HUE UNIVERSITY
UNIVERSITY OF MEDICINE AND PHARMACY

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STUDY THE OUTCOMES OF SEMI-RIGID URETEROSCOPY IN THE TREATMENT OF RENAL STONES

Specialism: Surgery
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ABBREVIATIONS

ASA	American Society of Anesthesiologists
CT scan	Computed tomography scan
ESWL	Extracorporeal shock wave lithotripsy
Fr	French scale (1 Fr = 1/3 mm)
KUB	Kidney–Ureter–Bladder
P	Probability value
PCNL	Percutaneous Nephrolithotomy
RIRS	Retrograde Intrarenal Surgery
SFR	Stone-free rate
S-URS	Semi-Rigid Ureteroscopy
UIV	Urographie Intraveineuse
UPJ	Ureteropelvic junction
URS	Ureteroscopy

INTRODUCTION

In general, the worldwide prevalence of urolithiasis ranges from 2-15% of the population, in which renal stones are the most common, representing about 40-50% of cases. In the past, without lithotripsy, open surgery was the first choice in the treatment of kidney stones. The advent of extracorporeal shockwave lithotripsy in the 80s of the 20th century has opened a new era for the treatment of renal stones. Subsequently, with the advent of other less invasive intervention methods such as percutaneous nephrolithotomy and retrograde intrarenal surgery, the rate of open surgery in the treatment of kidney stones has decreased notieceably, even to less than 5% in certain areas.

Retrograde intrarenal surgery accesses the stones via a natural route, thus avoiding damage to the renal parenchyma and reducing the risk of bleeding. While flexible ureteroscope possesses the ability to access the entire pelvicalyceal system, semi-rigid ureteroscopy is superior regarding the endoscopic field of view, larger irrigation and working channel, allowing larger laser wire and instruments to help fragment the stones quickly, at the same time, at a lower cost with high durability. For the stones of the renal pelvis and/ or upper calyces, which are accessible without requiring the use of flexible ureteroscope, retrograde nephroscopy using a semi-rigid ureteroscope delivers highly satisfactory results.

In 1983, Huffman JL et al. reported the first cases of using a semi-rigid ureteroscope for the treatment of renal pelvic stones without early or late complications and long-term renal dysfunction. Since then, there have been many studies using semi-rigid ureteroscope to treat kidney stones in the world and in Vietnam, which all proved that this technique to be a safe, highly effective method, with low complication rate, short hospital stay, reduced postoperative pain, quick recovery, and unaffected longterm kidney function.

Currently, several urology centers across the country have applied semi-rigid ureteroscopy in the treatment of kidney stones including Hanoi, Da Nang, Quang Binh, Quang Tri, etc. Hue University of Medicine and Pharmacy Hospital has implemented this technique since 2013, achieving initial positive results with a high success rate

of over 70% and a low rate of intraoperative and postoperative complications. In order to evaluate the safety and effectiveness of this technique in the treatment of kidney stones, as well as to provide additional data and basis for clinicians to select the optimal treatment, we conducted the thesis: "Study the outcomes of semi-rigid ureteroscopy in the treatment of renal stones" with two objectives:

1/ To study the clinical and paraclinical characteristics of patients with renal pelvis and/ or upper calyx stones treated by semi-rigid ureteroscopy at Hue University of Medicine and Pharmacy Hospital from 2016 to 2020.

2. To evaluate the outcomes of the treatment of kidney stones by semi-rigid ureteroscopy and influencing factors in the above patient group.

CONTRIBUTIONS

1. The new contributions of the thesis

The thesis has contributed to domestic research data on the applicability of semi-rigid endoscope in the treatment of renal stones. The success of this study will further confirm the advantages of the treatment method for renal stones.

This is a minimally invasive technique, accessing the stones via a natural route, thus avoiding damage to the renal parenchyma and reducing the risk of bleeding. Today, with the significant technological improvement in the design of semi-rigid ureteroscope and the development of Holmium laser technology and ancillary instruments, retrograde intrarenal surgery with the use of semi-rigid ureteroscope is increasingly widely applied in the treatment of kidney stones.

Treating kidney stones with semi-rigid ureteroscopy is a safe and feasible choice with a high stone-free rate (70-95%), shortened operative time, and reduced treatment costs as well as fewer intraoperative and postoperative complications, shorter length of hospital stay, reduced postoperative pain, quick recovery, no longterm kidney dysfunction and good patient's satisfaction. A number of factors affecting the treatment results including technical details, stone position were investigated to improve success and stone-free rates, as

well as reduce the risk of intraoperative and postoperative complications.

2. The layout of the thesis

The thesis consists of 135 pages with introduction: 2 pages, overview: 35 pages, research objects and methods: 27 pages, results: 23 pages, discussion: 45 pages, conclusion: 2 pages, recommendation: 1 page. In the thesis, there are 57 tables, 7 charts, 1 diagram and 33 figures. There are 125 references, including 21 in Vietnamese and 104 in English.

CHAPTER 1
LITERATURE OVERVIEW

1.1. Endoscopic anatomy of the upper urinary tract

1.1.1. Cystoscopy and upper urinary tract access

When evaluating the bladder endoscopically the ureteral orifices are approximately 5 cm apart when the bladder is full and about 2.5 cm when the bladder is empty. The ureteral orifices together with the neck of the bladder form a triangle called the trigone. The raised ridge connecting the two ureteral orifices is the interureteral ridge.

Traumatic instrumentation or incision of the ureteral orifice can result in permanent reflux. Atraumatical dilation of the ureteral orifice with a catheter or balloon can avoid this complication. However, dilation of the ureteral orifice alone may in some cases not be sufficient for passage of the ureteroscope up the upper urinary tract due to the narrowing of the ureteral lumen.

There are many techniques to dilate ureteral orifice: (1) Prior JJ stent placement to dilate the ureteral orifice and the ureter; (2) Active dilation with use of a ureteric access sheath; (3) Balloon dilator.

