CHALLENGES

IN SONOGRAPHIC DETECTION

OF FETAL STRUCTURAL ABNORMALITIES

AT THE 11–13 - WEEKS SCAN

-RESUMEE-

PHD CANDIDATE: DOMINIC ILIESCU

SCIENTIFIC COORDINATOR: PROF. DR. NICOLAE CERNEA

- 2011 –
Challenges in Sonographic Detection of Fetal Structural Abnormalities at the 11–13-week Scan

CONTENTS

INTRODUCTION

I. CONSIDERATIONS REGARDING FIRST TRIMESTER MORPHO-GENETIC ULTRASOUND EVALUATION

I.1. Is first trimester anomaly scan efficient?
   I.1.1. Heart assessment during first trimester
   I.1.2. Central nervous system early morphological evaluation

I.2. Time consuming?

I.3. Are contingent policies feasible? Markers for underlying abnormalities

I.4. Is fetal morphological and functional assessment during the first trimester safe?

I.5. Implications of the first trimester anomaly scan in the diagnostic of genetic abnormalities
   I.5.1. Importance of first trimester genetic screening
   I.5.2. Screening policies
   I.5.3. Screening in twin pregnancies
   I.5.4. Selective use of ultrasound or biochemistry within the first trimester
   I.5.5. Screening for aneuploidies other than trisomy 21 (Down syndrome)
   I.5.6. Timing of ultrasound and blood testing within the first trimester
   I.5.7. First-trimester screening followed by second-trimester scan

II. SECOND TRIMESTER ANOMALY SCAN

II.1. Efficiency of second trimester anomaly scan

II.2. Settings and protocol for second trimester anomaly detection
   II.2.1. Anatomical survey
   II.2.2. Extended basic cardiac examination and fetal echocardiogram
   II.2.3. CNS evaluation

II.3. Classification of structural fetal anomalies

I. METHODS

I.1. Reliability of first trimester structural abnormalities detection
   I.1.1. Procedures and the design of the study
   I.1.2. FIRST TRIMESTER ANOMALY SCAN PROTOCOLE

I.1.3. SECOND TRIMESTER ANOMALY SCAN PROTOCOLE

I.2. Accessibility to stored parameters of early neurosonography
Challenges in Sonographic Detection of Fetal Structural Abnormalities at the 11–13-week Scan

I.3. Feasibility of intracranial translucency (IT) assessment
   I.3.1. Repeatability and reproducibility of IT measurement
   I.3.2. Neurosonographic assessment of fetuses presenting abnormal IT
   I.3.3. Histological approach for sono-histological structural correlation

II. RESULTS
   II.1. Reliability of first trimester anomaly scan
      II.1.1. General considerations
      II.1.2. Genetical findings
      II.1.3. First trimester anomaly scan
      II.1.4. Follow-up findings
      II.1.5. Relation of fetal abnormalities with increased NT thickness
      II.1.6. Relation of fetal abnormalities with other markers
      II.1.7. Comparison between first trimester and subsequent examinations

II.2. Accessibility to stored parameters of early neurosonography

II.3. Feasibility of intracranial translucency assessment
   II.3.1. Repeatability and reproducibility of IT measurement
   II.3.2. Neurosonographic assessment of fetuses presenting abnormal IT
   II.3.3. Histological approach for sono-histological structural correlation

III. DISCUSSIONS
   III.1. Reliability of first trimester anomaly scan
      III.1.1. Overall detection rates first trimester vs. second trimester
      III.1.2. Importance of first trimester screening in severe abnormalities detection
      III.1.3. Disadvantages of a detailed protocol: time and storage
      III.1.4. Cost/efficiency analysis
      III.1.5. Preliminary conclusions
   III.2. Accessibility to stored parameters of early neurosonography

III.3. Feasibility of intracranial translucency assessment
   III.3.1. Repeatability and reproducibility of IT measurement
   III.3.2. Neurosonographic assessment of fetuses presenting abnormal IT
   III.3.3. Histological approach for sono-histological structural correlation

IV. CONCLUSIONS
Challenges in Sonographic Detection of Fetal Structural Abnormalities at the 11–13-week Scan

Key-words: ultrasound, first trimester, anomaly scan, malformations, genetic abnormalities

Objective
To assess the potential performance of the first trimester (FT) scan in the detection of fetal abnormalities using an extended protocol achievable with reasonable resources of time, personnel and US techniques and technologies already used in fetal diagnostic units.

