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The outcome of open renal stone surgery calls for limitation of its use: A single institution experience

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Abstract

Objectives: To critically analyze retrospectively the outcome of cases treated with open renal stone surgery (ORSS) at a single urology institution over a 7-year period.

Subjects and methods: Out of 5172 stone-removal procedures performed at Al-Azhar University Hospitals, Cairo, Egypt, between January 2002 and December 2008, 533 cases (10.3%) underwent open surgery. The patients' age ranged from 3 to 72 years (mean 41.7). The hospital charts, operative notes and pertinent radiographs of these 533 cases were revised to determine clinical data, stone burden, indications and operative and peri-operative outcome of surgery. The follow-up data covering a period of two years since the date of surgery were retrieved to study long-term results.

Results: The indications for ORSS included complex stone burden (62.1%), failure of percutaneous nephrolithotomy (10.3%), large or multiple stones associated with calyceal diverticulum, ureteropelvic obstruction (5.8%) or ectopic and horse-shoe kidneys (3.4%). Additional indications were an abnormal body habitus, including an increased body mass index (BMI > 35), and scoliosis (3.4%), concurrent open surgery (4.1%), and stones in non-functioning or infected kidneys (5%). 5.8% of the patients refused minimally invasive surgery and opted for ORSS.

Operative complications, mainly in the form of primary or secondary hemorrhage, occurred in 186 (35%) patients. Salvage nephrectomy (secondary nephrectomy) was needed in two cases and mortality occurred in another two.

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Peri-operative (at 3 months) outcome, included significant residual fragments in 59 cases (11%) and deterioration of renal function in 92 (17.3%) cases. At discharge from the hospital, 76.2% of the patients were stone-free, while complete stone clearance was attained in a total of 89.1% at 3 months after additional auxiliary measures.

Conclusions: Although nowadays, the treatment of choice for renal stones is minimally invasive, yet some cases still require open surgery. The high rate of surgical complications with ensuing compromised renal function and prolonged hospital stay are not in favor of ORSS. This option thus has to be limited to selected cases of complex stone burden, associated renal anomalies and after failure of minimally invasive surgery. The unavailability of minimally invasive equipment, lack of surgical experience and patient preference should not be taken as indication of ORSS.

Introduction

In the past two decades, advances in endoscopic management of nephrolithiasis, in the form of newer refined endoscopes and stone fragmentation energies, have resulted in a major shift toward minimally invasive therapy [1]. However, in spite of these advances, there still remains a need for open surgical stone removal as a second- or third-line treatment option in few cases [2]. Due to the availability of the equipment, expertise and experience in surgical treatment of urinary stones, most urological centers worldwide report a need for open surgery in only 1–5.4% of the cases. However, in developing countries, the rate of open stone surgery amounts to up to 14% [3–8].

In spite of the availability of most procedures of stone extraction, an appreciable number of renal stone cases were treated with open surgery at Al-Azhar University Hospitals during the period studied.

Subjects and methods

This retrospective study entailed a review of hospital charts, operative notes and pertinent radiographs of all patients who underwent open renal stone surgery (ORSS) at Al-Azhar University Hospitals between January 2002 and December 2008. Age ranged between 3 and 72 years, with a mean of 41.7. Two thirds of cases were males.

At our department, the treatment of choice for renal stones is minimally invasive, while open surgery is an exception. Retrograde intrarenal surgery and laser lithotripsy were not available at our hospital during the study period. Out of 5172 stone procedures, shock wave lithotripsy (SWL) monotherapy represented the main treatment option, while open surgery accounted for 533 cases (10.3%) in 514 patients (Table 1).

Table 1 Surgical treatment modalities used in 5172 renal stone cases.

Procedures	No. cases	%
SWL monotherapy	3558	68.8
PNL monotherapy	439	8.5
PNL followed by SWL	642	12.4
ORSS	533	10.3

SWL, shock wave lithotripsy; PNL, percutaneous nephrolithotomy; ORSS, open renal stone surgery.

Table 2 Co-morbidities in 514* patients.