1.1.2. Size of the lumen of the ureter

The average adult length of the ureter is 25 - 30 cm (6.5 - 7.0 cm in neonates) and its diameter is 1.5 - 6mm. The specific description of each ureter segment viewed on retrograde endoscope from the bladder is as follows:

- The intramural ureter: this is the first physiological narrowing, which is 1.2 - 2.5cm in length in adults and 0.5 - 0.8cm in neonates. At this level, the ureteral lumen is minimal (1.5 - 3mm), requiring its dilation when ureteroscopes with a larger caliber are used.

- The second physiological narrowing is the point where the ureter crosses over the iliac artery. It has a diameter of 4mm and witnesses a change in the curve of the ureter. Where the ureteral caliber is of approximately 4 mm, is situated in the area where it crosses the iliac vessels. The pulsations of iliac artery being observed postero-internally through the ureteral wall as a significant anatomic landmark of this ureter segment.

- The next segment is the abdominal ureter, with the largest size, which can reach 10mm in its most dilated condition, making it favourable for the scope to be passed through. This segment is relatively straight and located anterior to the psoas muscle.

- The third physiological narrowing is the ureteropelvic junction with a fairly narrow lumen (2 - 4mm) and a change in its course.

1.1.3. Ureteropelvic Junction

The ureteropelvic junction (UPJ) can be easily identified during retrograde nephroureteroscopy because of its frequent opening and closing. The UPJ then empties into the wider renal pelvis superiorly. The respiratory movement of the kidney could be seen by endoscopy after passing the relatively fixed UPJ. During retrograde endoscopy, it is necessary to wait for the ureter to dilate before passing the ureteroscope up to avoid trauma to the mucosal ureter.

1.2. Types of ureteroscopes

1.2.1. Rigid ureteroscopes

Rigid ureteroscope is suitable for distal ureter due to its usability and good control of maneuvers.

Most rigid ureteroscopes has its size increasing from the tip to the body of the scope. Therefore, when performing ureteroscopy, it may not be possible to pass the scope up because the body of the scope is stuck at the ureterovesical junction. The large diameter of the scope has certain advantages such as: larger working channel, better irrigation and better visibility. However, because its diameter is greater than 10 Fr, accessing the ureter requires dilatation of the ureteral orfice, moreover, the large size of the scope is also more likely to cause trauma to the ureter.

1.2.2. Semirigid ureteroscopes

Today, rigid ureteroscopes have been mostly replaced by semi-rigid ones. The size of the scope varies from 6 - 10 Fr at its tip, while

that of its body ranges from 7.8 to 14.5 Fr. These types of scopes can be bent along its vertical axis without either damaging the optic or the scope body or affecting the quality of the endoscopic images, therefor, they are called semi-rigid ureteroscopes.

The working channel of the semi-rigid ureteroscope ranges from 2.1 to 6.6 Fr in size. Nowadays, the ureteroscope with two working channels is increasingly widely used. The larger working channel has a diameter of 3.4Fr, while that of the smaller one is 2.1 – 2.4Fr. This design allows an empty channel for continuous irrigation when manipulating instruments during endoscopy. Notably, when performing lithotripsy with small laser wire, this wire can be passed through the small working channel, while the larger channel is used for irrigation. This will help improve irrigation capacity, reduce pressure in the pelvicalyceal system and clearer optical field.

1.2.3. Flexible ureteroscopes

From the first report by Marshall VF. about the flexible ureteroscope in 1964, up to now, the flexible ureteroscope has undergone significant improvement in terms of design and application.

Although the flexible ureteroscope is small in size, the magnification of the ureteroscope can be up to 3-50 times. Normally, flexible ureteroscopes have an active flexion of 180^0-275^0, which is sufficient to access the subrenal calyx because the angle between the ureter and the inferior calyx is about 140^0.

Currently, there are two types of digital flexible ureteroscopes: reusable and disposable one.

1.3. Laser lithotripsy technique during retrograde intrarenal surgery

A: “Dusting” or “Dancing” technique, which is best applied to soft stones.

B: “Chipping” technique, when the periphery of the stone is chipped off into small fragments. This is the optimal option for harder stones.

C: “Popcorning” technique, best used for small stone segments which are 3 – 4mm in size and located in a non-dilated calyx.

D: “Fragmenting” technique, when the stones are divided into big fragments, considered as the best option for very hard, large and small in quantity stones.

1.4. Some intraoperative and postoperative complications

1.4.1. Intraoperative complications

- Renal pelvis mucosal abrasion.
- Hemorrhage during surgery.
- Burns of the renal pelvis mucosal.
- Perforation of renal pelvis.
- Renal pelvis avulsion.

1.4.2. Early postoperative complications

- Urinary extravasation.
- Postoperative hemorrhage.
- Postoperative fever.
- Urinary tract infection.

1.4.3. Late postoperative complications

- Ureteral stricture.
- Urethral stricture.

CHAPTER 2
RESEARCH SUBJECTS AND METHOD

2.1. Research subjects

2.1.1. Patient selection criteria

- Age: ≥ 16 years old.
- Stone location: renal pelvis and/ or upper calyx.
- Stone size: 7-30 mm.
- Grade of hydronephrosis: non-hydronephrotic or ≤ grade 2.
- Pre-anesthesia assessment with an ASA of ≤ 3.
- Regardless of gender and patients have agreed to take part in the study.

2.1.2. Exclusion criteria

- Untreated urinary tract obstruction.
- Ipsilateral non-functioning kidney
- Pregnant women
- Hip joint disease preventing leg abduction.
- Uncured urinary tract infection.

2.1.3. Time and place: Our study was performed from 01/2016 to 06/2020 at the Department of Neuro-urologic surgery, Hue Univerisity of Medicine and Pharmacy hospital.

2.2. Methodology

2.2.1. Study design

Prospective, descriptive, interventional study with no control group.

2.2.2. Sample selection method

Sample size was calculated using a formula for prevalence studies and p is the stone-free rate after 1 month. According to previous studies, the stone-free rate after 1 month fluctuates around 80%. Therefore, presuming the p of our research is 80%, the minimal sample size is $n \geq 62$.

2.3. Research content

2.3.1. Clinical features: Age, gender, disease duration, surgical history, reason for hospitalization.

2.3.2. Laboratory features: Blood-related tests, urine-related tests, imaging tests (ultrasound, Kidney-Ureter-Bladder, intravenous urogram, CT urogram with contrast).

