



MP15-17: NOVEL ENDOSCOPE TIP DESIGNS FOR ASPIRATION OF RENAL STONE FRAGMENTS: AN *IN-VITRO* STUDY



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INTRODUCTION

Basket removal of stone debris after laser lithotripsy commonly fails to clear < 1.5 mm residual fragments, leaving nidi for future stone formation. We evaluated the effectiveness of several novel endoscope tip designs with regard to aspiration of stone remnants.

METHODS

- Six designs were created in CATIA™ V5 (Dessault Systèmes®) and 3-D printed using PrusaSlicer (Figures 1 and 2).
- To ease handling, all tip prototypes were scaled up to 27 Fr and attached to a suction apparatus (Aeros Mobilvac III, Arduus Medical Inc.®) (Figure 3). The central channel behind the tip was 21.4 Fr.
- For each trial, one gram of pre-measured stone fragments (1.00 mm, 1.25 mm, 1.70 mm, 2.00 mm, 2.50 mm, 3.00 mm, 3.55 mm, 4.00 mm, 5.00 mm) were sequentially placed in a basin and aspirated (suction pressure 100 mmHg).
- All tips were first evaluated using whole millimeter sized debris; high performing tip designs (A - batwing, C – power bar, and E – half-moon configuration) were then compared using more targeted, extensive trials.
- Percent clearance, rate of fragment evacuation, and number of channel occlusions were recorded.