	No. cases	%
Non	276	53.7
Hypertension	115	22.4
Diabetes mellitus	96	18.7
Hepatic impairment	32	6.2
Chronic renal impairment	30	5.8
Ischemic heart disease	11	2.1

* More than one co-morbidity may present in one patient.

The medical history, clinical and radiographic data, the indication and type of open surgery used and operative details and complications, if any, were reviewed. The co-morbidities of patient were summarized in Table 2. About 255 (47.8%) of patient had urinary tract infection (UTI) but all were treated before surgery.

Stone features, associated anatomical renal abnormalities and residual stone burden, if any, were recorded. In this study, the term complex renal stones define a variety of stone-bearing situations, depending on the stone burden and its site, renal function and associated UTI. Most complex renal stones were staghorn calculi, but also multiple or large stones behind an infundibular stenosis or in a calyceal diverticulum, horse-shoe or ectopic pelvic kidney were considered as complex stones (Tables 3 and 4).

Table 3 Stone features of 533 ORSS cases.

Stone features	No. cases	%
Stone size		
≥2–3 cm	104	19.5
>3 cm	429	80.5
Stone number		
Single	128	24
Multiple	405	76
Stone nature		
De novo	411	77.1
Recurrent	122	22.9
Stone density		
Opaque	481	90.2
Lucent and faint	52	9.8
Total	533	100

Table 4 Stone location and morphology of 533 ORSS cases.[a]

Stone features	No. cases	%
Stone location		
Pelvis	43	8.1
Pelvicalyceal	441	82.7
Multiple calyceal stones	49	9.2
Stone morphology		
Non-staghorn	154	28.9
Borderline staghorn	94	17.6
Partial staghorn	166	31.2
Complete staghorn	78	14.6
Giant staghorn	41	7.7

[a] Classification according to Al-Kohlany et al. [4].

A compromised renal function and/or infection of the renal collecting system always represent a challenge to the urologist [3]. Renal function was determined by serum creatinine, intravenous pyelography (IVP) or renal radionuclide scan in some cases when indicated (Table 5). Serum creatinine was normal in all but 30 patients. The renal function of the ipsilateral (operated) and contralateral kidney is shown in Table 5.

Follow-up data covering at least two years after the date of surgery or after any auxiliary procedure were collected.

The statistical presentation and analysis of data was conducted, using Chi-Square and ANOVA by SPSS Version 16.0 for Windows.

Results

In total, 5172 procedures were performed for the purpose of renal stone removal between January 2002 and December 2008.

The techniques of ORSS used included pyelolithotomy in 88 cases (16.5%), nephrolithotomy in 167 cases (31.3%), pyelonephrolithotomy in 188 cases (35.3%), extended pyelolithotomy in 56 cases (10.5%), anatrophic nephrolithotomy in 11 cases (2.1%), partial nephrectomy in 7 cases (1.3%), and nephrectomy in 16 cases (3%).

Table 5 Function of the upper tract of 533 ORSS cases (ipsilateral and contralateral).

Status of the upper tract	No. cases	%
Ipsilateral (operated side) renal function		
Normal	341	64
Impaired	88	16.5
Poor and non-functioning	104	19.5
Contralateral side renal function		
Normal	473	88.7
Impaired	41	7.7
Poor and non-functioning	19	3.6
Total	533	100

NB1; renal function on IVP:
- Perfect: excretion of dye within 10 min.
- Impaired: excretion of dye within 30 min.
- Poor: no excretion of dye or opacification within after 30 min.

NB2; preoperative serum creatinine was normal ($\leq$ 1.5 mg/dl) in 484 cases (94.2%) and elevated in 30 cases (5.8%) [more than 2 mg/dl in 12 (2.3%) cases but ranging between 1.6 and 2 in 18 (3.5%) cases].

Table 6 Overall indications of ORSS of 533 cases.