2.3.3. Selecting the optimal location of the stones for high success rate

In our study, patients underwent CT urography with contrast or an intravenous urogram before surgery to estimate the axis of the kidney or the direction of the ureter – renal pelvis – stone axis.

Based on Figure 2.5, we evaluated the following parameters:

- Ureteropelvic axis (line A): a straight line connecting the midpoint of the renal pelvis on the vertical line along the medial border of the kidney and the midpoint of the upper ureter at the level of the lower pole of the kidney.

- Axis of the upper calyx (line B): a straight line connecting the two midpoints along the upper calyceal neck.

- Line C: parallel to line A and close to the outer border of the ureter.

During surgery, we found that the initial accessible area of the semi-rigid ureteroscope was located medial to the C-line, but when the lower border of the renal pelvis was used as a prop for the ureteroscope in the attempt of accessing the lateral part of the C line, the abovementioned area can be extended to the D line *(Figure 2.5).*

Therefore, in order to get access to the stones and improve operative success, we selected cases with stones located in the renal pelvis and/ or upper calyces and most of the stones were located medial to the D line.

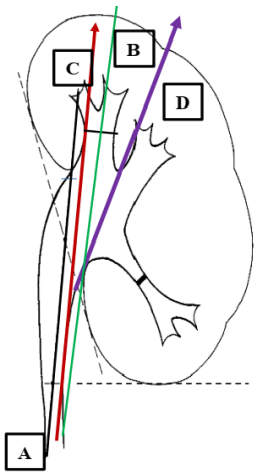

Figure 2.5. *Method to determine the axises at the renal pelvis and upper calyces:*
Line A (black): ureteropelvic axis
Line B (green): upper calyceal axis
Line C (red): parallel to line A and close to the outer border of the ureter.
Line D (purple): the border to which the accessible area can be extended in case the lower border of the renal pelvis was used as a prop for the ureteroscope in the attempt of accessing the lateral part of the C line
Source: *ElBahnasy AM. et al. (1998)*

2.3.4. Semi-rigid ureteroscopy in the treatment of renal stones

2.3.4.1. Instruments and equipment: 9.5 Fr semi-rigid ureteroscope; Karl Storz – branded system of a light source, a camera, and a monitor; Potent's Holmium laser lithotripsy system; 550-µm laser fiber; Guidewire: 0.035 inch; Ureteral JJ stent (6 Fr); Stone basket (Dormia); Grasping forceps; C-arm fluoroscope.

2.3.4.2. Technique

- Positioning: Dorsal lithotomy position.
- Step 1: Cystoscopy
- Step 2: Insert the guidewire into the ureter through the ureteral orifice.
- Step 3: Insert the ureteroscope into the ureter, so as to approach the renal stones
- Step 4:

+ If the stones can be reached and clearly seen, the ureteroscope will be removed and the ureter will be viewed outside of the guidewire.

+ Approach the stone and insert the laser conductor through the working channel of the ureteroscope until reaching the stone. When the tip of the laser fiber is in contact with the stone, adjust the frequency and intensity accordingly and proceed with the lithotripsy.

+ If the stone is dispersed into gravel dust or small fragments with a maximum diameter of ≤ 4 mm, it is considered as complete stone

fragmentation (evaluated directly on the endoscopic field of view or through the fluoroscopic monitor).

- Step 5: Insert JJ stent.

2.3.5. Evaluation of surgical outcomes

2.3.5.1. Intraoperative outcomes

- Failure:

+ Unable to reach the stones.

+ The stone has been reached but not yet fragmented or only partially fragmented before migrating into the renal pelvis or calyces, making them inaccessible.

- Cases in which the stone has been reached and fragmented were divided into 2 groups:

+ Complete stone fragmentation (Immediate or intraoperative stone free): the stone is fragmented into small fragments with a diameter of ≤ 4 mm.

+ Partial stone fragmentation (residual stone fragments): the stone is fragmented with residual fragments larger than 4mm.

2.3.5.2. 1 month and 3 months postoperative outcomes

- Stone-free: KUB radiograph and ultrasound images revealed either no stones or stones ≤ 4 mm.

- Residual stone: Stone fragments larger than 4mm were detected on KUB radiograph and ultrasound images.

2.3.6. Intraoperative evaluation: Anaesthesia method; Urine during surgery; Combined procedures during lithotripsy; Intraoperative complications; Volume of irrigation fluid during surgery; Lithotripsy time; Operative time; Insertion of JJ stent after lithotripsy.

2.3.7. Postoperative evaluation: Hemodynamic status; Abdominal and general condition of the patient; Early complications.

2.3.8. Follow-up results (after 1 month and 3 months)

- Clinical parameters.

- Paraclinical parameters.

- Monitor subsequent treatment in case of residual stones after 3 months.

2.3.9. Monitoring of subsequent treatment on cases of residual stones after 3 months of follow-up

2.3.10. Follow up cases which operate failure.

2.3.11. Study on factors influencing treatment outcomes.

2.4. Study variables.

2.5. Data analysing and processing

The data were processed by medical statistical method via SPSS 20.0 statistical software.

2.6. Ethics in research

Approved by the ethics committee in medical research of University of Medicine and Pharmacy, Hue University.

CHAPTER 3
RESULTS OF STUDY

3.1. Clinical and paraclinical features

3.1.1. Clinical features

- Age: the average age is 48.5 ± 11.8 (25 – 75), the 41 – 60 age bracket occupied 62.3%.

- Gender: Males took up 58,0%

- The proportion of cases with disease duration of > 2 years was 39,1%.

- There were 31/69 cases (44.9%) with a history of surgical intervention of ipsilateral urolithiasis, including: 6 cases (8.6%) with a history of more than 1 treatment method used on the same studied kidney, the percentage of extracorporeal shockwave lithotripsy was 14,6%.

- Flank pain was the reason of hospitalization in 87.0% cases, while the proportion of urinary frequency was 23.1%. There were 3 cases (5.8%) in which kidney stones were accidentally detected on examination for other diseases.

3.1.2. Paraclinical features

- Complete Blood count: there were 81.2% patients with normal white blood cell number.

- Serum urea and creatinine: 98.6% cases with these parameters within normal range.

