Original Article

The Value of Nuchal Translucency (NT) Ultrasonography for Fetal Malformation Screening

L Zhang, Y Zhang[1], Y Yan

Departments of Obstertrics and Gynecology, [1]Ultrasound, Minhang Hospital, Fudan University, Shanghai, China

Abstract

Background: Early detection of fetal malformations is crucial for timely intervention and management in obstetric care. Existing screening methods may have limitations, prompting the exploration of novel approaches to improve detection accuracy. **Aim:** This retrospective study explores an efficient fetal malformation screening method, aiming to provide a reference for obstetric examination. **Methods:** A total of 511 puerperae who underwent standardized ultrasound examinations in our hospital's first trimester from December 2020 to August 2022 were enrolled. Ultrasound was used to detect the thickness of the nuchal translucency (NT) in all puerperae during prenatal examination. The clinical values of detection indices in maternal prenatal physical examination were analyzed. **Results:** A total of 511 puerperae were investigated, and 12 malformed fetuses were detected, presenting a fetal malformation rate of 2.35%, including 3 cases of head and neck hydrocele, 2 cases of megacystis, 3 cases of anencephaly, and 4 cases of omphalocele. Among 499 normal fetuses, NT thickness > 3.0 mm accounted for 3.41%, while among the 12 malformed fetuses screened, NT thickness > 3.0 mm accounted for 75.00%, and there was a statistical difference between the two groups (Chi-square = 124.374, $P < 0.05$). Using ultrasound for fetal malformation screening revealed that the fetus with NT thickness value above 3.0 mm performed better in ultrasound screening (>3.0: AUC of 0.904; >3.5: AUC of 0.928; >4.0: AUC of 0.944 vs. >2.0: AUC of 0.863; >2.5: AUC of 0.878). **Conclusion:** The findings underscore the critical clinical significance of NT thickening as a promising ultrasound soft index for screening fetal malformations. Beyond aiding in clinical diagnosis and postpartum treatment, the potential applications of these findings hold immense practical value. They pave the way for enhanced prenatal and postnatal care practices, emphasizing the translation of research outcomes into tangible benefits for healthcare providers and expectant parents alike.

Keywords: *Fetal malformation screening, nuchal translucency, ultrasonography, value*

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Introduction

Fetal malformation is the structural or chromosomal abnormality of the fetus, affecting 900,000 of the 16 million births in China, immensely hobbling the healthy growth of newborns.[1] Routine detection methods such as amniocentesis are invasive, intensify maternal pain, and raise the possibility of miscarriage during pregnancy.[2] With advancements in ultrasound technology, it has become a preferred, real-time, safe, and user-friendly modality for obstetric examinations, crucial for comprehending fetal growth, accurately visualizing the fetus, screening abnormalities, and predicting variability in pregnant women of all risk levels.[3]

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Address for correspondence: Y Zhang, Department of Ultrasound, Minhang Hospital, Fudan University, Shanghai, China.
E-mail: zyf800321@163.com

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In addition, it is considerably valuable in prenatal diagnosis, in which the nuchal translucency (NT) value can be obtained by ultrasound detection. The thickening of this index is linked to fetal chromosomal abnormalities, intrauterine death, structural malformations, etc., Accordingly, it is conducive for the evaluation of various fetal malformations, and screening fetuses with abnormal growth and development[4] Clinical studies have shown[5,6] that increased NT value can objectively reflect adverse pregnancy outcomes, and can be used dominantly in screening for Down syndrome.

In light of these, this study measured the fetal NT value by ultrasonography, to provide more reference for fetal malformation screening. By emphasizing the importance of integrating NT measurements into standard prenatal screening practices, this research aims to fill this gap and improve the early detection and management of fetal abnormalities, thereby enhancing the overall quality of prenatal care.

Materials and Methods

Study design and participants

The retrospective study included a total of 511 puerperae who underwent standardized ultrasound examinations in the first trimester at our hospital from December 2020 to August 2022. The puerperae were aged between 22 and 38 years, with an average age of (27.6 ± 4.3) years. The fetal head-rump diameter ranged from 42 to 87 mm, with an average of (64.52 ± 5.3) mm, and the gestational age at the time of ultrasound varied from 11 to 14 weeks, with an average of (12.3 ± 0.5) weeks. The average pre-pregnancy BMI was (22.24 ± 2.11) kg/m^2. The study cohort comprised 235 multiparous women and 276 primiparous women. This trial was conducted according to the principles of the Declaration of Helsinki (2013).[7] This study was approved by the Ethics Committee of Minhang Hospital, Fudan University (Ethics Approval Number: 2020-12-0801).

