Efficacy of surgical techniques and factors affecting residual stone rate in the treatment of kidney stones

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ABSTRACT

Objective: In this study, we aimed to evaluate, the efficacy of surgical methods and the factors affecting the residual stone rate by scrutinizing retrospectively the patients who had undergone renal stone surgery.

Material and methods: Records of 109 cases of kidney stones who had been surgically treated between January 2010, and July 2013 were reviewed. Patients were divided into three groups in terms of surgical treatment; open stone surgery, percutaneous nephrolithotomy (PNL) and retrograde intrarenal surgery (RIRS). Patients' history, physical examination, biochemical and radiological images and operative and postoperative data were recorded.

Results: The patients had undergone PNL (n=74; 67.9%), RIRS (n=22; 20.2%), and open renal surgery (n=13; 11.9%). The mean and median ages of the patients were 46±9, 41 (21-75) and, 42 (23-67) years, respectively. The mean stone burden was 2.6±0.7 cm² in the PNL, 1.4±0.1 cm² in the RIRS, and 3.1±0.9 cm² in the open surgery groups. The mean operative times were 126±24 min in the PNL group, 72±12 min in the RIRS group and 82±22 min in the open surgery group. The duration of hospitalisation was 3.1±0.2 days, 1.2±0.3 days and 3.4±1.1 days respectively. While the RIRS group did not need blood transfusion, in the PNL group blood transfusions were given in the PNL (n=18), and open surgery (n=2) groups. Residual stones were detected in the PNL (n=22), open surgery (n=2), and RIRS (n=5) groups.

Conclusion: PNL and RIRS have been seen as safe and effective methods in our self application too. However, it should not be forgotten that as a basal method, open surgery may be needed in cases of necessity.

Key words: Kidney stones; open surgery; percutaneous nephrolithotomy; retrograde intrarenal surgery.

Introduction

Urinary system stone disease is one of most frequently encountered diseases in the urology practice. The stones are frequently observed in the renal localization, and most of them require intervention. With the introduction of extracorporeal shock wave lithotripsy (ESWL) into clinical practice after 1980s, a new era had begun in the treatment of urinary system stone disease.^[1] In recent years, percutaneous nephrolithotomy (PNL) has taken increasingly greater part in the treatment of stone disease with success rates nearing to 80 percent.^[2] These technological advancements have decreased the role of open surgery considerably in the treatment of kidney stones. Nowadays, techniques of retrograde intrarenal surgery (RIRS), and other minimally invasive treatment modalities have found increasingly greater field of application. Subsequently, advanced technology has nearly eliminated the

indication for open stone surgery. Thanks to the development of minimally invasive techniques, efficacy, and success of surgery in the management of renal stones have been more frequently questioned. Success, and complications of the surgical method to be selected should be very well known, and used in suitable indications.

In this study we have retrospectively analyzed the patients who underwent surgical treatment with the indication of renal stone, and evaluated effectiveness of surgical methods we used, and factors effecting postoperative residual stone rate.

Material and methods

In our clinic, medical records of 169 patients who underwent surgical treatment in our clinic, between January 2010, and July 2013 were retrospectively reviewed, and 109 patients

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were included in the study. Patients in the pediatric age group, and the patients with missing information in their medical history, operative, and postoperative imaging modalities were excluded from the study. Since the study had a retrospective design, evaluation of the indications for the surgical method selected were not determined as inclusion criteria.

The outcomes of the patients who underwent open stone surgery, PNL, and RIRS were divided into 3 groups. Information about history, physical examination, biochemical, and imaging methods, operative, and postoperative data of the patients were evaluated. Endoscopic stone surgery was performed for stone fragmentation in all patients using pneumatic lithotripter or Holmium: YAG laser. The patients were evaluated during the postoperative period with non-contrasted computed-tomographic examinations. According to surgical techniques complications were evaluated using Clavien grading system. Stones equal or larger than 4 mm were considered as residual stones. The cases with residual stones were evaluated separately. The dimensions of the stones were calculated. We multiplied the largest horizontal, and vertical diameters of the stone measured with a ruler based on radiological images, with each other, and expressed the product in cm².

