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Extracorporeal Shock Wave Lithotripsy (ESWL) Versus Percutaneous Nephrolithotomy (PCNL) in the Eradication of Persistent Bacteriuria Associated with Infected Stones

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ABSTRACT

INTRODUCTION: Infected stones function as a sanctuary for organisms that attenuate the effects of antibiotics. Therefore, to treat urinary tract infection associated with urinary calculi, complete extirpation of the stones is necessary.

OBJECTIVE: We compared the incidence of persistent bacteriuria among patients with infected renal stones treated by (ESWL) and who received long-term antibiotics versus those who were treated by (PCNL) with the aim to completely eradicate all stone fragments.

METHODS: We studied 73 patients with infected stones who presented with recurrent or persistent urinary tract infections (UTI). Urine culture was positive in all patients. We treated 35 patients by ESWL, of whom 23 had stones larger than 2 cm and were provided with fixed double-j stents for drainage and to prevent obstruction (stents were left in for no more than 6 weeks). The other 38 patients were operated upon by PCNL through single (29 patients) or multiple (9 patients) punctures or sessions.

RESULTS: Of the 73 patients included in the study, 67 were available for follow-up (32 from the ESWL group, 35 from the PCNL group). Out of the 35 patients treated with PCNL, 32 (91.4%) were rendered stone-free, and only 2 of the 3 (5.7%) patients with residual stones showed evidence of persistent bacteriuria. Out of the 32 patients treated with ESWL, 16 (50%) were stone-free, and 13 of the 16 (40.6%) with residual stones showed evidence of persistent bacteriuria. A positive relation was found between residual stone fragments and persistent bacteriuria, as all patients in either group who were stone-free were also free of persistent infection. The study also showed that, in the ESWL group, the rate of eradication of stones and persistent infection was much better in cases with stones less than 2 cm (90.9% vs. 28.6%). The incidence of residual infected stone fragments was directly related to the degree of hydronephrosis.

CONCLUSION: PCNL is better than ESWL monotherapy in the eradication of persistent bacteriuria associated with infected stones, especially when associated with moderate and marked hydronephrosis, as it has a much better clearance rate of the residual infected stone fragments.

KEYWORDS: Persistent bacteriuria, Stones, ESWL, PCNL

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INTRODUCTION

Infected stones function as sanctuaries for organisms and may attenuate the effects of antibiotics used against them thereby causing persistent infection [1]. Incorporation of urea-splitting bacteria within the developing struvite stones, as well as calcium oxalate stones that have become secondarily infected, result in a focus of infection resistant to conventional antimicrobial therapy and clinically manifested by repeated urinary tract infections (UTI) caused by the infecting organism. Therefore, complete removal of all the infected stone material is considered to be essential for the eradication of persistent bacteriuria associated with the infected renal calculi [2]. The pros and cons of percutaneous nephrolithotripsy (PCNL) versus extracorporeal shockwave lithotripsy (ESWL) are highlighted in discussion of the management of renal stones. For example, PCNL entails a prolonged hospital stay, whereas ESWL is typically an outpatient procedure. However, PCNL has a superior stone clearance rate as compared to ESWL, especially for lower pole stones. In addition, PCNL is more suitable for large stones and when ancillary procedures are required (e.g. endopyelotomy) [3].

ESWL effectively pulverizes infected renal calculi. However, stone fragments usually remain in the renal collecting system for weeks to months and may harbor infecting bacterium [4].

Studies were held to determine whether ESWL could sterilize infected stones, thus decreasing the recurrence rate of infection. They investigated the impact of ESWL on the microbiological flora of staghorn calculi on true stone fragments and on the viability of the infecting bacteria within a simulated struvite stone matrix. They concluded that ESWL has no discernible effect on the microbiological flora of infected staghorn calculi, and ESWL treatment of infected stones must be accompanied by antimicrobial coverage [4,5]. When compared to infected stones, studies show that, provided the urine is sterile and there is a negative history of urosepsis, antibiotic prophylaxis is unnecessary in patients with non-infected renal stones submitted to ESWL treatment [6].

PCNL is the treatment of choice for renal stones, especially when they are larger than 2 cm, based on its high stone-free (87%) and low complication rates. However, residual stone burden following PCNL is problematic, as fragments may propagate and form new stones or serve as a source for recurrent UTI [7].

In this work, we retrospectively studied the incidence of persistent bacteriuria among patients with infected stones who were treated by ESWL and received long-term antibiotics versus those who were treated by PCNL with the aim of completely eradicating all stone fragments.

