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Open Surgery in the Management of Multiple and Staghorn Kidney Stones: Its Role in the Era of Minimally Invasive Techniques

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ABSTRACT

BACKGROUND: The use of minimally invasive techniques in the treatment of staghorn and multiple renal stones has overshadowed the open techniques in the past two to three decades. In this study, we reevaluate the role of open techniques in the management of these conditions.

OBJECTIVE: To compare the role of open techniques versus combined percutaneous nephrolithotomy (PCNL) and extracorporeal shock wave lithotripsy (ESWL) in the management of staghorn and multiple renal stones.

METHODS: Between 1999 and early 2005, a total of 208 patients were operated upon: 111 patients with 118 renal units underwent open-technique surgery, and 97 patients with 106 renal units underwent combined PCNL and ESWL. Operative time, operative cost, blood loss, stone-free rate, use of single or multiple sessions, hospital stay, complications, total cost, and time to return to ordinary activities were calculated and plotted in a database, analyzed, and compared for the two groups of patients.

RESULTS: Operative time for the open group was significantly less than the PCNL group, as most of the latter needed multiple sessions of PCNL and ESWL, raising the hospital stay, the operative cost, and the total hospital cost. In the open group, 106 (89.8%) patients were stone free in a single session, and only 12 (10.2%) needed ESWL sessions. In the PCNL group, 88 (83%) the patients were stone free after the first session, a statistically significant difference. However, the time needed for convalescence was significantly less for the PCNL group.

Comparing the complication rate for both groups, we found that the open group had less incidence of colonic injury, AV fistula, and urinary leakage, which reflected on the length of hospital stay and cost. However, the open group had more incidence of blood loss and pneumothorax, comparable incidence of sepsis, and needed more time to return to ordinary activity compared to the PCNL group.

CONCLUSION: Open techniques are still a viable option that should be considered when treating patients with complex multiple and staghorn renal stones, especially regarding their cost-effectiveness in the face of limited resources in developing countries.

KEYWORDS: Stone, Renal, Staghorn, PCNL, Open

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INTRODUCTION

Calculi in the urinary system have plagued humanity since the earliest civilizations. Ancient Egyptian surgeons were the first to be credited with performing bladder stone removal via urethral dilation and sucking out the stones [1]. Some historians have suggested that Hippocrates performed surgery on the kidney [2]. William Ingalls of the Boston City Hospital was the first to perform a planned nephrolithotomy in 1872 [3]. Since then, multiple approaches of open surgery for kidney stones have dominated the world of renal lithiasis.

The development of minimally invasive surgical techniques has depended mainly on technological advances, such as fiber optics and imaging, and the development of shock wave, ultrasonic, and laser lithotriptors. The term endourology was coined to encompass antegrade and retrograde techniques for the closed manipulation of the urinary system [4]. After many attempts to establish a percutaneous tract in the early twentieth century, Fernstrom and Johansson [5] were credited with the first established percutaneous access with the specific intention of removing a stone in 1976. With the improvement in the technologies and applied expertise, endourology has taken the upper hand in the management of renal lithiasis to the decline of the role of open surgery.

Table 1. Patient characteristics

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Item	Open	PCNL
Number of Patients	111	97
Renal Units	118	106
Mean Age	47 ± 14.9	42 ± 13.4
Male/Female	66/45 (59.9/40.5%)	61/36 (62.9/37.1%)
Nature of case		
Fresh	83 (74.8%)	74 (76.3%)
Recurrent	28 (25.2%)	23 (23.7%)
Stone size	8.3 ± 3.6 cm	7.6 ± 2.9 cm
Stone number		
1	18 (15.3%)	23 (21.7%)
1-3	34 (28.8%)	29 (27.4%)
>3	66 (55.9%)	54 (50.9%)
Stone location		
Pelvis	25 (21.2%)	24 (22.6%)
Pelvis + 1 calyx	33 (28%)	30 (28.3%)
Pelvis + > 1 calyx	60 (50.8%)	52 (49.1%)

Data are expressed as mean ± standard deviation and as numbers (%)

In this work, we try to reevaluate the role of open surgery in the management of renal stones, especially in the working conditions of developing countries.

(left) Figure 1. Staghorn stone

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(right) Figure 2. Postoperative KUB after extended pylonephrolithotomy with single nephrotomy with DJ stent in place with no residual stones

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METHODS

Between 1999 and early 2005, a total of 208 patients with multiple and staghorn renal calculi were operated upon either via open surgery or percutaneous nephrolithotomy (PCNL). 118 renal units in 111 patients with multiple and staghorn renal calculi were operated upon via open techniques, and 106 renal units in 97 patients were operated upon via minimally invasive techniques in the form of PCNL.