Inclusion and exclusion criteria

Individuals were eligible for inclusion if they had ① complete examination data and singleton pregnancy; ② good compliance with the test; and ③ no contraindications to ultrasound examination.

Individuals were excluded if they had ① complicated vital organ dysfunction; ② mentally disabled or compromised; ③ intrauterine infection; ④ those who were under medication during pregnancy; and ⑤ malignant tumor.

Methods

The NT measurements conducted on all puerperae were performed in strict adherence to the First Trimester Ultrasound Screening Guidelines as outlined in the Fetal Medicine Foundation (FMF) Version for NT.[8] A color Doppler ultrasound detector (manufacturer: GE Company, Model: Voluson E8) was used to examine the puerperae, and the probe frequency was 4.0–6.0 MHz, and the NT thickness of the fetus was recorded in detail. The specific steps were as follows: The participants were instructed to assume a prone position during the examination, with the detection instrument placed sagittally in the middle of the fetal position. The fetus was maintained in a natural stretch and flexion state throughout the examination, allowing for the assessment of fetal development within the mother. Corresponding slice images were captured to ensure the accuracy of the obtained NT thickness values. According to the NT measurement standard developed by the British Fetal Foundation,[9] the thickness of ≥2.5 mm was regarded as a positive result. If fetal malformation was found by ultrasonography, the treatment method shall be determined by taking the influence and type of the malformation on development into consideration, and whether the pregnancy was terminated or continued.

Outcomes

The fetal malformation data and the type of malformation were documented.

The NT thickness value of each newborn was measured, and the number and proportion of normal fetuses and deformed fetuses with NT values >3 mm and <3 mm were counted.

The sensitivity, accuracy, and specificity of ultrasonic measurement of NT thickness were calculated.

Statistical analysis

SPSS26.0 (GraphPad Software, Inc. San Diego, USA) was used to analyze the data of this study. The count data was expressed as [n (%)], and the Chi-square test was performed. The measurement data were normally distributed and represented as ($\bar{x} \pm s$). Independent sample t-tests were used for comparisons between two groups of measurement data, while paired t-tests were employed for within-group comparisons. ROC curve was plotted to analyze the diagnostic performance of ultrasound in diagnosing NT values of different thicknesses by calculating the area under the curve (AUC), sensitivity, and specificity based on IBM SPSS Statistics 20 (IBM Corp, NY, USA). All calculations were based on a 2-sided t-test at the 5% level of significance.

Results

Fetal malformation screening

A total of 511 postpartum women were examined, revealing 12 cases of fetal malformations, resulting in a fetal malformation rate of 2.35%. The identified malformations included 3 cases of head and neck hydrocele, 2 cases of megacystis, 3 cases of anencephaly, and 4 cases of omphalocele.

Ultrasound examination of NT thickness values

Among 499 normal fetuses, NT thickness > 3.0 mm accounted for 3.41%, while among the 12 malformed fetuses screened, NT thickness > 3.0 mm accounted

