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ORIGINAL ARTICLE

# Effects of Period of Gestation and Position of Fetal Neck on Nuchal Translucency Measurement

**Kore Shailesh · Hegde Aparna · Kanavia Divya · Supe Pradnya · Parikh Mansi · Nandanwar Y. S.**

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**Abstract**

*Objective* The aim of this study was to determine the effects of period of gestation and position of fetal neck on nuchal translucency measurement.

*Materials and Methods* Nuchal translucency was measured in the mid-sagittal plane, with the fetal neck in the flexed, neutral, and extended positions in 100 pregnant women between 11 and $13^{+6}$ weeks. Mean nuchal translucency measurements at different periods of gestation were compared. Differences between the extended and neutral positions (Δ extended nuchal translucency) and those between the flexed and neutral positions (Δ flexed nuchal translucency) were calculated. The repeatability coefficients for the measurements in all the three positions were computed. Statistical analysis was also done.

*Results* Nuchal translucency values were 1.050 ± 0.282 mm in the 11th week, 1.243 ± 0.348 mm in the 12th week, and 1.823 ± 0.357 mm in the 13th week ($r = 0.747, p < 0.0001$). The mean Δ flexed value was 0.233 ± 0.133 mm lesser than the neutral value ($p < 0.0001$). The mean Δ extended nuchal translucency was 0.305 ± 0.155 mm greater than the neutral value ($p < 0.0001$). The repeatability coefficient was the lowest in the neutral position (0.17 mm in the neutral position, 0.28 in the flexed position and 0.41 mm in the extended position).

*Conclusion* We concluded that the period of gestation and fetal neck position can make a significant difference to nuchal translucency measurement. Repeatability of measurement is more accurate with the fetal neck in the neutral position. These findings have important implications for clinicians using nuchal translucency to screen the obstetric population for Down's syndrome.

**Keywords** Nuchal translucency · Period of gestation · Fetal neck position

## Introduction

There are established associations between increased nuchal translucency measurement and fetal aneuploidies, fetal anomalies, rare genetic syndromes and spontaneous abortions [1]. Fetal nuchal translucency at 11–14 weeks has been combined with maternal age and maternal serum biochemistry to provide effective method of screening for trisomies [2, 3]. When describing the usefulness of nuchal translucency measurement in screening for fetal trisomies in the first trimester, it has been implied that nuchal translucency measurement might partly depend on period of gestation and degree of flexion of the fetal head.

**Electronic supplementary material** The online version of this article (doi:10.1007/s13224-012-0341-7) contains supplementary material, which is available to authorized users.

Kore S. (✉), Associate Professor · Hegde A., Lecturer · Kanavia D., Registrar · Supe P., Registrar · Parikh M., Registrar · Nandanwar Y. S., Professor & Head
Obstetrics & Gynecology, L.T.M. Medical College, Sion, Mumbai, 400022, India
e-mail: shaileshkore@hotmail.com

## Aims of the Study

- To assess effect of the period of gestation on measurement of nuchal translucency.
- To assess effect of fetal neck position on nuchal translucency measurement.
- To compute the repeatability coefficient (RC) in different neck positions and period of gestation.

## Materials and Methods

This cross-sectional study was conducted as a part of an ongoing programme of first trimester screening for trisomies, at the Fetal Medicine clinic of a tertiary teaching institute in Mumbai. Approval for the project, and the study was taken from the hospital Ethics Committee.

One hundred pregnant women between 11 and $13^{+6}$ weeks gestation from unselected population were included in this study. In all these women, trans-abdominal sonography was done by curvilinear probe on Toshiba Eccossy machine.

Measurement of nuchal translucency was done in longitudinal midline sagittal view. The measurement was done in three different positions: with fetal neck in maximum extension, neutral, and maximum flexed positions using cineloop facility. This facility records last 10 seconds of real time display, thus allowing operator to record the fast movement of the fetus, away from the amniotic membrane and to be able to play back the recording frame by frame. Often, the movement will start with an extension followed by neck returning to neutral position and finishing with maximum flexion. The neutral position is defined as position where angle between sagittal spine and occiput is zero. All measurements were to the nearest 0.1 mm. Same examiner performed all scans.

