Semi-automatic Sono T measurement of nuchal translucency

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Summary

A prospective study of 63 singleton pregnancies between 11 + 0 and 13 + 6 weeks gestation underwent semi-automatic nuchal translucency (NT) measurement and were compared with two-dimensional ultrasonography (2D US). Inter-observer variation and the repeatability were evaluated. Sono T automatically achieves mid-sagittal plane views and measures the maximum NT thickness. Measurements have less inter-observer variation (CI = -0.13, -0.04) when compared with 2D measurements (CI = -0.45, 0.28). It is reproducible and comparable to conventional 2D US technique for NT measurement. However, incorporating Sono T into routine practice requires further program refinements in order to reduce erroneous NT measurements.

Key words: 2D/3D; HDlive US; Semi-automatic Sono T; Nuchal translucency measurements.

Introduction

Nuchal translucency (NT) measurement, detection of presence or absence of nasal bone, and evaluation of the characteristics of vascular flow in the ductus venosus, are highly sensitive screening tools for trisomy 21, for other major chromosomal defects, for congenital structural anomalies, for heart defects, and for adverse pregnancy outcome that results from other etiologies [1].

Using properly-measured NT alone allows prenatal detection of over 70% of cases of trisomy 21. Using NT in combination with maternal serum alpha-fetoprotein (AFP), pregnancy-associated plasma protein A (PAPP-A), and free beta-human chorionic gonadotropin β-hCG, provides efficient Down's syndrome risk assessment, with a detection rate of 80%-87% (five percent false-positive rate), and also allows earlier diagnosis of fetal aneuploidies [2, 3].

NT measurement is well-standardized for two-dimensional ultrasonography (2D US) [2, 4]. Errors in measurement may have a significant effect on risk assessment.

To improve reliability and to avoid errors, new US measurement modes such as:

– three/four dimensional (3D/4D) surface [5-18],
– volume calculation with virtual organ computer-aided analysis (VOCAL),
– automated volume count (AVC) [19, 20],
– semi-automatic systems [1, 21-28] and
– HDlive [29, 30] (Figure 1) have been tested.

Volume measurement of the nuchal area has been reported [19, 20] and provides more detailed information when the shape of a target object, such as an hygroma colli, is irregular on a 2D image [20].

Only a small number of studies [1, 8, 24, 25, 27, 28] have been reported on the potential benefits of using a semi-automated approach in NT measurement. Six of the references are scientific papers, all with a small sample size, and one is an editorial [26]. All of them indicate that the experience is too small and it is not possible to recommend its use.

The aims of this study were: to evaluate the clinical usefulness of semi-automated distances using a 3D Sono T software and to establish if the measurements using either 2D or Sono T have significant differences, in order to justify a high-economic inversion with the new software.

Materials and Methods

2D and 3D NT mid-sagittal measurements were performed in 63 patients with normal singleton pregnancies at gestational ages between 11 weeks and 13 weeks + six days. 2D US and Sono T software were then employed to calculate the maximum NT width. All measurements were acquired trans-abdominally.

Although the sample size is small (as the other publications), it is mathematically sufficient. This investigation obtained the approval from the Ethics Committee from the "Fundación para la Investigación del Hospital Clínico Universitario de Valencia, (Spain)". All patients signed informed consent.

Semi-automatic measurements were performed using the Sono NT function in a mid-sagittal section determined by conventional 2D US.The operator placed the region of interest (ROI) in the most representative section of the nuchal area. The upper calliper was located on the inner border of the upper echogenic line and the lower calliper was placed on the inner border of the lower echogenic line (on-to-on measurement). The maximum vertical distance was automatically selected (Figure 1) [25].

Abnormal fetuses with enlarged NT and fetuses in the prone position were excluded from the initial enrolment.

In each one of these, the authors measured NT in mm by one operator, using 2D (NT1) and Sono T software (NT2). Manual measurement of NT was performed according to the Fetal Medicine Foundation (FMF) guidelines [4].