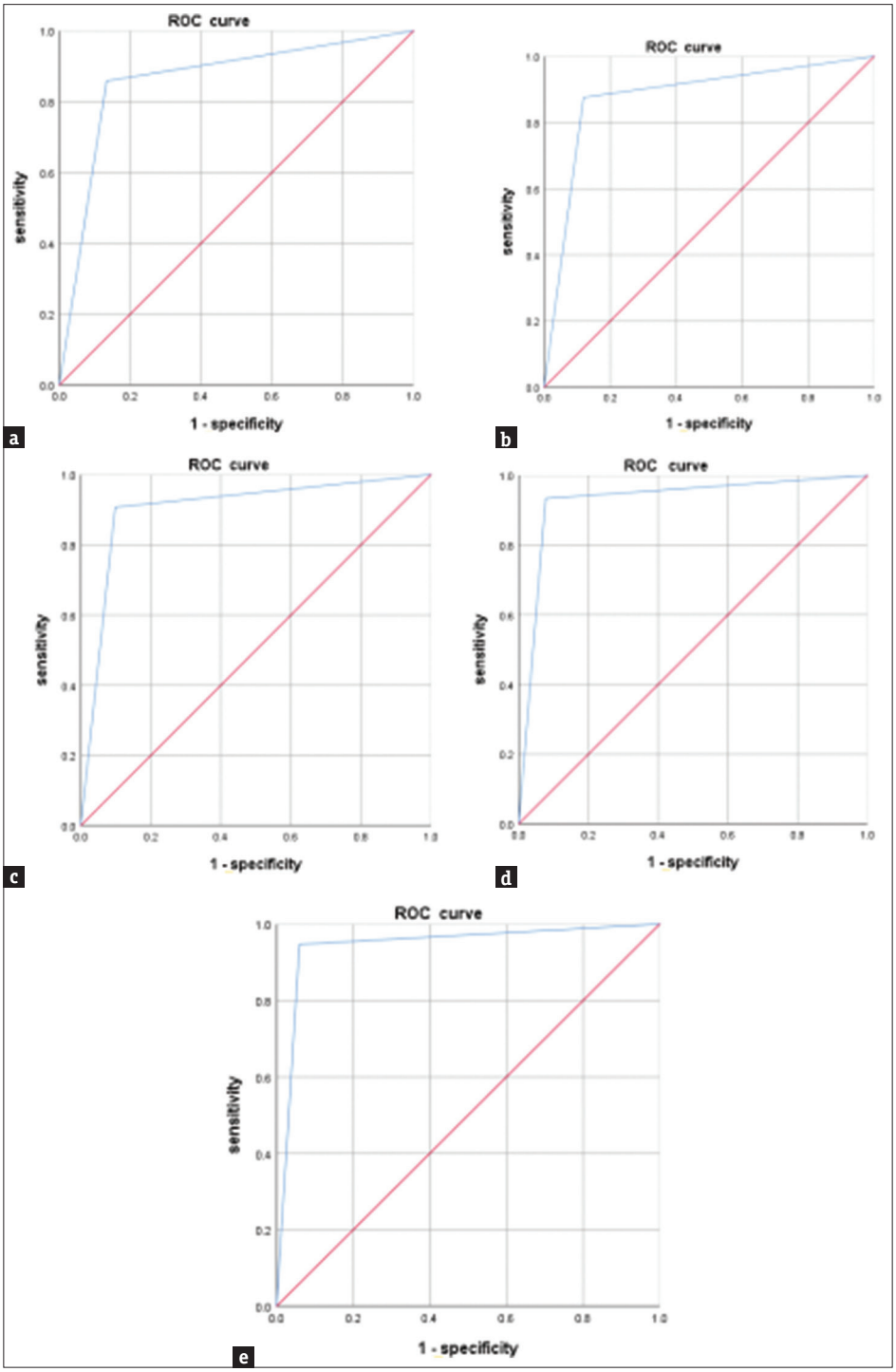

Figure 1: ROC curves of NT value detected by ultrasonic. (a) ROC of ultrasound in the diagnosis of NT value >2.00 mm; (b) ROC of ultrasound in the diagnosis of NT value >2.5 mm; (c) ROC of ultrasound in the diagnosis of NT value >3.0 mm; (d) ROC of ultrasound in the diagnosis of NT value >3.5 mm; (e) ROC of ultrasound in the diagnosis of NT value >4.0 mm

Table 1: Distribution of nuchal translucency (nt) values among normal and malformed fetuses [*n* (%)]

Fetal type	NT value (mm)	*n*	Percentage
Normal fetus	>3.0	17	3.41
	<3.0	482	96.59
Malformed fetus	>3.0	9	75.00
	<3.0	3	25.00

Table 2: Comparison of nuchal translucency (nt) values between normal and malformed Fetuses [mean±SD]

	NT value (mm)	*t*	*P*
Normal fetus (*n*=499)	2.99±0.02	6.921	<0.0001
Malformed fetus (*n*=12)	3.00±0.06		

Table 3: ROC parameters for different nuchal translucency (NT) value thresholds (%)

NT value (mm)	Sensitivity	AUC	Specificity	95% CI
>2.0	83.62	0.863	88.53	0.828-0.897
>2.5	85.34	0.878	89.96	0.845-0.911
>3.0	87.98	0.904	92.45	0.875-0.934
>3.5	90.56	0.928	94.60	0.902-0.954
>4.0	92.64	0.944	95.71	0.920-0.967

for 75.00%, and there was a statistical difference between the two groups (Chi-square = 124.374, $P < 0.05$) [Table 1]. The NT thickness values of normal and deformed fetuses are shown in Table 2.

