ORIGINAL RESEARCH

Early postoperative outcomes of open renal stone surgery: A prospective study with 1-month follow-up across 3 referral hospitals in Addis Ababa, Ethiopia

Seyfe Bekele Tilahun, Messay Mekonnen Molla

Department of Surgery, School of Medicine, College of Health Sciences, Addis Ababa University, Addis, Ababa, Ethiopia

Correspondence: Dr Seyfe Bekele Tilahun (seyfebekele@gmail.com)

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Abstract

Background
The surgical management of urinary tract stone disease has undergone revolutionary changes from open stone surgery to minimally invasive procedures with comparable efficacy. In regions where minimally invasive surgery is not widely accessible, open surgery persists as the primary management approach for urolithiasis. Surgical outcomes for renal stones are primarily evaluated based on the stone clearance rate, the necessity for additional procedures, and postoperative morbidity. This study aimed to ascertain the stone clearance rate and perioperative complications associated with open renal stone surgery.

Methods
This prospective study, conducted at 3 referral hospitals in Addis Ababa, Ethiopia, was conducted over a 1-year period, with patients followed up for 1 month postoperatively to assess outcomes. It included all patients who underwent open surgery for renal stones across the hospitals from 1 June 2020 to 1 June 2021. Data were collected during the preoperative, intraoperative, and postoperative periods using a structured data collection form. Descriptive analyses covered preoperative, intraoperative, and early postoperative data. Categorical variables were analysed using the chi-square test, as appropriate. Two-sided *P* values <0.05 were considered statistically significant.

Results
Of the 81 patients who underwent open surgery for renal stones, the overall stone clearance rate was 50%. Factors such as stone multiplicity, stone architecture, the absence of intraoperative imaging, and the type of surgery were significantly associated with stone clearance rates. Intraoperatively, blood transfusions were necessary for 3 patients, and pleural injuries were reported in 2. Postoperatively, the incidence of surgical site infections was 9.9%, and the incidence of symptomatic urinary tract infections was 3.3%.

Conclusions
The stone-free rate was found to be lower in patients with large, complex, and multiple stones.

Keywords: urolithiasis, open stone surgery, pyelolithotomy, nephrolithotomy, stone-free rate, surgical outcomes, Ethiopia

Introduction

Urinary tract stone disease has been recognized to affect humans since ancient times and is currently among the most common urological conditions, imposing a substantial health cost burden. The average lifetime prevalence of urinary tract stone disease is 15%, with the incidence seemingly on the rise primarily due to environmental factors.[1] Ethiopia's close proximity to the Afro-Asian stone-forming belt likely contributes to a higher prevalence of stone disease within the country.

Urolithiasis ranks among the conditions frequently managed by urologists, including those in Ethiopia. A hospital-based cross-sectional study conducted at Tikur Anbessa Specialized Hospital (TASH) in Addis Ababa, Ethiopia, found that urolithiasis accounted for 22.3% of urological admissions.[2] Another study conducted at the same hospital found that urolithiasis constituted 12.1% of all elective surgical admissions between 2010 and 2015.[3]

Surgical management of urinary tract stone disease has significantly improved over time. Presently, the principal minimally invasive procedures for the management of

urolithiasis are extracorporeal shock wave lithotripsy, ureterorenoscopy, percutaneous nephrolithotomy, and laparoscopic or robot-assisted stone surgery. In regions of the globe where endourologic services are widely available, open stone surgery has become an outdated method, accounting for only 1% of procedures for stone treatment.[4] Conversely, in settings where endourologic services are not readily accessible, open surgery remains the mainstay of management for nephrolithiasis. TASH has been noted to have a 55% rate of open surgery among stone treatment procedures[2]; another teaching hospital—in Hawassa, Ethiopia—reported a rate of 72.8%.[5] In Nigeria, a retrospective study revealed that open stone surgery accounted for over 96% of all procedures performed for stone disease.[6]

Outcomes of procedures for stone disease are primarily evaluated by the stone clearance rate, the requirement for auxiliary treatments, and morbidity related to the procedures. Higher incidences of bleeding, transfusion necessity, organ injury, prolonged operative times, postoperative complications, extended hospital stays, and increased overall costs have rendered open stone surgery less favourable in regions where endoscopic equipment and expertise are available.[4],[7],[8] Currently, the indications for open renal stone surgery are confined to complex, high-burden renal stones, particularly in patients with anatomical abnormalities.

