Surg Endosc (1987) 1: 119–121

Surgical Endoscopy

Intrarenal dimensions

Guidelines for flexible ureteropyeloscopes

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Summary. Designs for flexible ureteropyeloscopes should be based on the configuration of the intrarenal collecting system. This study measured retrospectively the ureteroinfundibular angle and infundibular lengths of 30 patients treated for calculus disease. Recommendations are given for the design of flexible ureteropyeloscopes that could visualize the entire normal intrarenal collecting system.

Key words: Ureteropyeloscope – Intrarenal measurements – Ureteroinfundibular angle – Infundibular length.

Increased interest in ureteroscopy and technical advances in fiberoptic instrumentation have resulted in the manufacture of several new flexible ureteroscopes [5, 6]. Many of these instruments are passively deflectable and, therefore, their endoscopic range is limited to the ureter, the medial aspect of the pelvis, and some upper infundibula [2, 4]. To reach the entire intrarenal collecting system, a flexible ureteropyeloscope must have an actively deflectable tip. It should provide deflection adequate to reach most lower infundibula with the tip and a field of view adequate to visualize the papillae [1, 3]. Many endoscopes have been designed according to clinical experience and the urologist's personal preference. Designs for adequate ureteropyeloscopes can be based on the configuration of normal intrarenal collecting systems. We have measured the dimensions of a large group of these to define the parameters for the design of a flexible ureteropyeloscope.

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Materials and methods

The excretory urograms of 30 patients treated for calculus disease were studied. The renal outlines and the intrarenal collecting systems were traced on white paper for recording and ease of measurement. The ureter was also indicated to define its major axis.

The intrarenal measurements included the ureteroinfundibular angle, the lower infundibular length, and the midinfundibular length. The ureteroinfundibular angle was defined as the angle between the major axis of the ureter and that of the lower infundibulum as measured on an anterior-posterior (A/P) X-ray film of the excretory urogram (Fig. 1). The midinfundibular length was measured from a point on the ureteral axis within the pelvis along a line extending laterally to the closest papillary projection within a medial infundibulum (Fig. 2). The lower infundibular length, which was considered the distance necessary for the deflected tip of a flexible ureteropyeloscope to reach the inferior calyces, was determined by measuring the distance from the inferior papillary projection along the axis of the infundibulum to either (1) the superior margin of the pelvis or (2) the axis of the ureter if these two lines cross within the pelvis (Fig. 3).

By using the excretory urograms retrospectively, no correction could be made for errors resulting from projection of the kidneys on the A/P X-ray films. This error, which could not be evaluated, could result in underestimation of the distances measured. It could also increase the ureteroinfundibular angle. In contrast, radiographic magnification increases the distances. No accurate attempt could be made to correct these errors.

Results

A wide variation was seen in the intrarenal collecting systems documented. The measurements of particular interest are noted in Table 1. The ureteroinfundibular angle, which represents the angle of deflection necessary for a flexible endoscope located along the ureteral axis to turn to enter the lower infundibulum, ranged from 104° to 175°. The average angle among the patients studied was 140°.

