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The effects of maternal and fetal parameters on the quality of nuchal translucency measurement

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ABSTRACT

Objective *To evaluate the influence of maternal and fetal parameters on the quality of fetal nuchal translucency measurement.*

Design *This was a prospective study in 227 consecutive pregnant women undergoing nuchal translucency screening by transabdominal sonography. The same well-qualified sonographer performed all the scans and in each case the best-quality image was selected and scored according to an image scoring system (total maximum score, 9). The quality of the image was examined in relation to maternal age, weight, abdominal wall thickness, amniotic sac diameter, posterior uterine wall depth (distance between abdominal wall surface and posterior uterine wall surface), placental location, fetal crown–rump length and nuchal translucency thickness. Correlation coefficients were calculated and stepwise linear regression was used to adjust for confounders and to define the predictors for image score.*

Results *The only two parameters that provided a significant independent contribution to the prediction of the image score were posterior uterine wall depth and fetal crown–rump length. Intravariable analysis of these two parameters demonstrated that the cut-off associated with a significant change in the image quality was 80 mm for posterior uterine wall depth (score difference, 1.06;* $P < 0.001$*) and 70 mm for crown–rump length (score difference, 0.77;* $P = 0.001$*). In the group of women with two values above these cut-off points, an average score decrease of 1.90 (*$P < 0.001$*) was observed.*

Conclusions *The quality of fetal nuchal translucency measurement is poorer when the fetal crown–rump length is > 70 mm and the posterior uterine wall depth is > 80 mm.*

INTRODUCTION

Increased fetal nuchal translucency (NT) thickness at 10–14 weeks is associated with chromosomal defects, cardiac anomalies and a wide range of genetic syndromes[1–4]. The success of screening by fetal NT depends on the appropriate training of sonographers and the use of strict sonographic criteria, including a good sagittal section with the fetus in the neutral position, magnification such that the fetus occupies at least 75% of the image, fetal skin distinguished from the amnion, and calipers used to measure the maximum thickness of the subcutaneous translucency between the skin and the soft tissue overlying the cervical spine[5,6]. Herman and coworkers[7,8] developed an objective image scoring method, based on the above criteria, to quantify the quality of NT images and reported that quality depends on the degree of training of the sonographer.

The aim of this study was to examine the possible influence on the image quality of fetal NT of non-performer-dependent factors, including maternal age, weight, abdominal wall thickness, amniotic sac diameter, posterior uterine wall depth, placental location, fetal crown–rump length (CRL) and NT thickness.

METHODS

This was a prospective study in 227 consecutive singleton pregnancies referred for NT screening, from June 1999 to March 2000, to the ultrasound unit at Barzilai Medical Center, Ashkelon, Israel. Patients with major fetal anatomical defects were excluded from the study. All scans were carried out by the same sonographer, who had received The Fetal Medicine Foundation Certificate of Competence in the 10–14-week Scan.

Fetal NT was measured transabdominally (2–5-MHz curved array transducer, HDI 3000, ATL, Bothell, WA, USA) and the images were printed on high-quality thermal paper (SONY-110HD-UPP High Density). In each patient at least three NT thickness measurements were performed and the best-quality image was selected for the study. Another qualified sonographer scored the images according to the image scoring method described by Herman and coworkers[7]. In this

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system there are three major criteria: fetal section (oblique, 0; mid-sagittal, 2), caliper placement (misplaced, 0; appropriate, 2), skin line (nuchal only, 0; nuchal and back, 2) and three minor criteria: image size (unsatisfactory, 0; satisfactory, 1), amnion (not visualized, 0; visualized, 1) and head position (flexion/hyperextension, 0; neutral, 1). The final score was categorized into one of four quality groups: excellent (score 8–9), reasonable (score 4–7), intermediate (score 2–3) and unacceptable (score 0–1).

The following data were recorded for each patient: maternal age, weight, abdominal wall thickness (measured as the distance between the abdominal surface and the anterior wall of the amniotic sac) (Figure 1), amniotic sac diameter (anterior–posterior diameter of the gestational sac), posterior uterine wall depth (distance between abdominal wall surface and posterior uterine wall surface), placental location, fetal CRL and fetal NT thickness.

