



Semi-automated method to measure fetal abdominal wall thickness – how superior is it?

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Objective

To assess the intra operator and inter operator reliability of fetal abdominal wall thickness measurement using a newly developed software method and the traditional manual method.

Methods

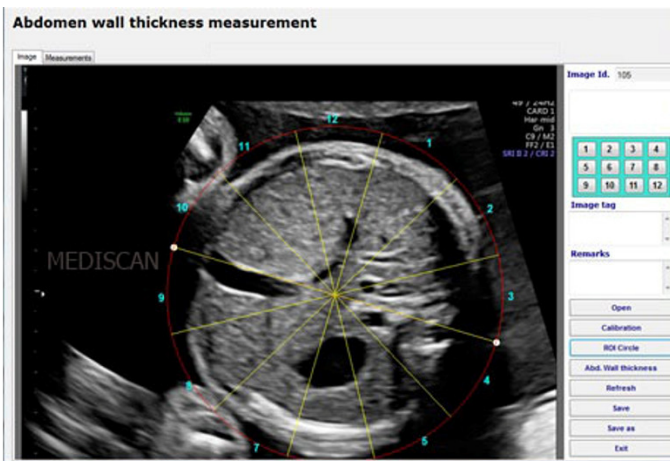
A semi-automated method was developed to measure the abdominal wall thickness, wherein the software divides the transverse section of the fetal abdomen into 12 quadrants. The operator selects the particular quadrant in the anterior abdominal wall and places an adjustable box over the required area for measurement. The software automatically identifies the edges of the abdominal wall in the region of interest box selected by the operator. Once the edges are identified, multiple automated measurements are taken and the maximum distance is displayed as the abdominal wall thickness. Since at present there is no gold standard method the current practice of manual measurement is used for comparison. Ninety four stored images of standard abdominal circumference section taken according to existing guidelines were used in 4 sets, total of 376 images. Three operators with varying levels of experience in the field of ultrasonography participated in the study. Each set of images was measured by all three operators, twice using the manual method and twice using the semi-automated method. Inter and intra observer reliability was calculated using R software version 3. 4. 1. Further, the applicability of the software on seventy three images acquired from other centers was also tested.

Results

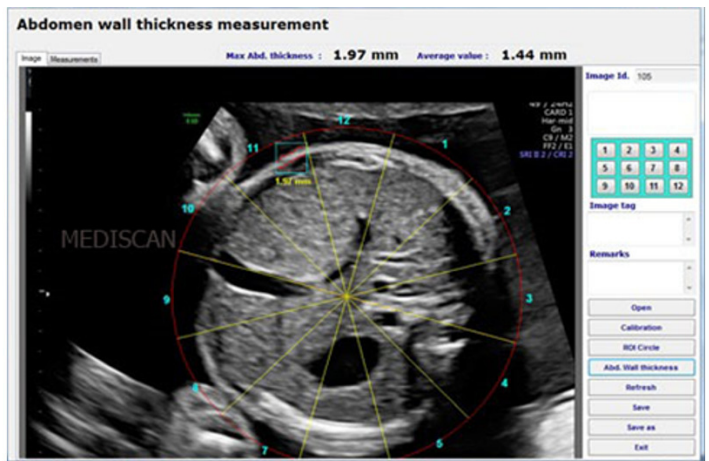
The inter and intra operator reliability was calculated using Intra class correlation coefficient. The intra operator reliability for all 3 sonographers using manual method was 0. 783, 0. 732, 0. 832 and using software method was 0. 822, 0. 83, 0. 934 respectively. All three operators showed better intra operator agreement using the semi-automated method. The inter operator reliability for manual method was 0. 898 and software method was 0. 965. The software vs manual measurement agreement among the three operators is varied from moderate to excellent (0. 77, 0. 867, 0. 920), with overall agreement being good (0. 852). Irrespective of the operators the repeatability of a measurement is good using both methods with semi-automated method showing better intra class correlation coefficient (0. 863) than manual (0. 791). The software could be used in 89% of routine abdominal circumference images from other centers.

Conclusion

The semi-automated method showed better inter and intra operator reliability and overall repeatability than the traditional manual method, thereby proving to be a superior tool for measuring fetal abdominal wall thickness.



Abdominal wall thickness (AWT) measured within the adjustable box



Transverse section of fetal abdomen divided into 12 quadrants

Table 1. Intra operator reliability using manual method.

Operator	Measurement I (Mean ± SD)	Measurement II (Mean ± SD)	ICC (95% CI)
RP	2.4 ± 0.66	2.43 ± 0.77	0.783 (0.69 – 0.85)
JR	2.2 ± 0.62	2.23 ± 0.71	0.732 (0.623 – 0.813)
SP	2.09 ± 0.72	2.06 ± 0.67	0.832 (0.757 – 0.885)

Table 2. Intra operator reliability using software method.

Operator	Measurement I (Mean ± SD)	Measurement II (Mean ± SD)	ICC (95% CI)
RP	2.10 ± 0.61	2.12 ± 0.67	0.822 (0.743 - .878)
JR	2.18 ± 0.70	2.11 ± 0.60	0.830 (0.754 – 0.884)
SP	2.16 ± 0.67	2.16 ± 0.68	0.934 (0.902 – 0.955)

Table 3. Inter operator reliability for manual method.

Operator	Average measurement (Mean ± SD)	ICC (95% CI)
RP	2.42 ± 0.68	0.898 (0.816 – 0.939)
JR	2.26 ± 0.62	
SP	2.07 ± 0.67	

Table 4. Inter operator reliability for software method.

Operator	Average measurement (Mean ± SD)	ICC (95% CI)
RP	2.11 ± 0.61	0.965 (0.95 – 0.976)
JR	2.15 ± 0.62	
SP	2.16 ± 0.66	

Table 5. Agreement between software and manual measurements.

Operator	Average manual (Mean ±SD)	Average software (Mean ± SD)	ICC (95% CI)
RP	2.42 ± 0.68	2.11 ± 0.61	0.770 (0.513 – 0.876)
JR	2.26 ± 0.62	2.15 ± 0.62	0.867 (0.794 – 0.913)
SP	2.07 ± 0.67	2.16 ± 0.66	0.920 (0.878 – 0.948)