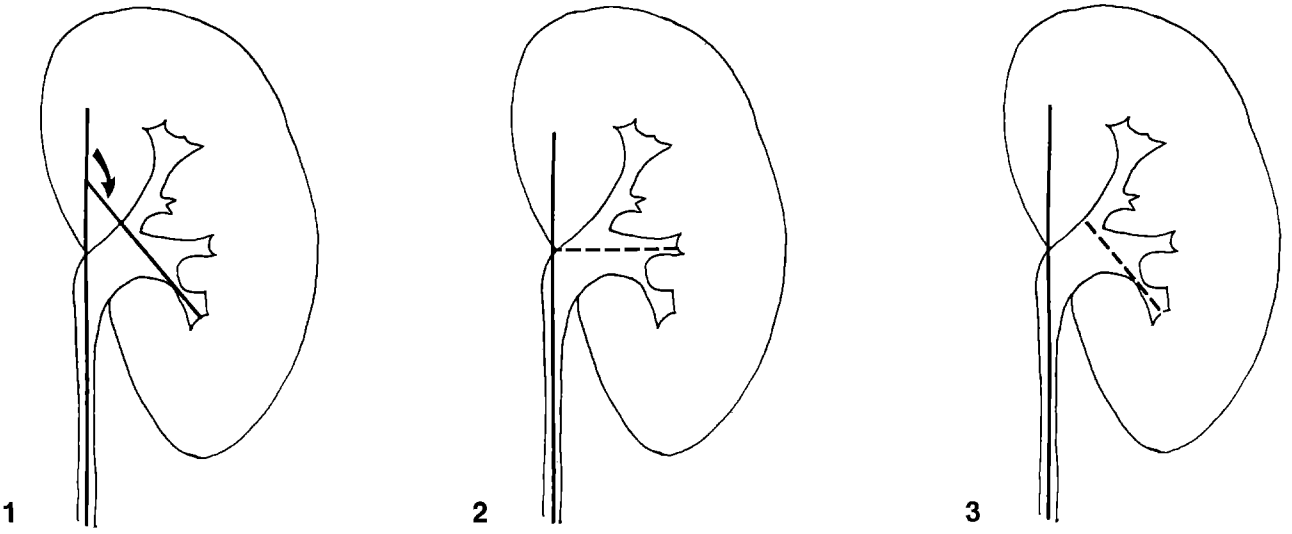

Fig. 1. The ureteroinfundibular angle measured from the major axis of the ureter to the axis of the lower infundibulum (*arrow*). This represents the angle of deflection necessary for a lower infundibulum

Fig. 2. The midinfundibular length extends from the ureteral axis along a line passing directly laterally to the papillary projection within a medial infundibulum (*dotted line*)

Fig. 3. The lower infundibular length extends along the axis of the lower infundibulum from the axis of the ureter if the two lines cross within the pelvis or, as in this case, the superior margin of the pelvis (*dotted line*). This is the distance necessary for the deflected tip of a flexible ureteropyeloscope to reach the inferior calyx

Table 1. Intrarenal dimensions

Ureteroinfundibular angle		Infundibular length	
		Mid	Lower
Average	140°	3.4 cm	3.8 cm
Range	104° – 175°	2.5 – 5.4	2.3 – 5.2

The infundibular length was only slightly longer in the lower infundibula than in the mid-infundibula. The average for the lower infundibula was 3.8 cm and for the mid-renal infundibula 3.4 cm.

Discussion

The appropriate design of endoscopes requires that they fit into the lumen of the viscus to be studied. The tip of the objective should be placed at an appropriate distance from the surface to allow good focal visualization with that particular instrument. Adequate light must be provided through the endoscope, and there should be provision for irrigation to distend and clear the field of view.

The dimensions of many endoscopes have been determined by extensive clinical experience. However, flexible ureteropyeloscopy is a relatively new technique. The design of appropriate endoscopes must rely upon either the limited clinical experience available or upon measurements of the ureter and the intrarenal collecting system. The results in this study can serve as a guideline for the design of endoscopes entering the intrarenal collecting system from the ureter. The general aim of a functional ureteropyeloscope should be to provide an instrument that can enter all of the intrarenal infundibula with the tip of the instrument located within observation and/or working distance of the surface.

Clearly, the range of a flexible ureteropyeloscope within the kidney increases with increasing deflectability [2, 4, 5]. Passively deflectable instruments may be limited to the medial portion of the renal pelvis and the upper infundibulum. Deflection to approximately 90° would give access to the upper half of the kidney. Greater deflection allows the tip of the instrument to enter a greater number of infundibula, including those in the lower pole.

As demonstrated in this study, the average ureteroinfundibular angle was 140°. This describes the arc through which the tip of a flexible ureteroscope must pass to move from the axis of the upper ureter to the axis of the lower infundibulum. The range of angles, however, was fairly wide – from 104° to 175°. Therefore, to enter

every infundibulum with active deflection of the tip alone, angulation should be 175°.

Active deflection can be assisted further by a passively deflectable segment built into the endoscope. By this mechanism, after active deflection of the tip into the lower infundibulum, the instrument can be advanced to the upper margin of the pelvis, and that segment of the endoscope can passively deflect just proximal to the actively deflected tip. Thus, the angle of deflection is effectively increased, and the length of the deflected tip is also increased.

The length of the deflected tip should extend 3.8 cm to reach the average lower pole papilla and 3.4 cm to reach the average mid-renal papilla. However, active deflection of the tip requires an arc of movement for the tip, and the radius of the deflected segment also adds to the length of that deflected portion. The objective lens should not touch the tissue, and the depth of focus of the lens increases the effective length. As an example, an endsocope that can visualize clearly 1 cm from its tip should be positioned at that distance from a papilla for examination. The total length of the deflecting tip of the ureteroscope should then be 2.8 cm to allow visualization at 3.8 cm.

Flexible ureteropyeloscopes intended for use within the kidney should be capable of active deflection. Angulation of 175° allowed entry into all lower infundibula measured in this study. Capability to deflect only 140° would permit entry into 50% of the lower infundibula. Angulation of less than 175° could be combined with a secondary, passively deflectable segment to increase the range of the endoscope. The deflected tip should total 3.8 cm with correction for the radius of deflection and the depth of focus of the endoscope to reach the average lower and medial infundibula.

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