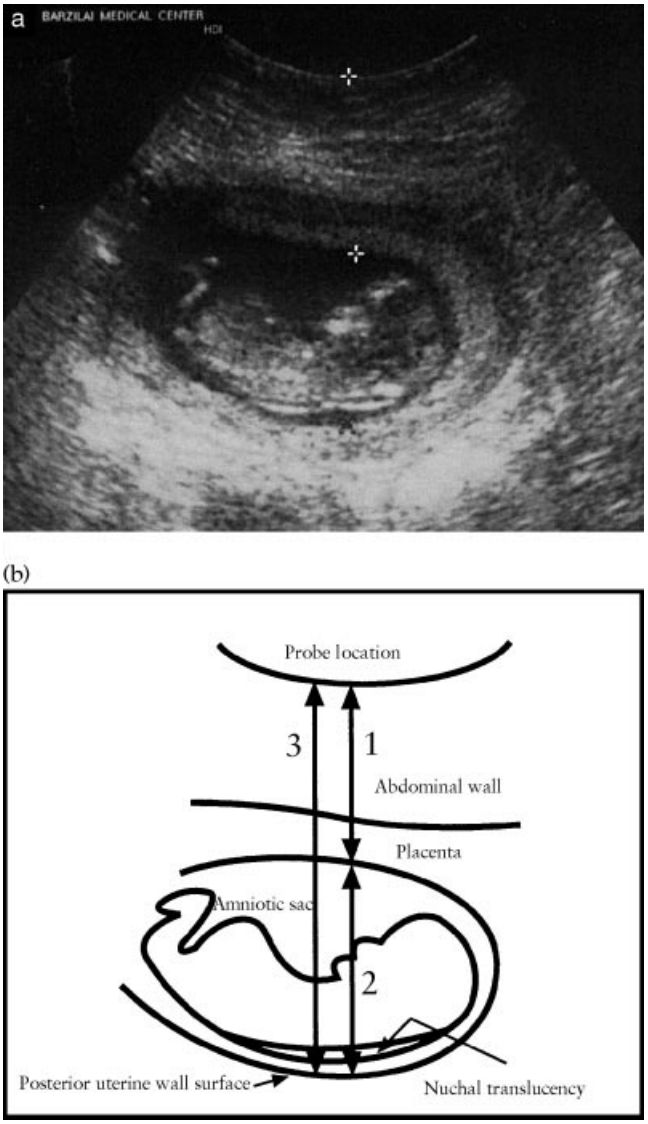

Figure 1 Ultrasound image (a) and schematic drawing (b) for the measurement of fetal nuchal translucency thickness, illustrating the defined parameters of this study. 1, distance between abdominal surface and anterior amniotic membrane; 2, distance between anterior and posterior amniotic membranes; 3, distance between abdominal wall surface and posterior internal uterine wall surface.

Regression analysis was used to determine the significance of the association between image score and each variable. Stepwise linear regression was then used to adjust for confounders and to define those variables that provided a significant independent contribution to the prediction of image score.

RESULTS

Fetal NT was successfully measured in all 227 pregnancies. The mean image score was 6.6 (standard deviation (SD), 1.6; range, 3–9). The means for the variables examined and their relation to the image score are shown in Table 1. There were significant associations between image score and abdominal wall thickness, amniotic sac diameter, posterior uterine wall depth and CRL. There was no significant difference ($P = 0.09$) in image score between those with an anterior placenta ($n = 92$; average score, 6.37) and those with a posterior placenta ($n = 120$; average score, 6.74). In the linear regression model there were two variables with significant independent association with image score: posterior uterine wall depth ($\beta = -0.228$; $P < 0.001$) and CRL ($\beta = -0.159$; $P = 0.014$; $r^2 = 8.4\%$). Table 2 shows the intravariable analysis of these two parameters. This analysis yielded a cut-off point for each parameter that significantly changed the image quality score: 80 mm for posterior uterine wall depth (score difference = 1.06; $P < 0.001$) and 70 mm for CRL (score difference = 0.77, $P = 0.001$). Table 3 presents the effect of these two factors, in various combinations, on image score. In women with a posterior uterine wall depth of < 80 mm and a fetal CRL of < 70 mm the average image score was 7.05. When posterior