Ultrasonic detection of NT value

The ultrasound examination for fetal malformation screening showed that the fetus with NT thickness value above 3.0 mm had higher sensitivity, accuracy, and specificity of ultrasound screening [Table 3 and Figure 1].

Discussion

Epidemiological statistics reveal a 0.8-3.9% incidence of malformed fetuses as a result of abnormal structural development caused by internal or external factors in the mother.[10,11] Fetal malformations cause appearance problems in the newborn and may be associated with intellectual, height, and language dysfunction, resulting in a substantial decline in the quality of life.[12,13] The implementation of prenatal screening is the key factor in ensuring the health of newborns, yet the current routine diagnostic methods, such as amniotic fluid examination, are invasive tests that can easily lead to miscarriage.[14]

As increased emphasis is focused on prenatal and postnatal care, there are more requirements for the progress of fetal malformation screening. In contrast, ultrasonography is a non-invasive diagnosis, and imaging technology that can assess the shape, location, and size of the organs. Due to its high diagnostic accuracy and safety, it is widely used in the prenatal examination of puerperae.[15] The development of the fetus can be accurately grasped, different deformities and diseases can be found, and an accurate basis for obstetricians can be provided via ultrasound examination. In recent years, with the upliftment of computer and imaging technology, its integration with ultrasonography has hugely enhanced the screening rate of fetal malformations.[16-18] NT thickness measurement is considered a soft indicator for assessing fetal aneuploidy risk in the first trimester, and its specificity is superior to that of serology.

Clinical studies have shown that the change in NT thickness is closely related to the occurrence of various neonatal diseases.[19,20] The pathophysiological reasons for its thickening are cardiac abnormalities, infection, and abnormal expression of atrial natriuretic peptides, resulting in heart failure and lymphatic system. Abnormal structure and return flow lead to the accumulation of lymph in the thoracic duct, which may compress the heart and eventually result in abnormal cardiac structure or dysplasia. In this regard, accurate measurement of fetal NT value is of great significance for predicting abnormal growth and development.

This study explored the clinical value of NT in fetal malformation screened by analyzing the relationship between fetal NT and structural malformations in the first trimester. In the present study, a total of 12 deformed fetuses were detected, accounting for 2.35%. The ROC curve is a reliable tool to assess the diagnostic value, and the AUC reflects the accuracy of the test. The findings of present study reported that the fetal NT thickness value was above 3.0 mm by plotting the ROC curve, and the sensitivity, accuracy and specificity of ultrasound screening were high, indicating a reliable prenatal screening tool for fetal malformations. Similar to our study, Petersen *et al*.[21] have suggested that the NT cut-off for invasive testing could be 3.0 mm for a chromosomal aberration. Accordingly, when an NT value exceeds 3.0 mm, it typically indicates an increased risk of chromosomal abnormalities and certain fetal anomalies. In such cases, further diagnostic tests or consultations with a maternal-fetal medicine specialist may be warranted to assess the situation comprehensively.

However, this study has some limitations. Firstly, the small sample size, especially the small sample size of malformed fetuses may bring biases in the study results. Secondly, the reliance on retrospective data collection may introduce potential information bias and limit the ability to control for confounding variables. Future studies with larger sample sizes and prospective data

collection methods are warranted to further validate the findings and minimize biases associated with sample size and data collection approaches.

In conclusion, NT thickening is a promising ultrasound soft index for screening fetal malformations, which contributes to clinical diagnosis and postpartum treatment, with excellent application value. It also establishes conducive conditions for domestic prenatal and postnatal care, advocating for its incorporation into standard prenatal screening guidelines.

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Conflicts of interest

There are no conflicts of interest.

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