

ABSTRACT

Objective: This study aimed to evaluate and compare nuchal translucency (NT) measurement between sagittal and transverse planes for aneuploidy screening.

Materials and Methods: This prospective study was conducted at the antenatal clinic, department of obstetrics and gynecology, Bhumibol Adulyadej Hospital, Royal Thai Air Force, Bangkok, Thailand between November 2023 and July 2024. Subjects were singleton pregnant women who underwent fetal chromosome anomaly screening by NT measurement of both sagittal and transverse planes by transabdominal ultrasonography between 11 and 14 weeks of gestational age (GA). Demographic and clinical data were collected and evaluated. Relationship between sagittal and transverse planes measurement was analyzed.

Results: A total of 295 pregnant women were recruited. The mean age and GA of participants were 31.7 years old and 12.9 weeks, respectively. Prevalence of aneuploidy was 2.7% (8/295). The mean NT measurement in the sagittal plane was significantly lower than in the transverse plane (1.5 and 1.7 mm). Transverse and sagittal plane measurement exhibited a linear correlation. The cut-off point of NT by transverse and sagittal approach were 2.9 mm and 3.0 mm, respectively that giving comparable diagnostic value.

Conclusion: NT measurement cut-off by transverse approach at 2.9 mm had comparable to 3.0 mm of sagittal approach.

Keywords: Nuchal translucency; aneuploidy; pregnancy; transverse plane; ultrasound (Siriraj Med J 2025; 77: 168-174)

INTRODUCTION

Fetal malformation or genetic abnormalities should be diagnosed as early as possible.¹ Ultrasound screening in the first trimester is mainly performed by fetal nuchal translucency (NT), with serum analytes, namely pregnancy associated plasma protein-A (PAPP-A), human chorionic gonadotropin (hCG) and alpha-fetoprotein (AFP) between 10 and 14 weeks of gestation were introduced by American college of Obstetricians and Gynecologists (ACOG) recommendation in year 2020.¹ NT is a measurement of subcutaneous development behind the fetus' neck during the first trimester of pregnancy.^{1,2} Thick NT signifies fetal heart failure, extracellular matrix abnormality, or abnormality of the lymph system.¹ Meanwhile, ultrasound screening in the second and third trimester is mainly performed to predict of neonatal outcomes.³⁻⁶

NT is the most effective tool for detecting Down Syndrome during the first trimester of pregnancy around 11-14 weeks of gestation at nearly 90%, with only a 5% false positive rate.^{7,8} Thick NT (of more than 3.0 mm) measured by median sagittal view was associated with fetal anomalies or cardiac anomalies, this allows for early management to prevent high risk of spontaneous fetal loss.^{1,7,9-11}

In current practice NT is measured using the sagittal plane. The sagittal plane necessitates an experienced sonographer and is successful only if the fetus holds a specific position.^{12,13} A transverse approach was an easier operation to perform and offered a shorter learning curve.¹³ If the measurement could be performed using

a transverse plane, the result would be less dependent on the position of the fetus. This investigation aimed to explore sagittal and transverse plane NT imaging as a tool for aneuploidy risk assessment.

MATERIALS AND METHODS

A prospective study was conducted in the Obstetrics and Gynecology Department at Bhumibol Adulyadej Hospital (BAH), Royal Thai Air Force, Bangkok, Thailand between November 2023 and July 2024. This study was approved by the BAH Institutional Review Board in 2023 (IRB No.84/66).

Participants were singleton pregnant women between 11 and 14 weeks of gestation (GA). Inclusion criteria was pregnant women with intrauterine pregnancy, age 18 and up, who attended antenatal care at BAH. Exclusion criteria included inability to communicate in Thai. All participants were counseled about fetal chromosome screening (FCS). All participants received briefings about the investigation and all gave written informed consents. According to BAH protocol, subjects were screened either using maternal serum for cell-free DNA (cfDNA) screening detection or quadruple test. The cfDNA was performed by taking maternal blood samples. Maternal serum was sent for fetal microDNA labs. Quadruple tests consisted of maternal serum AFP, hCG, estriol and inhibin. Standard amniocentesis for fetal chromosome study was performed on subjects who had abnormal FCS either via cfDNA or quadruple test methods. Amniocentesis was performed during 15 and 20 weeks of GA.