Statistical analysis

Descriptive data of the patients were evaluated using SPSS (Statistical Package for Social Sciences Inc., Chicago, IL USA) for Windows Version 15.0. All numerical data with normal distribution were expressed as mean $\pm$ standard deviation, and those with non-normal distribution were given as median (min-max) values. Categorical data were indicated as percentages.

Results

The patients underwent PNL (n=74; 67.9%), RIRS (n=22; 20.2%), and open surgery (n=13; 11.9%). Data related to stone burden, operative times, residual stone rate, and length of the hospital stays are shown in Table 1.

Twenty-nine female, and 45 male patients with a mean age of 46 $\pm$ 9 years underwent percutaneous nephrolithotomy with the

patients in the prone position. Two access tracks were created for two patients with staghorn stones, and for other patients PNL was performed through a single access track. Double -J stent (DJS) was implanted in 6 (8.1%) patients during the postoperative period because of persistent drainage. Nine out of 22 cases with residual stones were referred to ESWL, and for 13 patients a follow-up protocol was recommended.

Retrograde intrarenal surgery was performed for 10 male, and 12 female patients with a median age of 41 years. Eight (36.3%) patients had a history of failed ESWL. Double -J stents were implanted in 15 (68.1%) patients. In 4 (18.1%) patients with greater stone burden only incomplete fragmentation could be performed during the first session, and in the 2. session RIRS was applied. Stone-free rates were achieved in 17 (77.2%) patients, and in only one patient insignificant residual stones ($\leq$ 4 mm) were detected. In these four patients, we approached the stones but because of difficulties in deflexion manoeuvres, laser probe could not be advanced further.

Open stone surgeries were performed in 4 (30.7%) female, and 9 (69.3%) male patients with a median age of 42 years. These patients were treated with nephrolithotomy (n=6; 46.1%), pyelolithotomy (n=5; 38.4%), and anastrophic nephrolithotomy (n=1; 7.6%) (Figures 1, 2). In open stone surgery subcostal flank incision (n=8; 61.5%), and dorsal lumbotomy incisions (n=5; 38.4%) were preferred.

Data about cases with residual stones are shown in Table 2. The classification of complications related to surgical techniques as evaluated based on Clavien grading system are presented in Table 3.

Discussion

Nowadays, PNL which is prevalently used in the surgical treatment of renal stones, is a successful method with confirmed efficacy. In guidelines of both European Association of Urology (EAU), and American Urological Association (AUA), endoscopic methods (PNL, RIRS) are recommended as the first alternatives.^[3,4] In parallel with this, in our country where stone

Table 1. Data concerning surgical techniques

	Age (year)	Stone burden (cm ²)	Operative time (min)	Length of hospital stay (day)	Number (%) of cases with residual stone(s)
PNL (n=74)	46 $\pm$ 9	2.6 $\pm$ 0.7	126 $\pm$ 24	3.1 $\pm$ 0.2	22 (29.7%)
Open surgery (n=13)	42 (23-67)	3.1 $\pm$ 0.9	82 $\pm$ 22	3.4 $\pm$ 1.1	4 (30.7%)
RIRS (n=22)	41 (21-75)	1.4 $\pm$ 0.1	72 $\pm$ 12	1.2 $\pm$ 0.3	4 (18.1%)
PNL: percutaneous nephrolithotomy; RIRS: retrograde intrarenal surgery					