Indications of ORSS[a]	No. cases	%
Complex stone burden	331	62.1
Failed PNL	55	10.3
Anatomical renal abnormality:		
• UPJ obstruction	21	3.9
• Calyceal diverticulum	10	1.9
Abnormal body habitus (obesity and scoliosis)	18	3.4
Concurrent open surgery:		
• Conjunction with ureterolithotomy	21	3.9
• Conjunction with ureteroplasty	1	0.2
Associated congenital renal abnormalities:		
• Ectopic	7	1.3
• Horse-shoe	11	2.1
Stones in non-functioning kidney	21	3.9
Inflammatory renal conditions	6	1.1
Patient refusing minimally invasive therapy	31	5.8

[a] ORSS, open renal stone surgery.

The indications of ORSS mainly included a complex renal stone burden and failure of minimally invasive modalities (Table 6). Example cases of complex renal stone burden that were difficult to be treated by minimally invasive surgery are shown in Figs. 1–3. Nephrectomy was done in associated pyonephrosis or xanthogranulomatous pyelonephritis or after uncontrollable operative bleeding.

Operative complications occurred in 186 (35%) cases that mainly included intra-operative and early post-operative bleeding (Table 7). Blood transfusion was needed in 23.3% of cases; this was closely related to the stone morphology and the type of surgery. Blood transfusion was more needed in patients treated with nephrolithotomy compared to pyelolithotomy, and in all patients with partial nephrectomy.

Other complications included fever, leakage, pneumothorax, wound infection and ileus. Pneumothorax occurred in 10 cases (1.9%), 5 of them needing chest tube drainage for few days. Most of these complications were managed conservatively.

Figure 1 Plain radiography of a case of bilateral staghorn stones showing major stone volume located peripherally in the calyces.

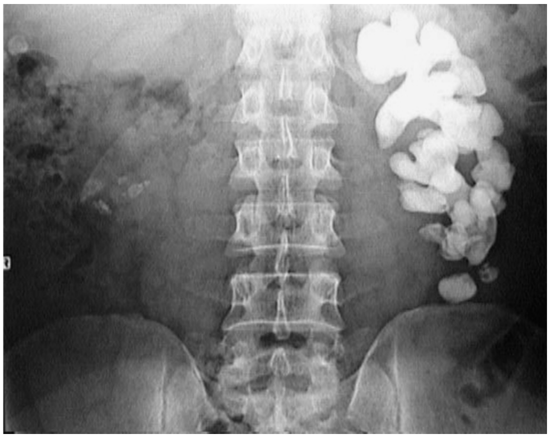

Figure 2 Plain radiography of recurrent renal staghorn stone. This case underwent anatrophic nephrolithotomy.

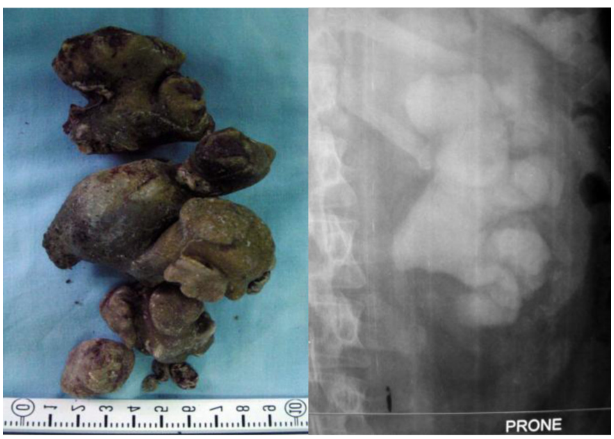

Figure 3 Plain radiography and extracted staghorn stone treated by anatrophic nephrolithotomy.

Salvage nephrectomy (secondary nephrectomy) was needed in two cases due to uncontrollable bleeding. The factors influencing the occurrence of operative complications included recurrent stone surgery, stone size and site, the type of ORSS, the presence of anatomical abnormalities and the experience of the surgeon.

Mortality occurred in two cases; the first patient developed hemorrhagic shock which was uncontrolled, and the patient died on the 3rd post-operative day. The second patient developed septicemia and died 30 days after surgery.

Table 7 Operative complications.

	No. of complications	%
Bleeding needing 2 units or more	129	24.3
Parenchymal laceration	5	0.9
I V C injury	1	0.2
Salvage nephrectomy	2	0.4
Residual stones	59	11.1
Secondary hemorrhage	7	1.3
Septic shock	4	0.8
Pneumothorax	10	1.9
Perinephric abscess	2	0.4
Persistent leakage over 2 weeks	13	2.5
Wound infection with delayed healing	17	3.2
Total	249	46.9

Table 8 Peri-operative complications (90 days after surgery).