MATERIALS AND METHODS

From June 2002 to June 2005, we studied 73 patients with infected stones presenting with recurrent or persistent UTI.

All patients had normal lower urinary tracts. Mean age was 47 years (range = 25-63 years). There were 51 men and 22 women, and 22 patients had previous surgical intervention for stone disease. The mean stone size as measured from KUB standard AP film was 3.56 ± 1.73 cm.

Urine culture was positive in all patients, and localization of the site of infection was carried out via bilateral ureteric catheterization and pelvic urine sampling. Quantitative urine cultures were performed by inoculating sheep blood and McConkey agar plates with 0.1 ml of urine, and isolates were identified by standard biochemical tests. Isolates of different species in concentrations more than 10^3 in the bladder and pelvic urine were considered as evidence of infection. Infected stones were diagnosed when the specimens of the bladder and pelvic urine samples from the side with the stone tested positive and when stone fragments from PCNL or ESWL tested positive, as all stone fragments retrieved after ESWL or PCNL were collected in strainers and cultured.

Stones occupied the pelvis only in 27% (19) of patients, extended into the lower calyx in 38% (28), and were in more than 1 calyx in 35% (26). Hydronephrosis was mild in 23% (17) of patients, moderate in 37% (27), and severe in 40% (29). The infecting organism was E-coli in 45% (33) of patients, proteus mirabilis in 38% (28), klebsiella pneumonia in 13% (9), and pseudomonas aeurginosa in 4% (3). After giving informed consent, patients were randomly directed to receive either ESWL or PCNL. There was no significant difference between the 2 groups regarding the mean stone size.

In our study, 35 patients received ESWL, of whom 23 patients had stones larger than 2 cm and were fixed with a double-J (DJ) stent for 4-6 weeks to provide drainage and prevent obstruction by gravels. The remaining 12 patients had stones less than 2 cm and were managed by ESWL without stenting. Patients

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were discharged after overnight admission if no complications supervened. ESWL fragmentation was considered to be complete when the entire stone material had been reduced to fragments measuring 3 mm or less 3 months after starting the treatment. Of the 35 patients, 28 (80%) received more than 1 session of ESWL.

Comparatively, 38 patients were managed by PCNL through punctures using 28-30 Ch Amplatz sheaths. Only a single puncture was needed for 29 patients, whereas 9 patients needed multiple punctures or sessions. Patients were discharged after removal of the nephrostomy tube or tubes, usually after 2-4 days.

The 2 groups of patients were discharged provided there was no pain, fever, sepsis, or manifestations of systemic inflammatory response syndrome (SIRS), defined as presence of 2 or more of the following [8]:

1. Temperature ≥ 38°C or ≤ 36°C
2. Heart rate > 100/min
3. Respiratory rate ≥ 20/min
4. White blood count > 12,000 or < 4000

All patients received antibiotics according to culture and sensitivity. Patients who received ESWL started the antibiotic treatment 48 hours before the procedure and continued for 48 hours afterwards, then continued on oral ciprofloxacin (500 mg twice daily) for a 2-week period. Patients with DJ stents received chronic suppressive antimicrobial therapy until the stents were removed. Patients who were managed by PCNL started the antibiotic treatment 48 hours before the procedure and continued for 48 hours after nephrostomy tube removal. Patients in either group with pyrexia or sepsis received further appropriate antibacterial therapy for at least 10 days.

Patients were followed-up at the outpatient clinic by KUB noncontrast spiral CTs when needed and midstream urine sample cultures at monthly intervals.

Statistical Analysis

Results were expressed as mean ± standard deviation (SD) or number (%). Comparison between the mean values of the 2 groups was done using Mann-Whitney U test. Comparison between categorical data (*N* (%)) was done using chi-square test. SPSS computer program (v.11 for Windows) was used for data analysis. *P* value less than 0.001 was considered extremely significant.

RESULTS

A total of 73 patients were included in the study (35 treated with ESWL, 38 treated by PCNL). However, only 67 patients were available for follow-up (32 patients in the ESWL group, 35 in the PCNL group). Follow-up after termination of antibiotics ranged between 1 and 12 months (mean 9.7 ± 3.6 months). There was no significant difference between the 2 groups regarding follow-up period. Characteristics and results of the 2 groups are shown in Table 1.