In settings where the expertise and equipment for minimally invasive procedures are not readily available, open stone surgery still stands as the primary method for the surgical extraction of renal stones. This study aimed to determine the stone-free rate and perioperative outcomes following open renal stone surgery in patients treated for renal stones at TASH, Menelik II Hospital, and Yekatit 12 Hospital, which are the main referral and teaching hospitals in Addis Ababa. Although minimally invasive procedures, especially percutaneous nephrolithotomy and retrograde intrarenal surgery, are unavailable in these hospitals for randomized comparison, this study's findings will serve as an important baseline for future research and to compare the outcomes of open stone surgery with local and international data.

Methods

This study, spanning from 1 June 2020 to 1 June 2021, evaluated the immediate postoperative outcomes of open renal stone surgery at 3 referral centres in Addis Ababa: TASH, Menelik II Hospital, and Yekatit 12 Hospital. It specifically targeted all patients undergoing open renal stone surgery within the year-long period, with a follow-up duration of 1 postoperative month for each patient to assess outcomes.

All patients who underwent open renal stone surgery during the study period were included. In total, 81 patients underwent open stone surgery within the study timeframe. Data were collected using a structured data collection form during the preoperative and intraoperative periods. The preoperative diagnosis was established using abdominal computed tomography. Stone clearance was ascertained using kidney–ureter–bladder x-rays and abdominal ultrasonography on the immediate postoperative day and during the first postoperative month. Intraoperative and postoperative complications were documented during the patients' hospital stays and subsequent outpatient department visits. The collected data were entered into SPSS Statistics for Windows, version 23 (IBM Corp., Armonk, NY, USA). Descriptive analyses of preoperative, intraoperative, and early postoperative data (up to 1 postoperative month) were conducted. Categorical variables were analysed using the chi-square test, as appropriate. Two-sided *P* values <0.05 were considered statistically significant.

Ethical approval for the study was obtained from the Department of Surgery Research and Publication Committee.

Table 1. Preoperative factors

Variable	Quantity
Presentation	
Flank pain	98.7%
Lower urinary tract symptoms	23.5%
Haematuria	16%
Pyonephrosis	4.9%
Comorbidities	
Hypertension	14.8%
Diabetes mellitus	8.6%
Chronic kidney disease	8.6%
Preoperative investigations	
Mean haemoglobin, g/dL ± SD	14.4±1.8
Mean serum creatinine (mg/dL)	1.1±0.7

Results

From a cohort of 81 patients, 58 (71.6%) were male, and 23 (28.4%) were female, resulting in a male-to-female ratio of 2.5:1. The youngest patient was 15 years old, and the oldest was 78, with a mean age of 40.01±14.2 years. The majority of patients (67.9%) were aged between 20 and 49 years.

Flank pain was the most frequently reported symptom at presentation. Other associated clinical features, including preoperative haemoglobin and creatinine levels, are summarized in Table 1.

Preoperative stone characteristics, such as site, size, number, and architecture, are detailed in Table 2. The largest measured stone diameter was 4.7 cm, with the majority of stones (44.1%) located in the renal pelvis, followed by lower and middle calyces.

The most prevalent indication for open surgery was a complex stone burden, accounting for 87.1% of cases. Anatomical abnormalities were noted in 6 patients, which included 2 cases of ureteropelvic junction obstruction, 3 patients with ectopic kidneys, and 1 with a horseshoe kidney. Preoperatively, 4 patients had stenting and 2 had percutaneous nephrostomy tubes placed, all of whom presented with severe hydronephrosis.

Table 2. Analysis of stone-free rate based on preoperative factors

Variable	Percentage	Stone-free rate	*P* value
Previous stone surgery			
Yes	11.1%	22.2%	0.074
No	88.9%	54.1%	
Stone size			
1-2 cm	12.3%	75%	0.060
2-3 cm	59.3%	42.9%	
>3 cm	28.4%	55%	
Stone number			
Single	29.6%	94.7%	<0.001
Multiple	70.4%	33.3%	
Stone architecture			
Nonstaghorn	38.3%	73.1%	0.010
Partial staghorn	46.9%	39.4%	
Complete staghorn	14.8%	27.3%	
Degree of hydronephrosis			
No hydronephrosis	3.7%	100%	
Mild hydronephrosis	17.3%	42.9%	0.337
Moderate hydronephrosis	53.1%	50.0%	
Severe hydonephrosis	25.9%	45.5%	