Table 2. Some demographic characteristics of the cases with residual stones

	Age (year)	Stone burden (cm ²)	Operative time (min)	Length of hospital stay (day)	Location of the residual fragment n/%
Post-PNL (n=22)	39±7	3.5±0.4	110±12	4.3±0.4	Only upper calyx (calices) 10 (45.4%) Only lower calyx (calices) 5 (22.7%) Isolated lower calyx 5 (22.7%) Pelvis 3 (13.6%) Multiple 4 (18.1%)
Following open surgery (n=4)	48 (45-61)	4.3 (3.7-4.9)	90 (60-130)	4.2 (4-6)	Only upper calyx (calices) 2 (50%) Multiple 2 (50%)
Post-RIRS (n=4)	43 (27-75)	1.4 (1.1-1.9)	75 (45-120)	1.5 (1-3)	Only upper calyx (calices) 1 (25%) Only lower calyx (calices) 2 (50%) Pelvis 1 (25%)

PNL: percutaneous nephrolithotomy; RIRS: retrograde intrarenal surgery

Figure 1. KUB of the patient scheduled for anatomic nephrolithotomy
KUB: kidney-ureter-bladder

disease is endemic, PNL has become the most preferred treatment method.^[5] In our clinic PNL is the most preferred alternative in renal stone surgery.

Though stone-free rate in percutaneous nephrolithotomy can vary dependent on the stone location, and size, as reported in the literature, it increases up to 90 percent.^[6-8] In the AUA guideline, this rate has been given as 78 percent.^[4] In our study, in 74 patients, a 70.3% stone-free rate has been detected. Size, location, composition of the stone, anatomy of the affected kid-

Figure 2. Stones extracted using anatomic nephrolithotomy

ney, and experience of the surgeon are effective on success, and complications of PNL.^[9] Lingeman et al.^[10] reported 88-91% success rates for stones with a diameter of 1-3 cm, mean success rate decreased to 75% in stones larger than 3 cm in diameter. Still Clayman et al.^[11] reported success rates as 89.2, and 97-100% for stone with a stone burden of >2, and <2 cm², respectively. In our study, an increased residual stone burden was observed. In our study, most of the residual stone fragments were located in the upper calyces. This phenomenon can be explained by our inadequate experience with supracostal, and multiple interventions, and increased rate of major complications inherent to these interventions. In our study, most of the patients underwent single-access subcostal interventions. Intrarenal access through subcostal approach is frequently preferred method in that it is easier to apply with lower complication risk, and also it allows a wider range of nephroscopic manipulation within the renal collecting system. In only 5 cases, access through supracostal approach was used. Any major complication was not encountered in these cases. Still capability of the surgical equipments

Table 3. Distribution of the complications among PNL, RIRS, and open surgery according to modified Clavien grading system

	PNL, n/N, (%)	RIRS, n/N, (%)	Open surgery, n/N, (%)
Class 1	Fever 11/74 (14.8)	Fever 2/22 (9)	Fever 3/13 (23)
	Persistent pain 7/74 (9.4)		Persistent pain 2/13 (15.3)
Class 2	Transfusion 18/74 (24.3)	Infection 2/22 (9)	Transfusion 2/13 (15.3)
	Infection 6/74 (8.1)		Infection 1/13 (7.6)
Class 3a	Urine leakage 6/74 (8.1)	-	-

PNL: percutaneous nephrolithotomy; RIRS: retrograde intrarenal surgery

is another important factor effecting the stone-free rates. It has been reported that stone-free rates increased up to 95% with the use of flexible nephroscope, and the need for an additional intervention decreased.^[12,13]

Michel et al.^[14] evaluated complications of PNL, and reported major complication rate as 0.9-4.7% in their study performed on more than 1000 cases. In this study the rates of complications as fever, and prolonged drainage were detected to be 21-32, and 7.2%, respectively, while need for transfusion was indicated as 11.2-17.5 percent. In our study, any major complication was not detected, and the rate of minor complication was in compliance with the literature findings. Complication rates can vary dependent on the experience of the surgeon, general health state of the patient, stone burden, stone location, and anatomical structure of the kidney. Still even in experienced hands major, and minor complication rates have been reported as 1.1-7, and 15-25%, respectively.^[15]

