DUS examination

Examinations were performed during one of two periods scheduled for routine fetal anomaly scans, either at the early second trimester (14–16 weeks) and this was done in 98 patients or at 20–24 weeks of gestation which was done in 90 patients.

All examinations were performed by using a commercially available Ultrasonography scanner (Voluson 730 Pro; GE, Milwaukee, WI) equipped with a 4–8 MHz abdominal probe for 3-dimensional volume scanning which was used to assess the fetal ribs. Data sets of the fetal ribs were acquired either with static 3D volumes using the skeleton map or with volume contrast imaging using spine map. Static 3D volumes were taken with a sagittal sweep over the fetal thorax and abdomen and displayed in the antero-posterior projection. The acquisition time was 2–4 s per volume, and acquisition was performed only in the absence of fetal movement with the fetal back facing up toward the transducer. In order to obtain clear and obvious rendered images, the region of interest in the multiplanar images was reduced as much as possible and the threshold values were also adjusted accordingly. Three to four volume datasets were obtained for each spine. Both multiplanar and rendered images were displayed simultaneously and the ribs were counted on the rendered image only. Regarding the volume contrast imaging (VCI) thickness around 15 mm was used (varying according to gestational age). The spine was lined up in the sagittal plane, and the locator line was positioned along the spine. The VCI displayed with the spine map used a 100% maximum intensity mode with the low threshold set at 20.

Table 2 The relationship between abnormal number of ribs in (7) fetuses with associated anomalies.

	Number of ribs *N* (%)				
	Eleven ribs (5 patients) 2.7%		Thirteen ribs (2 patients) 1.1%		
	Bilateral (3 patients) 1.6%	Unilateral (2 patients) (1.1%)	Bilateral (2 patients) 1.1%	Unilateral (0 patients) 0%	
Anomalies					
(2) MCDK (Multi-cystic dysplastic kidney) – urinary		1 Unilateral MCDK	1 Bilateral MCDK		
(1) Pelvi-ureteric Junction obstruction (PUJO) – urinary	1				
(1) Posterior urethral valve – urinary	1				
(2) Anencephaly – (CNS)	1	1			
(1) Ventriculomegaly (CNS)			1		
(1) Jejunal atresia (GIT)	1				
(1) Clubfoot (others)			1		
(1) Omphalocele (others)	1				
Total	5	2	3		Total 10