	No. of complications	%
Stricture at PUJ	11	2.1
Pyonephrosis	3	0.6
Perinephric abscess	4	0.8
Chronic pyelonephritis	18	3.4
Deteriorated renal function	92	17.3
Total	128	24.1

More than on complication may occur in the same patient. This was true in 101 cases (19%)

Unsatisfactory peri-operative outcome (90 days after surgery) occurred in 101 cases (19%) (Table 8) and included significant residual fragments in 59 (11%), chronic pyelonephritis in 18 (3.4%), stricture at the ureteropelvic junction (UPJ) in 11 (2.1%), perinephric abscess in 4, pyonephrosis in 3, and deterioration of renal function in 92 cases (17.3%). Deterioration of renal function occurred secondary to obstructive, infective or iatrogenic causes. The impact on renal function in the operated kidney is shown in Table 9.

The average hospital stay was 6.7 days. At discharge from the hospital, 76.2% of the cases were stone-free, while 19.7% of cases had clinically significant residual fragments (SRF), and 4.1% with clinically insignificant residual fragments (Fig. 4). Cases with SRF were subjected to SWL or percutaneous nephrolithotomy (PNL) alone, or a combination of both. SWL monotherapy and stented SWL were chosen in 69 (13%) and 23 (4.3%) cases, respectively.

The total stone-free rate including the patients subjected to auxiliary procedures was 89.1% (Fig. 5). Stone clearance depended on many factors, including stone size, stone number, stone morphology, renal system dilatation, stone location, indication for surgery and the method of ORSS.

Table 9 Effect of ORSS on the renal function status in the ipsilateral site of 533 renal cases at the last follow-up.

	No. cases	%
Stable	188	35.3
Improved	240	45
Deteriorated	92	17.3
Lost to follow-up	13	2.4

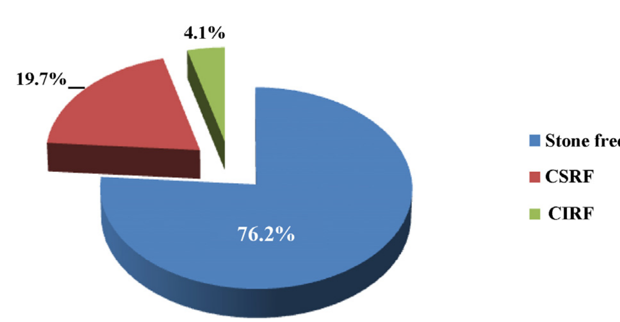

Figure 4 Stone clearance at discharge from hospital in 533 cases.

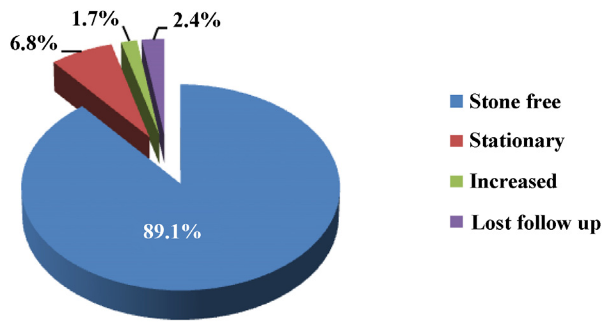

Figure 5 Stone clearance at follow-up in 533 cases after auxiliary procedures.

Discussion

Due to the availability of the equipment, expertise and experience in surgical treatment of urinary stones, most urological centers worldwide report a need for open surgery in only 1–5.4% of the cases [3–8]. In 2000, only 2% of the medicare patients undergoing a stone-removing procedure in the USA were treated with open surgery [9]. Moreover, tertiary medical centers are reporting that open surgery is used in less than 1% of stone patients [2,10]. In the UK the frequency of ORSS was reported to be 1% in 2006 [11].

