# Effect of Arm Dominance on Quantitative Transmission Ultrasound at the Forearm

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## BACKGROUND & PURPOSE

The long range objective of this research is to significantly expand the clinical utility and application of ultrasound to non-invasive assessment of bone, for diagnosing and managing osteoporosis [1,2]. The purpose of this study was to determine the effect of arm dominance on ultrasound measurements, using a new ultrasound device that measures the forearm (radius) at the 1/3rd location (Figs. 1 and 2).

## MATERIALS AND METHODS

*Clinical Study:*

•Twenty-one people were evaluated with the *UltraScan 650*, each being measured 3 times on both the left and right arms and arm dominance recorded (Fig. 2). Each test measurement takes about 5 seconds. Ambidextrous individuals were excluded from this analysis.

•The source and receiver were operated in thru-transmission mode; each transducer was rectangular (1 cm x 4.8 cm), the source was a single element and the receiver was a linear array with 64 elements with pitch=0.75 mm.

•The array signals for each acquisition were used to compute two net time delay (NTD) parameters. The product of the two NTD parameters for each of the three measurements made on each arm and subject was computed and averaged.

•The two *net time delay* (NTD and NTDb) parameters were computed according to:

$$NTD = \tau_w - \tau_d \quad \text{and} \quad NTDb = \tau_d - \tau_c$$

where $\tau_w$, $\tau_d$, and $\tau_c$ are the times of arrival of ultrasound signals which have propagated through soft tissue only, soft tissue-cortex-medullar cavity-cortex-soft-tissue, and soft tissue-cortex-only-soft tissue, respectively (Fig. 3).

•The product of the NTDs has been shown to be proportional to the cortical cross-sectional area (CCSA) *in vitro* and in simulation [3,4]. Fig. 4 shows the correlation of the NTD product with CCSA *in vitro* [3]. A paired one-sided *t*-test was used to evaluate the statistical difference between dominant and non-dominant arms.

•Short term precision (%RMS-CV) was also computed [5].

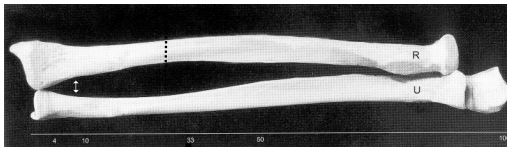


Fig. 1. *Radius and ulna with a scale showing the "1/3" location.*

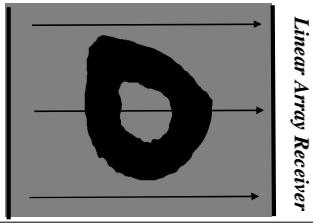


Fig. 3. *Schematic set-up showing single element source in a through-transmission configuration with a linear array receiver. The arrows denote direction of propagation of ultrasound.*

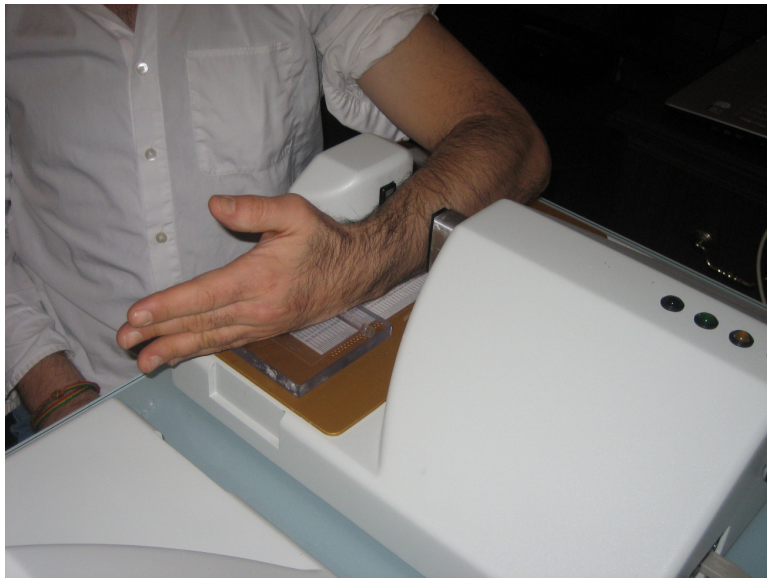

*Fig. 2. UltraScan 650 Ultrasound Forearm Scanner*

## RESULTS

The data showed that the dominant arms had 5.8% more CCSA, although there was a relatively high degree of variability (in 7 of the 21 subjects the non-dominant arm had a larger CCSA) and the *P*-value was equal to 0.17 (Fig. 5). Short term precision (%RMS-CV) was found to be 2.7%.

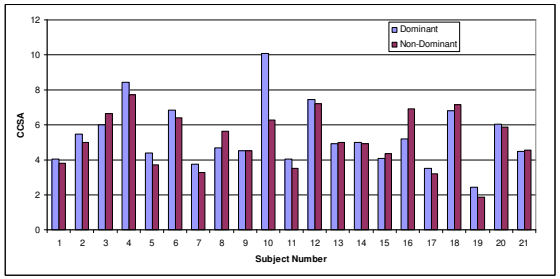


*Fig. 5. Ultrasound results for the 21 study subjects.*

## DISCUSSION AND CONCLUSION

The results obtained are consistent with prior studies using DXA that showed a 6-9% increase in bone mineral content (BMC) in the dominant vs. non-dominant arms [5]. This suggests that the ultrasound estimate of CCSA and x-ray determined BMC may be closely related. The CCSA also has been shown to be significantly correlated with increased fracture risk [6].

Further studies are on-going, including direct comparisons of ultrasound with DXA at the same anatomical site, in order to determine directly the correlation of ultrasonic parameters with BMD and BMC. The *UltraScan 650* has the potential to become a simple, safe and effective screening tool for bone loss and fracture risk assessment.

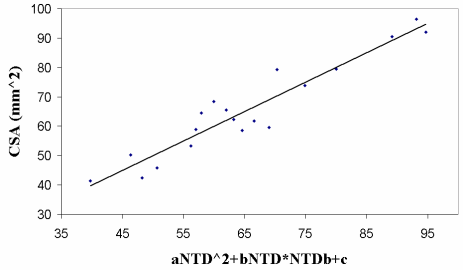


Fig. 4. *Ultrasound based (on NTD and NTDb) estimate of CSA for in vitro ultrasound data* ($R^2$=0.90).

## BIBLIOGRAPHY

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## ACKNOWLEDGMENT

*The authors would like to thank the National Institute of Arthritis and Musculoskeletal and Skin Diseases of the NIH for support of this work through SBIR Grant #AR054307.*

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