Developments in the Technique of Endoscopic Combined Intrarenal Surgery in the Prone Split-leg Position

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OBJECTIVE To develop a new technique for performing endoscopic combined intrarenal surgery in the prone split-leg position and to evaluate its efficacy using computed tomography.

MATERIALS AND METHODS Between December 2010 and January 2013, 60 patients with large calculi (39.2 ± 2.6 mm) underwent this surgery. A laser fiber was used with a flexible ureteroscope introduced through a ureteral access sheath, and lithoclast lithotripsy was performed through a mini-percutaneous tract. Three-dimensional computed tomography was performed to determine anatomic variations, including the ureteral location and ureteropelvic junction angle in all patients in both the supine and prone positions.

RESULTS All procedures were performed successfully with a single tract and the patient in the prone split-leg position. The mean surgical time was 120.5 ± 6.7 min. The initial stone-free rate was 82%, and the final stone-free rate was 87% after further treatment. One patient required blood transfusion, but none had severe complications. Computed tomography showed that the ureter between the orifice and ureteropelvic junction was straighter and the ureteropelvic junction angle was significantly smaller for surgeries conducted in the prone position than the supine position.

CONCLUSION Flexible ureteroscopy in the prone split-leg position is a viable technique. It allows easy insertion of the ureteral sheath and access of the ureteroscope to the renal pelvis. The findings suggest that this hybrid surgery is an efficient, effective, and versatile procedure for the management of renal calculi. UROLOGY 84: 565−570, 2014.

Large renal stones and staghorn calculi often impair renal function, cause urinary tract infections, and promote additional stone growth; therefore, their complete removal is an important treatment goal.[1-3] Current modalities for removal of renal calculi include extracorporeal shock wave lithotripsy (SWL), retrograde intrarenal surgery (RIRS) using flexible ureteroscopy (fURS), and percutaneous nephrolithotomy (PNL). According to the guidelines on urolithiasis of the European Association of Urology, SWL remains the gold standard for treating stones measuring <20 mm and located within the renal pelvis or in the upper or middle calices; PNL is recommended for larger stones.[3] Several authors have recently demonstrated that RIRS achieves excellent stone-free rates with low incidence of complications,[4,5] which has led to its greater application in treating renal calculi. However, a high rate of second-stage procedures has also been reported in association with RIRS.[6] For treating staghorn calculi, a combination of PNL and SWL is preferred, but there are many problems associated with complete calculi removal using this method, including long treatment durations, operative stress, and high costs.[7,8]

Minimally invasive PNL (miniPNL) was introduced in response to the complications encountered with conventional PNL, such as extravasation and the need for transfusion. MiniPNL can be performed with a tract size of 16F-20F, and it has been reported to reduce procedure-related morbidity.[9-11] However, this technique has several disadvantages, including low therapeutic efficacy in the removal of large stones, because of diminished intraoperative field visibility and increased surgical time.[12]

Endoscopic combined intrarenal surgery (ECIRS) using retrograde fURS and PNL was developed as a single-step treatment for removal of renal calculi to avoid multiple access points and the related morbidity while achieving a high stone-free rate.[13-18] Although the modified supine position is more commonly used in this procedure, the supine position is advantageous because it

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Table 1. Overview of the patient characteristics, operative parameters, and complications

Characteristic	Value
Characteristics of patients and stone features, mean ± SD	
N (male:female)	60 (44:16)
Age (y)	54.5 ± 1.5
BMI (kg/m^2)	24.6 ± 0.6
Hb (g/dL)	14.4 ± 0.2
Hct (%)	40.7 ± 1.3
eGFR (mL/min/1.73 m^2)	75.5 ± 3.0
Side (right:left)	21:39
Stone Size (mm)	39.2 ± 2.6
Staghorn (complete:partial)	33 (12:21)
Coexistent with ureteral stones	3
CT (HU)	1043.7 ± 36.2
Preoperative history, n	
SWL	3
URS	0
PNL	2
Operative parameters, mean ± SD	
Surgical time (min)	120.5 ± 6.7
Hb drop (g/dL)	1.04 ± 0.13
Hct drop (%)	2.33 ± 0.40
eGFR drop (mL/min/1.73 m^2)	2.61 ± 1.70
Hospital stay (d)	7.0 ± 0.6
Initial stone free, n (%)	49 (82)
Final stone free, n (%)	52 (87)
Ancillary treatment	
Total	7
Second PNL	2
SWL	4
URS	1
Intra and postoperative complications according to the modified Clavien classification	
Clavien grade 0, n (%)	54 (90.0)
Urinary fistula	1 (1.7)
Clavien grade I, n (%)	
Urethral injury	1 (1.7)
Fever	3 (5.0)
Clavien grade II, n (%)	
Required blood transfusion	1 (1.7)
Clavien grade ≥III, n (%)	0 (0)

