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Utility Of Transvaginal Sonography With Extended Examination For Fetal Anatomical Survey During 11-13+6 Weeks Of Pregnancy

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ABSTRACT:
Introduction: *The 11–14 week period of pregnancy is a crucial window for detailed fetal anatomical assessment, as major organ systems begin to form, making it ideal for early detection of congenital anomalies through ultrasound. Technological advancements, particularly in high-resolution transvaginal scanning, have greatly enhanced the accuracy of first-trimester evaluations, making early ultrasound a key tool in prenatal care for diagnosing abnormalities, guiding parental counseling, and improving pregnancy outcomes.*
Methods: *This is prospective analytical study conducted at the Department of Obstetrics and Gynecology, Adichunchanagiri Institute of Medical Sciences, Adichunchanagiri University, B G Nagara, Mandya, Karnataka, India for duration of 18 months from May 2023 to December 2024, comprising of 200 subjects.*
Results: *The transvaginal scan seems to be slightly better at visualizing most body parts compared to the transabdominal scan, especially for the face, spine, kidneys, and bladder. Transvaginal scans generally provide better visualization for most structures in smaller CRL ranges compared to transabdominal scans. a total of 3 cases of unossified nasal bone and 5 cases of fetal anomalies(4%), i.e. 1 case of right club foot, 1 case of cystic hygroma, 1 case of anencephaly, 1 case of acrania-anencephaly sequence and 1 case of acrania- exencephaly sequence were identified during study.*
Conclusion: *While both TAS and transvaginal ultrasound (TVS) are effective in visualizing fetal structures, TVS offers slightly better detection of key anatomical features and serves as a valuable complementary tool, especially when TAS is limited.*
Keywords: *first trimester scan, USG, Fetal anatomy, 11to 13+6 weeks, TVS, TAS*

INTRODUCTION:

The early stages of pregnancy, particularly between weeks 11 and 14, are critical for fetal development and maternal health. During this period, prenatal care increasingly utilizes advanced imaging technologies, especially ultrasound (USG), to monitor fetal growth and detect potential anomalies. This time frame is particularly significant because major organ systems begin to form, making it an optimal window for detailed anatomical assessment [1].

Ultrasound plays a vital role in early fetal evaluation. It aids in the early detection of congenital defects, significantly influencing both pregnancy management and the long-term health of the child[2]. Key structures assessed during this scan include the heart, brain, kidneys, and spine[3]. One of the most important components of the scan is the measurement of nuchal translucency, which helps evaluate the risk of chromosomal abnormalities such as Down syndrome. Elevated levels can also indicate structural issues and genetic syndromes, thereby enhancing genetic counseling and decision-making for expectant parents[4-5].

Historically, prenatal diagnosis focused more on the second trimester, using maternal serum screening and anatomical scans. However, technological advancements have shifted this focus toward the first trimester. By 12 weeks, over 80% of common anatomical abnormalities can be detected, making the 11–14 week scan a vital tool in early screening protocols[6-7]. The effectiveness of ultrasound at this stage depends on several factors: the resolution of the ultrasound probe, the skill of the sonographer, and their understanding of normal and abnormal fetal development[8]. Previously, transabdominal ultrasound had limitations in early detection due to poor resolution. However, the advent of high-resolution transvaginal scanning (TVS) has significantly improved early visualization, especially in high-risk pregnancies and in cases where abdominal wall thickness impedes clear imaging, such as in obese patients[9-10]. Thus, the 11–14 week ultrasound is a cornerstone of modern prenatal care, enabling timely diagnosis of abnormalities, better parental counseling, and informed pregnancy management[11].

MATERIALS AND METHODS:

Study design: This is prospective analytical study conducted at the Department of Obstetrics and Gynecology, Adichunchanagiri Institute of Medical Sciences, Adichunchanagiri University, B G Nagara, Mandya, Karnataka, India for duration of 18 months from May 2023 to December 2024.

