AN ADVANCED ECHOSOUND APPROACH FOR FEMORAL NECK DENSITOMETRY

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Background Dual X-ray absorptiometry (DXA) currently represents the most common method for osteoporosis diagnosis and it is considered the gold standard for bone mineral density (BMD) measurements. However, DXA has also some important limitations that prevent its use for population screenings and this has led to the investigation of alternative ultrasound (US) approaches. In this context, we have recently introduced a new US methodology for osteoporosis diagnosis, which is based on a closely integrated processing of echographic images and corresponding "raw" radiofrequency (RF) signals ("echosound approach" [1]). The basic idea underlying this approach is that the RF signals acquired during an echographic scan of the investigated bone district can be employed to assess the bone health status through comparisons with previously derived reference spectral models. The implemented RF signal analysis method is also integrated with echographic imaging, which provides both the identification of the regions of interest and the simultaneous acquisition of a statistically significant number of US signals for each frame.

Objectives To assess the accuracy of an advanced echosound approach, which was specifically tailored and optimized for femoral neck densitometry.

Methods A total of 289 female patients (55–80 y) underwent both a femoral DXA and an echographic scan of proximal femur. Specific attention was paid to ensure adherence to correctness criteria for DXA scanning and data analysis as reported in the guidelines of the International Society for Clinical Densitometry [2]. The algorithm adopted for US data analysis was based on the echosound approach and included an additional dedicated signal compensation, which was specifically implemented to better account for the physiological variability in soft tissue thickness and corresponding US attenuation. The diagnostic agreement between DXA and US was assessed by accuracy calculation, Cohen's *k*, Pearson correlation coefficient (*r*), root mean square error (*RMSE*), and Bland-Altman analysis, whereas the method precision was assessed by the root mean square (*RMS*) average of the *SD*(*RMS-SD*) of repeated measurements, the root mean square coefficient of variation (*RMS-CV*), and the least significant change for a 95% confidence level (*LSC95*).

Results By assuming DXA output as the gold standard reference, the overall US accuracy in patient classification was 93.1% (k=0.882, p<0.0001). A strong correlation was also found between US-estimated BMD values and DXA-measured ones (r =0.86, p<0.001), with a low residual error (*RMSE* =0.044 g/cm^2). The average difference between paired BMD measurements was -0.002 ± 0.089 g/cm^2 (bias ± 2 SDs). US method precision, expressed as *RMS-SD*, resulted to be 0.003 g/cm^2 (*RMS-CV* =0.29%; *LSC95*=0.008 g/cm^2).

Conclusions The proposed echosound approach for femoral neck densitometry showed an excellent agreement with corresponding DXA diagnoses and an optimal measurement reproducibility, indicating a potential for an effective clinical routine adoption.

References

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