Inclusion criteria:

All patients who presented with multiple or staghorn renal stones were included in the study. Seven cases with complete staghorn stones and calyceal stenosis were operated upon via anatrophic nephrolithotomy; the remainder were operated upon via either open surgery or PCNL. Open surgery was preferred in patients with large stone burden (e.g. giant staghorns or numerous stones filling many calyces), associated

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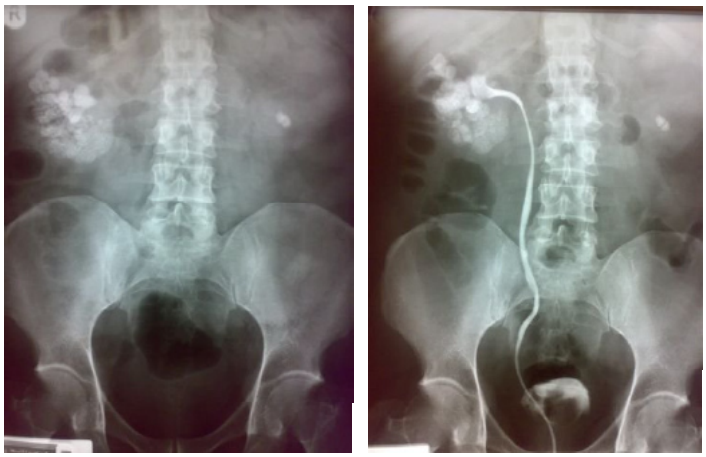

(left) Figure 3. KUB film shows staghorn stone with numerous stones occupying all calyces
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(right) Figure 4. Retrograde ureteropylography shows the anatomy of the pelvicalyceal system
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anomalies that needed concomitant intervention (e.g. PUJ obstruction, calyceal diverticula, ectopic or horseshoe kidneys), or patients with cardiorespiratory problems prohibiting the supine position for PCNL.

Preoperative preparation:
History, physical examination, and routine laboratory investigations were done for all patients. Patients with creatinine <1.5 mg/dl also underwent radiological evaluations in the form of plain kidney, ureter, and bladder (KUB), ADB Ultrasound, and intravenous urography (IVU). In patients with higher creatinine, non-contrast spiral CT was done to evaluate the upper system and stone burden and, in some cases, to evaluate stone topography for better PCN access. 125 (60%) patients with UTI were treated.

Operative techniques:
A total of 111 patients with multiple and staghorn renal calculi in 118 renal units underwent open pyelotomy (21 units), extended pyelonephrolithotomy (25 units), pyelotomy with single or multiple nephrotomies (65 units), and anatrophic nephrolithotomy (7 units) with intraoperative fluoroscopic guidance and sometimes the use of intraoperative endoscopy. 97 patients and 106 renal units were operated upon via minimally invasive techniques in the form of PNCL either through single or multiple punctures. We used the lithoclast machine with one or more sessions of extracorporeal shock wave lithotripsy (ESWL), using a portable machine for the significant residual stones or sandwich therapy by the same team of operators. Table 1 presents patient characteristics.

Postoperative evaluation:
A KUB was done for all patients to evaluate the presence of clinically significant stones (stones >4 mm). If they were found, the patient was subjected to one or more sessions of ESWL aimed at rendering the patient stone free. Operative time, operative cost, blood loss, stone-free rates, use of single or multiple sessions, hospital stay, complications, total cost, and time to return to ordinary activities were calculated and plotted in a database, statistically analyzed, and compared for the two groups of patients. Figures 1-6 shows two cases of staghorn and multiple renal stones.

Table 2. A comparison of the results of the two groups
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Item	Open group (n = 118 renal units)	PCNL + ESWL (n = 106 renal units)	P value
Operative time (minutes)	170 ± 32.9	210.0 ± 59.3	<0.01
Operative cost (US dollars)	290.4 ± 26.3	418.5 ± 47.2	<0.01
Stone-free rate	106 (89.8%)	88 (83.7%)	NS
Multiple sessions	12 (10.2%)	70 (74.2%)	<0.01
Hospital stay (days)	7.2 ± 2.3	8.4 ± 2.2	<0.05
Total Hospital cost (US dollars)	381.5 ± 31.6	509.3 ± 35.8	<0.01
Time to return to ordinary activity (days)	21.7 ± 4.4	15.4 ± 3.8	<0.01

Data are expressed as mean ± SD or number (%)
p< 0.05= significant; p< 0.01= highly significant.

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Table 3. A comparison the complications rate for both groups
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Item	Open group 118 renal units	PCNL group 106 renal units	P value
Intraoperative complications:			
Blood loss	250.4 ± 178.6 ml	150 ± 103.8ml	< 0.01
Blood transfusion	30 (25.4%)	21 (19.8%)	NS
Colonic injury	1 (0.9%)	2 (1.9%)	NS
Pneumothorax	6 (5.8%)	2 (1.9%)	NS
Renal pelvis perforation	0	4 (3.8%)	NS
Postoperative complications:			
Sepsis	7 (5.9%)	4 (3.8%)	NS
A-V fistula	1 (0.9%)	2 (1.9%)	NS
Urinary leakage	3 (2.5%)	5 (4.7%)	NS
Incisional hernia	2 (1.7%)	0	NS

Data are expressed as mean ± SD and as number (%)

Statistical analysis:
Data are expressed as mean ± standard deviation (SD) or number (%). The comparison between the mean values of the two groups was done using an unpaired Student's t test. The comparison between categorical data [n (%)] was done using the chi-square test. The SPSS computer program (Windows version 14) was used for data analysis. P values less than 0.05 were considered significant, and values less than 0.01 were considered highly significant.

