

Radial Dilation Force of Tipless and Helical Stone Baskets

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ABSTRACT

Purpose: To evaluate one aspect of tipless and helical stone basket function that is critical for ureteral stone extraction: the radial-dilation force.

Materials and Methods: Nine commercially available tipless baskets and five commercially available helical stone baskets were tested. Two Teflon blocks were positioned with the lower block sitting on a digital scale and the upper block secured to a plastic frame and base. A 0.01-inch gap was maintained between the blocks using a digital micrometer. Alignment pins secured the position of the lower block in relation to the upper block. A 4-mm cylindrical hole was drilled through the center of the block interface, and each basket was passed through the hole and opened to its fully extended length. The basket was then slowly retracted through the hole, and the maximum force reading was recorded. Twenty repetitions were performed for each basket.

Results: Of the tipless baskets $\geq 3.0F$, the Cook N-Circle 3.2F provided the best radial dilation (24.7 ± 0.4 g). For tipless baskets $< 3.0F$, the Sacred Heart Vantage 2.4F provided the best radial dilation (19.6 ± 0.8 g). Of the helical baskets, the Sacred Heart Hercules provided the most radial dilation (102 ± 12.1 g) followed by the Cook N-Force (71.8 ± 4.3 g).

Conclusion: The radial-dilation force of tipless and helical stone baskets differs significantly among baskets and may impact stone extraction performance in the ureter.

INTRODUCTION

URETEROSCOPY WITH STONE EXTRACTION has established a prominent role in the management of urolithiasis, and much of the efficacy rests in the quality of disposable stone extraction baskets. Baskets have particular physical characteristics that facilitate optimal stone extraction in different clinical situations.

Stone-basket radial-dilation force facilitates ureteral stone identification and entrapment. Tipless Nitinol baskets, initially designed for intrarenal use, are now commonly utilized for ureteral stone extraction. Helical stone baskets are commonly employed if ureteral edema or stricture necessitates increased radial-dilation force for stone identification and entrapment. Modifications to increase radial force include triangular wires and paired wires.

While one previous *in vitro* study suggested that helical baskets were inferior in their ability to capture ureteral calculi compared with double-helical, flatwire, and tipless baskets,¹ other studies² found that helical baskets are superior for removal of

single ureteral calculi and Steinstrassen. Our study evaluated one aspect of basket function that is critical for ureteral stone extraction, namely, the radial-dilation force, of nine commercially available tipless stone baskets and five commercially available helical baskets.

MATERIALS AND METHODS

In the tipless-basket category, the ACMI (Sur-Catch NT 3.0), Bard (Dimension 3.0), Boston Scientific (Zero-tip 2.4 and 3.0), Cook (N-Circle 2.2, 3.0, and 3.2), and Sacred Heart (Halo 1.9, Vantage 2.4) baskets were tested. In the helical-basket category, the Cook N-Force (3.2F), Microvasive Gemini (3.0F), Microvasive Leslie Parachute (3.1F), Microvasive Bagley (1.9F), and Sacred Heart Hercules (3.0F) were evaluated.

Two Teflon blocks ($1.0 \times 0.55 \times 0.325$ inches) were positioned with the lower block sitting on a digital scale (400×0.1 -g capacity) and the upper block secured to a plastic frame and base (Fig. 1). The digital scale was calibrated to 0 with the

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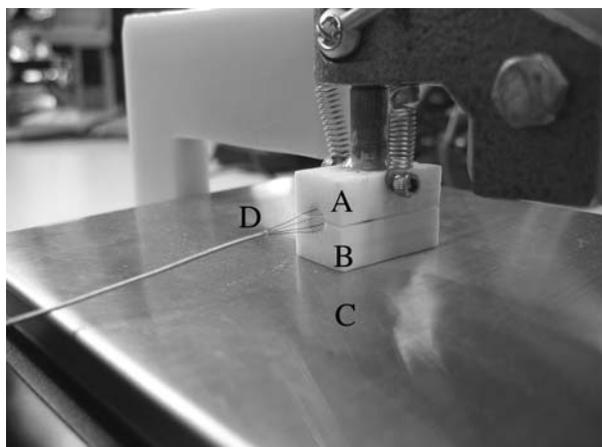


FIG. 1. Experimental set-up to evaluate radial dilation force. Stationary block (A) aligned with floating block (B), which presses down on digital scale (C) as basket (D) opens.

lower block in place, and the upper block was lowered onto the bottom block. A 0.01-inch gap was maintained between the blocks using a digital micrometer. Alignment pins secured the lower block in relation to the upper block. A 4-mm cylindrical hole was drilled through the center of the block interface. Each basket was passed through the cylindrical hole and opened to its fully extended length. The basket was then slowly retracted through the hole, and the maximum force reading was recorded. Twenty repetitions were performed for each basket.

RESULTS

Tipless baskets

The baskets with the strongest to weakest radial-dilation force were, in order, the N-Circle-3.2F (24.7 ± 0.4 g), Vantage (19.6 ± 0.8 g), Zero-tip 3F (15.3 ± 0.5 g), N-Circle 3.0F (13.1 ± 0.2 g), Sur-Catch (12.3 ± 0.8 g), Halo (8.8 ± 0.5 g), Zero-tip 2.4F (7.9 ± 0.3 g), Dimension (7.6 ± 0.2 g), and N-Circle 2.2F (4.7 ± 0.1 g). Of the baskets ≥ 3.0 F, the N-Circle 3.2F provided the best radial dilation. For baskets < 3.0 F, the Vantage 2.4F provided the best radial dilation.

Helical baskets

The baskets with the strongest to weakest radial-dilation force were, in order, the Hercules (102 ± 12.1 g), N-Force (71.8 ± 4.3 g), Gemini (45.9 ± 0.8 g), Parachute (43.7 ± 0.8 g), and Bagley (16.7 ± 0.7 g). It should be noted that the Bagley is a 1.9F basket that is not specifically designed to exert maximum radial-dilation force.

DISCUSSION

Previous comparative studies of stone baskets have focused on *in vitro* models of stone extraction using metal beads and

human stones.¹⁻³ Although these studies identified specific advantages of particular baskets in certain situations, they have not examined the physical specifications that confer these advantages. To our knowledge, this is the first study to evaluate multiple baskets of the same design category (helical and tipless).

The tipless stone basket has particular advantages with regard to minimizing ureteral trauma during stone extraction. When it is desirable to couple the characteristics of a tipless basket with maximal radial dilation for ureteral stone extraction, the Cook N-Circle 3.2F basket is optimal for use through a semirigid ureteroscope, while the smaller Sacred Heart Vantage 2.4F is optimal for use through a flexible ureteroscope. When radial dilation is essential to overcome a tight spot and the urologist resorts to a helical basket, the Sacred Heart Hercules basket maximizes force, while the Cook N-Force provides the second highest force.

Although greater radial dilation may facilitate stone capture under ureteroscopic guidance, the exponential dynamics of basket actuation (opening and closing) associated with higher radial-dilation force may impede the more controlled capture sequence seen with baskets that open and close under linear dynamics.⁴

It is important to note that this study did not test all commercially available baskets and sizes in each category. However, these results may be utilized as a guide to selection of baskets and comparison of current devices and future prototypes.

CONCLUSION

The radial-dilation force of tipless and helical stone baskets differs significantly among baskets. It can be of potential importance in the ability of stone baskets to work effectively in the ureter.

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