



# MP4-24: ACCURACY IN STONE VOLUMES: AN IN-VITRO COMPARISON OF CT-BASED 3D SOFTWARE AND THE ELLIPSOID FORMULA



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## INTRODUCTION

- Accurate kidney stone measurements are important in order to formulate an effective treatment for nephrolithiasis.
- Stone volume determinations are typically calculated using the European Association of Urology (EAU) ellipsoid formula which relies on measuring the largest length, width, and depth of the stone.
- We compared the accuracy of computed tomography (CT)-based 3D volumes (3Dv) and ellipsoid formula volumes (EFv) to gas pycnometer measured volumes (GPv). GPv is a well-documented method for accurately measuring volume.

## METHODS

- Twenty-five human, spectroscopically confirmed calcium oxalate stones were air-dried and weighed.
- The AccuPyc II gas pycnometer (Micromeritics, Norcross, GA) was used to measure true stone volume and calculate density in replicates of five.
- Two additional methods were used to calculate stone volume: the EAU ellipsoid formula (volume =  $0.167 \times \pi \times \text{width} \times \text{length} \times \text{height}$ ) and a CT-based 3D rendering software (3D Slicer).
- Scatter plots were generated and coefficients of determination were calculated to understand the agreement of stone volumes between 3Dv, EFv, and GPv (Figure 1-2).

## RESULTS

- Independent stone volume measurements indicated that, on average, 3Dv overestimated stone volumes by 17% while EFv overestimated stone volumes by 175% (Figure 1).
- The coefficient of determination for GPv vs 3Dv was 0.9943, indicating strong correlation (Figure 2).
- The coefficient of determination for GPv vs EFv was 0.8255, indicating poor correlation (Figure 2).

Comparison of Stone Volumes Obtained From Three Independent Methods

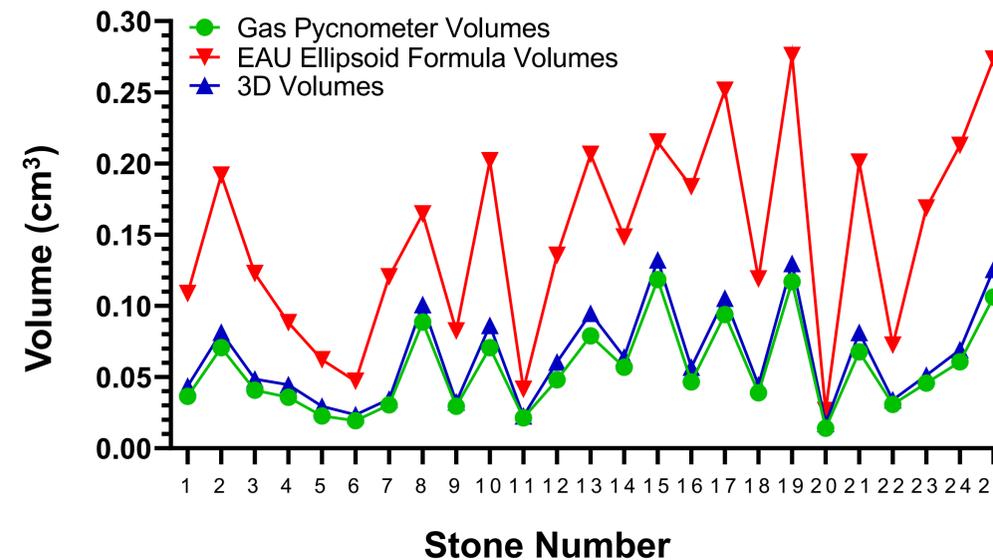


Figure 1: Individual stone volume measurements demonstrating that ellipsoid formula volumes trend higher estimations in relation to gas pycnometry volumes, while CT-based 3D volumes closely match gas pycnometry volumes.

## RESULTS

Correlation of Calculated Volume to Measured Volume

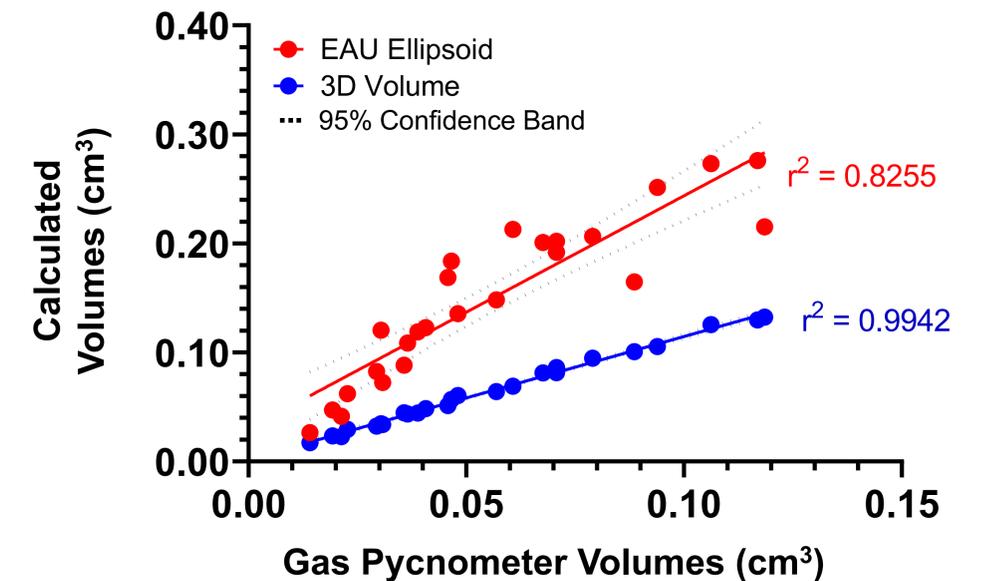


Figure 2: Scatter plot depicting gas pycnometry's strong correlation with CT-based 3D volumes, but poor correlation with ellipsoid formula volumes.

## CONCLUSIONS

- CT-based 3D volumes more accurately represent the stone volume compared to the EAU ellipsoid formula.
- Both methods overestimate stone volume. The EAU ellipsoid formula overestimates stone volume by 175% compared to 17% for the CT-based 3D volume.