SYSTEMATIC EVALUATION OF URETERAL ACCESS SHEATHS

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ABSTRACT

Objectives. To compare the physical characteristics of ureteral access sheaths that affect their ability to resist buckling and kinking in the ureter.

Methods. Eight commercially available ureteral sheaths were tested. The buckling pressure was measured by adding sequential loads to a point 20 cm from the tip of the sheath until the mass that resulted in buckling of the catheter was determined. The kinking pressure was determined by measuring the diameter of the sheath with a digital caliper as sequential loads were applied to the surface of the sheath. The frictional properties of the sheath were measured by testing the force required to push the sheath through a mock tube.

Results. The Cook Flexor was more resistant to buckling, requiring 202 g of force before buckling occurred, and both the Cook Flexor and the Applied access sheaths were more lubricious. The kinking measurements demonstrated a linear loss of diameter of the sheath with added loads. The Applied Forte XE and Cook Flexor ureteral access sheaths were more resistant to kinking than were the other sheaths tested.

Conclusions. Understanding the physical characteristics of ureteral sheaths may help determine which sheaths will perform well with regard to buckling during insertion and kinking during use. UROLOGY **63:** 834–836, 2004. © 2004 Elsevier Inc.

Ureteral access sheaths have expanded the role of flexible ureteroscopy in the management of intrarenal calculi.[1,2] The ability to place an access sheath into the ureter is dependent on the coefficient of friction of the sheath surface and the axial force that results in buckling of the sheath at the ureteral orifice. The ability to pass a ureteroscope through the sheath is dependent on the compressive force that results in kinking of the sheath. This study evaluated these physical properties.

MATERIAL AND METHODS

Eight commercially available ureteral sheaths were tested (Table I). Two of these sheaths, the Applied Forte XE and Cook Flexor Sheaths, are reinforced with an impregnated wire to prevent buckling and kinking. The other sheaths tested are not reinforced. Testing of buckling was conducted without a wire in the lumen to limit the evaluation to the physical properties of the sheaths themselves.

The buckling pressure was measured with the inner dilator within the sheath, by adding sequential loads to a point 20 cm from the tip of the sheath until the mass that resulted in buckling of the catheter was determined (Fig. 1A). A piece of wood was secured over the edge of a table, and a small indentation was made in the middle of the wood to stabilize the sheath dilator. Two paper clips were secured to the sheath 20 cm from the tip, and nylon threads (Coats and Clark, CA00011) were then attached to the edges of the paper clips and dropped through two holes drilled through the wood. The other ends of the threads were attached to a plastic bag. Incremental mass was added to the bag (ACCO Stock No. 72580 jumbo paper clips 1.52 g and pennies 2.7 g) until the sheath buckled.

The kinking pressure was determined after removal of the inner dilator by measuring the outer diameter of the sheath with a digital caliper as sequential loads were applied to the surface of the sheath (Fig. 1B). The sheath was laid over a piece of wood that was secured in a vise over the edge of a table. A hole was drilled in the wood directly next to the sheath, and the depth tool of a digital caliper (Mitutoyo Digmatic Model CD-6B) was inserted into this hole to measure the outer diameter of the sheath. A normal AA battery was placed on top of the sheath to distribute the force on the sheath evenly. A nylon thread (Coats and Clark, CA00011) was attached to each end of the battery and threaded perpendicularly through holes in the wood to connect to a bag below into which sequential loads were added (pennies 2.7 g and paper clips 1.52 g). After every addition of mass, the battery was leveled off on the top of the tube, and the diameter of the tube was taken from the surface of the wood to the bottom of the battery. With the

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TABLE I. ***Ureteral access sheaths tested***

Name	Company	Inner Diameter (F)	Outer Diameter (F)	Length Tested (cm)
Applied Forte				
B7241	Applied Medical	10	12–16	35
B7041	(Rancho Santa Margarita, Calif.)	12	14–18	35
Applied Forte XE				
B7011	Applied Medical	12	15–18	35
ACMI Snap N Peel				
61012BX	ACMI (Southborough, Mass.)	10	12	45
Cook Flexor				
FUS-095035	Cook Urological	9.5	12	35
FUS-120035	(Spencer, Ind.)	12	14	35
Cook Peel-Away				
073910	Cook Urological	10	12	37
073912		12	14	37