Method
This was a prospective study from January 2009 to January 2011, involving two university centers – Craiova (Romania) and Athens (Greece). In both institutions the university’s Ethics Committee approved the research protocol presented below. Written informed consent was obtained before US examination.

First trimester evaluation
The study group consisted in consecutive 3283 unselected pregnant women examined in the prenatal units affiliated to the university hospitals involved. In the enrolled pregnant women we recorded maternal characteristics and medical history, then the ultrasound exam was performed at 12+0 to 13+6 GW, after previous appointment. The rationale for choosing this gestational age was the intention to implement in the screening protocol an extended study of the fetal heart, routinely performed transabdominally, with little supplementary resources involved (time, equipments, examination route). In our experience and as stated in previous research, satisfactory assessment of the heart in transabdominal route is achievable after 12 GW without significant supplementary time allocated. The gestational age was ascertained by measurement of the fetal crown–rump length (CRL) during the first trimester. The exclusion criteria were: ectopic and molar pregnancies. We decided not to exclude the chromosomal abnormal cases, as previous studies described that structural abnormalities other than FT genetic markers may lead to the diagnosis.

The evaluation aimed to assess in one session the genetic and morphologic parameters suitable for evaluation at the respective gestational age and established in the presented protocol (Table 1). However, in cases of incomplete visualization of the targeted structures, the women were reexamined after a short break or rescheduled after several days. Thirty minutes were proposed to be allocated for each examination; the evaluation was not interrupted if not completed within this time frame, in cases of unfavorable fetal position or when additional time was invested for proper documentation of fetal abnormalities. The cases with suspected abnormalities that could not be confirmed during the FT examination were invited to an early ST reassessment.

The examinations were performed by obstetricians with special interest in fetal medicine, with minimum 5 years of experience in prenatal US and qualified to practice 11- to 14-week scan according to Fetal Medicine Foundation (FMF) criteria.

Transabdominal sonography was performed using Voluson 730 Pro and Expert Medical Systems GE medical Systems, Kretztechnik, ZIPF, Austria US machine, equipped with C5–7-MHz curvilinear transducer. A transvaginal examination with C5–10-MHz curvilinear transducer was added only when necessary, in case of not satisfactory visualization of anatomical structures (unfavorable fetal position, unfriendly maternal conditions) or for better visualization of fetal abnormalities. The examiners involved in the study tried to minimize the fetal exposure time, using the lowest possible power output needed to obtain diagnostic information, following the ALARA principle (As Low As Reasonably Achievable). Consecutive to US evaluation, the genetic risk was calculated using The First Trimester Screening Programme, FMF, version 2.3.2 software. The FT sonographic markers were assessed according to the standard outlined by FMF - nuchal translucency thickness (NT), nasal bone (NB), ductus venosus (DV), tricuspid valve (TV), fronto-maxillary facial angle (FMFA). Those considering their risk to be higher than a 1/250 cut-off were offered invasive genetics recommendations for fetal karyotyping.

Follow-up
In all studied fetuses, a detailed anomaly scan was performed as routinely, at 17+ to 24+ GW (preferably and recommended at 18 to 22 GW). The ST anomaly scan followed the protocols proposed by the Clinical Standards Committee of International Society of Ultrasound in Obstetrics and Gynecology (ISUOG). The same capabilities in terms of equipments and personnel were used during ST evaluations. The rest of US evaluations were carried depending on the obstetrician’s recommendations. However, a wellbeing scan at 32–36 GW was routinely offered to all women and performed in 68.5% of the cases.
Whenever abnormalities were suspected at US examination, two experienced examiners studied the fetus to confirm the anomalies. After confirmation, appropriate counseling and management were provided by interdisciplinary team (obstetrician, genetician, neonatologist – pediatrician, pediatric surgeon). Termination of pregnancy (TOP) was offered to couples when chromosomal or morphological abnormalities were highly suspected by more than one examiner.

In all live fetuses a general clinical evaluation was performed by neonatal pediatricians; postnatal general US exam was performed, including echocardiography. The design of the study stated that the terminations and intrauterine demises cases should be examined by interdisciplinary teams of pathologists and obstetricians. If not confirmed by pathological or neonatal evaluation, the abnormal suspected cases were not taken into account.

