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ORIGINAL ARTICLE

Fetal anatomy screening at 11–14 weeks' ultrasonography, comparison of TAUSG and TVUSG

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ABSTRACT

Objective: This study aimed to evaluate the success of fetal anatomy screening at 11–14 weeks' ultrasonography and also to compare the superiority by performing fetal anatomy screening for both transabdominal and transvaginal probes.

Material and Methods: A total of 73 patients who applied to Istanbul University, Istanbul Faculty of Medicine, Department of Obstetrics and Gynecology Perinatology Department for 11–14 weeks of screening tests between May 2018 and December 2018 were evaluated. It was designed as a prospective, single-center clinical study. Fetal anatomical structures were determined by reference to the guideline published by the International Society of Ultrasound in Obstetrics and Gynecology for first-trimester ultrasound and were evaluated as normal, abnormal, and unevaluated both for transabdominal and transvaginal probes.

Results: Nasal bone and nuchal translucency were found to be seen at a higher rate in transabdominal ultrasound. The heart, kidneys, and bladder were significantly higher in transvaginal ultrasound.

Conclusion: In the 11–14-week ultrasonography, the anatomical evaluation of the fetus is possible in addition to the screening test, and transvaginal ultrasound is a complement to the transabdominal ultrasound evaluation. All anomalies cannot be detected in 11–14 weeks of ultrasonography and it is not appropriate to replace the ultrasonography of 18–23 weeks. The evaluation should be completed with transvaginal ultrasound examination when suspicion of anomaly occurs, some structures with abdominal ultrasound cannot be visualized, or when image quality is insufficient due to obesity.

Keywords: Fetal anatomy screening, transvaginal anatomy screening, 11–14 weeks' ultrasonography.

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INTRODUCTION

Routine ultrasound examination has become a part of almost every visit of obstetric patient evaluation with easier access nowadays.

Obstetric ultrasonographic evaluation; it can be performed for different indications from the diagnosis of pregnancy to delivery. While fetal anomaly screening is indicated as an indication for the evaluation of major anomalies in the first trimester, it is the main component of the second-trimester ultrasonography.[1]

Anomaly screening of the fetus in the first trimester is an indication for first-trimester ultrasound, especially in high-risk pregnant women.

However, even with current technologies; most anomalies that can be detected in the second-trimester ultrasound cannot be detected in the first-trimester ultrasound. While some major anomalies can be detected more easily in the first-trimester ultrasound, the detection rates of more specific anomalies are quite low. In a prospective study conducted by Syngelaki et al.[2] in 2011, 45191 pregnancies were evaluated, 11–14-week ultrasonography, second-trimester ultrasonography, and postnatal newborn examinations were performed on the patients and records were kept. For 11–14 weeks of ultrasonography, some anomalies are always detectable; some are concluded as potentially detectable. Potential detectability has been associated with increased Nuchal translucency (NT), phenotypic expression of the anomaly according to the gestational week, and being targeted during ultrasound. Although the importance of first-trimester anomaly screening is gradually increasing in the light of studies, it does not seem reliable to replace fetal anomaly screening in 11–14 weeks' ultrasonography with anomaly screening in second-trimester ultrasonography, since some anomalies can be diagnosed in later weeks.

Structural anomalies of the fetus complicate 2–3% of all pregnancies.[3,4] Prenatal anomaly screening; With newer ultrasound machines with high-frequency transducers and a better understanding of the developmental anatomy of the fetus, it has gradually begun to be transferred from the second trimester to the first trimester. First-trimester evaluation of fetal anatomy and detection of abnormalities began with the emergence of effective transvaginal probes in the late 1980s and early 1990s.[5,6] Compared to transabdominal probes, higher-frequency transvaginal probes can obtain images with better resolution in anatomy examination. Since the TV probe is located closer to the pelvis, there is no need for deep penetration from the abdominal wall, adipose tissue, intestinal loops. Especially when the position of the fetus is not suitable, in cases where adequate images cannot be obtained with the transabdominal probe due to reasons such as thick subcutaneous fat tissue or abdominal scar tissue, in the presence of uterine position or accompanying lesions such as fibroids, adnexal mass, use of abdominal and vaginal probes as complementary to each other facilitates full anatomical evaluation.[7]

Advantages of fetal anomaly screening in the first trimester; early recognition/exclusion of major anomalies, providing information to risky pregnancies in the early period, early genetic counseling, and if appropriate, earlier and easier termination of pregnancy. This can reduce repetitive ultrasound examinations and potential health-care costs.