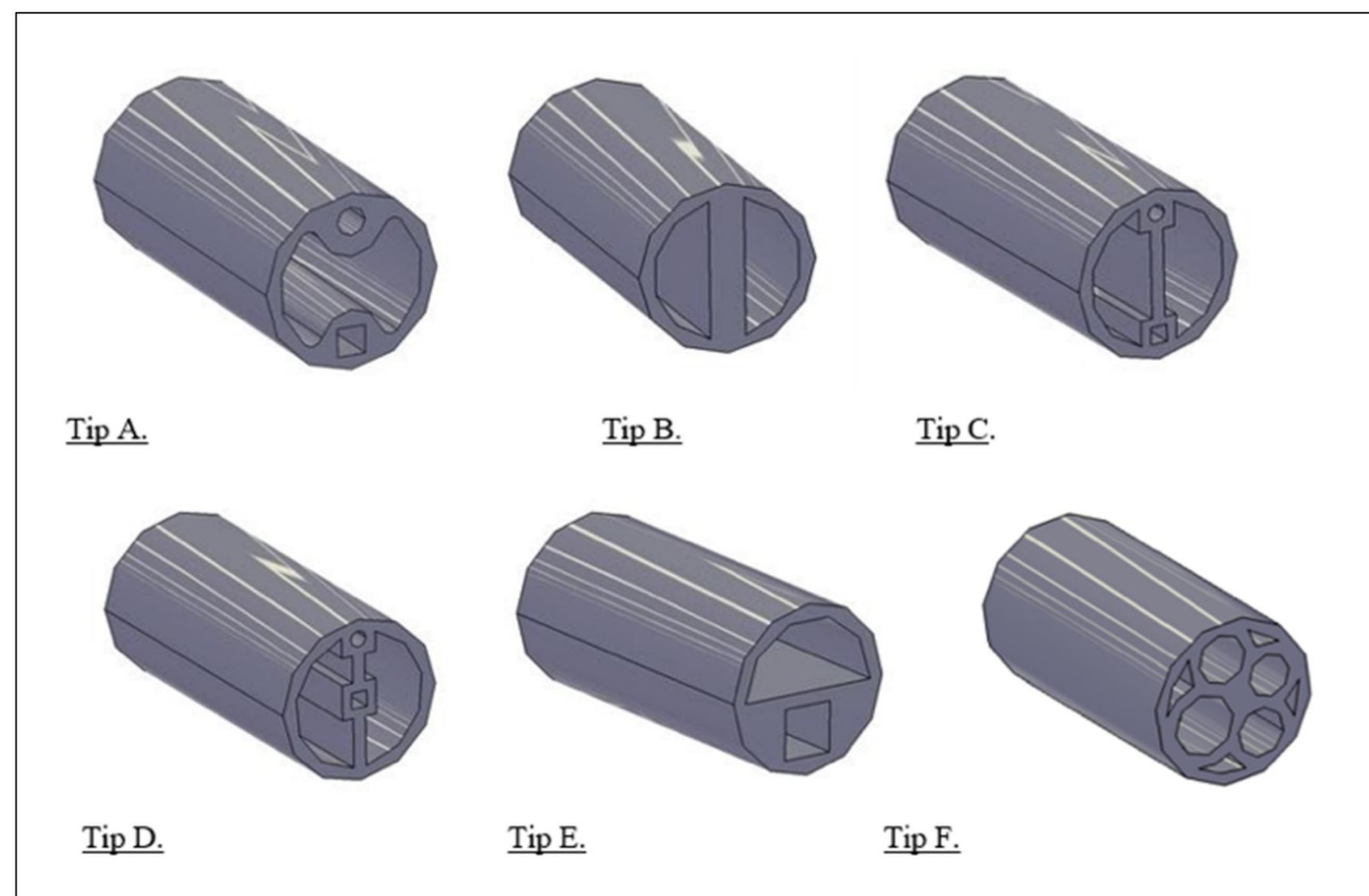


Figure 1: 3-D rendering of six novel aspiration endoscope tip lumen arrangements.

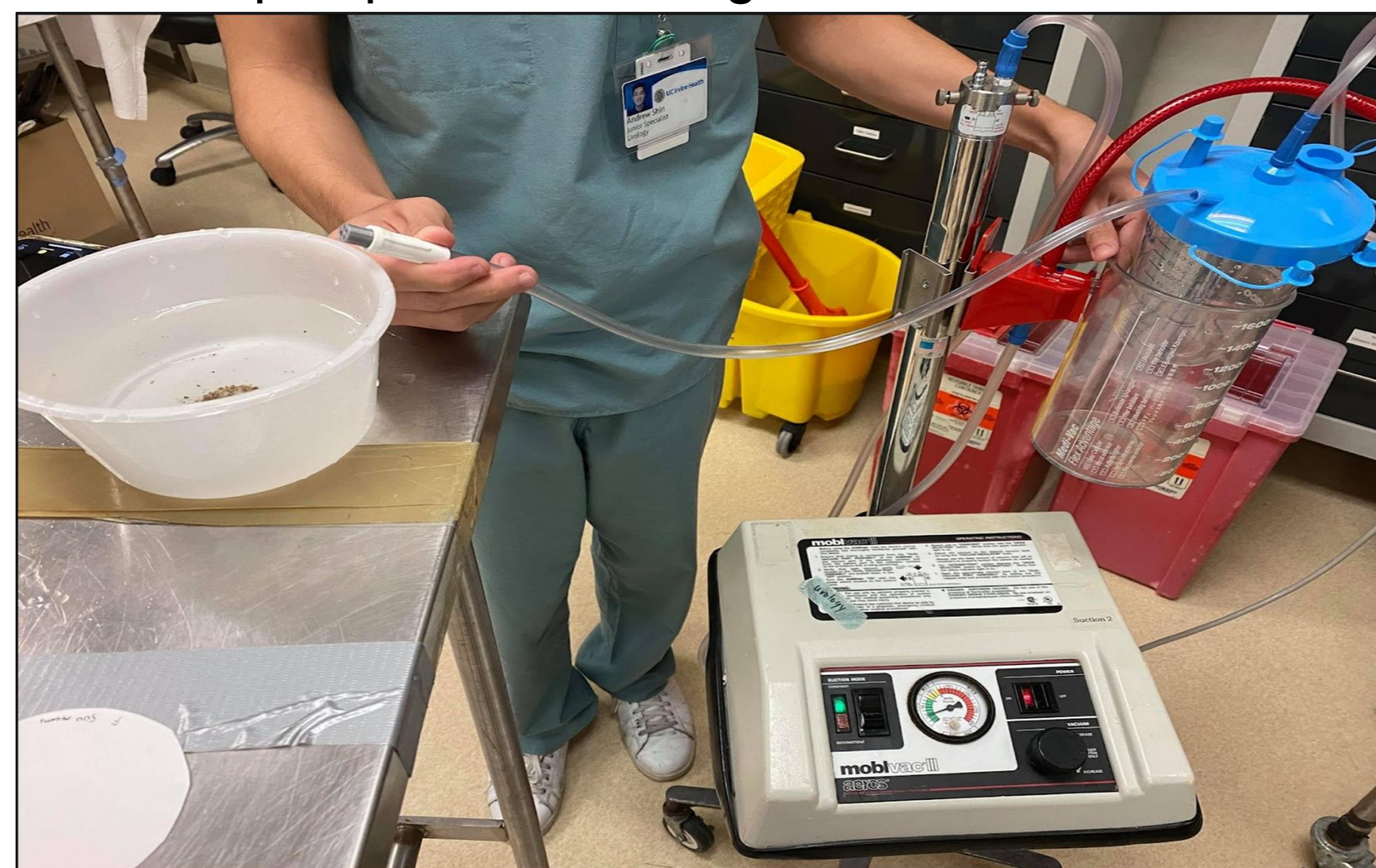


Figure 3: Setup of 3D-printed tip attached to suction apparatus with basin containing stone fragments.