**Discussions**

FT combined test have been demonstrated a useful screening tool for genetic syndromes and consecutively the FT US scan became a routine examination in most prenatal diagnostic centers. Its performance in structural abnormalities detection has been communicated in high-, medium- risk populations or unselected low-risk variable number of patients and compared to the ST anomaly scan effectiveness. We considered our study group characteristics’ corresponding to a low-risk pattern, as the severe malformations rate in our population was within the ranges of other studies performed in unselected low-risk groups.

**The efficiency of first trimester extended anomaly scan**

It has been shown that the efficiency of the routine anomaly scan varies widely between the studies performed both in early or mid-pregnancy. The analysis of technique and study designs reveals that in each gestational age, the extension of the investigational protocol is the most important factor in modulating the detection rate. Moreover, the use of similar basic check-lists at the FT and ST examinations revealed comparable anomaly detection rates in large population groups.

Considering these data, the design of our study was to screen a low-risk unselected population of FT pregnancies using an extended morphological protocol, expecting detection rates comparable with the efficiency of ST detailed structural assessment, at least for fetal major abnormalities. We thought that strong arguments are favoring this approach. One is that the technical requirements (involving examiners and US machines) for FT genetic markers assessment are also appropriate for a concomitant detailed structural evaluation, inspired from the ISUOG Guidelines regarding the standards for ST anomaly scan. Second, an extended protocol of heart investigation that can assess confidently the fetal heart anatomy in FT fetuses has been demonstrated as feasible with little investment in examination time (less than 10 min additional time) and training of the personnel. Third, early contingent markers as NT, DV, TV, cardiac axis, posterior brain complex, RNT, have been demonstrated to identify high-risk pregnancies for cardiac, neurological, facial or skeletal abnormalities.

It is impossible to implement in the FT protocol the entire ST extended evaluation of structures. Syngelaky et al pointed these limitations of the FT anomaly scan due to the later structural or physiologic development of some fetal structures. In our experience, other features of ST anomaly scan cannot be satisfactory visualized routinely or it would increase unacceptable the examination time (ex. lips integrity, atrial venous connections and appendices, pulmonary branching / short axis view, septo-aortic continuity, aortic arch branching). However, we believe that these limitations should not discourage the routine detailed FT anatomical evaluation because the unremarkable or “undetectable” anomalies do not constitute a significant part of lethal and severe fetal structural defects. Moreover, an extended protocol is very efficient in depicting the “potential detectable” fetal malformations as stated by Syngelaky et al, which in our opinion represent a larger group of severe abnormalities.

Although the FT scan contributed with 40% of the overall detected cases anomalies, its efficiency in detection of major structural defects is the most important argument in favor of this exploration. The large majority of lethal or severe anomalies 80.55% were discovered during the FT anomaly scan and more than two thirds 69.04%, of the anomalies detected during the FT were severe or lethal. Indeed we experienced similar detection rates for severe anomalies to the ones reported by literature obtained in the FT or ST detailed evaluation. Conversely, the ST anomaly scan contributed with the vast majority of minor/medium anomalies.
Challenges in Sonographic Detection of Fetal Structural Abnormalities at the 11–13-week Scan

It is hard to establish the real efficiency of the extended FT protocol. On one hand, some of the cases were detected as abnormal due to the use of an up-graded morphological protocol. On the other hand, consecutive to a better anatomical evaluation, supplementary abnormal features may be discovered before termination in malformed fetuses diagnosed with the basic protocol. Detailed information regarding the malformation(s) or the rest of fetal structure may prove useful to further counseling of parents or genetic assessments. In many centers, a detailed or interdisciplinary fetal evaluation is performed consecutive to the diagnosis of a malformation. However, frequently in general practice the termination of pregnancy is offered in FT suspected structural abnormalities with no recommendation for evaluation in specialized units.

Our analysis aimed to estimate the percentage of FT abnormal cases and the percentage of malformations detected due to the use of an extended protocol.

These facts underlines the necessity of an attentive and up-dated FT protocol of examination, that should take into consideration the recent described markers and techniques in order to obtain high detection rates.

**The role of contingent markers and color Doppler cardiac sweep**

The remarkable overall detection rate of the severe anomalies during the first trimester is sustained by the high detection rates obtained in the most frequently affected systems, as the central nervous system (CNS) and cardio-vascular system.