- Urine test:

+ Complete urinalysis was performed on 100% patients

+ There were 64/69 cases (92.8%) in which urine culture was carried out, 8 of which (11.6%) had a positive bacterial culture.

3.1.3. Diagnostic Imaging

- Urinary tract ultrasound: Grade 1 hydronephrosis took up 52.2%, 10 cases (14.5%) were non-hydronephrotic, Grade 2 hydronephrosis occupied 33.3%.

- Urogram with contrast:

+ Urography with contrast was carried out on 65/69 patients (94.2%), including: 68.1% cases with CT urography and 26.1% with intravenous urography.

+ There were 4 patients (5.8%) on whom JJ stent had been placed 1 month before, thus, only ultrasound and KUB X-ray could be performed in these cases.

3.1.4. Kidney stones features

- Side of intervention: Right kidney stones took up 55.1%.

- Location of stones: Simple renal pelvic stones were found in 84.1% cases, simple upper calyx stones made up 5.8%, concurrent renal pelvic stones accounted for 10.1%.

- Number of stones: In total, there were 84 stones in 69 cases, with an average of 1.2 ± 0.5 stones per case, a minimum of 1 stone and a maximum of 3 stones. Cases with 1 stone constituted 81.2%.

- Size of stones:

+ The average size of the stones was 20.2 ± 5.5 mm, the smallest was 9mm and the biggest was 30mm.

+ Stones which were ≤ 20 mm made up 55.1% cases, including 1 case (1.4%) in which the size of the stone was < 10mm.

- Radiopacity of stones: stones with radiopacity equivalent to that of ipsilateral 12th rib constitubed 75.4%, lower than that of ipsilateral 12^{th} rib made up 15.9%, the remaining cases (8.7%) had a higher radiopacity.

3.2. Evaluation of surgical outcomes

3.2.1. Intraoperative characteristics

3.2.1.1. Anesthesia method

Table 3.14. *Relationship between gender and anesthesia method*

Gender	Anesthesia method		Total	p
	Endotracheal	Spinal		
Male	28 (70.0%)	12 (30.0%)	40 (100%)	0.490
Female	18 (62.1%)	11 (37.9%)	29 (100%)	

- Endotracheal anesthesia accounted for 66.7%, this method was more prevalent among males than females (70.0% versus 62.1%, respectively), this difference was not statistically significant (p<0.05).

3.2.1.2. Intraoperative outcomes: The stones were reached and fragmented into small fragments in 92.8% cases, while there were 5/69 cases of failure (7.2%).

3.2.1.3. Reasons of failure and management method

Table 3.15. *Reasons of failure and management method*

Reasons of failure	n (%)	Phương pháp giải quyết
Kink of ureteropelvic junction, unable to access the stones	2 (3.0%)	JJ stent placement + follow-up for further management
Stone migrating into the renal pelvis before being fragmented	1 (1.4%)	JJ stent placement + follow-up for further management
Stone migrating into the renal pelvis after being partially fragmented	1 (1.4%)	JJ stent placement + follow-up for further management
Stone migrating into the low calyces after being partially fragmented	1 (1.4%)	JJ stent placement + follow-up for further management

We evaluated failed cases in a separate part.

3.2.1.4. Intraoperative complications

As for cases when renal stones were reached and fragmented, there were 5 cases (7.8%) with intraoperative complications, including mild haemorrhage (4.7%) and injury of the renal pelvic mucosa (3.1%).

These were mild in severity and did not put the surgery to end.

3.2.1.5. JJ stent placement: JJ stent was inserted in 100% cases.

3.2.1.6. Lithotripsy time: the average lithotripsy time was 39.1 ± 12.6 minutes (15 – 72 minutes). lithotripsy time of ≤ 60 minutes was observed in 58 cases (90.6%).

3.2.1.7. Operative time

Table 3.18. *Operative time*

Operative time (mins)	Number (n)	Proportion (%)
≤ 60	56	87.5
> 60	8	12.5
Total	**64**	**100**
Average Operative time	48.7 ± 13.1 (25 - 85)	

3.2.1.8. Volume of fluid used intraoperatively

Table 3.19. *Volume of fluid used intraoperatively*

Volume of fluid (Litter)	Number (n)	Proportion (%)
≤ 2	57	89.1
> 2	7	10.9
Tổng	64	100
Average volume	1.6 ± 0,6 (1.0 – 4.0)	

Table 3.20. *Relationship between operative time and fluid volume*

Fluid volume / Operative time	n (%)	Average (litter)	p
≤ 60 mins	56 (87.5%)	1.6 ± 0.6	0.006
> 60 mins	8 (12.5%)	2.2 ± 0.3	

3.2.1.9. Intraoperatively stone-free (immediate stone-free): immediate stone-free rate was 65.6%, 34.4% cases had residual stones.

3.2.2. Postoperative follow-up

3.2.2.1. Early complications after surgery

There were 9 cases with early complications after surgery (14.1%), in particular:

Table 3.22. *Early complication grading according to modified Clavien classification*

Grade	Early complication	Number (n)	Proportion (%)
Grade 0	No complication	55	85.9
Grade I	Postoperative hematuria	4	6.3
	Postoperative fever	3	4.7
Grade II	Urinary tract infection	2	3.1
Tổng cộng		**64**	100

Table 3.23. *Factors influencing early complications after surger*

Early Complication / Factor	No	Yes	p
Average operative time (mins)	48.0 ± 12.8	52.6 ± 14.6	0.338
Average fluid volume (litter)	1.6 ± 0.6	1.9 ± 0.8	0.116

3.2.2.2. Postoperative hospital stay

- The average postoperative hospital stay was 4.1 ± 1.7 days (1 – 8 days); 1 to 4 days group took up 62.5%.

- The average postoperative hospital stay of group with early complications (6.6 ± 0.9 days) was longer than that of group without early complications (3.7 ± 1.4 days) and this difference was statiscally different ($p<0.05$).

3.2.3. Follow-up evaluation

1 month and 3 months after lithotripsy, we scheduled a follow-up appointment for patients at the Department of Urologic surgery, Hue University of Medicine and Pharmacy hospital.