In developing countries ORSS rate is considerably higher. In a Chinese study published in 2009 the rate of ORSS was reported to be 7.4% [12], while Zargooshi found an incidence of 14% when reviewing a series of cases of open stone surgery in children over a 10-year period in Iran [13]. In Pakistan, Rizvi et al. even reported a rate as high as 30% for ORSS in pediatric patients [14]. In our series covering a period of 7 years, the rate of ORSS was 10.3% with the availability of other minimally invasive treatment modalities (mainly SWL and PNL).

The factors responsible for the frequent use of ORSS in developing countries are: (i) later presentation and, therefore, more complex cases with an increased stone burden; (ii) unavailability of equipment for non-invasive and minimally invasive techniques; and (iii) increased emphasis on the cost (which is borne, at least in part, by the patient) and the consequent desire for a single procedure. In the light of these limiting factors, open stone surgery will probably remain a viable option in those countries for some time [7].

Complex stone disease and significantly large stone burden remain indications for ORSS in selected clinical scenarios. It is certainly true that even staghorn stones can now be approached safely and effectively with PNL, either alone or in combination with SWL. ORSS, however, is likely to continue playing a role in the management of this type of stone disease, especially in kidneys with a dilated collecting system. The incidence of ORSS due to a complex stone burden reported in our study (62.1%) is comparable to that reported by Paik and Resnick, who considered a complex stone burden as an indication for ORSS in 55% of their patients. More than half of these complex stone cases had either complete or nearly complete staghorn calculi and were treated with anatrophic nephrolithotomy [15]. Honeck et al. opted for ORSS in 42% of their patients with a complex stone burden [10].

The most widely accepted classification of renal stones divides them into non-staghorn and staghorn stones. The latter are further classified into (i) border line staghorn stones filling the renal pelvis and only branching into one calyx; (ii) partial staghorn stones filling the renal pelvis and branching into at least 2 calyces, corresponding to a minimal cast of 40% of the renal collecting system; (iii) complete staghorn stones filling the entire renal collecting system or at least 80% of it Fig. 2; and (iv) giant staghorn stones which are stones with large pyelic and calyceal portions, with a high density, located in a dilated renal collecting system [4].

Since the mid-1980s, urologists have become successful in using less invasive therapies for the treatment of patients with large renal calculi, including complete staghorn stones. The main treatment options for large complex staghorn stones are generally accepted to be PNL with or without SWL or open surgery [17].

Failure of PNL in the management of renal stones accounted for 10.3% of the indications for ORSS in our series. The corresponding figures were 16%, 17%, 29% and 48.6% of cases in reports by Sy et al. [16], Kane et al. [17], Paik et al. [7] and Assimos et al. [5], respectively. The lower percentage of treatment failures in our series could reflect a better selection of patients, combined with an increased proficiency of urologists and improved instrumentation for minimally invasive modalities.

In our series, 5.8% of cases had anatomical renal abnormalities requiring open stone removal combined with correction of the anatomical defect. Anatomical renal abnormalities include calyceal diverticulum and UPJ obstruction. In general, each of these problems can be approached percutaneously and/or endoscopically, along with concomitant stone removal. In our cases of UPJ obstruction, open surgery was resorted to for reasons unique to each case, including the inability to perform PNL, a patient younger than 5 years, the presence of a crossing vessel or a large dilated renal pelvis.

Stones in calyceal diverticula can certainly be approached with minimally invasive techniques. However, in our series, previous failure of less invasive therapies due to a narrow diverticular neck, a calyceal diverticulum in an anterior calix and a large stone burden in a dilated diverticulum were reasons for selecting an open surgical approach. Collecting system abnormalities generally do not preclude less invasive treatment approaches.

A combined open approach with minimally invasive procedures was advocated for patients with a large stone burden and/or a more complex anatomical deformity, while those with a minimal to moderate stone burden and limited anatomical abnormality were treated with less invasive therapies.

Paik et al. reported that 24% of their patients had anatomical abnormalities of the urinary tract that may have contributed to recurrent stone disease and/or failure of less invasive therapies [7]. Yan and Wei reported that 20% of their patients with anatomical renal abnormalities underwent open surgery [12].