RESULTS

Table 2 is a comparison of the results of the two groups of patients regarding operative time, operative cost, hospital cost, hospital stay, and time to return to ordinary activities. The operative time was significantly less for the open group compared to the PCNL group, as most of the latter needed multiple sessions of PCNL and SWL. This also raised the hospital stay, the operative cost, and the total hospital cost. In the open group, 106 (89.8%) patients were stone free in a single session and only 12 (10.2%) needed additional ESWL sessions. In comparison, the PCNL group yielded 88 (83%) patients that were stone free, a statistically significant difference. However, the time needed for convalescence was significantly less for the PCNL group.

Table 3 is a comparison of the complication rates for both groups. The open group had less incidence of colonic injury, AV fistula, and urinary leakage, reflecting on the hospital stay and cost. However, the open group had more incidence of pneumothrax and blood loss, comparable incidence of sepsis, and needed more time to return to ordinary activity compared with the PCNL group. Figure 7 compares the operative time, need for multiple sessions, and total hospital cost in both groups.

DISCUSSION

Staghorn and complex multiple renal stones remain a clinical challenge. To start with, the term staghorn and its classification is still a point of debate. Staghorns are defined as either partial (extending into two or more calyceal groups) or complete (extending into all calyceal groups) [6]. Rassweiler *et al.* [7] divided them further into borderline, partial, complete, and giant. Conservative treatment for staghorn stones carries a high risk of renal loss and a possible mortality rate of up to 30% [8,9].

In the era of minimally invasive procedures, PCNL is recommended by most authors as the first-line and gold standard treatment for most patients because of its low morbidity rate [10,11]. However, other studies give the upper hand to open surgery in the form of anatrophic nephrolithotomy [12,13]. ESWL monotherapy for staghorn and multiple renal stones is

Figure 5. Most of the stones extracted after pyelotomy with multiple nephrotomies
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Figure 6. Postoperative KUB with 3 residual stones and DJ stent in place. The patient had ESWL later on for these residual stones

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reserved for low volume stones with pelvicalyceal systems with minimal or no dilation and provided there is adequate system drainage via either ureteral stenting or PCN. According to the guidelines, open surgery is considered for extremely large stone burdens with unfavorable collecting systems [14]. Recently, some authors reported the introduction of laparoscopy and robotically-assisted laparoscopy as a way of managing complex and staghorn renal stones [15,16].

Our work is a retrospective study aimed at the evaluation of the role of open surgery in the management of complex multiple and staghorn renal stones, especially in the working conditions of developing countries. Due to the high patient load and limited resources, each procedure should be directed in the most efficient and cost-effective way. Many factors should be weighted against each other to determine what lines of treatment are suitable and available for treating this condition with the ultimate goal of rendering the patient stone free with the least chance of morbidity.

Most of the literature showed a stone-free rate of around 85%, with a stone recurrence of around 30%, using combined PCNL and ESWL [17,18]. In our study, we achieved comparable results using the same technique. However, the open group achieved a significantly higher stone-free rate of 89.8% when operating with the aid of intraoperative fluoroscopy and endoscopy, a lower number of multiple sessions, a lower total cost, and a shorter hospital stay.

The PCNL group showed less bleeding, less need for blood transfusion, and a shorter convalescence time, but with a higher incidence of colonic injury, pneumothorax, and postoperative bleeding needing angio intervension. Al-Kohlany *et al.* [18] stated that staghorn stones represent a troublesome therapeutic challenge because of the lack of consensus on how to define the stones, how to assess the burden, treatment options, and the highly variable reported results. Our work shows that every treatment option has its advantages and disadvantages. No one option should be condemned and considered inferior to other options. Treatment recommendations should be weighed against treatment effectiveness, cost-benefit analysis, and patient conditions, especially in the working conditions of developing countries with limited resources.

CONCLUSION

Open techniques for the management of complex multiple and staghorn renal stones are still a viable option that should be considered in treating patients with such conditions, especially regarding their cost-effectiveness in the face of limited resources in developing countries.

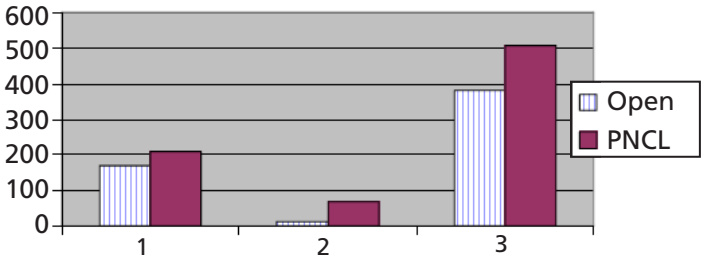

Figure 7. A comparison of the (1) operating time, (2) need for multiple sessions, and (3) total hospital cost in both groups

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