Table 3.27. *Stone-free rate after 1 month and 3 months*

Stone-free	After 1 month		After 3 months	
	n	%	n	%
Yes	46	71.9	51	79.7
No	18	28.1	13	20.3
Total	**64**	**100**	**64**	**100**

3.2.4. Stone-free rate by follow-up time

Table 3.28. *Stone-free rate by follow-up time*

	1 month vs. immediate follow-up		3 months vs. immediate follow-up		3 months vs. 1 month follow-up	
	1 month	Immediate	3 months	Immediate	3 months	1 month
Stone-free	46 (71.9%)	42 (65.6%)	51 (79.7%)	42 (65.6%)	51 (79.7%)	46 (71.9%)
Residual stone	18 (28.1%)	22 (34.4%)	13 (20.3%)	22 (34.4%)	13 (20.3%)	18 (28.1%)
p	0.001		0.001		0.001	

3.3. Factors influencing treatment outcomes

3.3.1. Gender

Table 3.29. *Relationship between gender and treatment outcomes*

Factor \ Gender			Male	Female	p
Intraoperative outcome	Fragmentation		35 (87.5%)	29 (100%)	0.048
	Failure		5 (12.5%)	0 (0%)	
Early complications	No		31 (88.6%)	24 (82.8%)	0.505
	Yes		4 (11.4%)	5 (17.2%)	
Stone-free after surgery	1 month	Yes	23 (65.7%)	23 (79.3%)	0.228
		No	12 (34.3%)	6 (20.7%)	
	3 months	Yes	27 (77.1%)	24 (82.8%)	0.578
		No	8 (22.9%)	5 (17.2%)	
Average operative time (mins)			50.7 ± 15.2	48.7 ± 13.1	0.162
Average postoperative time (days)			3.9 ± 1.5	4.1 ± 1.7	0.223

3.3.2. History of previous surgery

Table 3.30. *Relationship between history of previous surgery and treatment outcomes*

Factor \ History of previous surgery			No	Yes	p
Stone-free after surgery	1 month	Yes	27 (79.4%)	19 (63.3%)	0.153
		No	7 (20.6%)	11 (36.7%)	
	3 months	Yes	28 (82.4%)	23 (76.7%)	0.573
		No	6 (17.6%)	7 (23.3%)	
Average operative time (mins)			47.9 ± 13.5	49.6 ± 12.8	0.605

3.3.3. Size of stones

Table 3.31. *Relationship between size of stones and treatment outcomes*

Factor \ Size of stones			≤ 20 mm	> 20 mm	p
Intraoperative outcome	Fragmentation		38 (100%)	26 (83.9%)	0.010
	Failure		0 (0%)	5 (16.1%)	
Early complications	No		35 (92.1%)	20 (76.9%)	0.086
	Yes		3 (7.9%)	6 (23.1%)	
Stone-free after surgery	1 month	Yes	34 (89.5%)	12 (46.2%)	0.001
		No	4 (10.5%)	14 (53.8%)	
	3 months	Yes	36 (94.7%)	15 (57.7%)	0.001
		No	2 (5.3%)	11 (42.3%)	
Average operative time (mins)			43.5 ± 10.2	56.3 ± 13.3	0.001
Average fluid volume (litter)			1.5 ± 0.7	1.8 ± 0.4	0.030
Average postoperative time (days)			4.0 ± 1.7	4.2 ± 1.8	0.597

3.3.4. Location of stones

Table 3.32. *Relationship between location of stones and treatment outcomes*

Factor \ Location of stones		Renal Pelvis	Upper Calyx	Pelvis + Upper	p
Intraoperative outcome	Fragmentation	54 (93.1%)	3 (75.0%)	7 (100%)	0.296
	Failure	4 (6.9%)	1 (25.0%)	0 (0%)	
Early complications	No	45 (84.9%)	3 (100%)	7 (87.5%)	0.758
	Yes	8 (15.1%)	0 (0%)	1 (12.5%)	

Stone-free after surgery	1 month	Yes	42 (79.2%)	1 (33.3%)	3 (37.5%)	0.016
		No	11(20.8%)	2 (66.7%)	5 (62.5%)	
	3 months	Yes	47 (88.7%)	1 (33.3%)	3 (37.5%)	0.001
		No	6 (11.3%)	2 (66.7%)	5 (62.5%)	
Average operative time (mins)			47.9 ± 12.5	46.7 ± 16.1	54.8 ± 15.7	0.372
Average fluid volume (litter)			1.6 ± 0.6	1.5 ± 0.5	1.9 ± 0.4	0.508
Average postoperative time (days)			4.1 ± 1.8	4.3 ± 1.5	3.8 ± 1.3	0.817

3.3.5. Number of stones

Table 3.33. *Relationship between number of stones and treatment outcomes*

Factor \ **Number of stones**			**1 stone**	**≥ 2 stones**	**p**
Intraoperative outcome	Fragmentation		51 (91.1%)	13 (100%)	0.263
	Failure		5 (8.9%)	0 (0%)	
Early complications	No		44 (86.3%)	11 (84.6%)	0.878
	Yes		7 (13.7%)	2 (15.4%)	
Stone-free after surgery	1 month	Yes	42 (82.4%)	4 (30.8%)	0.001
		No	9 (17.6%)	9 (69.2%)	
	3 months	Yes	46 (90.2%)	5 (38.5%)	0.001
		No	5 (9.8%)	8 (61.5%)	
Average operative time (mins)			47.2 ± 12.8	54.4 ± 13.1	0.077
Average fluid volume (litter)			1.6 ± 0.6	1.9 ± 0.4	0.118
Average postoperative time (days)			4.1 ± 1.7	3.9 ± 1.6	0.688

3.3.6. Degree of hydronephrosis on ultrasound

Table 3.34. *Relationship between degree of hydronephrosis on ultrasound and treatment outcomes*