Out of the 32 patients included in the ESWL group, 16 (50%) had residual fragments 3 months after ESWL. None of the stone-free patients showed persistent bacteriuria in their follow-up, while 13 of the 16 (81.3%) patients with residual stones showed persistent bacteriuria. In other words, 13 out of 32 (40.6%) patients included in the ESWL group showed persistent bacteriuria, all of whom had residual stone fragments.

By further analyzing this group, we found that 10 of 11 (90.9%) patients who had stones less than 2 cm were stone-free, and all 11 showed no bacteriuria in their follow-up. Of the 15 ESWL patients with stones more than 2 cm, 15 (71.4%) had residual

Table 1. Characteristics and results of the 2 groups treated with either ESWL or PCNL

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	ESWL	PCNL
No. of pts available for follow-up	32	35
Follow-up period (months)	8.2 ± 4.1	7.3 ± 3.9
Mean stone size (cms)	3.5 ± 1.8	3.6 ± 1.7
Mean days oral antibiotics	16 ± 3	5 ± 2*
Stone-free patients	16 (50%)	32 (91.4%)*
No. of pts with residual stone fragments (%)	16 (50%)	3 (8.6%)*
No. of pts with persistent bacteriuria	13/32 (40.6%)	2/35 (5.7%)*
No. of pts with persistent bacteriuria in pts. with residual stones	13/16 (81.3%)	2/3 (66.6%)
Fever after treatment	8 (22%)	5(13%)

*$P < 0.001$

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Table 2. Results of the ESWL group in relation to the stone size
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Stone size	Less than 2 cm	More than 2 cm
No. of patients	11	21
Stone-free	10/11 (90.9%)	6/21 (28.6%)*
Residual stones	1/11 (9.1%)	15/21 (71.4%)*
Incidence of persistent infection with residual stones	0/1	13/15

*$P < 0.001$

stone fragments, 13 of whom showed persistent bacteriuria (Table 2).

Of the 35 patients included in the PCNL group, 32 (91.4%) were stone-free, and all 32 were free of persistent bacteriuria. Of the 3 (8.6%) patients who had residual fragments, 2 showed persistent bacteriuria in their follow-up. Hence, out of the 35 patients treated with PCNL, the 2 (5.7%) who showed persistent bacteriuria had residual stone fragments.

In both groups, a positive relation was found between the residual stone fragments and persistent bacteriuria, as shown in Figure 1.

The types of the bacteria postoperatively recovered were similar to those originally found preoperatively in the pelvic urine cultures and the stone fragment cultures. No correlation was found between the infecting organism and the success rate of eradication of infection or between previously operated and nonoperated kidneys. We noticed from this study that the percentage of residual stone fragments is directly proportional to the degree of hydronephrosis, as shown in Figure 2 and Figure 3.

DISCUSSION

ESWL can be performed without difficulty on infected stones, yet it should be stressed that the association of infection and urinary stones calls for a different approach from that of noninfected stones. Experience to date suggests that small collections of sterile, non-obstructing fragments after ESWL are of no clinical significance. On the contrary, even minute but infected fragments are foci of persistent infection that places the patient at risk for general morbidity of a chronic bacterial infection, as well as stone recurrence [9].

Many authors have studied the proposed bactericidal effect of ESWL on the infected stones, but all have concluded that it has no clinical significance regarding this point [4,9]. In comparison to patients with infected stones, patients with noninfected stones showed no evidence of bacteriuria or bacteremia after ESWL treatment [6]. PCNL is favored over ESWL in patients with large stones, as a single session of PCNL will often achieve complete stone removal without the necessity of ancillary procedures [10].

We studied the incidence of persistent bacteriuria in a group of patients with infected stones treated by ESWL and long-term antibiotics versus those treated via PCNL aimed at complete removal of the stone fragments. None of our patients had any other abnormalities that could be responsible for the persistent bacteriuria, and pelvic urine and stone fragments culture proved that the source of infection was the stones.

In both groups, it was found that the most important factor for the clearance of infection was the eradication of all infected fragments, not the prolonged use of antibiotics. In this regard, PCNL is favorable in clearing stone fragments, as shown in Figure 1.