Statistical analysis

The *repeatability* of the observations provided by both operators was compared by calculating the 95% ranges of agreement over the differences [31]. This measurement is used by the British Standards Institution [32] to define the repeatability coefficient. Likewise, the point estimate of this difference and the 95% con-

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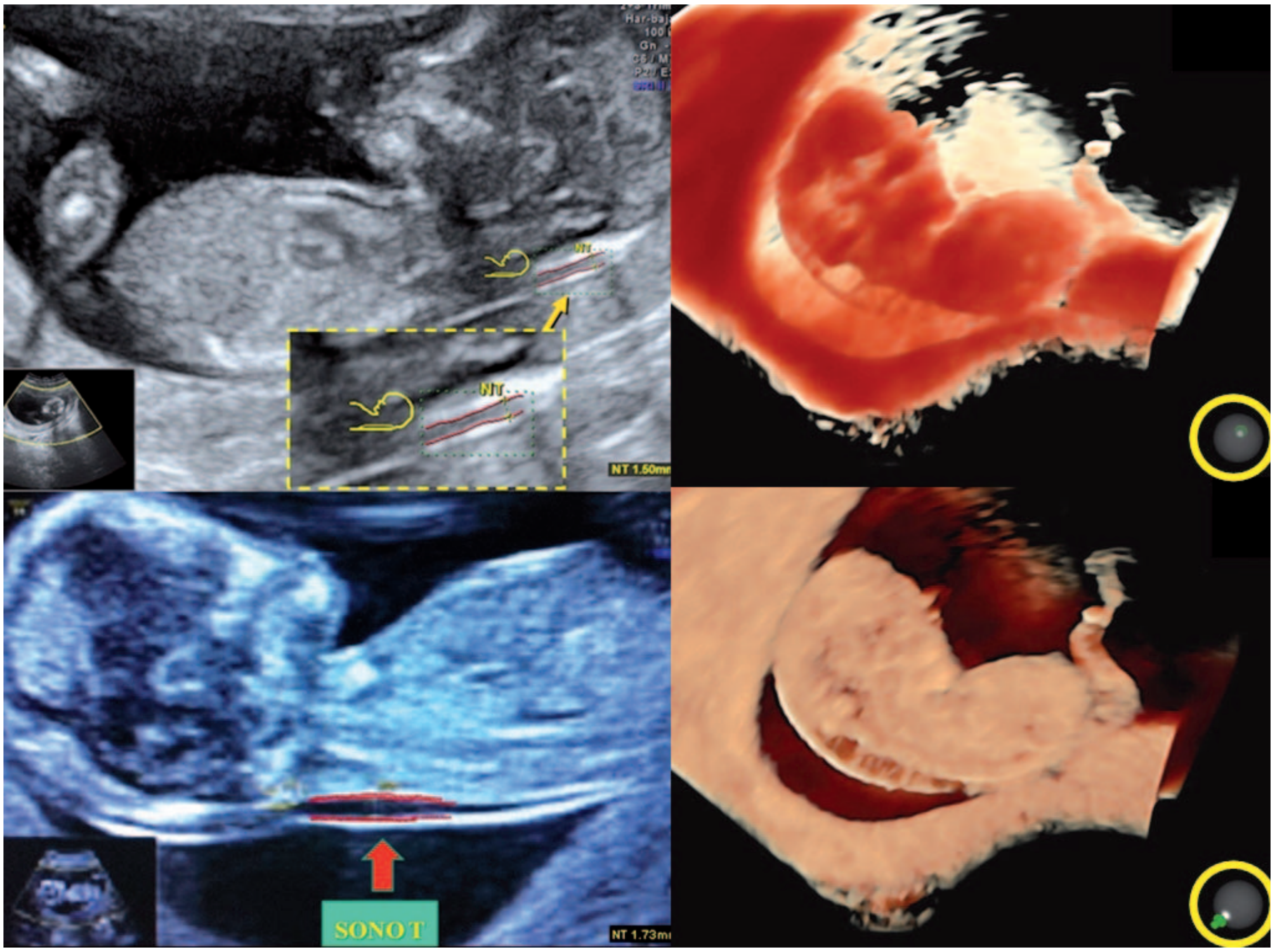

Figure 1. — To the left Sono T showing the two red lines located in the inner border of both NT membranes (on to on measurement, yellow arrow). The computer automatically measures the distance, appearing in the screen (same figure below right). To the right transvaginal sonogram HD live. Upper right: transparency mode. Lower right different position of light source producing different surface shadowing providing splendid image quality.

fidence interval was calculated. This method was applied for NT measurements (NT1 vs NT2). Measurements were compared with values of the FMF. All calculations were made with the Statistics R, version 2.12.2 software [33].

Results

Two measurements, one of the NT in mm using 2D (NT1), and one using Sono T software (NT2)**,** were carried out from observations on 63 patients.