Ethical considerations: This study was approved by the ethics committee of Adichunchanagiri Institute of Medical Sciences (approval number: AIMS/IEC/072/2023) dated 13-05-2023.

Sample size: In a study done by Souka AP et al.,[13] full examination of fetal anatomy using transvaginal and transabdominal scan was done in 48% of fetuses, with 95% confidence interval and 15% relative precision

$$n = \frac{4\,p\,q}{d^2}$$

P= Fetuses in which full examination of fetal anatomy was done=48%

q = 100-p = 52%

d = 15% of p=7.2

$$n = \frac{4 * 48 * 52}{7.2^2}$$

=192

The minimum required sample size as per the above-mentioned calculation is 192.

Inclusion Criteria:

Participants included those with a singleton pregnancy between 11 and 13+6 weeks of gestation, who were either primigravida or multigravida with a history of normal delivery or cesarean section, and who had given informed consent.

Exclusion Criteria:

Individuals were excluded if they had not given informed consent, had a gestational age less than 11 weeks or more than 13+6 weeks, had multiple gestations, or had cervical incompetence.

Study Procedure: Participants detailed history with the following, name, age, education, socio-economic status, occupation, address, married life, past medical and surgical history, family history. General physical examination, systemic examination is done. The subjects will be explained the necessity of transvaginal ultrasound and transabdominal ultrasound. Gestational age was calculated from the first day of last menstrual period (LMP). If the women didn't remember dates or when there was a difference 7 or more days between menstrual age and ultrasound age, the pregnancy was dated by crown–rump length (CRL).

Ultrasound examinations of various fetal structures were performed at the 11–13+6 week period according to the guidelines of IUSOG [12]. The same investigator performed both transabdominal and transvaginal sonography on a patient. Both ultrasound examinations were conducted using a Samsung HS30 ultrasound machine with a curvilinear transducer C2-5 of 2.0 MHz to 5.0 MHz for transabdominal ultrasound and vaginal transducer ER4-9 of 4.0 MHz to 9.0 MHz for transvaginal scan. Great care and importance was given to the subjects' privacy by separating the scan section with opaque curtains.

Statistical analysis: All characteristics were summarized descriptively. For continuous variables, the

summary statistics of mean±standard deviation (SD) were used. For categorical data, the number and percentage were used in the data summaries and diagrammatic presentation. Chi-square (χ^2) test was used for association between two categorical variables. The difference of the means of analysis variables between two independent groups was tested by unpaired t test. The difference of the means of analysis variables between more than two independent groups was tested by ANOVA and F test of testing of equality of Variance.

The sources of the variation include treatment; Error (a); the effect of Time; the interaction between time and treatment; and Error (b). Error (a) is the effect of subjects within treatments and Error (b) is the individual error in the model. All these add up to the total. If the p-value was < 0.05, then the results were considered to be statistically significant otherwise it was considered as not statistically significant. Data were analyzed using SPSS software v.23(IBM Statistics, Chicago, USA)and Microsoft office 2007.

RESULTS:

A prospective analytical study done in a tertiary care center. All the 200 participants were subjected to both TVS and TAS.

The study analyzed 200 cases, categorizing them into four age groups, with the majority (52.5%) aged 21–25 years and a mean age of 25 years. Second-degree consanguineous marriages accounted for 7% of cases, while non-consanguineous marriages made up 93%. Parity was evenly distributed, with 100 primigravidaes and 100 multigravidaes participants. Regarding conception methods, 92% conceived spontaneously, while 8% used assisted reproductive techniques. There were 4 cases of diabetes, 3 cases of HTN, 2 cases of Hyperthyroidism, and 28 cases of Hypothyroidism. Overall, the study population was predominantly young, non-consanguineously married, and conceived spontaneously.