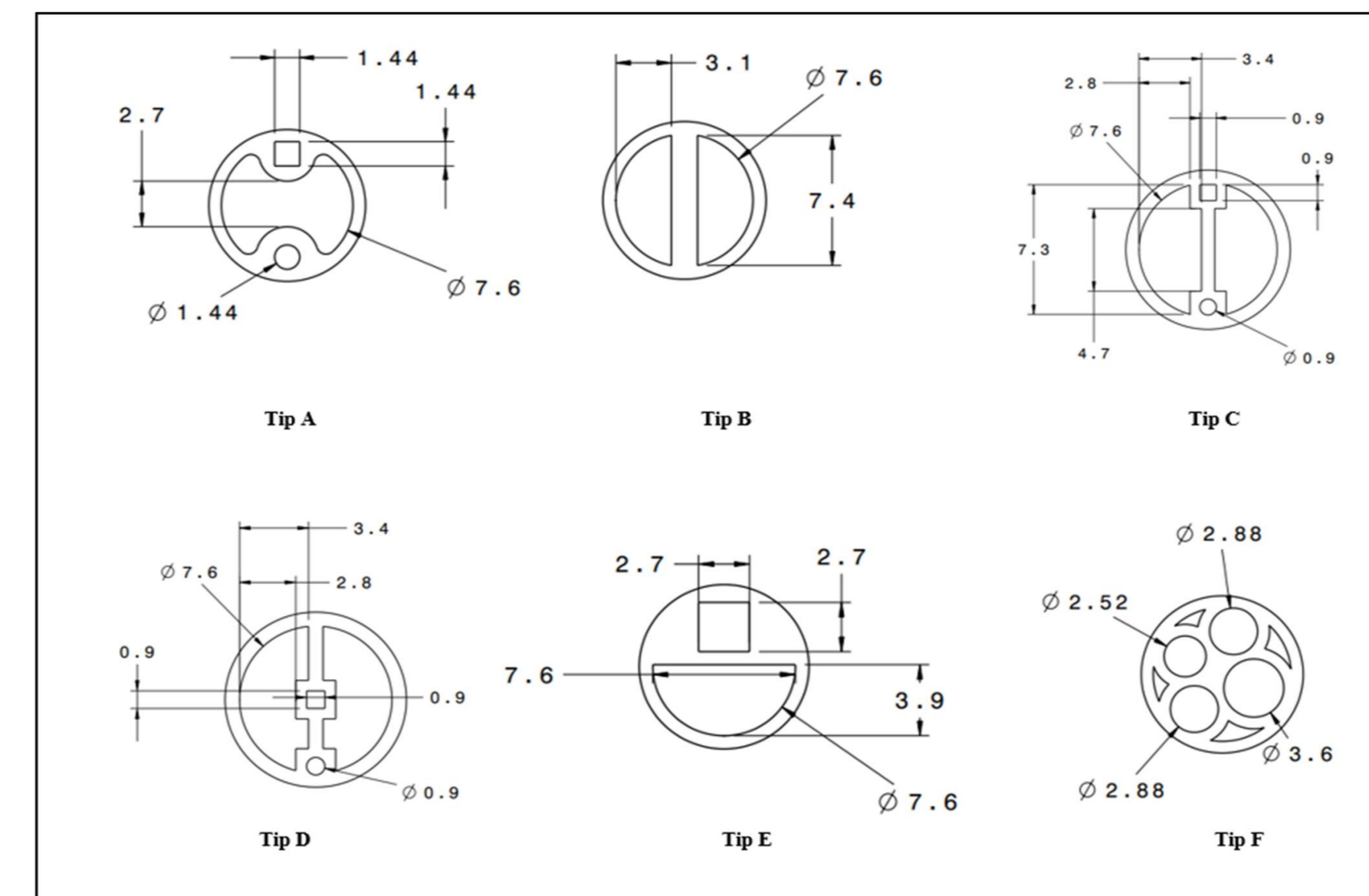


Figure 2: Tip design upscaled dimensions (measurements in mm)