During FCS routine protocol, all participants underwent transabdominal ultrasound (Voluson E10 model: GE healthcare, Zipf, Austria) for NT measurement. The measurement of NT in sagittal plane was performed three times. In addition, the same sonographer measured on the transverse plane using transabdominal ultrasound three times. Sonographer was member of the maternal-fetal medicine (MFM) fellowship under the supervision of experienced MFM staff.

According to International Society of Ultrasound in Obstetrics and Gynecology (ISUOG) recommendation, NT measurement was performed via sagittal plane.¹⁴ During NT measurement, fetuses were aligned in neutral position. Fetal head, neck, tip of nose, upper thorax and NT edge margin were demonstrated in midsagittal plane during NT measurement.¹⁴

During NT measurement via transverse plane, transverse plane of fetal head was aligned similarly to the transcerebellar view.^{15,16} Frontal horns, cerebral peduncles and optic thalami were the landmarks for NT measurement. Distance from the external contour of the occipital bone to the outer contour of the skin by positioning ultrasound calipers was the NT value.¹³

Data from sagittal and transverse measurement was collected and further analyzed. Demographic and clinical data were also collected from electronic medical records including maternal age, parity and body mass index.

The data was processed using the Statistic Package for the Social Sciences (SPSS version 27.0). A p-value less than 0.05 was considered statistically significant. The mean values of each measurement plane were used for calculation. Transverse and sagittal NT were compared and evaluated. The accuracy of transverse measurement

was assessed and compared to the NT value of more than 3.0 mm. Scatter plots and linear correlations during regression analysis were used for strengthening the interpretation of the results.

RESULTS

A total of 295 cases were included in the study as presented in Fig 1. Half (164/295) of participants were of nulliparity. Mean age and GA of participants were 31.7 years old and 12.9 weeks, respectively. The total of amniocentesis was 30 cases. Only 8 cases had a report of abnormal chromosome study, namely trisomy 21 (6 cases) and trisomy 18 (2 cases). Prevalence of aneuploidy was 2.7% (8/295). NT measurement by sagittal approach and transverse approach averaged 1.5 and 1.7 mm, respectively as shown in Table 1.

Comparison of NT measurement between sagittal and transverse approaches by scatter plot were presented in Fig 2. Correlation between sagittal and transverse approaches followed a linear pattern as shown in Fig 3. Standard cut-off point of NT by sagittal approach was chosen at 3.0 mm.¹ Area under curve (AUC) was at 0.980. At the best value, the cut-off point for NT by transverse approach was 2.9 mm, giving the same diagnostic value as the cut-off point of NT by sagittal approach at 3.0 mm. We proposed that subjects who had NT transverse measurement of 2.9 mm or greater represented a high risk of aneuploidy at the same level as those who had 3.0 mm measurement using a sagittal approach. The accuracy of NT measured by transverse approach was 97.6% with a false positive rate of 2.4% (7/291).

A transformation model of NT by transverse approach to sagittal approach was created. The formula was $0.597 + [0.528 \times \text{transverse}(\text{mm})]$ as depicted in Fig 2.