The results showed that 32 of 35 (91.4%) patients treated by PCNL were stone-free, and all 32 were free of infection at follow-up. Of the 3 patients with residual stones, 2 had persistent infection (5.7% of the total 35 patients in this group). While 16 of 32 (50%) patients managed by ESWL had residual

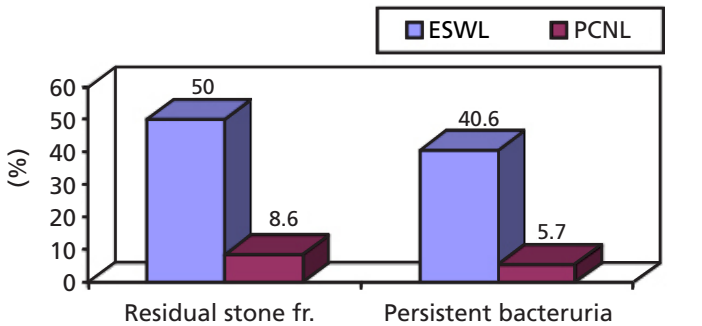

Figure 1. Residual stone fragments and persistent bacteriuria in ESWL and PCNL patients
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stones, 13 (81.25%) patients had persistent infection (a total of 40.6% of the patients in this group), as shown in Table 1. Beck and Reihle [10] support this conclusion and state that patients with residual stone fragments at 3 months postoperative had a high progression rate (78%) and should be monitored closely.

The success rate of stone clearance in the ESWL group was related to stone size. When the stone was less than 2 cm, 10 of 11 (90.9%) patients were stone-free and none had persistent bacteriuria. On the other hand, when the stone was more than 2 cm, only 5 of 21 (28.6%) patients were stone-free, and 13 patients with residual stones had persistent infections, as shown in Table 2.

Another finding was that, in both groups, the degree of residual fragment clearance was directly related to the degree of hydronephrosis. The greater the degree of hydronephrosis, the lesser the degree of stone clearance, and PCNL had the upper hand in stone fragment eradication (Figure 2 and Figure 3). Other studies support this concept, such as Shigita *et al.* who reported that in cases of stones with moderate or marked hydronephrosis, PCNL is recommended rather than ESWL monotherapy [11].

ESWL monotherapy may result in a better stone-free and bacteriuria-free outcome for small infected stones (< 2 cm) in the renal pelvis in patients with only mild hydronephrosis. In cases of moderate and marked hydronephrosis and when there is a likelihood of fragments remaining in the lower calyces, PCNL is of particular relevance. This is especially true for patients with large infected stones, in whom complete evacuation of all fragments is mandatory to eradicate persistent bacteriuria.

CONCLUSIONS

PCNL is better than ESWL monotherapy in the eradication of persistent bacteriuria associated with infected stones. PNCL should be used for the treatment of large stones and associated moderate to marked hydronephrosis, as it has a much better clearance rate of residual and infected stone fragments. ESWL showed a good result for stone and infection clearance for small infected stones in the renal pelvis and associated mild hydronephrosis.

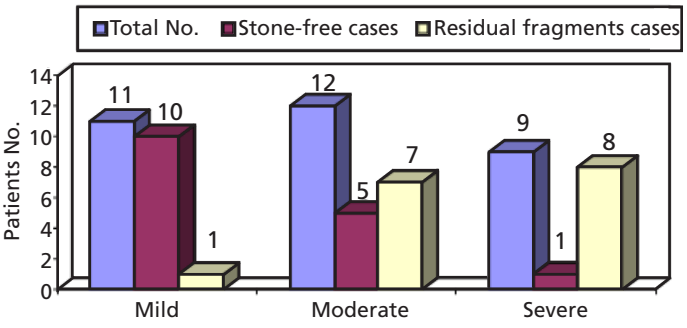

Figure 2. Relation between the degree of hydronephrosis and the stone clearance in ESWL cases
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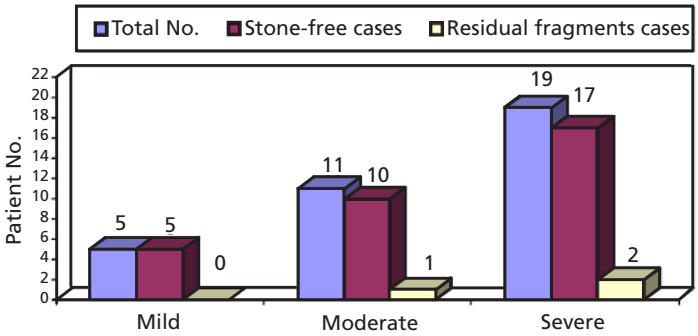

Figure 3. Relation between the degree of hydronephrosis and the stone clearance in PCNL cases
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