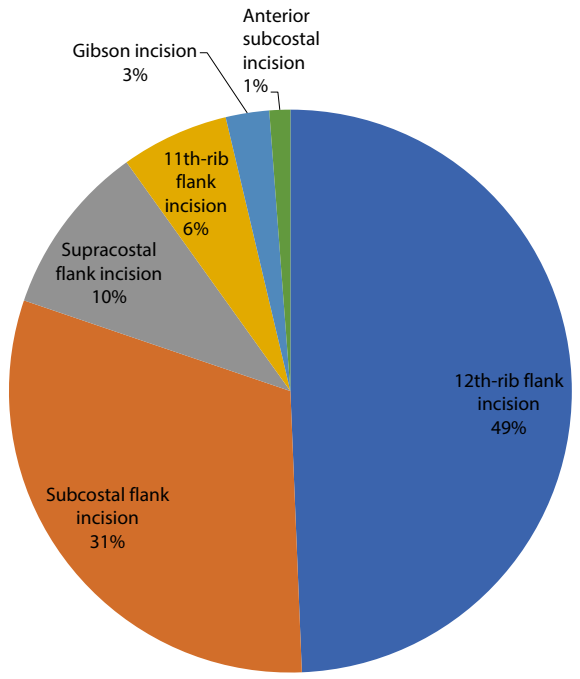

Figure. Surgical approaches employed

General anaesthesia was administered to all patients. The 12th-rib transcostal flank incision was the most commonly employed surgical approach, used in 49.4% of cases, followed by the subcostal flank incision (30.9%) (Figure).

Pyelolithotomy was the procedure most frequently performed (42%), followed by anatrophic nephrolithotomy (14.8%) and radial nephrolithotomy (13.6%). Nephrectomy was performed on 11 patients (13.6%) with nonfunctioning kidneys.

Intraoperative imaging was not used. Surgeons reported residual stones in only 5 patients (6.2%), attributing the incomplete clearance to difficulties in stone access. A double J stent was placed intraoperatively in 74.1% of cases. Retroperitoneal drainage was implemented in all cases, while nephrostomy tubes were not used. The mean operating time was 119.8±32.6 minutes.

Intraoperative complications included significant bleeding necessitating blood transfusion in 3 patients. One patient, initially planned for pyelolithotomy, sustained an injury to the inferior vena cava (IVC) and subsequently required a salvage nephrectomy and IVC repair, along with a blood transfusion. In another case requiring blood transfusion, significant inflammatory adhesions were encountered intraoperatively in a patient with a primary stone (>3 cm in diameter) and pyonephrosis. The third patient, with recurrent partial staghorn calculi following nephrolithotomy, was reported to have substantial adhesions by the operating surgeon.

Pleural injury occurred intraoperatively in 2 patients; however, neither patient required tube thoracostomy placement.

Eight patients (9.9%) developed surgical site infections postoperatively, 2 of which were classified as deep and 6 as superficial. Two patients with persistent leakage from the drainage tube were managed with extended drainage. Three patients (3.7%) developed symptomatic urinary tract infections. There were no deaths associated with open stone surgery during the study period.

The mean total hospital stay was 10 days, with the mean postoperative stay being 4.8 days. According to postoperative kidney–ureter–bladder x-rays and abdominal ultrasonography findings, 35 of 70 patients (50%) had residual stones >4 mm in diameter, resulting in an overall stone clearance rate of 50%.

The majority of residual stones (67.6%) were solitary, while 32.4% were multiple. Residual stones were most commonly located in the lower calyx (47.7%), followed by the middle calyx (43.2%). The diameters of residual stones ranged from 4 mm to 20 mm, with a mean diameter of 10 mm.

Table 3. Analysis of stone-free rate according to intraoperative factors

Variable	Stone-free rate	*P* value
Surgical incision		
Gibson	100%	
11th-rib flank	60%	
Supracostal flank	50%	0.657
12th-rib flank	48.5%	
Subcostal flank	47.6%	
Anterior subcostal	0%	
Type of surgery		
Pyelolithotomy	64.7%	
Anatrophic nephrolithotomy	58.3%	
Extended pyelolithtomy	50%	
Radial nephrolithotomy	36.4%	0.042
Pyelolithotomy + radial nephrolithotomy	11.1%	
Extended pyelolithotomy + radial nephrolithotomy	0%	

Stone-free rates were analysed based on various factors, including prior stone surgery, stone characteristics (nature, site, size, number, architecture), degree of hydronephrosis, primary surgeon, surgical approach, and the type of surgery undertaken. Stone size, number, and architecture were found to have a statistically significant association with stone clearance rates. Stone multiplicity and complex architecture were associated with lower clearance rates compared with solitary stones and those of simpler architecture. The type of surgery also significantly influenced stone clearance, with the highest stone-free rate observed among patients who underwent pyelolithotomy (64.7%), followed by anatrophic nephrolithotomy and extended pyelolithotomy. The results of this analysis are presented in (Table 2, Table 3).