Factor \ **Degree of hydronephrosis**			**Non-**	**Grade 1**	**Grade 2**	**p**
Intraoperative outcome	Fragmentation		9 (90.0%)	33 (91.7%)	22 (95.7%)	0.793
	Failure		1 (10.0%)	3 (8.3%)	1 (4.3%)	
Early complications	No		8 (88.9%)	29 (87.9%)	18 (81.8%)	0.788
	Yes		1 (11.1%)	4 (12.1%)	4 (18.2%)	
Stone-free after surgery	1 month	Yes	5 (55.6%)	25 (75.8%)	16 (72.7%)	0.487
		No	4 (44.4%)	8 (24.2%)	6 (27.3%)	
	3 months	Yes	6 (66.7%)	27 (81.8%)	18 (81.8%)	0.578
		No	3 (33.3%)	6 (18.2%)	4 (18.2%)	
Average operative time (mins)			50.0 ± 7.4	48.4 ± 15.0	48.5 ± 12.2	0.948

3.3.7. Renal axis

Table 3.36. *Relationship between stone location relative to D line and treatment outcomes*

Factor \ Stone location relative to D line			Mostly medial	Mostly lateral	p
Intraoperative outcome	Fragmentation		53 (94.6%)	7 (77.8%)	0.078
	Failure		3 (5.4%)	2 (22.2%)	
Early complications	No		46 (86.8%)	6 (85.7%)	0.937
	Yes		7 (13.2%)	1 (14.3%)	
Stone-free after surgery	1 month	Yes	40 (75.5%)	2 (28.6%)	0.011
		No	13 (24.5%)	5 (71.4%)	
	3 months	Yes	43 (81.1%)	3 (42.9%)	0.024
		No	10 (18.9%)	4 (57.1%)	
Average operative time (mins)			47.6 ± 13.4	55.7 ± 12.0	0.133
Average fluid volume (litter)			1.6 ± 0.6	1.8 ± 0.4	0.460

CHAPTER 4
DISCUSSIONS

4.1. Clinical and paraclinical characteristics

4.1.1. Clinical characteristics

History of previous intervention for ipsilateral urolithiasis

We take the history of previous interventions for ipsilateral urolithiasis into consideration in order to evaluate and predict preoperatively, especially in case with a history of open surgery on the same side on which ureteroscopy lithotripsy will be performed. In these cases, there are often anatomical changes and significant adhesions, etc, which may affect the surgical outcomes. In contrast, for cases with a history of ipsilateral ureteroscopic lithotripsy, the possibility of successful re-intervention is higher because the ureter is often dilated due to the previous endoscopic procedure, making stone access easier. However, there are also cases in which intraoperative and postoperative complications including ureteral perforation or trauma occurred, resulting in eventual ureteral narrowing, impeding stone access and being the possible cause of kidney stone formation.

In our study, there were 31 cases (44.9%) with previous intervention for ipsilateral urolithiasis, of which, 6 cases (8.6%) had a history of intervention with more than 1 method on the same study kidney; ESWL alone accounted for 14.6%; ureteroscopy with previous emergency JJ stent placement made up 5.8%.

Reason for hospitalization

In our study, patients admitted to hospital due to flank pain accounted for the highest percentage with 87.0%; followed by urinary frequency (23.1%).

According to Nguyen Khoa Hung et al. (2015), the main reason for hospitalization was flank pain, accounting for 75.4%.

Similarly, Dang Van Duy (2018) reported that most patients admitted to the hospital because of flank pain accounted for 98.4%; Nguyen Viet Hieu (2021) for 47.4%; Tran Trong Luc (2017) for 90.7%; Ngo Quoc Thang (2016) for 75%; Mursi K. (2013) for 87%.

4.1.2. Features on Diagnostic imaging

Urinary tract ultrasonography

In the study, grade 1 hydronephrosis accounted for the highest proportion with 52.2%; Grade 2 hydronephrosis made up 33.3% and 14.5% was non-hydronephrotic.

Hydronephrosis can also be considered as a potential factor in the failure of lithotripsy because in these cases, the stone could easily migrate, making it difficult to be located, fixed and fragmented. Simultaneously, this condition can affect the long-term results of surgery due to the reduced ability to eliminate the stones and limit the ability of renal function to recover. Therefore, in the study, we only selected patients with kidney stones with hydronephrosis grade lower than 2 so that the stones could be accessed more easily during ureteroscopic lithotripsy and prevented from moving into other renal calyces (especially into the lower calyx) where the stones can't be reached and fragmented.

Urogram with contrast

According to Table 3.8: There were 65/69 patients on whom urography with contrast was carried out (94.2%), including 68.1% with CT urography and 26.1% with UIV. There were 04 patients on whom only ultrasonography and KUB were performed. These were those on whom JJ stent had been placed previously because of acute pyelonephritis due to upper urolithiasis.

In the early stages, we performed UIV, but in later cases, we indicated contrast-enhanced CT uroscan with image reconstruction to accurately assess the axes of the kidney *(according to section 2.3.3)* and stone location in order to provide appropriate intervention methods for each case of kidney stones.

4.1.3. Characteristics of the stones

Ultrasound, KUB, UIV or CT-scan were performed on patients in

our study in order to evaluate the following features:

Location of renal stones

According to Table 3.10, simple renal pelvic stones accounted for the highest proportion of 84.1%, upper calyx stones constituted 5.8% cases and the remaining cases (10.1%) had renal pelvic stones in combination with upper calyx.

Accessing the stones plays a key role in nephrolithotripsy with semi-rigid ureteroscope. The advantageous feature of flexible ureteroscope is its ability to reach both the renal pelvix and calyces. Having said that, this method still has certain drawbacks including short durability, narrow field of view, limited irrigation, small working channel and higher expenses as compared to semi-rigid ureteroscope.

As for stones in accessible locations which do not require the use of flexible utereroscope, semi-rigid one proves to be a reasonable option, which can even shorten the time for fragmentation compared to flexible ureteroscope, as well as obviate the need for prior JJ stent placement.

Size and number of stones

The average size of stones in our study was 20.2 ± 5.5 mm (9-30 mm). The group of stones with the size of ≤ 20 mm accounted for a higher proportion than those of > 20 mm (55.1% and 44.9%). Regarding the number of renal stones: there were a total of 84 stones in 69 patients, with an average of 1.2 ± 0.5 stones for each case, (1-3 stones); Most of them were one single renal stone with a proportion of 81.2%, the remaining cases were 2 stones (15.9%) and 3 stones (2.9%).