The sensitivity of sonography for fetal anomaly screening varies depending on factors such as gestational age, maternal habitus, obesity, fetal position, device characteristics, examination type, operator's ability, and specific anomaly. Maternal obesity alone is associated with a 20% decrease in fetal anomaly detection rate regardless of the type of examination.[8] Abdominal obesity limits the technical quality of ultrasound examination. In a study conducted by Dashe et al.[8] in 2009, when patients with normal body mass index (BMI) were compared with obese patients, the rate of anomaly was found to be 20% lower in obese patients.

To improve the image quality, when the patient is in the side-lying position, the probe can be placed from the side rather than the midline, where the abdominal fat tissue is the thickest, or a transvaginal probe can be used. Although anatomical scanning of the fetus for malformations is typically performed at 18–20 weeks, performing a transabdominal examination later in gestation (20–22 weeks) may improve visualization of the anatomy in obese patients, or fetal anatomy can be more effectively evaluated with transvaginal ultrasound in the early weeks.[9]

In our study, we aimed to conduct a prospective study evaluating the superiority of transabdominal and transvaginal probes over each other and the success of anomaly scanning performed at 11–14 weeks by performing fetal anatomy scanning with both transabdominal and transvaginal probes, in addition to the parameters that we routinely evaluate at 11–14 weeks of ultrasonography.

MATERIAL AND METHODS

Our study was designed as a prospective, single-center clinical study. Before starting the study, approval was obtained from the İstanbul Faculty of Medicine Clinical Research Ethics Committee (Ethics committee number: 22). Between May 2018 and December 2018, a total of 73 patients who applied to Istanbul University, Istanbul Medical Faculty, Gynecology and Obstetrics Clinic, Perinatology Department for 11–14 weeks of screening tests were evaluated. This study was conducted in accordance with the Declaration of Helsinki. Consent was obtained from all pregnant women, which was accepted by the ethics committee, showing that they were informed about the content of the study and participated voluntarily.

Pregnant women from all age groups who had a singleton pregnancy and were referred to the Perinatology Department for the 11–14-week screening test were included in the study. Exclusion criteria from the study were defined as not accepting transvaginal examination, having multiple pregnancies and having previously diagnosed anomaly. The evaluation of the patients was made by a single physician in the presence of perinatology minor assistants using the Hitachi Aloka Arietta 850 ultrasound device. While evaluating the patients, patient follow-up forms including patient characteristics, obstetric history, biometric measurements, and evaluation of anatomical structures were filled.

Age, height, weight, last menstrual period, previous obstetric history, and previous abdominal surgery history were questioned in the antenatal characteristics of the pregnant women. Gestational age was calculated according to the 1st day of the past menstrual period, early ultrasound image, and CRL measurement.

The evaluation of the patients started from the transabdominal route; first, routine biometric measurements were taken and fetal heart rate was recorded. Then, the anatomy scan was started, and the structures were evaluated as normal/abnormal or not evaluated by keeping 10 min for the transabdominal route and 10 min for the transvaginal route.

The anatomical structures of the evaluated fetus were determined with reference to the guideline published by The International Society of Ultrasound in Obstetrics and Gynecology for the first-trimester ultrasound. These structures are intracranial butterfly image, falx, upper lip, lenses, profile, nasal bone, vertebra axial and longitudinal and skin integrity on the vertebra, four chambers in the heart, stomach pocket, kidneys, bladder, three-vessel cord, diaphragm defect, cord insertion, upper extremity bone counts, finger counts in hands, arm-hand orientation, lower extremity bone counts, finger counts in feet, leg-foot orientation. In addition to these parameters, great vessel outflows in the heart, presence of ductus venosus and ductus venosus Doppler application, and tricuspid regurgitation were evaluated. Anatomy evaluation was started from the appropriate region according to the position of the fetus, and a routine sequence was not followed. After the end of the ultrasound examination, all patients were referred to the laboratory for blood donation for the biochemical parameters of the screening test (free Beta-hCG, PAPP-A).