BMI, body mass index; CT, computed tomography; eGFR, estimated glomerular filtration rate; Hb, hemoglobin; Hct, hematocrit; HU, Hounsfield unit; PNL, percutaneous nephrolithotomy; SD, standard deviation; SWL, shock wave lithotripsy; URS, ureteroscopy.

allows quick patient positioning, low pressure in the renal pelvis (thus reducing the risk of fluid absorption), and ureteroscopic access.[19] However, the potential access angles in the supine position are limited, and this may increase the risk of visceral injury during renal puncture.[20]

In 1988, Bagley and Lehman[16] used a modified prone position for nephroscopic and ureteroscopic procedures in female patients. Five years later, the prone split-leg position with simultaneous anterograde and retrograde endoscopy using a 2-team approach was reported.[17] However, the suitability of the prone split-leg position in surgery for treating renal calculi has not previously been examined, and urologists are not currently familiar with the use of this position for ECIRS.

The aim of this study was to develop a new ECIRS technique that involves the simultaneous use of fURS and miniPNL in the prone split-leg position. Additionally, the efficacy of this procedure was evaluated by analyzing ureteral curving using 3-dimensional (3D) computed tomography.

MATERIALS AND METHODS

Preoperative Evaluation

The records of 60 patients who underwent ECIRS in the prone split-leg position for treatment of large renal calculi between December 2010 and January 2013 at our departments were retrospectively reviewed and analyzed. This study was approved by the institutional review board of Toyota Kosei Hospital. Written informed consent was obtained from all patients, and all patients completed a minimum follow-up of 3 months. All those who were candidates for PNL surgery as the primary indication based on the European Association of Urology and American Urological Association guidelines were eligible for the study. Inclusion criteria were single or multiple renal stones including staghorn stones and stone diameter >2 cm. Treatment of patients with PNL was based on the presence of symptoms of pain in the flank, hematuria, and/or urinary tract infection. Patients were excluded for the following reasons: age <18 years, inability to understand informed written consent, sever ureteric stricture suspected, pregnancy, and American Society of Anesthesiologists classification of physical status grade ≥III. Preoperative patient evaluations included medical history, clinical examination, and routine laboratory tests. Preoperative imaging, including plain abdominal radiography, ultrasonography, excretory urography, and computed tomography, was used to determine the location, size, and radiodensity of the stones. Size was defined as the longest diameter observed during the preoperative imaging investigations. Patient characteristics and stone features are summarized in Table 1.

Surgical Techniques

The patient was oriented in the prone split-leg position throughout the operation, thus allowing both retrograde and antegrade access (Fig. 1). This procedure was performed by 2 urologists working simultaneously to fragment the renal stones; one performed RIRS, and the other performed PNL. Flexible cystoscopy was performed to locate the ureteral orifice, which was easily observed with the patient in the prone position, at the 11-o'clock direction on the left side. Under fluoroscopic guidance, the ureteral orifice was cannulated with a 0.035-mm guidewire that was passed into the upper urinary tract, and a ureteroscope (Flex X-2, Karl Storz, Tuttlingen, Germany) was inserted to observe the ureteral obstruction. If a ureteral stone was detected, RIRS was initially performed using a holmium:yttrium-aluminum-garnet (YAG) laser. If no stones or ureteral strictures were observed, a 12F or 14F ureteral access sheath was inserted to allow frequent passage of the ureteroscope to the site of the renal calculi. This enabled optimal visualization and allowed retrograde injection of contrast medium to facilitate renal puncture. A 200- or 365-μm holmium:YAG laser fiber with fURS was used to fragment the renal calculi. Attempts were made to fragment the calculi in the renal pelvis or low pole calyces to create sufficient space for antegrade access. Renal puncture was achieved using ultrasonography and fluoroscopic guidance. An 18F miniPNL tract (Karl Storz) was used to dilate the tract and establish working access. Lithoclast lithotripsy (Boston Scientific Japan, Tokyo, Japan) was