Comparative Analysis of Ultrasound Beam Profiles Produced by Various Manufacturers

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GRANT INFORMATION SUMMARY

PRACTICAL SIGNIFICANCE

The manufacturers' generalization of Effective Radiating Area (ERA) leads to significant variability in the dose of ultrasound delivered to the patient. Significant differences exist between manufacturers and across individual transducers from the same manufacturer.

STUDY BACKGROUND

ERA is a measure of the portion of an ultrasound crystal that is producing ultrasound. Accurate measurement of ERA is essential and is utilized in the calculation of the SAI (Watts/cm^2), and in determination of treatment area. Many manufacturers report a single ERA value for both 1 and 3MHz which is utilized as a default ERA measurement (e.g. 5cm^2) in the software of their machines to determine SAI; as opposed to using the true ERA of that particular ultrasound transducer. Clinically, variability of true SAI would lead to discrepancies in the dose of therapeutic ultrasound and clinical outcomes.

OBJECTIVE

To independently evaluate the existence of significant differences in ERA, total power and SAI across 6 manufacturers using standardized methodology.

DESIGN AND SETTING

A mixed model design was utilized in a controlled laboratory setting. The independent variables were manufacturer and frequency. The dependent measures were: ERA, Total Power and SAI.

SUBJECTS

Eleven 5cm^2 ultrasound transducers from 6 manufacturers (n=66).

MEASUREMENTS

Following calibration, each machine was set to 1.0 Watts/cm^2 and the total Watts produced for each transducer was measured via Wattmeter. ERA at 5mm from the transducer surface was determined at both 1 and 3MHz with a 400 micron detecting hydrophone (Onda HNZ-0400).

RESULTS

At 1MHz (table 1), Dynatronics ERA was larger than Xltek, Omnisound, Mettler, Chattanooga, and Rich-Mar ($P<0.05$). Xltek and Omnisound ERA was larger than Mettler, Chattanooga and Rich-Mar ($P<0.05$). At 3MHz, (table 2) Mettler and Xltek ERA, were larger than Chattanooga, Dynatronics, Omnisound and Rich-Mar ($P<0.001$). Overall ERA at 1MHz (4.47 cm^2+0.65) was smaller ($P<0.005$) than at 3MHz (4.96 cm^2+0.60). At 1MHz (table 1), Mettler SAI was higher than all others

(P<0.05) and Dynatronics SAI was lower than all others (P<0.05). At 3MHz (table 2), the SAI of Chattanooga was lower than all other. SAI range across all 66 transducers at 1 and 3MHz was 1.56 to 0.76 and 1.44 to 0.69, respectively.

CONCLUSIONS

Due to the wide variability in ERA between individual transducers and frequencies, manufacturers should report and utilize frequency specific ERA values in the calculation of SAI for each transducer. Incorporation of these finding by manufacturers and clinicians may increase consistency in applied treatments.

Publication and Presentation List:

Johns LD, Howard SM, Straub SJ, Zaino A. Comparison of Lateral Beam Profiles between Ultrasound Manufacturers. *Journal of Athletic Training*. 2005;40:S50.

Johns LD, Straub SJ, Howard SM, Zaino A, Morres E. Independent measures of axial and planar BNR shows variability between manufacturers. *Journal of Athletic Training*. 2005;40:S51.

Zaino A, Straub SJ, Johns LD, Howard SM, Morres E. Independent analysis of ERA at 1 and 3MHz across five manufacturers. *Journal of Athletic Training*. 2005;40:S51.

TABLE 1

1 MHz	ERA Measured	Total Power Measured	*SAI Measured
Mettler	4.01 + 0.34	5.45 + 0.20	1.36 + 0.11
Rich-Mar	3.83 + 0.21	4.57 + 0.23	1.19 + 0.07
Xltek	4.61 + 0.49	5.14 + 0.23	1.12 + 0.15
Chattanooga	3.97 + 0.25	4.28 + 0.43	1.09 + 0.13
Omnisound	5.03 + 0.58	4.95 + 0.38	1.00 + 0.16
Dynatronics	5.35 + 0.28	4.42 + 0.20	0.83 + 0.06

TABLE 2

3 MHz	ERA Measured	Total Power Measured	*SAI Measured
Dynatronics	4.83 + 0.11	5.11 + 0.44	1.06 + 0.10
Rich-Mar	4.55 + 0.33	4.72 + 0.20	1.04 + 0.07
Omnisound	4.56 + 0.62	4.95 + 0.41	1.02 + 0.20
Mettler	5.64 + 0.30	5.49 + 0.19	0.97 + 0.07
Xltek	5.56 + 0.15	5.16 + 0.22	0.93 + 0.04
Chattanooga	4.64 + 0.44	3.94 + 0.29	0.81 + 0.06

Table 1 and Table 2:
Manufacturers are listed in rank order according to group mean SAI.
ERA in cm^2, Total Power in Watts and SAI in W/cm^2.
*SAI when the ultrasound generator reads 1.0 $Watts/cm^2$.

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