Table 1: Demographic Variables

Variable	Number of participants	Percentage
Mean age	25 years	
Consanguinity		
Non consanguineous marriage	186	93
2nd degree consanguineous marriage	14	7
Parity		
Primigravida	100	50
Multigravida	100	50
Conception		
Assisted reproductive techniques	16	8
Spontaneous	184	92
Comorbidities		
Diabetes Mellitus	4	2
Hypertension	3	1.5
Hyperthyroidism	2	1
Hypothyroidism	28	14

CRL was categorized into five ranges: <45 mm, 45-54 mm, 55-64 mm, 65-74 mm, and >75 mm. The majority of cases fall within the 65-74 mm range, indicating it as the most common CRL measurement among the subjects. The data suggests that CRL measurements between 55 mm and 74 mm are the most prevalent, covering 63.5% of the cases.

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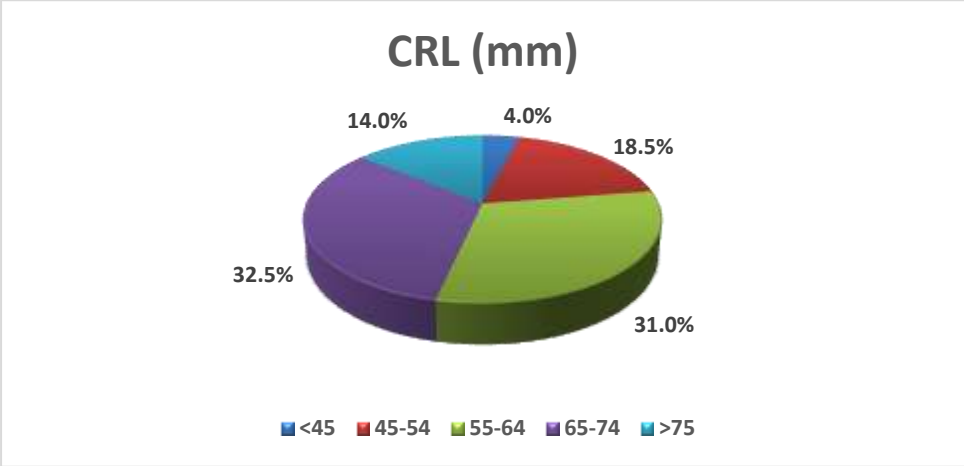
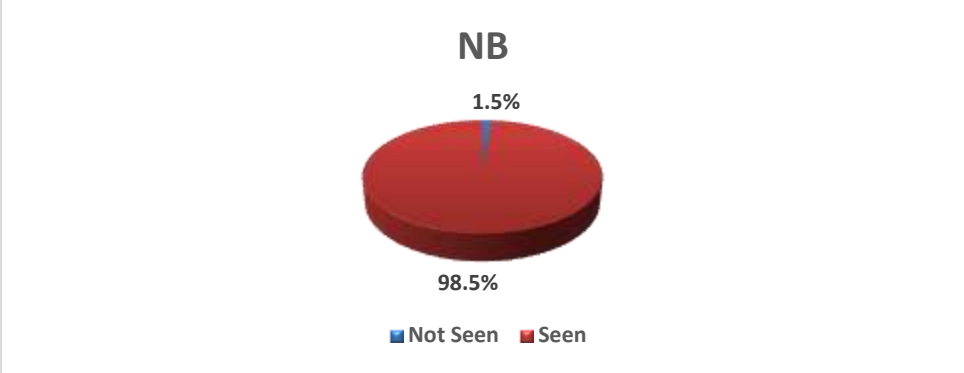
Figure 1: Distribution of Cases according to CRL