The women were not given any special instructions regarding filling of the bladder. Maximum time taken for a scan was 25 min.

Statistical analysis was done. Paired Students *t* tests were used to examine the differences between mean values of neutral position nuchal translucency and extended (Δ extended nuchal translucency) or flexed (Δ flexed nuchal translucency) positions. Repeatability was assessed using the method described by Bland and Altman [4]. Unpaired *t* test assuming equal variance was used to compute the statistical significance of the difference in the nuchal translucency values at different periods of gestation. Correlation coefficient *r* was measured for the relationship between the period of gestation and the crown rump length with the nuchal translucency values in the neutral position and standard error of correlation was computed.

## Results

Hundred women between 11 and $13^{+6}$ weeks were studied.

Most of these women were below 30 years of age, mean being 23.4 ± 3.7 years.

There were 42 primigravidas and 58 multigravidas. The number of women with period of gestation 11–$11^{+6}$, 12–$12^{+6}$, and 13–$13^{+6}$ weeks were 34, 31, and 35 respectively.

Mean nuchal translucency in neutral position was 1.446 ± 0.460 mm. The nuchal translucency in the neutral position at 12–$12^{+6}$ weeks was 1.243 ± 0.348 mm which was significantly greater than that at 11–$11^{+6}$ weeks which was 1.050 ± 0.282 mm ($p < 0.0001$). The nuchal translucency at 13–$13^{+6}$ weeks was 1.823 ± 0.357 mm which was again significantly greater than nuchal translucency measurements at 11–$11^{+6}$ weeks ($p < 0.001$) and 12–$12^{+6}$ weeks ($p < 0.001$). Unpaired *t*-test assuming equal variance was used to compute the statistical significance (Fig. 1)

The nuchal translucency in flexed position (mean 1.213 ± 0.422 mm) was consistently lower than that in neutral one. Nuchal translucency in extended position (mean 1.751 ± 0.510 mm) was consistently higher than that in neutral position ($p < 0.0001$). The mean Δ extended NT was 0.305 ± 0.155 mm greater than the neutral value [95 % CI = 0.05–0.56 mm, $T = 19.640$; $p < 0.0001$].

The mean Δ flexed value was 0.233 mm lesser than the neutral value [95 % CI = 0.01–0.45 mm, $T = 17.470$; $p < 0.0001$]. Mean nuchal translucency in flexed position was lower than, and that in extended position was higher than, the neutral value at every week of gestation (Figs. 2, 3).

*RC*: The RC measures the degree and level of agreement between two measurements of the same variables. The lower the RC, the better is the repeatability and, hence the test.

The RC for the neutral position (0.17 mm) was less than that for measurement in the flexed position (0.28 mm) and extended position (0.41). Thus, repeatability was the best in the neutral position as seen in Fig. 4.

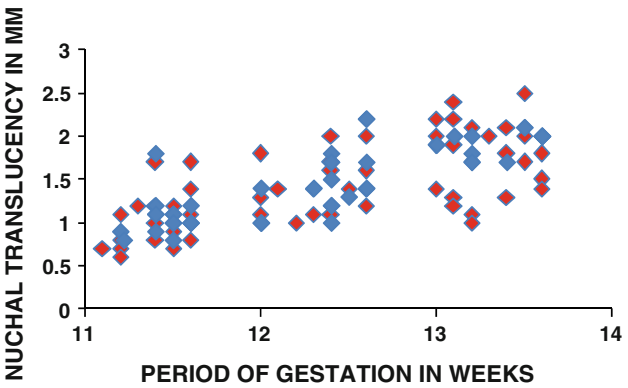


**Fig. 1** Effect of period of gestation on nuchal translucency value. *Blue dots* indicate overlapping of points (More than one subject). (Color figure online)

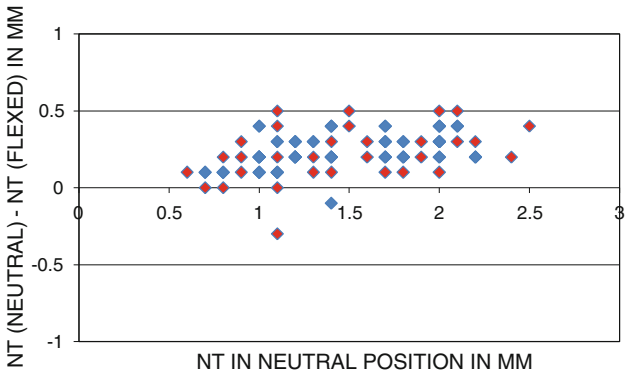


**Fig. 2** Difference between NT In neutral and flexed positions against NT in the neutral position. *Blue dots* indicate overlapping of points (More than one subject). (Color figure online)