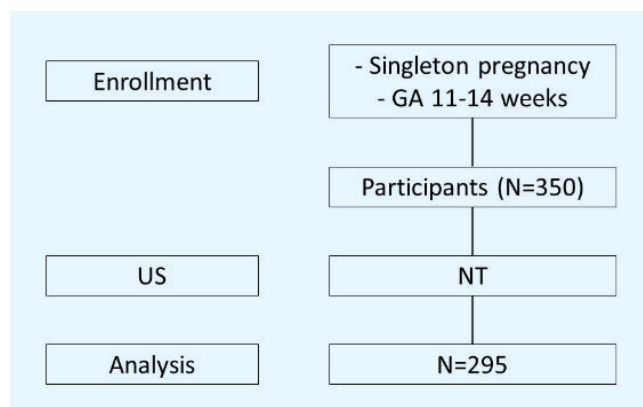


Fig 1. Flow chart of study

Abbreviations: US: ultrasound, NT: nuchal translucency, GA: gestational age

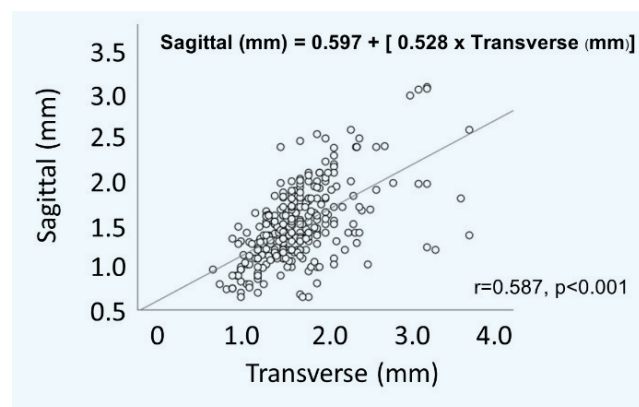


Fig 2. Comparison of nuchal translucency (NT) measurement between sagittal and transverse approach by scatter plot

Abbreviations: Sag: sagittal plane, Trans: transverse plane, MD: mean different

TABLE 1. Demographic character of participants who had positive and negative test result for aneuploidy screening

	Total (n=295)	Range	Positive (n=30)	Negative (n=265)	p-value
Age (year)	31.7 ± 5.5	18.0 - 44.0	35.9 ± 3.7	31.2 ± 5.5	<0.001*
BMI (kg/m ²)	25.7 ± 4.6	15.8 - 39.4	26.5 ± 5.6	25.6 ± 4.5	0.368
GA (days)	90.6 ± 4.7	77.0 - 98.0	89.4 ± 5.9	90.8 ± 4.6	0.144
CRL (mm)	66.9 ± 9.1	36.7- 87.0	65.6 ± 10.1	67.1 ± 9.0	0.421
Nulliparity	164 (55.6)		11 (36.7)	153 (57.7)	0.037*
Sagittal (mm)	1.5 ± 0.4	0.65 - 3.1	1.8 ± 0.6	1.4 ± 0.4	0.001*
Transverse (mm)	1.7 ± 0.5	0.67 - 3.2	1.9 ± 0.5	1.7 ± 0.5	0.030*

Abbreviations: BMI: body mass index, GA: gestational age, CRL: crown-rump length

DISCUSSION

In the current study, the aneuploidy rate was 2.7% from chromosome study via amniocentesis. Thai study in year 2024, prevalence of fetal aneuploidy was 0.33% (13/3928).¹⁷ Previous studies reported NT measurement conducted by transabdominal ultrasonography (TAS) in pregnant women with average age between 28.9 and 33 years old.^{10,11,13,18,19} In 2022 Montaguti from Italy a prevalence of aneuploidy from chorionic villous sampling of 0.6% (6/1023).¹³ Prevalence of aneuploidy from a Vietnamese study utilizing chromosome study from amniocentesis in 2011 was 1.5%.¹⁸ Yin's study in China in 2022 performed NT measurement and amniocentesis for karyotype study in all cases and reported the prevalence of aneuploidy from at 3.4%.¹⁹ Montaguti performed NT measurement and genetic screening by combined test or noninvasive prenatal testing (NIPT). Subjects who had high risk of trisomy 13,18, or 21 (45 cases) from combined testing and NIPT underwent chorionic villous sampling reporting only 6 cases.¹³ Tomai performed NT measurement and genetic screening by combined test. Subjects who had high risk of trisomy 13,18, or 21 from combined test underwent amniocentesis.¹⁸ Low aneuploidy prevalence of the current study might interfere the diagnostic efficacy of screening tool.