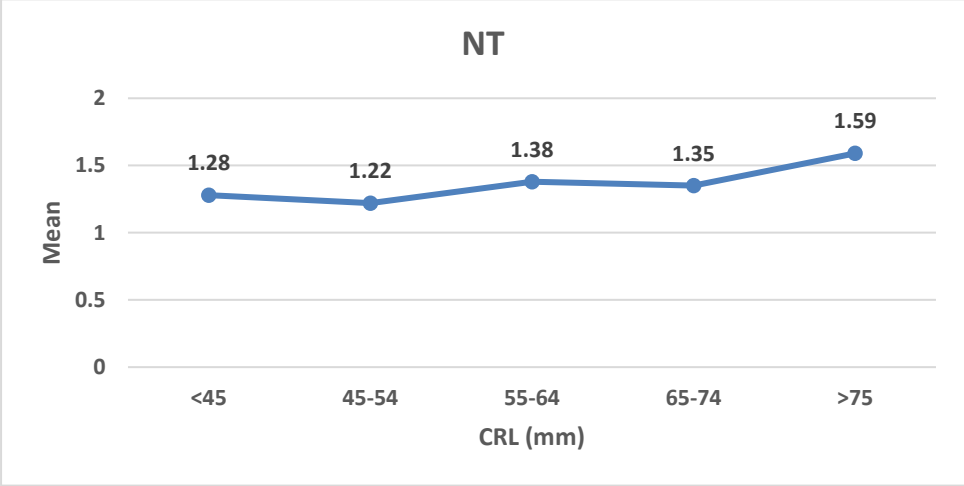
Nasal bone visualization was categorized into "Seen" and "Not Seen." "Seen" accounts for the majority with 197 cases (98.5%). "Not Seen" is significantly less frequent with only 3 cases (1.5%).

Figure 2: Distribution of Cases according to NB



The lowest mean NT value is observed in the 45-54 mm CRL category at 1.22. The highest mean NT value is recorded in the >75 mm CRL category at 1.59.There is a general increase in mean NT as the CRL increases, with a slight decrease in the 65-74 mm range.

Figure 3: Distribution of NT according to CRL



The transvaginal scan seems to be slightly better at visualizing most body parts compared to the transabdominal scan, especially for the face, spine, kidneys, and bladder.

Table 2: Successful visualization by Transabdominal and Transvaginal Scan

Successful visualization	Transabdominal Scan		Transvaginal Scan	
	No of cases	**Percent**	**No of cases**	**Percent**
Skull	196	98.0	196	98.0
Brain	198	99.0	198	99.0
Face	186	93.0	191	95.5
Spine	191	95.5	193	96.5
Heart	90	45.0	102	51.0
Stomach	189	94.5	191	95.5
Abdominal Wall	194	97.0	195	97.5
Kidneys	158	79.0	171	85.5
Bladder	181	90.5	192	96.0
Extremities	200	100	200	100

High visualization rates (>90%) are generally observed in larger CRL ranges (>55 mm) for most structures in both scanning techniques. Structures like the brain and heart show high visualization rates even in smaller CRL ranges in transvaginal scans. The extremities tend to have lower visualization rates in smaller CRL ranges in both scan types but improve significantly as CRL increases. Transvaginal scans generally provide better visualization for most structures in smaller CRL ranges compared to transabdominal scans. The significant p-values in certain categories suggest that the differences in visualization rates across CRL ranges are statistically significant, especially for critical structures like the heart and brain

Table 3: Successful visualization according to CRL in Transabdominal Scan

Successful visualization	CRL (mm)										p value
	<45		**45-54**		**55-64**		**65-74**		**>75**		
	N	%	**N**	%	**N**	%	**N**	%	**N**	%	
Skull	8	100.0%	33	89.2%	62	100.0%	65	100.0%	28	100.0%	0.001*
Brain	8	100.0%	35	94.6%	62	100.0%	65	100.0%	28	100.0%	0.064
Face	3	37.5%	33	89.2%	60	96.8%	62	95.4%	28	100.0%	<0.001*
Spine	6	75.0%	34	91.9%	60	96.8%	64	98.5%	27	96.4%	0.032*
Heart	1	12.5%	8	21.6%	25	40.3%	38	58.5%	18	64.3%	<0.001*
Stomach	5	62.5%	34	91.9%	59	95.2%	64	98.5%	27	96.4%	0.001*
Abdominal Wall	6	75.0%	34	91.9%	61	98.4%	65	100.0%	28	100.0%	0.001*
Kidneys	2	25.0%	24	64.9%	45	72.6%	63	96.9%	24	85.7%	<0.001*
Bladder	5	62.5%	30	81.1%	58	93.5%	61	93.8%	27	96.4%	<0.001*
Extremities	8	100.0%	37	100.0%	62	100.0%	65	100.0%	28	100.0%	-