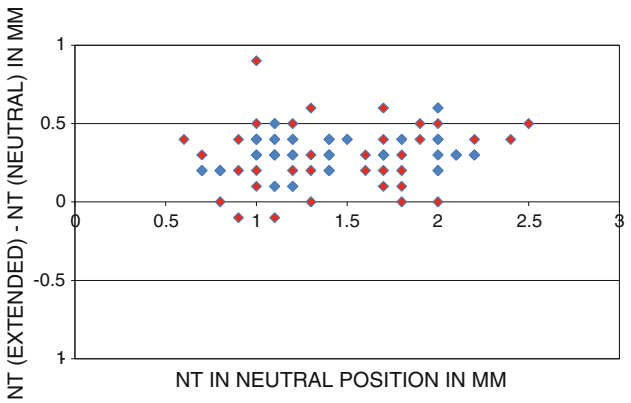


**Fig. 3** Difference between NT In extended and neutral positions against NT in the neutral position. *Blue dots* indicate overlapping of points (More than one subject). (Color figure online)

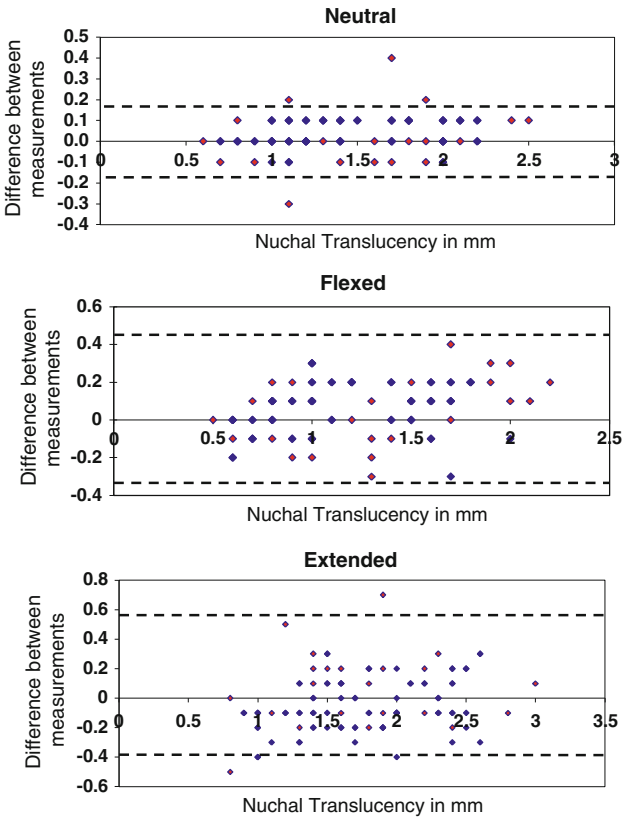


**Fig. 4** Repeatability of nuchal translucency measurements in neutral, flexed, and extended positions, 95 % confidence intervals (*blue dots* indicate overlapping). (Color figure online)

**Table 1** RC according to period of gestation at different neck position

| Period of gestation | RC in neutral position | RC in flexed position | RC in extended position |
|---|---|---|---|
| 11–$11^{+6}$ weeks | 0.21 | 0.25 | 0.49 |
| 12–$12^{+6}$ weeks | 0.15 | 0.31 | 0.33 |
| 13–$13^{+6}$ weeks | 0.14 | 0.31 | 0.33 |
| RC overall | 0.17 | 0.28 | 0.41 |

As seen in Table 1, as the period of gestation increases, the RC reduces, i.e., the repeatability of the test improves.

## Discussion

Fetal nuchal translucency increases with period of gestation and crown-rump length [5]. Therefore, it is essential to take gestation into account when determining whether a given nuchal translucency is increased. In our study, mean nuchal translucency values were $1.050 \pm 0.282$ mm in the 11th week, $1.243 \pm 0.348$ mm in the 12th week, and $1.823 \pm 0.357$ mm in the 13th week.