An increased BMI and scoliosis were found in 3.4% of our patients. The treatment of morbidly obese stone patients with SWL, endourological procedures and open surgery is difficult due to certain limitations, inherent risks and complications.

A combination of ORSS with other open surgical procedures was seen in 4.1% of our cases (ureterolithotomy in 21 cases (3.9%), ureteroplasty in one case). Other authors report incidences of 8% and 0.5% [12,16].

In our series, partial nephrectomy was performed in 7 (1.3%) cases; 3 cases due to a non-functioning lower pole with stones and 4 cases due to an infected lower pole (pyonephrosis) with stones. Total nephrectomy was performed in 19 cases (3.6%): 15 cases (2.8%) due to non-functioning kidneys with stones and two cases due to associated xanthogranulomatous or emphysematous pyelonephritis. Two other cases needed emergency salvage nephrectomy due to uncontrolled secondary hemorrhage.

Sy et al. reported nephrectomy in 20% of their cases, all of them due to non-functioning kidneys with stones [16]. Yan and Wei performed nephrectomy in 22% of their cases due to non-functioning kidneys, renal carcinoma or xanthogranulomatous pyelonephritis [12].

With respect to cost-effectiveness, Brannen et al. and Brown et al., in the mid-1980s, suggested that, when considering all renal calculi, percutaneous procedures lead to significantly decreased convalescence and cost compared to open surgery [18,19]. However, for renal calculi over 2.5 cm, Preminger et al. found that the percutaneous approach was slightly more expensive than open surgery, but was associated with significantly shorter convalescence [20]. While data from the 1980s do not necessarily translate to similar cost comparisons in the present era, we believe it is reasonable to assume that less invasive therapies for a large, complex stone burden requiring multiple procedures are probably more costly than one single open procedure with respect to hospital costs. Post-operative disability is still almost assuredly less with less invasive therapies.

The patient's preference should always be considered. In our series, it represents 5.8% of indications. It is our responsibility to ensure that patients are well informed on all the risks and benefits of each of the possible treatment modalities for stone disease. Given the choice, a minority of patients prefer to undergo open surgery rather than risk the potential need for multiple, less invasive procedures.

In our report the stone-free rate after discharge was 76.2%. Clinically significant residual fragments were present in 19.7%, clinically insignificant residual fragments in 4.1% of our cases. During follow-up, 8 patients with clinically insignificant residual fragments passed the stone. Patients with clinically significant residual fragments were subjected to SWL or PNL alone or a combination of both. SWL monotherapy was performed in 13%, stented SWL in 4.4% of cases. PNL alone was needed in 2 cases, PNL in combination with SWL in 3 cases. At the end of follow-up, the total stone-free rate including the patients subjected to auxiliary procedures was 89.1%.

Other authors report similar stone-free rates after discharge of 69% and 91% which increased to 98% and 95%, respectively, at the end of follow-up [10,16]. Paik and colleagues reported an overall stone-free rate of 93% after a follow-up period of 3 years [7]. It is noteworthy that in these studies the number of patients is relatively small which increases the stone-free rate.

Various series have demonstrated the use of PNL or a combination therapy in the treatment of staghorn calculi. Kahnoski et al. reported a 15% residual stone rate when combining percutaneous lithotripsy and SWL for partial and complete staghorn calculi [21]. Snyder and Smith compared percutaneous and anatrophic nephrolithotomy for staghorn calculi and, although the retained stone fragment rate was higher for percutaneous extraction compared to open surgery (13% versus 0%, respectively), the shorter procedure and convalescence were advantages observed in the percutaneous group [22].

Streem and Lammert found recurrent stones in 22% of their patients at a mean follow-up of 25.3 months when using a combination or sandwich therapy [23]. Lam et al. reported stone-free rates at the time of hospital discharge between 83.3 and 86.7% using a combination therapy [24]. Winfield et al. reported an 86% stone-free rate after percutaneous nephrolithotomy monotherapy for complete and partial staghorn calculi, while SWL monotherapy resulted in 39% of patients with some stone burden at 8 months after completion of treatment [25].