Note: p value* significant at 5% level of significance (p<0.05)

Table 4: Successful visualization according to CRL in Transvaginal Scan

Successful visualization	CRL (mm) <45		45-54		55-64		65-74		>75		p value
	N	%	N	%	N	%	N	%	N	%	
Skull	8	100.0%	33	89.2%	62	100.0%	65	100.0%	28	100.0%	0.001*
Brain	8	100.0%	35	94.6%	62	100.0%	65	100.0%	28	100.0%	0.064
Face	5	62.5%	36	97.3%	60	96.8%	62	95.4%	28	100.0%	<0.001*
Spine	7	87.5%	34	91.9%	60	96.8%	64	98.5%	28	100.0%	0.198
Heart	1	12.5%	12	32.4%	32	51.6%	37	56.9%	20	71.4%	0.004*
Stomach	5	62.5%	36	97.3%	59	95.2%	64	98.5%	27	96.4%	<0.001*
Abdominal Wall	6	75.0%	35	94.6%	61	98.4%	65	100.0%	28	100.0%	<0.001*
Kidneys	4	50.0%	29	78.4%	48	77.4%	64	98.5%	26	92.9%	<0.001*
Bladder	6	75.0%	34	91.9%	61	98.4%	64	98.5%	27	96.4%	0.012*
Extremities	8	100.0%	37	100.0%	62	100.0%	65	100.0%	28	100.0%	-

Note: p value* significant at 5% level of significance (p<0.05)

During our study period we noted a total of 3 cases of unossified nasal bone and 5 cases of fetal anomalies(4%), i.e. 1 case of right club foot, 1 case of cystic hygroma, 1 case of anencephaly, 1 case of acrania-anencephaly sequence and 1 case of acrania- exencephaly sequence.

Table 5: Anomalies identified during the study

Anomalies	CRL	n
Right club foot	71.9	1
Cystic hygroma	69.7	1
Anencephaly	47.2	1
Acrania Anencephaly sequence	52.7	1
Acrania Exencephaly squence	53.9	1
Unossified Nasal bone	64.1, 62.7, 52.3	3
Total		8 (4%)

DISCUSSION:

The study aimed to compare the effectiveness of transabdominal (TAS) and transvaginal (TVS) ultrasound examinations in evaluating fetal anatomy during the first trimester (11 to 13+6 weeks of gestation). Both techniques were found to be highly effective, although transvaginal ultrasound demonstrated slightly superior detection rates for many fetal structures, especially in early pregnancy. For instance, TVS had better visualization rates for the face, spine, kidneys, and bladder compared to TAS. These findings align with those of Souka et al.[13], who also observed higher accuracy in fetal anatomy detection using TVS over TAS in early pregnancy. Despite both being useful diagnostic tools, TVS offered a modest advantage in terms of image clarity and detail.

The mean maternal age in the current study was 25 years, with participants ranging from 19 to 35 years. This contrasts with Souka et al.[13], where the median age was slightly higher at 29 years. The age distribution observed here is more consistent with the findings of Kaur et al.[14], who reported the highest number of participants in the 21–25-year age group. Regarding marital patterns, 93% of participants in the current study were in non-consanguineous marriages, while 7% were second-degree consanguineous, showing a similar trend of low consanguinity compared to other studies.