In the current study, subjects underwent NT measurement and genetic screening either using quadruple test or cfDNA testing. Subjects from the current study who had high risk of aneuploidy screening underwent amniocentesis. There were no aneuploidy cases with NT less than 3.0 mm and low risk of genetic screening. There was no indication for amniocentesis for karyotype in every pregnancy. However, high prevalence of karyotype was reported from the center that performed all karyotype

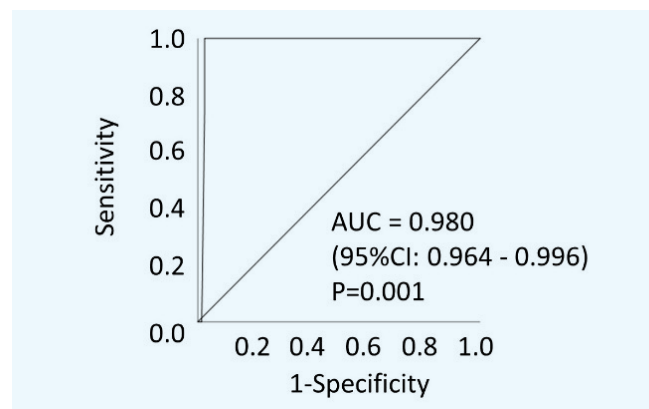


Fig 3. Correlation of nuchal translucency (NT) measurement between sagittal and transverse approach to predict positive aneuploidy screening.

Accuracy of NT by transverse approach were 97.6% with false positive rate 2.4% (7/291).

study or high-risk subjects. According to Yin's 2022 study, pregnant women with mean age of 29 and NT between 2.5 and 2.9 mm underwent amniocentesis for chromosome study by DNA sequencing. Prevalence of aneuploidy in Yin's study reported was 3.4%.¹⁹ They did not state the reason for amniocentesis in subjects with NT under 3.0 mm with an average age of 29 years old. The hidden reason for high-risk aneuploidy was not reported.

According to ACOG recommendation in 2020, pregnant women with NT greater than 3.0 mm were recommended for genetic study.¹ Turkish study by Dinc in 2021 found healthy fetus with NT greater than 3.0 and 3.5 mm at 4.1% and 2.1%, respectively.⁷ The cut-off point at 3.0 mm might include 6.2% of normal healthy fetuses. The karyotype study was needed to confirm and rule out these healthy fetuses. NT measurement was widely

performed for aneuploidy screening in early pregnancy by two-dimension ultrasonography (2D US).^{13,19,20} Khalifeh reported NT measurements by 2D US and three-dimension ultrasonography (3D US) were with comparable accuracy.²⁰ Standard cut-off point was widely accepted at 3.0 mm or more as the high-risk indicator for aneuploidy.¹ Sagittal plane approach during ultrasonography was recommended as following ISUOG guideline.¹⁴ Sagittal plane measurement is a very time-consuming task for obtaining high accuracy of measurement. Transverse planar approach by ultrasonography was introduced as an alternative approach.¹³

From the current study, NT measurement by sagittal and transverse plane were both performed by a single operator. The mean value of NT by transverse plane was significantly higher than those obtained from sagittal plane measurement. The result of NT measurement at 3.5 mm via sagittal plane was comparable to that of 3.2 mm measurement via transverse approach.¹³ There was a correlation between the sagittal and transverse line following a linear pattern. The suggestion cut-off value by transverse plane at 2.9 mm was equal to the cut-off value of 3.0 mm by sagittal plane. Previous studies reported the cut-off point ranged from 2.4 to 3.5 mm by 2D US via sagittal plane.^{18,19,21,22} Montaguti reported the same result as Khalifeh using 2D US. The current study supports the findings of Montaguti and Khalifeh with different cut-off point values. The comparison of NT

measurement from the previous studies were summarized and presented in Table 2. When the situation requires massive NT screening it usually faces a lack of personnel with trained expertise in ultrasonography.¹³ Screening by 2D US and transverse approach was an alternative diagnostic methodology.