In a series of patients with complete or partial staghorn calculi treated with percutaneous nephrolithotomy and SWL, Schulze et al. reported that 36.7% were stone-free at discharge from the hospital, and up to 76.7% were free of stones at some point after treatment, but the stone-free rate dropped to 61.1% at a mean follow-up of 24.7 months [26]. Karlsen and Gjolberg reported a 56% stone-free rate at an average of 11.1 months for patients with partial and complete staghorn stones treated with combination therapy [27]. Segura reported residual stone rates from 50 to 75% at 3–6 months of follow-up after combination therapy [28].

For stones larger than 3 cm exclusive of staghorn stones, Lingeman et al. reported a 75% stone-free rate with percutaneous nephrolithotomy alone [29]. Comparisons can be made with the series of Boyce and Elkins, who reported a 15% recurrent stone formation rate at an average of 3 years of follow-up after anatrophic nephrolithotomy for large staghorn stones or multiple large calculi equivalent to a staghorn calculus [30].

The AUA guidelines (2005) on the treatment of staghorn calculi were based on the previous guidelines published in 1994 and on the results of a meta-analysis of 32 articles published between July 1992 and July 2003; 51 patients underwent open stone surgery, compared with 1533 patients who underwent PNL and/or SWL. The overall estimated stone-free rate was 78%, 71% and 54% for PNL, open surgery and SWL, respectively. On average, PNL required 1.9 total procedures, combination therapy required 3.3, SWL required 3.6 and open surgery required 1.4 total procedures, in order to achieve stone-free rates. The estimated stone-free rate for open stone surgery was lower (71% compared with 82%), and the number of the total procedures performed was higher (1.4 compared with 1.0), when compared with the previous guidelines [31].

Other series have demonstrated a superiority of open surgery over less invasive therapies in selected cases of staghorn calculi. Assimos et al. demonstrated that in patients with staghorn calculi and any degree of calyceal dilatation, anatrophic nephrolithotomy resulted in stone-free rates of 89–100%, while PNL with or without SWL led to stone-free rates of only 12–25% [32]. Esen et al., in a series of complete or partial staghorn calculi, found a stone-free rate of 80% with open surgery versus 50% for PNL plus SWL and 25% for SWL monotherapy [33].

Laparoscopy can be an alternative modality in the management of renal stones. Laparoscopic pyelolithotomy combines the advantages of open surgery with the minimally invasive nature of laparoscopy [34]. Ramakumar et al. reported a combination of laparoscopic pyelolithotomy and pyeloplasty with a mean operating time of 4.6 h and a blood loss of 145 mL. Mean hospital stay was 3.4 days and the patients returned to activity by 3 weeks. They had no intra-operative complications [34].

Kaouk et al. described the first laparoscopic anatrophic nephrolithotomy. This was performed based on studies in a porcine model. The mean warm ischemia time was 30 min with complete “stone” removal in 70% of animals [35]. Laparoscopic nephrectomy may be considered in patients with staghorn calculi and poorly functioning kidneys [36].

In our report, operative complications occurred in 186 (35%) of cases. They included intra-operative and early post-operative complications, mainly consisting of primary or secondary hemorrhage. Blood transfusion was needed in 23.3% of cases. Other complications included fever, leakage, pneumothorax, wound infection and ileus. Pneumothorax occurred in 10 cases (1.9%) with 5 cases needing chest tube drainage for few days.

Salvage nephrectomy (secondary nephrectomy) was needed in two cases due to uncontrollable bleeding. Mortality occurred in two cases; the first case developed hemorrhagic shock which was uncontrolled; the patient died on the 3rd day of operation. The second patient developed septicemia and died 30 days after the operation.

Peri-operative complications occurred in 101 cases (19%) and included significant residual fragments in 59 (11%), chronic pyelonephritis in 18 (3.4%), stricture at the UPJ in 11 (2.1%), perinephric abscess in 4, pyonephrosis in 3, and deterioration of renal function in 92 cases (17.3%).

Previous reports on complications of open surgery showed a high variability, especially when comparing endourological and open surgical procedures. In one study the post-operative complication rate after open surgery was 8% with the complications mainly consisting of bleeding and wound infection [16]. Other studies mention overall complication rates of 10–20% [7,12].