Parity was evenly distributed in this study, with 50% of participants being primigravida and 50% multigravida. This is different from findings by Souka et al.[13], where a higher proportion of women (60.06%) were multigravida, and Ebrashy et al.[15], who observed a primigravida majority of 54%. Comorbidities were relatively uncommon in this cohort, with hypothyroidism being the most prevalent condition, affecting 28 cases. Other conditions included diabetes (4 cases), hypertension (3 cases), and hyperthyroidism (2 cases). In comparison, Souka et al.[16] reported fewer comorbidities, with 0.87% of participants having insulin-dependent diabetes and 0.26% using anticonvulsants.

In terms of conception methods, spontaneous conception dominated, with 92% of cases, while only 8% involved assisted reproductive techniques (ART). This is higher than the 1.57% ART usage reported by Souka et al.[13], suggesting a growing use of ART in more recent cohorts. Crown-Rump Length (CRL) was a key parameter evaluated. The most common CRL measurement in the current study was between 65–74 mm (32.5%), followed closely by the 55–64 mm range (31%), making CRLs between 55 and 74 mm the most prevalent, representing 63.5% of all cases. This closely aligns with Pandya et al.[17], who reported a median CRL of 57 mm, and Souka et al.[13] who also found the majority of cases in the 65–74 mm range. Nuchal translucency (NT) measurements showed a general increase with CRL. The lowest mean NT (1.22) was recorded in the 45–54 mm CRL group, and the highest (1.59) in the >75 mm group. These findings are supported by Drysdale et al.[18] , who noted that 3% of their participants were identified as high-risk for Trisomy 21 based on NT and maternal age. Nasal bone (NB) visibility also correlated with increasing CRL. In the current study, NB was seen in 98.5% of cases, with visibility peaking in the 65–74 mm range. Only 3 cases lacked NB visualization.

Anomalies were detected in 4% of cases (8 total), including unossified nasal bone (3 cases), club foot, cystic hygroma, anencephaly, acrania-anencephaly sequence, and acrania-exencephaly sequence. This anomaly rate was higher than that reported by Souka et al. [13], who identified 14 anomalies (1.21%) among 1148 cases, only half of which were detected in the first trimester. Dane et al. [19] found a wider range of anomalies in a larger sample, including acrania, cystic hygroma, encephalocele, iniencephaly, and various syndromes. These comparisons underscore the diagnostic value of first-trimester scans and the potential for early detection of congenital anomalies.

Strength: This study's strength lies in its focus on the first trimester, a crucial period for detecting fetal anomalies, by comparing transvaginal and transabdominal ultrasounds. The within-subject, prospective design with blinded expert assessments enhances accuracy, consistency, and objectivity. Its detailed anatomical evaluation provides valuable insights into the strengths of each imaging method, offering practical guidance for clinical decision-making, especially in challenging or resource-limited settings.

Limitations: The small sample size in this study restricts the ability to generalize the findings. To confirm these results, larger studies involving multiple centers are necessary. Since the research was carried out at a single institution, the outcomes may not be representative of other settings, especially those in different geographic areas with diverse healthcare systems and practices.

CONCLUSION:

India, with a population of 1.46 billion, has the highest number of people globally and a birth rate of 16.55 per 1,000 individuals. Congenital anomalies affect 1–3% of live births, and NTNB scans are commonly used between 11 and 13+6 weeks of gestation to screen primarily for trisomy 21. Both transabdominal (TAS) and transvaginal (TVS) ultrasounds are used for first-trimester scans, but most women prefer TAS due to its non-invasive nature and cultural sensitivities around internal examinations. Despite this preference, advances in high-frequency transvaginal probes have made TVS a superior tool for detailed fetal anatomical evaluation.

This study found both TAS and TVS highly effective for visualizing fetal structures like the brain and extremities, but TVS consistently showed slightly better detection rates for critical structures such as the face, spine, kidneys, and bladder. However, both methods struggled with early cardiac visualization. While TAS remains widely accepted for routine scans, TVS provides enhanced clarity and should be considered, especially in early pregnancy or when TAS is limited. The findings highlight the complementary roles of TAS and TVS in improving the accuracy and completeness of first-trimester fetal assessments in clinical practice.

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