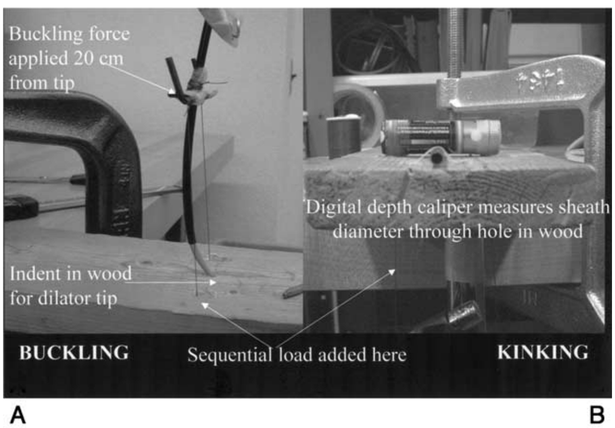

FIGURE 1. *Experimental setup for (A) buckling and (B) kinking experiments.*

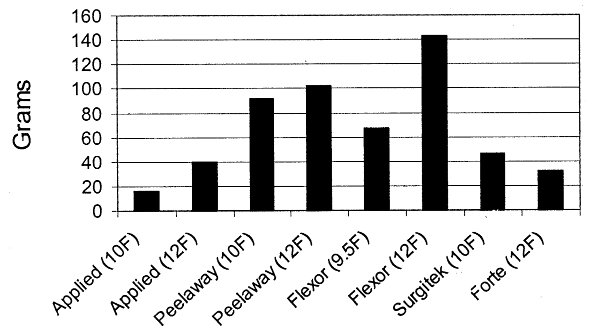

FIGURE 2. *Force in grams required to cause buckling of sheath and dilator.*

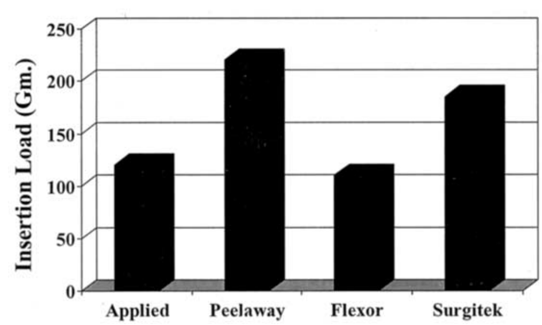

FIGURE 3. *Coefficient of friction measured as sheath and dilator are passed through mock tube of biologic tissue.*

addition of sequential loads, the incremental loss in the outer diameter of the sheath was measured.

The frictional properties of the sheath and dilator were measured by testing the force required to push the sheath through a mock tube. Uniform holes, 2.78 mm in diameter, were drilled through 35-mm-thick frozen biologic tissue (bologna), after which the tissue was thawed to room temperature. The tissue was slid down the wetted sheath with slow, uniform velocity, and the reaction force measured with a Salter load scale.

RESULTS

The Cook Flexor sheath was more resistant to buckling (202 g, Fig. 2), and both the Cook Flexor sheath (110 g) and Applied access sheath (120 g) were more lubricious (Fig. 3) than the other sheaths tested. Kinking measurements demonstrated a linear loss of diameter of the sheath with added loads (Fig. 4). The Applied Forte XE and Cook Flexor ureteral access sheaths were more resistant to kinking than other sheaths tested.

COMMENT

The use of a Teflon sheath placed across the ureteral orifice for insertion of the flexible ureteroscope was first introduced in 1974.[3] During the past few years, ureteral access sheaths have evolved, with an emphasis on characteristics that facilitate clinical application: specifically, a lubricious coating to facilitate atraumatic placement and a reinforced sheath to reduce buckling and kinking.[1]

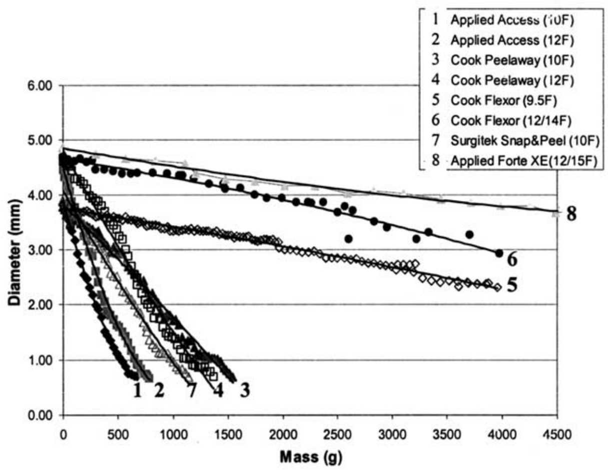

FIGURE 4. *Loss of inner diameter (kinking) of sheath with sequential increase in load. Numbers identify line corresponding to respective sheath in key.*

The routine use of a ureteral access sheath for flexible ureteroscopy has been demonstrated to decrease operative time and costs, facilitate ureteral entry and re-entry, and optimize success with intrarenal ureteroscopic surgery while minimizing morbidity. Postoperative discomfort after ureteral dilation with an access sheath was significantly less than that seen with balloon dilation.[2]

With increasing use of ureteral access sheaths and increasing alternatives for sheaths in the disposable market, it is imperative to conduct independent objective studies of the physical characteristics that may predict clinical outcome. The superiority in kinking, coefficient of friction, and buckling may be attributable to the impregnated coil design of the Cook Flexor and Applied Forte XE sheaths and the proprietary hydrophilic coating of each sheath. The results of this study suggest that although the Applied Forte XE and Cook Flexor sheaths share advantages with regard to resistance to kinking and low coefficients of friction, the Cook Flexor sheath is superior with regard to resistance to buckling. From a clinical standpoint, one might predict that the Cook Flexor and Applied Forte XE sheaths would be less likely to collapse after removal of the inner obturator, and the Cook Flexor may be more resistant to buckling at the ureteral orifice or iliac vessels. Whether this observation will hold clinical merit is currently being evaluated in a randomized prospective trial of these two access sheaths.

CONCLUSIONS

Understanding the physical characteristics of ureteral sheaths may help determine which sheaths will have the biggest impact on stone disease. On the basis of these studies, we conclude that the Cook Flexor 12F sheath is less likely to buckle and kink during insertion.

REFERENCES

1. Monga M, Bhayani S, Landman J, *et al:* Ureteral access for upper urinary tract disease: the access sheath. J Endourol **15:** 831–834, 2001.

2. Kourambas J, Byrne RR, and Preminger GM: Does a ureteral access sheath facilitate ureteroscopy? J Urol **165:** 789–793, 2001.

3. Takayasu H, and Aso Y: Recent development for pyeloureteroscopy: guide tube method for its introduction into the ureter. J Urol **112:** 176–178, 1974.