In our opinion, cardiac extended examination using color Doppler is of great use in achieving high detection rates. Even if the resolution and presets of US equipments are suitable nowadays for FT heart evaluation, most of gray-scale cardiac sweeps do not offer enough information to the examiners regarding the heart structures and function. All examiners participating in our study declared more confident heart anatomical features when using color Doppler. This is the main difference in examination protocol that led to high detection rates in other FT screening studies. Contrarily, most cases of cardiac defects were missed in the studies where the basic assessment of the fetal anatomy examination included the four-chamber view of the heart, as part of recording blood flow across the TV, but not the outflow tracts, or color Doppler visualization. In our experience, color Doppler cardiac sweep is not a time-consuming technique: the required time interval was similar to TV flow evaluation and the two techniques necessitate similar incidence, magnification and fetal quintescence time interval. The two assessments were in fact performed consecutively during examination, thus requiring little supplementary time allocated, while respecting the ALARA principles.

As it is generally accepted that the prevalence of major cardiac defects is higher in fetuses with increased NT thickness, early fetal echocardiography is commonly recommended in fetuses found with increased NT. We can easily observe that color Doppler mapping is a much more sensitive and specific screening tool for cardiac malformations as previously reported. We found cardiac abnormalities with normal appearance of gray-scale four-chamber view, normal TV and DV flows and normal NT. Interestingly, in previous research although the same US protocol was used in all patients, the detection rate of major cardiac and other anomalies was lower in the cases with normal NT than in the cases with increased NT. Possible explanations for this fact may be that the awareness of the operator is higher in high-risk cases, or the cardiac defects may be more severe when NT is increased. Regarding the new suggested morphological markers of posterior brain fossa, intracranial translucency (IT) was very sensitive for NTD and interestingly, it was found abnormal in all FT CNS major abnormalities. If confirmed in larger studies, it may prove a valuable tool for screening, with no supplementary time involved in examination, as it is easily evaluated in an essential plane of FT genetic ultrasonogram.

The assessment of RNT as a contingent marker for palate defect was very sensitive, but with low specificity, leading to a high rate of fals positive results, especially when visualization was poor (increased BMI, abdominal scarr). Consequently, it may lead to a high number of reevaluations for suspected facial clefts, but the false positive cases can be excluded by visualising the anterior palate in the transverse view of the face.

Although we presented the contribution of color cardiac sweep and some contingent markers that proved to be of great importance in larger pathologic study groups, our research did not gathered enough abnormal cases in order to statuate specific detection rates for general screening policy.

**Equipment, time and personnel resources involved**
Challenges in Sonographic Detection of Fetal Structural Abnormalities at the 11–13-week Scan

The same equipment previously allocated in our units for ST anomaly scan and FT genetic screening was used successfully to complete the FT morphologic assessment. No supplementary investments in were necessary as the capacities required (magnification, cineloop, 2D gray-scale and color Doppler high resolution) to evaluate accurately the morphological and functional aspect of small structures such as NT, NB, TV, DV were technically sufficient to assess the rest of the structures.

We did not encounter difficulties to use the same personnel already involved in FT / ST screening in our units. The examiners were able to extend their FT evaluation protocol, as they were familiar with the ST anomaly scan planes and parameters. However, a learning period of less than one week was necessary mostly to study the technical optimization of color Doppler flow presets in FT heart evaluation.

Detailed early anomaly scan may be argued because of supplementary time involved by the examination. A time limitation for the FT assessment should be established by each health-care system, considering the human and technical resources in relation with the addressability and the malformative risk in the population screened.

Cost / benefit considerations

As already demonstrated, accurate assessment of the FT morphology is efficient in depicting the large majority of severe anomalies. Based on the results of our study, we consider that the use of the FT extended assessment would significantly increase the detection rates, close to the ST efficiency, at least for severe and lethal abnormalities. The obvious advantage of early rather than late diagnosis of major abnormalities is that the parents are provided with the option of earlier and safer termination of pregnancy.

We should also be aware that the detailed protocol of examination involves supplementary resources. The increase of examination time is only about 10 minutes, but it usually represents half of the duration of basic FT evaluation. In the abnormal cases, highly specialized human resources (in FT scanning, echocardiography, pathologists specialized in early fetal autopsy) and sometimes high-resolution equipments are necessary for comprehensive morphological evaluation. It would be the best if such investigations and medical termination are carried in centers with special interest in fetal medicine. Even in these settings, certain structural abnormalities are unremarkable during the FT, thus early termination may prevent diagnosis of underlying condition and consecutively accurate counseling of the parents as to the risk of recurrence. However, this is not enough reason to delay the screening for fetal malformations at a later gestational age or to recommend the continuation of a severely affected pregnancy for the potential gain in fetal morphological evaluation.