Axial sections were taken in intracranial structures and the presence of symmetrical choroid plexuses and lateral ventricles (butterfly image) and the integrity and presence of the falx in the middle were recorded as evaluated/not evaluated.

In the evaluation of the upper lip, its integrity was evaluated with coronal and transverse sections while the fetus was facing the probe. If the ideal image was obtained, it was recorded as evaluated/not evaluated by looking at the echogenicity and integrity of the upper lip.

The profile was evaluated when the fetus was in the supine midsagittal position and the chin measurements were taken into consideration. Calcification of the nasal bone in this section was recorded as assessed if each was seen, noting the presence of three lines (nasal bone, overlying skin, and nasal tip). Otherwise, it was recorded as not evaluated.

It was recorded as evaluated/not evaluated by looking at the hyperechoic images of the lenses in both eyeballs in the axial and coronal planes.

While evaluating the vertebrae, longitudinal and axial sections were taken and the alignment of the vertebrae from the neck to the sacrum was followed, and it was recorded as evaluated/not evaluated by looking at the skin integrity on the vertebra in the position of the fetus without contact with the amniotic membrane.

In echo mode, the heart was taken at high magnification by placing its apex on the top of the screen, and the presence of two symmetrical atriums and ventricles was evaluated, and Doppler flow was applied to the tricuspid valve in this plane to see if there was tricuspid regurgitation. By angling the probe from the four-chamber plan, the exits of the pulmonary artery from the right ventricle and the aorta from the left ventricle were followed. Each parameter was recorded as evaluated/not evaluated by checking whether there were echogenicities such as stomach pocket, liver, intestinal loops in the thorax, and the integrity of the diaphragm in the coronal plane.

Table 1: Demographic characteristics of the patients (n=73)

	Average±SD	Min–Max
Age	30.12±2.12	18–46
Number of gravida	3±1.41	1–5
Body mass index (BMI)	24.5±2.12	17–41

SD: Standard deviation; Min: Minimum; Max: Maximum.

In the abdominal examination, the presence of the gastric pocket in the axial section was recorded as evaluated/not evaluated by looking at its position with the heart. It was noted that whether there was an abdominal wall defect was evaluated by looking at the cord insertion site in the sagittal or axial planes or not.

It was recorded as evaluated/not evaluated by looking at the presence of echogenicity in the paraspinal areas in the coronal and axial sections of the kidney. The presence of bladder echogenicity in the axial sections at the pelvis level of the fetus, and the presence of bilateral umbilical artery traces around the bladder in colored flow Doppler were evaluated as evaluated/not evaluated.

In the extremity evaluation, longitudinal sections were taken for each of the four extremities and the presence of single bone in the proximal and double bone in the distal was examined. If the hands can be detected in the open position, the number of fingers, if the feet can be viewed from the soles, the number of toes was evaluated, and each parameter was recorded as evaluated/not evaluated.

The presence of the ductus venosus was evaluated/not evaluated by following the trace of the umbilical vein from the entrance to the abdomen when the fetus was in the supine midsagittal position, by looking at the turbulent flow monitoring when colored Doppler flow was applied on it, and by applying Doppler if applicable.

Statistical Package for the Social Sciences 20.0 program was used for statistical analysis. When evaluating study data, descriptive statistics are presented in terms of mean, median, standard deviation, percentage, and min max. Categorical data were compared with Chi-square, McNemar, or Fisher's exact. Means were evaluated with the t-test and only the numbers were evaluated with the Mann–Whitney U test. Statistical significance was accepted as $p<0.05$.

RESULTS

In our study, in which a total of 73 patients were included; the mean age of the patients was 30.12±2.12 (between 18 and 46). The average number of gravida in the obstetric history of pregnant women is 3±1.41 (between 1 and 5). The mean BMI of the patients was 24.5±2.12 (between 17 and 41) (Table 1).