Our size of renal stones in our study is similar to that of other authors who used semi-rigid ureteroscope in the treatment of kidney stones. According to a number of studies, for cases of kidney stones located in a favorable position, with good access to the stones, semi-rigid ureteroscope proves to be superior to flexible ureteroscope in terms of the ability to fragment and remove the stones, especially significantly reduce the time using the flexible ureteroscope.

4.2. Evaluation of surgical outcomes

4.2.1. Intraoperative evaluation

Intraoperative outcomes

Intraoperative outcomes in out study were as follows: Failure occured in 5/69 cases (7.2%); the stones could be reached and fragmented in 64/69 (92.8%).

Mitsogiannis IC. (2012): there were 85% cases in which semi-rigid ureteroscope could get access to and fragment the renal stones; failure

rate with semi-rigid ureteroscope was 15%.

Similarly, Dang Van Duy (2018): the stones were accessible in 100% cases; Nguyen Viet Hieu (2021): 5.3% of cases in which kink of the ureter was detected during ureteroscopy, however the stones were successfully reached in 100% cases; Nguyen Khoa Hung (2015), 95% of cases could approach the stones and conduct lithotripsy; Doan Quoc Huy (2016): the rate of successful access wass 94.3%, the failure rate wass 5.7%; Tran Trong Luc (2017): 81.3% patients had their stones completely fragmented, while there were 5 cases of incompletely fragmentation, accounting for 15.6% and 1 case of inaccessible stones, making up 3.1%.

Hence, the rate of successful access and fragmentation in our study is high with 92.8% and similar to the findings of the aforementioned authors.

Reasons for surgical failures

In our study, there were 5 failed cases, accounting for 7.2%, including: 2 cases encountering kink of the ureteropelvic junction (UPJ) thus, preventing access to the stones; 1 case in which the stones had been reached, but before it was fragmented, the stone ran into the lower calyx; In 2 cases, the stones were only partially fragented but the stone ran deep into the renal pelvis and lower calyx, making it unable to access to the stones with the semi-rigid ureteroscope.

All of the above cases were managed by JJ stent placement and a follow-up appointment after 1 month for further resolution.

According to several studies, the explanation for failure of semi-rigid ureteroscopy is mainly the kink of the UPJ or that the stones had been reached but not fragmented soon enough before moving into the calyx, making them inaccessible. One of the disadvantages of the semi-rigid ureteroscope is its inferior ability to access renal stones, especially when the stones migrate deep into the renal calyces, particularly the lower ones during lithotripsy. Many studies have applied a combination of both semi-rigid and flexible ureteroscope to overcome this drawback: the authors actively used the semi-rigid ureteroscope for cases of kidney stones located in a favorable position, while the stones in locations where the semi-rigid ureteroscope cannot reach or in case the stones migrate into the kidney, the flexible ureteroscope will be utilized to access and fragment the stone.

Operative time

The average operative time in our study was 48.7 ± 13.1 minutes,

the shortest was 25 minutes, the longest was 85 minutes. The majority of the operative time ≤ 60 minutes with 87.5%.

Regarding lithotripsy and operative time, one of the advantages of semi-rigid ureteroscope compared to flexible ureteroscope is the large channel for better irrigation, larger laser wire, the ability to fragment the stones faster as well as better auxillary instruments which would shorten operative time, and optimize lithotripsy compared to flexible ureteroscope when lithotripsy is carried out in favorable positions. There are certain studies in which semi-rigid ureteroscopes were actively used to fragment the kidney stones at convenient locations to shorten the time of using flexible ureteroscopes, thereby reducing costs and shortening operative time.

4.2.2. Early postoperative complications

According to table 3.22 and chart 3.7, there were 9/64 cases with early postoperative complications (14.1%), including mild postoperative hematuria (6.3%), postoperative fever (4.7%), urinary tract infection (3.1%); All 9 cases above were successfully treated medically.

The findings of several studies show that the rate of early complications after semi-rigid ureteroscopy is relatively low, thereby, concluding that this is a safe and effective technique and a reasonable choice in the treatment of kidney stones.

According to numerous reports, RIRS has been shown to have fewer complications compared to PCNL, especially when regarding bleeding and organ injury. The rate of complications after PCNL was about 21%, although most of them are mild, serious complications are also worth noting, such as sepsis 0.9%-4.7%, serious bleeding 0.6%-1.4%, lung injury 2.3-3.1% and colon injury 0.2-8.0%. Severe complications often result from tunneling, which can damage renal tissue and surrounding structures, or perforate the urinary collecting ductal system. Moreover, ureteroscopy is a surgery which is carried out via a natural route, proven to be safe for patients with risks of complications such as pregnancy or coagulopathy, which are almost absolute contraindications to PCNL and ESWL. As for obese patients, it is difficult to perform ESWL as well as puncture in PCNL, while ureteroscopy is associated with operative outcomes, intraoperative and postoperative complications which are not affected by body mass index.

4.2.3. Postoperative hospital stay

Regarding postoperative time, the majority of patients stayed at the hostpital in 1-4 days subsequent to their surgery (62.5%); the average

length of postoperative hospitalization was 4.1 ± 1.7 days (1-8 days). The longest hospital stay was 8 days, occuring in 1 case (1.5%), which were subsequently treated stably with antibiotics before being discharged.

This result is consistent with many studies conducted by domestic and international authors. The length of stay after lithotripsy for cases without intraoperative and postoperative complications is only 1 - 4 days, which is one of the advantages of retrograde ureteroscopy, making it more cost-effective for patients.

4.2.4. 1 month and 3 months follow-up evaluation

There were 65.6% cases with immediate stone-free status, however, after 1 month and 3 months, this rate climbed to 71.9% and 79.7% respectievely.

Table 4.13. *Stone-free rate after 1 month and 3 months*

Study	Năm	n	SFR after 1 month (%)	SFR after 3 months (%)
Atis G.	2012	47	76.0	-
Mitsogiannis IC.	2012	20	82.3	-
Miernik A.	2013	38	72.7	81.8
Varela-Figueroa DA.	2014	7	-	85.7
Nguyen Khoa Hung	2015	20	70.4	-
Suer E.	2015	48	83.3	-
Doan Quoc Huy	2016	34	73.5	-
Ngo Quoc Thang	2016	20	83.3	-
Tran Trong Luc	2017	32	79.3	-
Al- Musawi MN.	2017	100	86	-
Al-Hamdani HA.	2021	50	86.0	-
Chúng tôi	**2022**	**64**	**71.9**	**79.7**

Thus, our results are similar to those of other researchers: the stone-free rate after semi-rigid ureteroscopy is fairly high, ranging from 70 to 90%, proving that this is an option worth considering in the treatment of kidney stones.