Discussion

In this study, the primary reasons for opting for open stone surgery were the absence of minimally invasive options and the presence of complex stone burdens, accounting for 52.4% and 34.7% of the cases, respectively. Generally, open stone surgery is typically reserved for patients with intricate stone burdens compounded by anatomical abnormalities.[4],[7],[9]

The persistence of residual stones is known to increase the rates of stone recurrence, growth, and the requirement for auxiliary procedures. The definition of residual stones within literature varies and is a matter of debate. In the era dominated by open stone surgery, any remaining fragments were deemed a procedural failure.[10] However, the advent of extracorporeal shock wave lithotripsy, percutaneous nephrolithotomy, and ureterorenoscopy led to the emergence of the concept of CIRFs (clinically insignificant residual fragments): nonobstructive, noninfectious fragments <4 mm in diameter.[11] This designation can be misleading as any size of residual stone may act as a nidus for future stone formation and persist as a source of infection. Residual fragments might also become dislodged, potentially leading to obstruction.[12] Therefore, the idea of clinically insignificant residual fragments should be discouraged, and the surgical management of stone disease should aim for complete stone clearance.

Factors such as the inappropriate selection of the surgical method, stone composition, anatomical peculiarities, technical limitations, and a surgeon's haste can contribute to the likelihood of leaving residual fragments. Of these, the choice of surgical technique has been considered the most critical factor in predicting stone-free status.[12]

The overall stone clearance rate for open surgery in this study was 50%, comparatively lower than the rates of 65.7% to 97.5% reported elsewhere.[9],[14]-[19]

In this series, intraoperative imaging was not employed in any case, attributable to the absence of such facilities in the operating theatres. This factor may have contributed to the relatively lower stone-free rate observed in this study. Interestingly, the operating surgeons documented incomplete stone clearance in only 5 patients; this tally was considerably lower than the number of patients who were found to have residual stones upon postoperative imaging.

In this study, stone multiplicity and complex architecture were associated with lower clearance rates compared with single and noncomplex stones. The stone-free rates for partial and complete staghorn stones were 39.4% and 27.3%, respectively, which were lower rates than those reported in other studies where stone-free rates ranged from 65% to 97%.[9],[14],[17],[19]

The incidence of bleeding necessitating blood transfusion in this study was 3.7%, which was lower than the transfusion rates reported elsewhere, which have reached up to 35%.[9],[18]-[20] Pleural injury occurred in 2 patients (2.5%), but neither of these instances necessitated chest tube placement. This rate of pleural injury was within the range of 1.9% to 8.9% found in other studies.[4],[9],[18] One patient sustained an iatrogenic IVC injury, requiring IVC repair and a salvage nephrectomy. The reported rates of vascular injury in our literature search ranged from 0.2% to 2.2%.[9],[18]-[20]

Surgical site infections were noted in 9.9% of cases in this study, and 2 patients experienced urinary leakage requiring prolonged drainage. The rate of wound infection observed was comparatively higher than other reports, with rates ranging from 2.1% to 3.2%.[9],[17]-[20]

Limitations

A limitation of this study was the absence of an alternative minimally invasive procedure, particularly percutaneous nephrolithotomy, which could serve as a control to compare outcomes.

Conclusions

While open stone surgery is a predominant treatment for urolithiasis in our setting, the stone-free rate found in this study was lower compared to other research. Various factors contribute to this lower clearance rate, including stone multiplicity, large stone size, complex stone architecture, and the type of surgery performed. The absence of intraoperative imaging also undoubtedly contributed to lowering the clearance rates relative to other settings. The rates of intraoperative and postoperative complications, such as bleeding requiring transfusion, vascular and pleural injuries, salvage nephrectomy, and prolonged urine leakage, were comparatively lower than in other studies. However, our study identified a relatively high rate of wound infections.

Based on these observations, we recommend thorough efforts to ensure complete stone removal and achieve stone-free status in patients presenting with multiple, sizable, and intricately structured stones.

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