Parents and national health care systems must be made aware that detailed second trimester scan is required for accurate diagnosis. Clearly, a wide range of abnormalities can be detected at 12 to 14 weeks and an important shift in the timing of fetal termination is achieved; but scanning at this age cannot replace the routine 16–22 week, as 19.4% of the severe anomalies and 81.1% of the mild/medium considered anomalies were detected during subsequent examinations. Health-care systems should establish if the early FT diagnosis of most major structural abnormalities is cost-effective, as the ST anomaly scan should not be replaced. Previous researches using inferior US equipment, a less extended protocol and subsequently with lower detection rates, communicated that FT anomaly scan is cost-efficient in terms of medical and economical expanses. Until the efficiency of the detailed FT protocol will be demonstrated in large groups, it is unlikely that the protocol will be incorporated into routine sonographic screening, but two alternative approaches may be considered.

One of the options is to reserve this examination for the subgroup of pregnancies with an increased risk for structural abnormalities, as in the cases with history of genetic or structural abnormalities or the cases with enlarged NT (knowing that they present an increased risk of severe cardiac abnormalities, lethal skeletal dysplasia and diaphragmatic hernia) (81). However, it is worth to mention that in our study group the vast majority of severe cases belonged in low-risk group pregnancies and a policy that offers an early anomaly scan only to women aged more than 35 years or with increased NT may seem discriminating, while to the younger ones or with normal NT this opportunity is not offered.

Another alternative is to confine FT evaluation in specialized, experienced and audited centers that performs high-quality both genetic and anomaly assessments, making the FT detailed protocol feasible and cost-efficient in large populational groups; this option would be optimal from the medical point of view, but less probable, as the number of first trimester screening providers is low anyway.
Challenges in Sonographic Detection of Fetal Structural Abnormalities at the 11–13-week Scan

Curriculum vitae

Pertinent experience and skills in the doctoral field include:

Perinatal Medicine, Education
- First trimester anomaly and genetic scan
- Second trimester anomaly scan

Curriculum vitae

Occupational fields

Work experience
Position held
9 years in obstetrics and gynaecology, 5 years in medical education
MD Obstetrics and Gynaecology, PhD, Teaching Assistant

Affiliation to Societies

ISUOG Member– International Society of Ultrasound in Obstetrics and Gynecology, from 2008;
FIGO affiliate member– International Federation of Gynecology and Obstetrics
EAPM Member– European Association of Perinatal Medicine, from 2008;

Education and training

Principal subjects/occupational skills covered

Dates and locations
Name and type of organisation providing education and training

MD Specialist Obstetrics and Gynecology, 22.10.2007, Ministry of Public Health, Romania, nr. 2097.
Certificate of competence in Ultrasound in Obstetrics and Gynecology, may, 2009, Bucharest University, Romania, Course Directors: Pelinescu-Onciul, Radu Vladareanu.


3D/4D ultrasound versus 2D ultrasound in contemporary medicine – Cluj Napoca, Romania, 28-30 may 2009, IAMU (International Academy of Medical Ultrasound ) and ARMP (Romanian Association of Perinatal Medicine), Course Directors: F. Stamatian, M. Wiechec.


Fetal echocardiography, ISUOG pre-congress course, Chicago, 26 August, 2008, Course Directors: Lindsey Allen, F. deVille.

Practical application of Doppler in obstetrics, ISUOG pre-congress course, Chicago, 26 August, 2008.

3D/4D ultrasound versus 2D ultrasound in contemporary medicine – Cluj Napoca, Romania, 22-24 may 2008, IAMU (International Academy of Medical Ultrasound ) and ARMP (Romanian Association of Perinatal Medicine).

Cambridge Basic Colposcopy Course, BSCCP approved (The British Society of Colposcopy and Cervical), 15-16 may 2008, Addenbrooke’s Hospital, Cambridge.


Ultrasound Examination at 18 – 23 Weeks, Ultrasound examination in Fetal Cardiology, Cervical
Challenges in Sonographic Detection of Fetal Structural Abnormalities at the 11–13-week Scan


FMF Certificates of competence in the 11-13 weeks scan, cervical assessment, Doppler ultrasound

ISUOG (International Society of Ultrasound in Obstetrics and Gynecology)

Prize for Best Oral Presentation at „6th ISUOG Outreach Course and Scientific Congress”, Singapore (Sentosa Island), 14 – 17 April, 2010.