The nuchal translucency measurement is affected by fetal neck position. When fetal neck is extended, the measurement can be increased by 0.6 mm and when the neck is flexed, the value can be decreased by 0.4 mm [6]. Our study has confirmed that angle of fetal neck can affect nuchal translucency measurements significantly.

Thus, measurement in extended position will significantly increase false positive rate, thereby increasing the need for invasive procedures, with consequent cost implications and the possible loss of healthy fetuses.

Also, the fetal neck is often flexed in the first trimester and hence measurement in the flexed position may result in some fetuses with trisomy going undetected, especially in cases with borderline measurement. In other words, it would increase the number of false negatives. If we consider the nuchal translucency in neutral position as the standard, then we can apply the 95th centile and the 99th centile confidence limits computed for the neutral position values to the values obtained in the flexed position and the

extended position. This would help us find the false negatives and the false positives when the nuchal translucency measured in the flexed and extended positions are used for screening.

For our study, the 95th centile confidence intervals for the neutral position are 0.69–2.20 mm and the 99th centile confidence intervals for the neutral position are 0.38–2.52 mm. Three women would be screened positive when nuchal translucency is measured in the neutral position for the 95th centile confidence intervals and none of the women would be screened positive when 99th centile confidence intervals are applied.

Applying these confidence intervals to the values in the flexed position, two women would be screened as positive for the 95th centile and none of the women would get screened as positive. Thus the false negative value, when flexed position measurements are considered for screening, is one for the 95th centile.

Similarly, when these confidence intervals are applied to the values in the extended position, 22 women would be screened positive for the 95th centile, and four would be screened positive for the 99th centile. Thus, the false positive values, when extended position measurements are considered for screening, are 19 for the 95th centile and 4 for the 99th centile.

The RC was the least in neutral position, meaning the best agreement between two measurements. The flexed and extended positions showed large repeatability values. One possible explanation for the wide repeatability in flexed and extended positions might be the variable degree of angulation of the fetal neck. Although it might be possible to standardize this by measuring the angle from the fetal occiput to the long axis of fetal spine, it might be difficult to implement in clinical practice. Also, repeatability is better as the period of gestation increases as seen in Table 1. This is because as the period of gestation becomes longer, the nuchal translucency value increases. The measurement with calipers is easier and more accurate when the nuchal translucency value increases.

Accuracy of nuchal translucency greatly depends on the quality of the image. The resolution of the transducer can be improved with good quality machines, especially with multivariate frequencies. In obese patients, transvaginal scanning is sometimes the only way of ensuring good resolution [7]. The position of the fetus in relation to the amniotic membrane can also produce an error in nuchal translucency measurement. Patience is required with regard to waiting for the fetus to move away from the membrane, so that nuchal edge is seen separately from the amniotic membrane. The placement of the calipers can also produce variation in the measurement, and it has been suggested that the calipers should be placed in an "on and on" position. The magnification of the image must be adequate, and the fetus should occupy at least three-quarters of the screen size when nuchal translucency is measured.

The accuracy and repeatability greatly depend on level of competence of the staff. The competence can be achieved by proper and adequate training, duly certified by an external agency. It should be subjected to quality control using high standard precision equipment and clinical protocol [8].

Recently, computerized three-dimensional reconstruction of image has been used to achieve the increased accuracy of measurement [9, 10]. High-quality performance of screening necessitates appropriate measurement of fetal nuchal translucency.

It must be remembered that small variation in measurement of nuchal translucency can greatly change the performance of the screening program [11]. As more and more women and prenatal centers prefer first trimester early screening [12], it is necessary to adhere to strict measurement criteria to improve the performance of the test.

## Conclusion

The nuchal translucency measurement increases with gestation and crown rump length. Thus, it is important to take the period of gestation into account when determining whether a given translucency thickness is increased, with different cut off levels and values for each week.

The fetal neck position affects nuchal translucency measurement significantly. The accuracy and repeatability are the best in neutral position. Hence, neutral position of the fetal neck should be taken as a standard, and nuchal translucency measurement should always be done in this position.

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