Strengths of the current study include data from NT measurement by sagittal and transverse plane that operated by a single experienced ultrasound operator to minimize inter-operator variability. Small sample size and low prevalence of aneuploidy affecting the robustness of study might be the limitation of the study.

In conclusion, when massive screening of aneuploidy was needed, the institution usually faced a shortage of experienced ultrasonography personnel. NT measurement by transverse approach with cut point at 2.9 mm gave similar accuracy as sagittal approach with a cut-off threshold of 3.0 mm as recommended by ACOG. In resource-limited setting, NT measurement by transverse approach might be the first step of screening tool for referring to experience MFM person. Validation of these findings in the larger and more diverse populations might be the future research plan.

CONCLUSION

NT measurement cut-off by transverse approach at 2.9 mm was comparable to 3.0 mm of sagittal approach.

TABLE 2. Comparison of NT measurement during GA 11-14 weeks between present and previous studies.

	Present	Pinnington	Montaguti	Yin	Dinç	Grossman	Khalifeh	Karki	Tomai
Year	2024	2024	2022	2022	2021	2020	2015	2013	2011
Country	Thailand	Thailand	Italy	China	Turkey	US	US	Nepal	Vietnam
Cases (n)	295	3,928	1,023	617	1,541	110	366	211	2,500
Age (years)	31.7	31.0	33	32.2	30.2		31.2	25.03	28.9
Nulliparity (%)	55.6		61.3						43.9
Prevalence (%)	2.7	0.33	0.6	3.4	6.7/4.1/2.1	0.7			1.5
Mode	2D	2D	2D	2D	2D	2D	3D	2D	2D
View	Tx	Sag	Tx	Sag	Sag	Sag	Tx	Sag	Sag
NT (mm)									
Sag	3.0	3.0	3.5	2.5	2.5/3.0/3.5	3.5	1.7	2.5	2.4
Tx	2.9		3.2				1.66		

Abbreviations: GA: gestational age, NT: nuchal translucency, 2D: two-dimensional sonography, 3D: three-dimensional sonography, Sag: sagittal view, Tx: transverse or axial view, Mode: ultrasonography mode, View: plane of study

What is already known on this topic?

Genetic abnormalities or fetal malformation should be diagnosed as early as possible. Combination of fetal nuchal translucency (NT) and maternal serum analytes between 10 and 14 weeks of GA were recommended in year 2020 by ACOG. NT is the most effective tool for detecting Down Syndrome. Thick NT (more than 3.0 mm) measured by median sagittal view was associated with fetal anomalies or cardiac anomalies. Currently NT has been measured in a sagittal plane that necessitates an experienced sonographer. The transverse approach required less skill from staff and merited investigation.

What does this study add?

When universal aneuploidy screening was needed in situations with a shortage of experienced ultra sonographers, NT measurement via transverse approach with a cut-off point at 2.9 mm gave comparable accuracy to a sagittal approach.

Data Availability Statement

The data supporting the findings of this study are available from the corresponding author upon reasonable request.

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Conflict of Interests

The author declares no conflict of interest.

Author Contributions

Conceptualization and methodology, P.J., S.M., S.P. and B.S. ; Investigation, P.J. and S.M. ; Formal analysis, P.J.,K.S.,S.P. and B.S. ; Visualization and writing – original draft, P.J., S.M. and K.S. ; Writing – review and editing, P.J., S.M., K.S. and K.B. ; Supervision, S.M. ; All authors have read and agreed to the final version of the manuscript.

Institutional Review Broad Statement

This prospective study had been approved by the local Institutional Review Broad (IRB No.84/66).

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