Nasal bone imaging could be evaluated in 72 (98.5%) patients on transabdominal ultrasound, but could not be evaluated in 1 (1.5%) patient. In transvaginal ultrasound, it could be evaluated in 53 (72.6%) patients, but not in 20 (27.4%) patients, and a statistically significant difference was found (p=0.00). (Table 2)

Table 2: Comparison of detection rates between two groups (n=73)

	Transabdominal ultrasonography				Transvajinal ultrasonography				p
	Evaluated		Not evaluated		Evaluated		Not evaluated		
	n	%	n	%	n	%	n	%	
Upper lift	24	32.9	49	67.1	29	39.7	44	60.3	0.383
Profile	69	94.5	4	5.5	61	83.5	12	16.5	0.057
Nasal bone	72	98.5	1	1.5	53	72.6	20	27.4	**0.00***
Nuchal translucency (NT)	69	94.5	4	5.5	42	57.5	31	42.5	**0.00***
Lenses	68	93.2	5	6.8	66	90.4	7	9.6	0.754
Skin integrity on vertebra	67	91.8	6	8.2	67	91.8	6	8.2	1.0
Four chamber in heart	54	74	19	26	65	89	8	11	**0.043***
Tricuspid regurgitation	49	67.1	24	32.9	61	83.5	12	16.5	0.052
Kidneys	49	67.1	24	32.9	66	90.4	7	9.6	**0.002***
Upper extremity bones	73	100	0	0	72	98.5	1	1.5	1.0
Lower extremity bones	73	100	0	0	71		2	2.7	0.5
Finger counts in hands	65	89	8	11	60	82.2	13	17.8	0.302
Finger counts in feet	31	42.5	42	57.5	34	46.5	39	53.5	0.728
Three vessel cord	62	84.9	11	15.1	67	91.8	6	8.2	0.332
Bladder	58	79.5	15	20.5	68	93.2	5	6.8	**0.031***
Presence of DV	67	91.8	6	8.2	62	84.9	11	15.1	0.332
DV doppler	63	86.3	10	13.7	51	69.9	22	30.1	0.031
Stomach pocket	72	98.5	1	1.5	73	100	0	0	1.0
Diaphragm	70		3	4.1	71		2	2.7	1.0
Cord insertion	71		2	2.7	72	98.5	1	1.5	1.0
Intracranial butterfly image	73	100	0	0	71		2	2.7	0.5
Gender	53	72.6	20	27.4	52	71.2	21	28.8	1.0

DV: Ductus venosus; *: Statistically significant difference.

NT could be evaluated in 69 (94.5%) patients on transabdominal ultrasound, but could not be evaluated in 4 (5.5%) patients. In transvaginal ultrasound, it could be evaluated in 42 (57.5%) patients, but it could not be evaluated in 31 (42.5%) patients, and a statistically significant difference was found. (p=0.00) (Table 2)

Heart four-chamber imaging could be evaluated in 54 (74%) patients in transabdominal ultrasound, but could not be evaluated in 19 (26%) patients. In the transvaginal ultrasound, it could be evaluated in 65 (89%) patients, but it could not be evaluated in 8 (11%) patients, and a statistically significant difference was found. (p=0.043) (Table 2)

Imaging of the kidneys could be evaluated in 49 (67.1%) patients on transabdominal ultrasound, but could not be evaluated in 24 (32.9%) patients. In transvaginal ultrasound, it could be evaluated in 66 (90.4%) patients, but it could not be evaluated in 7 (9.6%) patients, and a statistically significant difference was found (p=0.002). (Table 2)

Bladder imaging could be evaluated in 58 (79.5%) patients on transabdominal ultrasound, but could not be evaluated in 15 (20.5%) patients. In transvaginal ultrasound, it could be evaluated in 68 (93.2%) patients, but it could not be evaluated in 5 (6.8%) patients, and a statistically significant difference was found (p=0.031) (Table 2)

The presence of the ductus venosus could be evaluated in 67 (91.8%) patients on transabdominal ultrasound, but could not be evaluated in 6 (8.2%) patients. In transvaginal ultrasound, it could be evaluated in 62 (84.9%) patients, and it could not be evaluated in 11 (15.1%) patients. There was no statistically significant difference between the two ultrasounds for the evaluation of the ductus venosus (p>0.05). Ductus venosus Doppler could be evaluated in 63 (86.3%) patients on transabdominal ultrasound, but could not be evaluated in 10 (13.7%) patients. In transvaginal ultrasound, it could be evaluated in 51 (69.9%) patients, but it could not be evaluated in 22 (30.1%) patients, and a statistically significant difference was found (p=0.031). (Table 2)