4.2.5. The relationship of stone-free by follow-up time after surgery

We found that, when evaluating stone clearance immediately during the operation, it is probable that many stones have been fragmented into fragments with a size of ≤ 4mm but clustering together, thus, when viewed on fluoroscopic monitor, they appeared to be a larger stone. However, after 1 month, in many cases, these fragments will be eliminated automatically. In addition, as regard to patients with fragments of > 4mm in size after lithotripsy, after having their urinary tract unblocked, plenty amount of water drinking and

medical expulsive therapy alone can lead to stone-free in some patients.

Therefore, in our study, when comparing the immediate stone-free rate, after 1 month and 3 months, there was a statistically significant increase with $p < 0.05$ (65.6%, 71.9% and 79.7%, respectively).

Miernik A. (2013) reported an immediate stone-free rate of 63.2%, increasing to 72.7% after 1 month and 81.8% after 3 months of surgery.

Similarly, Mitsogiannis IC. (2012): the rate of stone removal after 1 day of surgery was 70.6% and increased to 82.3% after 1 month; Atis G. (2012): the rate of stone clearance after 1 day was 72.0% and increased to 76.0% after 1 month of surgery.

CONCLUSION

1. Clinical and paraclinical characteristics

Clinical features : Gender: 58% male/ 42% female. Average age: 48.5 ± 11.8 years old (25 - 75), the most prevalant age group was 41 – 60, accounting for 62.3%. There were 44.9% patients with a history of intervention on the kidney and ureter on the same side: 6 cases (8.6%) had a history of intervention with more than 1 methods on the same studied kidney, extracorporeal shockwave lithotripsy simply accounted for 14.6%. Reason for hospitalization: flank pain accounted for 87.0%.

Paraclinical features: All patients were evaluated preoperatively for urinary tract infection before surgery based on clinical signs and symptoms together with urinalysis, 92.8% of patients received urine culture, of which 8 cases (11.6%) were associated with the presence of bacteria growth. Grade 1 hydronephrosis on ultrasound accounted for 52.2%; There were 14.5% cases with no sign of hydronephrosis. There were 94.2% of patients undergoing urography with contrast.

Characteristics of kidney stones: Right kidney: 55.1%, left side: 44.9%. The mean stone size was 20.2 ± 5.5 (9 - 30 mm). Location of stones: simple renal pelvis accounted for 84.1%, simple upper calyces accounted for 5.8%. Number of stones: cases with 1 stone constituted 81.2%; on average there were 1.2 ± 0.5 stones for each patient.

2. Evaluation of treatment results and some related factors affecting operative outcomes

2.1. Operative outcomes

Intraoperative outcomes: cases in which access to kidney stones was attained and lithotripsy were successfully performed accounted for 92.8%; 5/69 failed cases, accounting for 7.2%.

Introperative complications: 7.8%, including: mild bleeding (4.7%) and injury of the renal pelvic mucosa (3.1%), there were no cases

requiring discontinuation of surgery. Early postoperative complications: 14.1%, all of which were successfully treated with medical treatment, specifically: grade I (haematuria, postoperative fever) - 11.0% and grade II (urinary tract infection) - 3.1%.

Average operative time: 48.7 ± 13.1 (25 - 85 minutes). The mean postoperative time was 4.1 ± 1.7 (1 - 8) days. Average amount of water used: 1.6 ± 0.6 (1.0 - 4.0 liters). The rate of immediate stone clearance, 1 month and 3 months after surgery was 65.6%, 71.9% and 79.7%, respectively.

2.2. Some related factors affecting the outcome of surgery

The difference between gender (male and female) and the intraoperative outcomes is statistically significant ($p<0.05$).

Stone characteristics: There are differences regarding operative time, average amount of water used in surgery, stone-free rate after 1 month & 3 months between groups of stones ≤ 20mm and > 20mm. All failed cases were in the group of stones with the size of > 20mm. The rate of stone clearance after 1 month and 3 months was significantly higher ($p<0.05$) between the group of 1 stone compared with the group of ≥ 2 stones.

There was a statistically significant increase in stone-free rate ($p<0.05$) when comparing 1 month with immediate (71.9% and 65.6%), between 3 months with immediate (79.7% and 65.6%), 3 months with 1 month (79.7% and 71.9%).

Stone location relative to D line on urogram with contrast: Stone-free rates after 1 month and 3 months were significantly higher ($p<0.05$) among patients whose stones were located mainly medial to D line compared to those with stones located mosly lateral to D line (75.5% and 81.1% versus 28.6% and 42.9%, respectively). Stones located mostly medial to D line are recommended so as to reduce failure rate, increase stone-free rate and reduce risks of complications as well as operative time for patients.

This study showed that semi-rigid ureteroscopy in the treatment of renal stones is a safe and feasible choice with a high stone clearance rate (70-95%), shortened operative time, and reduced treatment costs as well as fewer intraoperative and postoperative complications, shorter length of hospital stay, reduced postoperative pain, quick recovery, unaffected long-term kidney function and good patient's satisfaction.

LIST OF PUBLISHED RESEARCHES RELATED TO THE THESIS

1. Hoang Duc Minh, Nguyen Khoa Hung, Le Dinh Khanh, Le Dinh Dam, Nguyen Nhat Minh, Nguyen Xuan My, Vo Minh Nhat (2021), "Assessment of early complications of semi-rigid ureteroscopy for renal stone", *Journal of Medicine and Pharmacy,* January Special magazine, pp. 291-98.

2. Hoang Duc Minh, Nguyen Khoa Hung (2022), "Evaluating outcomes of semi-rigid ureteroscopy for renal stone", *Journal of Medicine and Pharmacy,* no. 5, vol. 12, pp. 15-22.