Figure 2 shows NT1 (2D) and NT2 (Sono T) measurements with a confidence interval of 90%, according to the values of the FMF [4].

Figure 3 shows the differences between NT1 (2D) and NT2 (Sono T) with respect to the percentile 50 of FMF. The authors conclude that both technique measurements are not significantly different from percentile 50 of FMF.

As can be seen in Figure 3, there is an association between the two measurements since Pearson's correlation is $r = 0.9$. The measurement of differences between the techniques was a calculation of a range where disagreements occurred in *95% ranges of agreement* [27, 28]. With more than 50 observations, it was based on the mean of the observed differences (d) and the standard deviation of these differences (s_{diff}). Defined as $d \pm 1.96 \cdot s_{diff}$. In this case, the interval obtained [-0.45, 0.28] indicates no significant differences between two measurements.

The confidence interval for the values (*d*, [d± s_{diff}/root (n)]) is [-0.13, -0.04], which indicates that there is a bias in the measurements of both operators. This means that a 2D technique with an interval of -0.024 provides values that are significantly lower than the values obtained with Sono T, with a +0.06 interval.

Discussion

Unfortunately, fetuses are not always properly positioned for technically adequate NT measurements (only

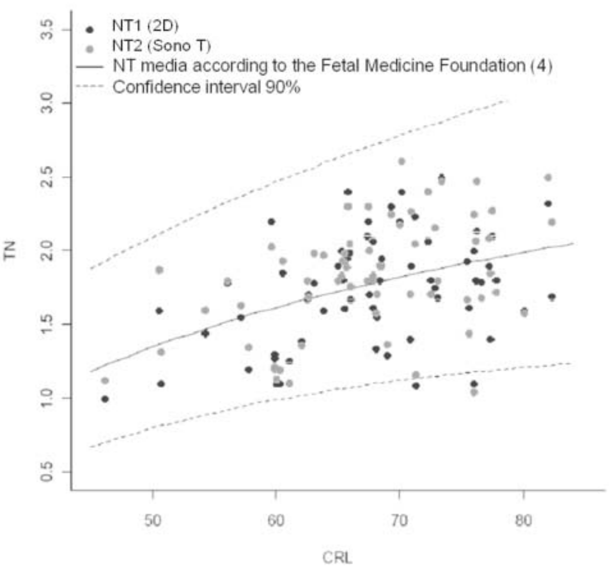

Figure 2. — Values of NT1 (2D) and NT2 (Sono T) vs NT media according to the values of the Fetal Medical Foundation (4).

10%-20% with the standard 2D abdominal or vaginal, approaches) [6]. Sonographers spend valuable time waiting (often unsuccessfully) for the fetus to move into an optimal position [19]. Moreover, when measurements obtained with 2D/3D have been compared, it has been observed that the 2D observations were often not realized in the optimal plane [6, 9].

In order to improve NT measurements, other technologies have been used:

The introduction of 3D US measurements created high expectations. Data from two decades were used for differential diagnoses between NT and hygroma colli [10, 11]. Later on, measurements between 2D and 3D were compared and values were attached to inter- and intra-observer visualization and reproducibility [11].

Refering to the semi-automatic methods, they have also been reported years ago [21, 22] and were not incorporated in the software of ultrasound machines. These methods are based on tracing the inner borders of the nuchal membrane, and consequently, they do not avoid the problem of underestimation of NT width associated with increased image magnification.

There are six recent reports similar to these in studies that used Sono T software [1, 8, 24, 25, 27, 28]. There is also one update, a state of the art report that raises many questions [26]. They all suggest that fetal NT measurement might afford some benefits.

Some like Moratalla *et al.* [1] compare the inter- and intra-observer variability with traditional measurement. Both variables were reduced with the automatic method. The standard deviation of measurement was ten times lower using a semi-automatic compared with a manual method (0.0149 mm vs 0.109 mm), and the semi-automatic method had an extremely high intra-class correlation coefficient of 0.98 mm. Others like Abele *et al*. [25] conclude that results are much better when obtained by "experts." They conclude that there is little evidence of any benefit in terms of measurement error variability when compared with manual methods.

A third group, Grangé *et al.* [24], suggests, curiously, that the only benefit would be obtained when this technology is used by less experienced operators and when they work with images of poorer quality.