DISCUSSION

In recent years, significant changes have occurred in the targets followed in first-trimester ultrasonography. Thanks to improvements in resolution and image imaging, it is increasingly aimed to diagnose anomalies in the first trimester. Anatomical evaluation of the fetus in the first trimester emerged with the introduction of effective transvaginal probes in the late 1980s and early 1990s.[10,11] Advantages of fetal anomaly screening in the first trimester; early recognition/exclusion of major anomalies, early reassurance to risky pregnancies, early genetic counseling, and earlier and easier termination of pregnancy if appropriate. This can reduce repetitive ultrasound examinations and potential healthcare costs. Some studies have also shown that parents prefer to learn about fetal problems as early as possible.[12,13]

The first prospective study comparing transabdominal and transvaginal ultrasound in fetal anomaly screening in the first trimester was published in 1991 by Achiron and Tadmor.[14] The anatomy scan of the fetus included the head, spine, heart, abdominal wall, stomach, kidneys, bladder, and extremities. The targeted complete anatomical evaluation with transabdominal ultrasound was 50% at 9–11 weeks, 85% at 12–13 weeks, while it was 70% at 9–11 weeks and 95% at 12–13 weeks with transvaginal ultrasound.

In a study published by Souka et al.[15] in 2006, they concluded that a detailed and structural examination of the anatomy of the fetus at 11–14 weeks of screening can detect 50% of major structural defects in low-risk pregnancies. The sensitivity of early anatomical examination was 50%, and the sensitivity of routine screening in the second trimester was reported as 92.8%. In 2007, in the publication of Dane et al.,[16] 1290 cases, 24 (1.86%) fetuses with anomalies were found by scanning the first and second trimesters. Seventeen of them were diagnosed in the first trimester, and they reported a sensitivity of 70% in the detection of major structural anomalies in the 11–14-week screening. In the current article of Jose A. Sainz et al.,[17] published in the Journal Maternal Fetal Neonatal Medicine in 2018, in which 512 pregnancies were evaluated, they found the sensitivity of early anatomy scan of the fetus to be 83.3% with a high detection rate of congenital heart diseases. They also identified technical features in the morphological assessment of the premature fetus that affect the ability to obtain a complete anatomical assessment. In this prospective study, in which all pregnant women were evaluated by transabdominal ultrasound, the features found to be statistically significant were BMI, scanning time, estimated fetal weight, and the quality of the scan. It was reported that the rate of complete assessment decreased as the BMI increased and the screening time increased, while the rate of complete assessment increased significantly as the estimated fetal weight increased.

In a prospective study conducted by Den Hollander et al.,[18] a total of 101 pregnancies at risk of anomaly were evaluated and all patients were examined with a transabdominal probe, but in the presence of suspected cardiac anomaly or in cases where the image quality was not sufficient with the transabdominal probe, the evaluation was completed with the transvaginal probe. All pregnancies were at 18–21 weeks, in some cases, she was screened again at 30–32 weeks of gestation. One or more anomalies were detected in 11 fetuses in total, 9 (82%) of them were diagnosed at 11–14 weeks of screening. The normal development could be demonstrated in 90% (90/101) of fetuses and it was confirmed after delivery.

In another study that prospectively evaluated 1144 singleton pregnancies at 11–14 weeks, full anatomical evaluation could be performed in 48% of fetuses, while this rate was reported as 86% for non-cardiac anatomy. It was found that the addition of transvaginal ultrasound to the examination increased the successful examination rate from 72% to 86%, and it was also found that transvaginal ultrasound was particularly helpful in the evaluation of the face, kidney, and bladder.[19] Similarly, in our study, in addition to kidney and bladder evaluation with transvaginal ultrasound, heart four-chamber imaging was found to be more successful. Another study supporting this was published in 2002 by Haak et al.[20] In this study, while the full cardiac evaluation was 20% at the 11th gestational week, it was stated as 92% at the 13th gestational week and the reason for this increased success; it has been shown as the use of high-frequency transvaginal probes in addition to increasing gestational week. Due to this successful evaluation, it has been recommended to perform a detailed echocardiographic examination in the early weeks for pregnant women at risk of cardiac anomaly and fetuses with increased NT. In another prospective study, published in 2010, in which 2876 pregnant women were evaluated over 5 years, the fetal anatomy scan at 13–14 weeks of gestation was first started with transabdominal ultrasound and if a complete evaluation could not be made, the pregnant women who could be completed with transvaginal ultrasound and followed up were re-evaluated with second-trimester ultrasound. They concluded that transvaginal ultrasound was significantly better in the evaluation of the cranium, spine, stomach, kidney, bladder, and extremities in the first-trimester screening.[21]