Ian Donald School, Greek Branch, 5th Advanced Course of Ultrasound in Obstetrics and Gynecology”,
topic covered “Intrapartum ultrasonography”
10-11 of December 2011, Athens, Goulandris Natural History Museum

Ultrasound examination in genetic screening,
11-12 November 2010, University of Medicine and Pharmacy Craiova, Medical College Romania.

Importance of Colposcopy in cervical lesions,
27.01.2009 – 20.02.2009, University of Medicine and Pharmacy Craiova, Medical College Romania.

Cervical Pathology,
9-17.02.2009, University of Medicine and Pharmacy Craiova, Romania.

Editor OMICS Group. Emergency Medicine

Ultrasound in Obstetrics and Gynecology, Impact Factor 3.163; ISI Journal Citation Reports
Ranking:2010: 3/29 (Acoustics); 9/75 (Obstetrics & Gynecology); 25/111 (Radiology Nuclear Medicine & Medical Imaging)

“SCREENING MARKERS AND EARLY MANAGEMENT IN DETECTION OF FETAL CHROMOSOMAL ABNORMALITIES”
Contract registered nr. 3451/2007, 4 years duration.
Project manager - Prof. Nicolae Cernea.

“IMPORTANCE OF MORPHOLOGICAL CHANGES AT THE NIDATIONAL SITUS IN ABORTIVE CONDITION”
Contract registered nr. 2104/2007. 4 years duration.
Project manager - Prof. Liliana Novac.

„DIAGNOSTIC AND MANAGEMENT CRITERIA IN CERVICAL INFECTION WITH HUMAN PAPILOMA VIRUSES”
Contract registered nr. 119 (P4) / 2006; duration: 3 ani
Project manager: Anton Gabiela (National Virology Institute Stefan S. Nicolau, Bucharest).
Challenges in Sonographic Detection of Fetal Structural Abnormalities at the 11–13-week Scan


9. Feasibility of neurosonogram adjusted with recently described markers at the 11-13 +6 week scan, D. Iliescu, Ș. Tudorache, A. Comanescu, R. Căpătănescu, M. Manolea, M. Novac, N. Cernea, L. Novac, Advance in Perinatal Medicine, Conference Proceedings Citation Index, a Web of Science® database, pg. 143-148; Conference Proceedings Citation Index, a Web of Science® database, ISBN 978-88-6521-027-7; 2010


12. Amniocentesis, an invasive procedure. Can we minimize the risk ? D. Iliescu, L. Novac, Ș. Tudorache, A. Comanescu, R. Căpătănescu, M. Manolea, M. Novac, N. Cernea, Advance in Perinatal Medicine, Conference Proceedings Citation Index, a Web of Science® database, pg. 143-148; Conference Proceedings Citation Index, a Web of Science® database, ISBN 978-88-6521-027-7; 2010


Challenges in Sonographic Detection of Fetal Structural Abnormalities at the 11–13-week Scan


19. Correlations Between Chorial Villositary Vasculogenesis and Ultrasound Morpho-Functional Markers of The Trofoblast In The Normal Pregnancy, Liliana Novac, Mihaela Niculescu, D. Iliescu, Maria Manolea, Ştefania Tudorache, R. Căpitanescu, N. Cernea, Current Health Sciences Journal, vol.35 nr.4, 2009, 244-250, ISSN 2087-0656.
Challenges in Sonographic Detection of Fetal Structural Abnormalities at the 11–13-week Scan


12. Assessment of screening for cardiac anomalies during the triple test - experts vs. training sonographers, A Comanescu, N Cernea, S Tudorache, D Iliescu, R Capitanescu, C. Oprea - EUROSON
Challenges in Sonographic Detection of Fetal Structural Abnormalities at the 11–13-week Scan


Challenges in Sonographic Detection of Fetal Structural Abnormalities at the 11–13-week Scan


27. Pathological correlations of nuchal translucency thickness measurements, Iliescu D., Cernea N., Tudorache S., „7th World Congress in Fetal Medicine” 22–26/06/2008, Sorrento, Italy, Fetal Medicine Foundation.


Published books


Additional information

Member of University Senate and Professorial Council since 2007