Finally, a fourth group [8] comparing the differences between "experts" and "beginners" observed that the differences with 2D were significant but were not with Sono T

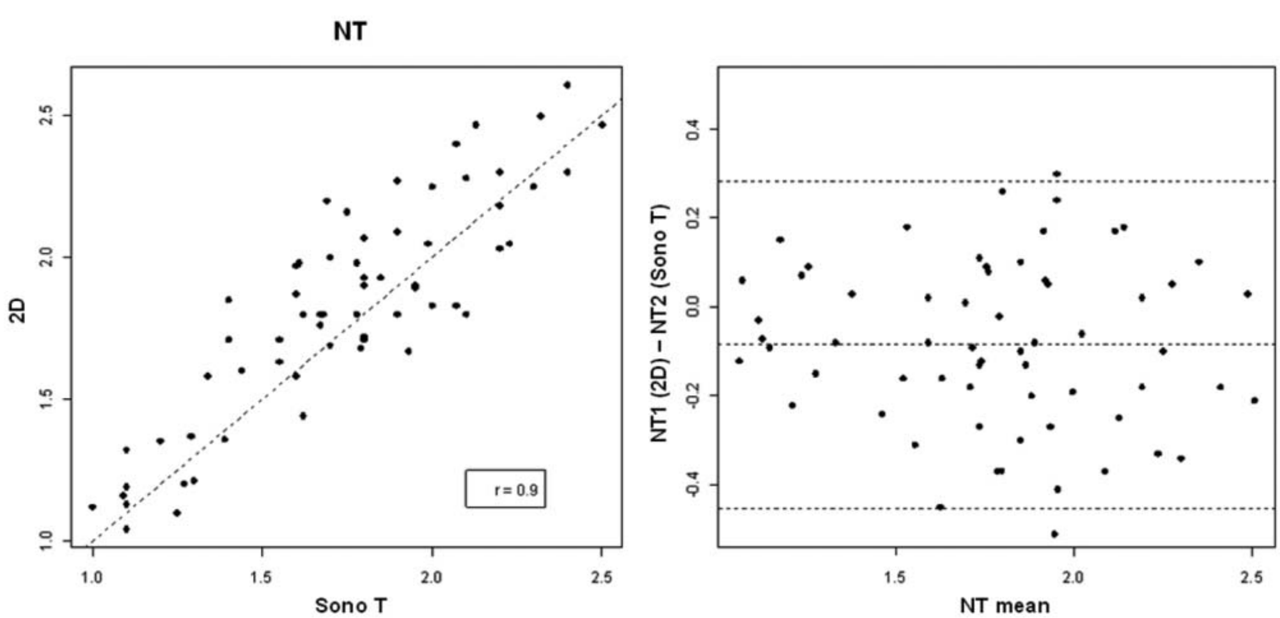

Figure 3. — Left: relation Observer 1 (2D) vs Observer 2 NT (Sono T). Right: NT differences between observers.

measurements.They recommend, as the present authors do, that Sono T be employed when experienced operators are not available.

Crude errors are generated in these measurements if the ROI box encompasses more of the nuchal area than strictly the margins of NT. It therefore remains operator-dependent [25].

Automatic measurement failed in 18.4% cases (the program was unable to acquire the correct mid-sagittal plane in 13.1% of cases or the caliper was misplaced in 5.3% of cases). [27, 28].

Manual skills are sufficient for reliable and reproducible NT measurements until proven otherwise with other clinical studies.

Widespread use of semi-automatic NT measurements, which is only now taking off as part of many national healthcare guidelines, could also lead to confusion at this critical time, thereby undermining 19 years of effort, exemplary teaching programs, and quality assessment projects [26]. Whether the new technologies Sono NT [24-26], AVC, and VOCAL [27, 28] can replace the current manual 2D methods, and whether the minimal tenths and hundredths of a mm differences in measurements are of interest, are yet to be determined.

Perhaps the new semi-automatic systems that evaluate the maximum distance over a 3D volume will be able to solve this problem [8, 27, 28]. However, the authors have not been able to see any evidence that this will be the case. At this time, these inconveniences stand in the way of universal unanimity in the use of these new 3D modes, since data are not available for them as is the case with 2D methods.

Conclusions

This work supports normal measurements between the gestational ages of 11 and 13 weeks + six days for Sono T as is the case with other reports [1, 8, 24, 25, 27, 28]. It is evident that semi-automatic measurements require further research [26] before definitive recommendations can be made [8, 27, 28]. The initial expectations for 3D US, AVC, and Sono T have yet to be fulfilled [1, 26-28].

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