The Acoustic Shadow Width is a More Accurate Predictor of True Stone Size During Ultrasound
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INTRODUCTION AND OBJECTIVES: While ultrasound is readily available, relatively less expensive than CT, and does not produce ionizing radiation; it is known to overestimate and inaccurately measure stone size. We explored the use of measuring the acoustic shadow behind kidney stones as a better predictor of true stone size.

METHODS: 45 calcium oxalate monohydrate kidney stones ranging from 1-10 mm were imaged in a water bath using a research-based ultrasound system with a C5-2 transducer. Stones were imaged at depths of 6, 10, and 14 cm. Under B-mode ultrasound, the width of both the stone and stone acoustic shadow was measured at each depth for every stone. Three blinded reviewers (2 urologists and an ultrasonographer) independently performed each measurement. A linear mixed-effect model was used to account for within-stone correlations, and compare stone and shadow measurements for each size, depth, and user. Subgroup analysis was performed to determine the percentage of stones that were over-classified as greater than 5 mm when true stone size was less than 5 mm.

RESULTS: Stone size was consistently overestimated when directly measuring stone width. Average overestimation was 1.1±0.8 mm, 1.9±1.0 mm, 2.7±1.4 mm at 6, 10, 14 cm depths, respectively. Overestimation increased with increasing depth (p<0.01). The acoustic shadow technique resulted in an overestimation of 0.2±0.8 mm, 0.0±1.1 mm, and 0.2±1.2 mm at 6, 10, 14 cm depths, respectively. The acoustic shadow technique was a better predictor of true stone size at all depths and sizes compared to measuring the stone width (p<0.001 at each depth). Subgroup analysis demonstrated that over-classification occurred in 15/60 (25%) when the stone was measured and 4/60 (7%) when measuring the posterior acoustic shadow.

CONCLUSIONS: There is consistent overestimation using the stone width under B-mode ultrasound, with increasing overestimation with increasing depth. Use of the acoustic shadow width significantly reduces overestimation and decreases over-classification by 18% for stones less than 5 mm.

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