Table 1 Association between the independent variables and image quality score

Variable	*Mean (SD, range)*	r	P
Maternal age (years)	29.9 (5.0, 21–44)	−0.061	0.365
Maternal weight (kg)	63.7 (12.0, 42–110)	−0.127	0.06
Abdominal wall depth (cm)	3.8 (1.4, 0.9–9.2)	−0.160	0.016
Gestational sac diameter (cm)	3.7 (1.1, 1.7–7)	−0.148	0.026
Posterior uterine wall depth (cm)	7.5 (1.6, 3.7–14.6)	−0.242	0.001
Crown–rump length (mm)	61.4 (11.4, 36–85)	−0.180	0.007
Nuchal translucency thickness (mm)	1.2 (0.4, 0.5–2.5)	−0.013	0.841

SD, standard deviation.

Table 2 Intravariable analysis of posterior uterine wall depth and crown–rump length

Variable	*Cut-off (mm)*	n1	n2	*Quality score difference*	P
Posterior uterine wall depth	70	142	85	0.46	0.033
	80	65	162	1.06	< 0.001
	90	34	193	0.95	0.002
Crown–rump length	50	184	43	0.17	0.522
	60	133	94	0.40	0.06
	70	56	171	0.77	0.001

*n*1, number of patients above the cut-off; *n*2, number of patients below the cut-off.

Table 3 Influence of posterior uterine wall depth and crown–rump length on the image score

Group	*Definition of group*	*Negative factors*	n	*Image score (mean (SD))*
1	Crown–rump length < 70 mm, posterior uterine wall depth < 80 mm	0	112	7.05 (1.43)
2	Crown–rump length > 70 mm, posterior uterine wall depth < 80 mm	1	43	6.47 (1.47)
3	Crown–rump length < 70 mm, posterior uterine wall depth > 80 mm	1	52	6.20 (1.64)
4	Crown–rump length > 70 mm, posterior uterine wall depth > 80 mm	2	20	5.15 (1.63)

SD, standard deviation.

Table 4 Statistical analysis and difference of quality between mean image score of groups described in Table 3

Compared groups	*Difference in quality*	P
1 vs. 2	0.54	0.024
1 vs. 3	0.76	0.003
1 vs. 4	1.90	< 0.001
2 vs. 3	0.18	0.585
2 vs. 4	1.32	0.002
3 vs. 4	1.14	0.010

uterine wall depth was > 80 mm and CRL was > 70 mm, the average image score was 5.15. Table 4 presents the mean difference between the cut-off point groups as defined in Table 3. A significant decrease of image score (1.90; $P < 0.001$) was found in the group of women with two values above the cut-off points mentioned above, compared to the group of women with two values under these cut-off points.

DISCUSSION

The accuracy of NT screening, provided that the appropriate criteria and high-resolution equipment are used, depends firstly on the competence of the sonographer, and secondly, as demonstrated in this study, on non-examiner-dependent conditions. The objective image scoring method, introduced by Herman and coworkers, has previously been used to demonstrate that the quality of NT images depends on the degree of training of the sonographer[7,8]. In our study, the same methodology was used to examine the possible importance on NT image quality of a series of maternal, uterine and fetal parameters. In order to neutralize the effect of various examiners and/or different ultrasound equipment on the quality of the measurement, the same well-qualified sonographer and the same high-resolution ultrasound equipment were used to perform all scans in this study.

The quality of the NT image significantly decreased with increasing posterior uterine wall depth and fetal CRL. The NT image score was decreased by approximately one point when the value was above the determined cut-off point of 80 mm for posterior uterine wall depth and 70 mm for fetal CRL. When both parameters had values above their cut-off points, the image quality score decreased by two points. In the image score method there are four quality groups and a decrease in the score by two points results in transfer of the total score to a lower quality group. A possible practical implication of our findings is that NT screening should be carried out before the fetal CRL reaches 70 mm (13 weeks and 1 day) in order to prevent the expected decrease in image quality. In patients with fetal CRL > 70 mm and posterior uterine wall depth > 80 mm, if the quality of the image is poor, transvaginal sonography should be considered, which may avoid the adverse effects of a high posterior uterine wall depth.

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