In reports comparing open surgery and PNL, the complication rates also vary greatly. In one study, open surgery had a 50% complication rate compared to 20% for the PNL group [37]. Other authors mentioned 45% minor and 34% major complications in the PNL group versus 50% and 10% in the open surgery group [32].

Contrary to these results, Rassweiler and colleagues reported 4% minor complications in the PNL versus 39% in the open surgery group. Major complication rates were 7% and 37% in the PNL and open surgery groups, respectively [3]. In a study conducted by Al-Kohlany and colleagues, the overall complication rate was 55.6% in the open surgery group versus 32.7% in the PNL group [4].

This variability is most probably due to the lack of a uniform system for the definition and the assessment of these complications and due to the different ways of display. Some report only urinary complications [22], some include extra-urinary complications [32], and others divide complications into minor and major ones [3,10]. In addition, there is no consensus about which complications are major and which are minor. Moreover, some studies are retrospective and others prospective, comparing different techniques for the treatment of heterogeneous types of staghorn stones over different periods of time.

In the literature, the blood transfusion rate after open stone surgery ranges between 4% and 90% [10,12,32]. In our study, the blood transfusion rate of 23.3% was closely related to stone morphology and the type of ORSS. We do not believe that these rates reflect the actual need for blood transfusion. The studies comparing open stone surgery with PNL showed different blood transfusion rates; there were 10% and 23.3% for PNL versus 37% and 31% for open surgery in two separate studies [3,4].

In our study, the mean hospital stay was 6.3 days. In other studies, it was 6.4, 7.5 and 10 days [7,10,16]. One of the advantages of PNL is a shorter hospital stay. Al-Kohlani et al. mention a hospital stay of 6 days for PNL versus 10 days after open surgery [4]. In another report, the hospital stay was longer for the patients treated with PNL which, however, was due to the fact that the hospital stay included chemolysis of residual stones [32].

The trend toward minimally invasive and endourological procedures is expected to continue. Further improvements in technology and expertise will widen the spectrum of indications. Traditional indications for open stone surgery may have to be re-defined. A good example for these new techniques is the rapid advent of laparoscopy in urology in recent years.

At present, the Joint Committee for Higher Surgical Training (JCHST), via its Specialist Advisory Committee (SAC) in urology, recommends that trainees have knowledge and experience in ‘the surgical treatment of renal calculi including PNL and open surgery’, and that trainees sub-specialising in endourology be assessed for competence in open stone surgery. Open stone surgery to date, constitutes a small number of selected cases likely to decline further. Is it really still necessary, justifiable or possible to continue to teach open stone surgery to trainee urologists/stone specialists? [11].

The role of open stone surgery is already limited and likely to decrease further. This presents some practical obstacles to training. To continue training would, therefore, be both unnecessary and impractical.

Would trainees be exposed to sufficient open procedures to attain an acceptable standard of competence? In a tertiary referral center in the US, only seven open procedures were performed in a 2.5-year period [7]. If this rate continues, it will be impossible to provide appropriate training for future urological stone surgeons.

The new generation of urologists may prefer doing minimally invasive skills, rather than performing a relatively inconsistent open procedure. However, the small number of cases in which open surgery is indicated will still be served, for some time, by surgeons proficient in open stone surgery. To train surgeons inadequately in a procedure they are unlikely to use can, therefore, be regarded as a waste of valuable learning time [11].

One might argue that open stone surgery remains an effective treatment in a selected group of patients. The medical profession, therefore, has a responsibility to preserve all valid options for treatment as long as a treatment has not been proven to be obsolete.

Conclusion

Nowadays, the treatment of choice for renal stones is the use of minimally invasive therapies. The high rate of complications of ORSS in this cohort of patients coupled with the negative impact on renal function and prolonged hospital stay are against its use as a viable treatment option of renal stones. ORSS has to be limited to selected patients with a complex stone burden associated renal anomalies, and after failure of minimally invasive therapy. The lack of surgical experience or minimally invasive equipment or the patient preference should not be as an indication for the use of ORSS.

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