In our study, bladder imaging was evaluated in 79.5% of patients in transabdominal ultrasound and in 93.2% of patients in transvaginal ultrasound. In a prospective study published in 1996, supporting our results, it was reported that the fetal bladder could be seen at a rate of 88% at the 12th gestational week and 92%–100% at the 13th gestational week with transvaginal ultrasound.[22] The other structure was found to be kidney. The imaging of the kidneys was 67.1% in transabdominal ultrasound, and 90.4% in transvaginal ultrasound. In the same study, it was reported that the kidneys of the fetus could be seen with transvaginal ultrasound at a rate of 86–99% at the 12th week of pregnancy and 92–99% at the 13th week of pregnancy.[22]

In a two-center prospective study published by Iliescu et al.[7] in 2013, 5472 pregnancies were included and a full anatomical evaluation was performed, starting with the transabdominal route first and performing transvaginal ultrasound when necessary. Transvaginal examination was required in 7.8% of the patients (n=427) to complete the anomaly screening in the first trimester. The reasons for this are mostly inappropriate fetal position, as well as a high BMI, retroverted uterus, fibroids, or the presence of abdominal scar tissue. The time required to complete the anatomical evaluation was found to be between 18 and 52 min (mean: 34).

Since we limited our patient evaluation time to 10 min each for the transabdominal and transvaginal routes, we may have recorded some structures that could be seen as not evaluated. Especially when the fetal position is not suitable to capture the appropriate sections within 10 min, the number of evaluated parameters may remain below normal. Therefore, in cases where there is no time constraint, it can be thought that better rates of anatomy scanning may be possible.

The limitations of the study can be shown as the small number of patients who could be included in the study, since most of the patients who applied for the 11–14 weeks screening test during the study period did not accept the transvaginal ultrasound evaluation. In our perinatology unit, where we performed our study, the time limitation due to the daily number of patients limits the evaluation of some structures.

CONCLUSION

In our study, it was emphasized that in addition to the screening test at 11–14 weeks of ultrasonography, anatomical evaluation of the fetus is possible and that transvaginal ultrasound is a complement to the transabdominal ultrasound evaluation. With the opportunities provided by today's technology, early anatomy scanning can be performed successfully and provides the opportunity to diagnose many fetal anomalies early. Especially in the high-risk patient population, early anatomy screening and early reassurance provide early genetic counseling and, if appropriate, earlier and easier termination of pregnancy, which can reduce repetitive ultrasound examinations and potential health expenditures. However, as studies have shown, not all anomalies can be detected at 11–14 weeks of ultrasound and it is unlikely to replace 18–23 weeks of ultrasonography. In cases where anomaly is suspected by evaluating the anatomy of the fetus with transabdominal ultrasound, in cases where some structures cannot be visualized with abdominal ultrasound, or when the image quality is insufficient due to obesity, the evaluation should be completed with transvaginal ultrasound examination.

Statement

Ethics Committee Approval: The İstanbul Faculty of Medicine Clinical Research Ethics Committee granted approval for this study (date: 28.12.2018, number: 22).

Informed Consent: Written informed consent was obtained from patients who participated in this study.

Peer-review: Externally peer-reviewed.

Author Contributions: Concept – İK, GK, LU, AY, DK; Design – İK, GK, LU, AY, DK; Supervision – İK, GK, LU, AY, DK; Resource – İK, GK, LU, AY, DK; Materials – İK, GK, LU, AY, DK; Data Collection and/or Processing – İK, GK, LU, AY, DK; Analysis and/or Interpretation – İK, GK, LU, AY, DK; Literature Search – İK, GK, LU; Writing – İK, GK, LU; Critical Reviews – İK, GK, LU.

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