In recent years, with the use of flexible ureterorenoscopes which provide higher imaging quality, and increased mobility, it has become possible to reach the most remote part of the renal pelvicalyceal system through retrograde route.^[16] Thanks to developments of holmium laser systems, they have become an important alternative to retrograde surgical interventions. RIRS is a safe, and successful minimally invasive treatment modality. In the literature, stone-free rates reported in the literature for RIRS range between 50, and 90 percent.^[17,18] Stone-free rates increase inversely with stone burden.^[19] In our study we detected a 81.9% stone-free rate. This rate is in compliance with the literature. Stone size, and location have an important place in the effectiveness of flexible ureterorenoscopy. In a prospective study where ESWL, and RIRS were compared in the

management of lower calyceal stones smaller than 1 cm, stone-free rates achieved using ESWL, and RIRS were detected as 35, and 50%, respectively.^[17] In addition, as stone size increases, the success rate of RIRS decreases markedly. In a study where lower calyceal stones were divided into 3 groups (1-11, 11-20, and >20 mm), after a 3-month follow-up period, stone-free rates were found to be 82, 71, and 65%, respectively.^[20] Retrieval of broken stone fragments out of the renal collecting system is an important problem. To preclude potential obstruction, implantation of DJ-S is a debatable issue.^[21,22] In our study, DJ-S was implanted in 15 (68.1%) patients, and in 6 (31.9%) patients there was no need for stent implantation.

Open stone surgery comprise nearly 1.5% of all stone surgeries performed in developed countries, however in developing countries its rate changes between 26, and 3.5 percent.^[23,24] In recent years, though its field of application has narrowed, concurrent open stone surgery has been performed in cases with comorbidities as complicated stone burden, ureteropelvic junction stenosis, infundibular narrowing, and calyceal diverticula, morbid obesity or inadequacy of minimally invasive therapies in the management of stone disease.^[3,24-26] Open stone surgery is not recommended directly in international guidelines. In the European Association of Urology (EAU) guidelines laparoscopic intervention is recommended in suitable cases, before resorting to open surgery.^[3] In AUA guideline, even in standard staghorn stones, priorly, application of ESWL, and PNL alternatives is recommended.^[4] Though open surgery is used with a gradually decreasing frequency, patients' compliance with the treatment, their opinions about the treatment method to be applied, surgical experience of the surgeon, can direct indications in daily practice. This finding relatively increases the rates of open stone surgery in our clinic. Doubtlessly, the most important disadvantage of open surgery is incisional morbidity. This condition increases the need for analgesia, hospital stay, and delays patients' return to their normal daily activities. Because of these causative factors, excessive work loss is frequently observed.^[26] In open surgery stone-free rate has been reported to range between 69, and 93 percent.^[23,27] In our study, stone-free rate of 69.3% was detected in 13 patients. However, complex stone burden which is one of the indications of open surgery, inadequacy of other minimally invasive methods, presence of anatomical abnormalities or comorbidities all decrease stone-free rates in this group.

Percutaneous nephrolithotomy, and RIRS have been increasingly used in the treatment of renal stones. Open renal stone surgery, though rarely, can be required in complicated stone disease patients or in patients who couldn't tolerate minimally invasive procedures. Urologists should priorly master endourological, and minimally invasive techniques, however we think that it is important especially for young urologists to develop

their competency, and skills in open stone surgery. Thanks to rapidly developing technology, and accumulating experience of urologists, the important role of RIRS will expectedly increase in the surgical treatment of renal stones.

Our single-centered study had a retrospective design with its known disadvantages. In addition to lack of data about the results of long-term follow-up, different distribution patterns of number of patients among various surgical techniques, and scarce number of population are other limitations of our study.

In conclusion, in our practice, PNL, and RIRS have been seen as safe, and effective methods. However, as a basic method, in case of need as a last resort open surgery should not be forgotten. Experience of the surgeon, stone burden, and location, adequacy of the surgical equipment, and renal anatomy can effect success rates. Whatever the preferred method will be it should not be forgotten that the novice urologist should be, careful about the selection of the cases for different types of renal stone treatment, and need for additional interventions before and after the procedure.

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Informed Consent: Written informed consent was obtained from patients who participated in this study.

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