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Comparison of Automatic Intima Media Thickness Measurement and Eye Balling

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Compound Imaging is an ultrasound technique that scans up to 9 lines of sight and combines them in real time. This technique may improve ultrasound evaluations of intima media thickness (IMT) and carotid plaque echomorphology due to less shadowing and reverberations [1, 2]. Automated programs to assess IMT are used to make the measurements more objective and reproducible, as compared to human observers. Ultrasound settings significantly alter IMT measurements [3]. We wanted to compare different manual and semi-automated ultrasound techniques of IMT assessment, including compound imaging.

We investigated both end-diastolic far wall IMT of the common carotid arteries of 163 ischaemic stroke/TIA patients from our stroke unit (102 men, 61 women, mean age 62 years) using the HDI 5000 (Philips, The Netherlands) colour duplex and the software version HDI Lab 2.0. The following modalities were used: (1) the arithmetic mean of 3 measurements (1.0, 1.5 and 2 cm proximally to the bifurcation) using the cursors of the software. (2) As in '1' but using the compound imaging function. (3) The software itself calculated (offline) the IMT over the above-mentioned segment of 1 cm, transposing the longitudinal picture into a cross-sectional 2-dimensional picture of ultrasound intensities. On this latter picture, the software automatically put cursors at the points of interest. (4) As in '3' using compound imaging. (5) Using the same frame as in '3', the cursors were adjusted if the investigator felt they were not placed correctly. (6) As in '5' using compound imaging. The second investigator used the identical frozen picture for '1' and '2'; however, for '3–6' he could also choose a different end-diastolic position.

We assessed reproducibility of the techniques by comparing the absolute differences between the measurements of the 2 investigators using the same modality, i.e. we compared procedure '1' of investigator I with procedure '1' of investigator II for each side separately, etc. In a two-way Friedman ANOVA, the ranks varied between 3.34 and 3.66 mm and the mean differences between 0.09 and 0.13 mm on the left side. On the right side, the ranks varied between 3.40 and 3.68 mm and the mean differences between 0.08 and 0.11 mm. Both p values were >0.05, indicating no significant absolute differences during repeated measurements between the 6 techniques (table 1).

Using the Wilcoxon test, we compared all the values obtained from compound imaging techniques to those obtained from conventional B-mode (table 1). None of these differences were statistically significant, except for variables 1 and 2, indicating that there were slightly higher values obtained using eyeballing and the conventional B-mode (mean 0.82 mm, median 0.81 mm) than using eyeballing and compound imaging (mean 0.81 mm, median 0.79 mm). The p value of 0.0344 was, however, not considered to

Table 1. Descriptive statistics [mm] of the IMT measurements in the right and left common carotid artery

	Median	Min	Max	Mean	Std
<i>Right side, observer I</i>					
Procedure 1, conventional eye balling	0.80	0.37	1.50	0.82	0.21
Procedure 2, compound eye balling	0.80	0.40	1.30	0.81	0.19
Procedure 3, conventional computer	0.77	0.21	1.41	0.80	0.22
Procedure 4, compound computer	0.80	0.29	1.43	0.81	0.21
Procedure 5, conventional computer assisted	0.82	0.10	1.60	0.83	0.22
Procedure 6, compound computer assisted	0.82	0.39	1.43	0.84	0.20
<i>Right side, observer II</i>					
Procedure 1, conventional eye balling	0.80	0.40	1.30	0.79	0.19
Procedure 2, compound eye balling	0.77	0.40	1.40	0.78	0.19
procedure 3, conventional computer	0.79	0.26	2.61	0.82	0.26
Procedure 4, compound computer	0.77	0.11	1.43	0.79	0.22
Procedure 5, conventional computer assisted	0.79	0.10	1.36	0.82	0.21
Procedure 6, compound computer assisted	0.82	0.44	1.85	0.82	0.22
<i>Left side, observer I</i>					
Procedure 1, conventional eye balling	0.83	0.43	1.60	0.84	0.20
Procedure 2, compound eye balling	0.80	0.43	1.60	0.83	0.21
procedure 3, conventional computer	0.82	0.23	1.37	0.81	0.22
Procedure 4, compound computer	0.81	0.39	1.33	0.80	0.20
Procedure 5, conventional computer assisted	0.84	0.28	1.59	0.86	0.24
Procedure 6, compound computer assisted	0.84	0.39	1.50	0.86	0.22
<i>Left side, observer II</i>					
Procedure 1, conventional eye balling	0.80	0.39	1.55	0.82	0.20
Procedure 2, compound eye balling	0.80	0.42	1.56	0.81	0.21
Procedure 3, conventional computer	0.83	0.34	1.68	0.83	0.22
Procedure 4, compound computer	0.77	0.36	1.73	0.82	0.25
Procedure 5, conventional computer assisted	0.84	0.46	1.68	0.86	0.24
Procedure 6, compound computer assisted	0.80	0.37	1.73	0.84	0.25

be meaningful, taking into account multiple testing. The study by Secil et al. [4] also described higher values when measuring manually.

No superiority of one technique concerning reproducibility and absolute values over another could be found in this study using the HDI Lab 2.0. Other studies, however, described a higher reproducibility using automatic measurements [4] and differences when using different software algorithms [5]. Despite the theoretical advantage of compound imaging, no practical advantage could be found; this is in contrast to other studies, and may be due to different algorithms and settings [1, 2]. It is necessary to use the same software for repeated measurements in 1 patient and when performing multicentre studies, as well as when applying normal values from large studies to a local ultrasound laboratory [5].

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