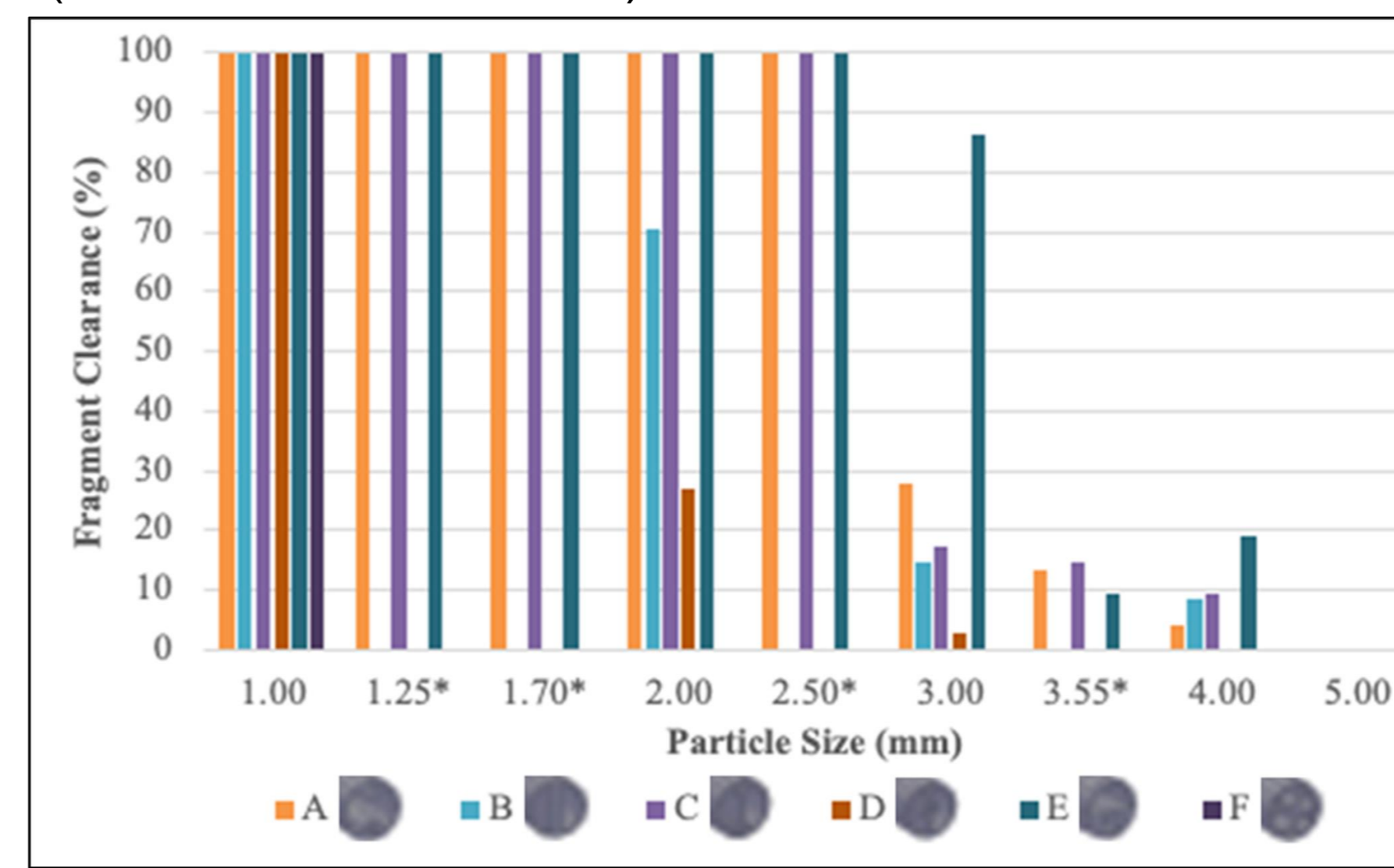


Figure 4: Percent stone clearance by stone particle diameter for each tip design. *Only tips A, C, and E were evaluated as they outperformed the other tip designs during the initial part of the study.

RESULTS

- All tips tested on fragment sizes up to 1.70 mm achieved 100% clearance without channel occlusions (Figure 4).
- The fastest suction rates for 1 mm were tips A, C, and E at 266, 265, and 260 mg/sec, respectively.
- At 2 mm, only A, C, and E had 100% clearance with tip A having 1 occlusion, tip C having 4 occlusions, and tip E having 2 occlusions.
- At 2.50 mm, tip A cleared fragments fastest (387 mg/sec) with no occlusions, while C and E encountered 4 and 1 occlusions, respectively.
- For both 3 mm and 4 mm, tip E had the highest percent clearance and aspiration rate (3 mm - 86.2% at 53 mg/sec; 4 mm - 18.9% at 16.3 mg/sec) with 5 occlusions for each size (max number of occlusions before ending the trial).
- At 3–5 mm all tips clogged equally; no tip successfully aspirated 5 mm.

CONCLUSIONS

In this study of novel endoscope tip designs, designs A, C, and E outperformed designs B and D. Overall, design E appeared to be the most promising for effective aspiration of stone fragments.