Abstract

Objectives
Use of extracorporeal shock wave lithotripsy (ESWL) in paediatric urolithiasis is a well-established treatment modality and currently represents the first choice therapy for the majority of reno-ureteric stones. In this study, we determined the safety and efficacy of ESWL in the management of paediatric urolithiasis, analyzed the impact of renal stone burden (number and size) and location on stone clearance and analyzed the complication rates of the use of ESWL in the management of paediatric urolithiasis.

Patients and methods
This is a prospective cross-sectional, hospital-based study conducted in the period from January 2010 to January 2011 at Soba University Hospital. Sixty paediatric patients from all paediatric age groups (Range 1-11 years) with renal stones treated with ESWL monotherapy using a third generation Dornier lithotripter. The doses of shock waves used ranged from 111 to 2555 (mean of 1333 shock waves per session). Pre-treatment plain radiograph and intravenous urography (IVU) were done to all patients. Stone fragmentation was assessed at the time of the procedure by fluoroscopy and stone clearance was assessed six weeks later by ultrasonography and plain radiographs. Di Mercapto Succinic Acid (DMSA) scan was done for seven patients (11.7%) in the last month of the study before and after the procedure.

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Results
Complete stone clearance was achieved in 63.3% of patients, 26.7% were partially cleared and 10% were not cleared. All the children who underwent DMSA scan pre and post ESWL showed normal results. Renal stone up to 2.9 cm in size, multiple stones and stones at any location in the upper urinary tract were treated with ESWL with variable outcomes. No complications were noted in 38.3% of patients, while self-limiting pain, haematuria, fever, rectal bleeding and urine retention occurred in 61.7% of patients.

Conclusion
Extracorporeal shock wave lithotripsy is a simple, safe and effective procedure, with mild complications and can be considered as a first-line treatment in the management of paediatric urolithiasis.

Keywords: ESWL, paediatric, urolithiasis, clearance rate, Sudan.

Introduction
Since its introduction by Chaussy et al in 1980\(^{(1)}\), the extracorporeal shock wave lithotripsy (ESWL) has become the first therapeutic option in most cases of upper-tract urolithiasis. The first report of success using ESWL in children was by Newman and associates in 1986\(^{(2)}\). The treatment options for urolithiasis in children are the same as those in the adult population, the majority of paediatric urolithiasis can be managed with ESWL, ureteroscopic stone extraction (URS), percutaneous nephrolithotomy (PCNL) or a combination of treatment modalities. Open surgery is currently reserved for cases with anatomical abnormalities or failed endourological attempts, while ESWL in general is considered to be the method of choice for managing the majority of paediatric urolithiasis\(^{(3)}\).

In appropriately selected patients, the overall success rate of ESWL is higher than 90% for stone clearance, with patients remaining stone-free for up to 2 years\(^{(4)}\).

As the degree of stone burden increases and stone diameter exceeds 2 cm, the clearance rate drops significantly. In patients with stone sized 2-3 cm, the clearance rate with ESWL mono-therapy was typically 50%. Clearance rates in patients with larger stones (complete and incomplete staghorn calculi) were correspondingly lower.

Extracorporeal shock wave lithotripsy is safe and effective. Although small series have shown successful treatment of stones in young children, long-term follow-up of the potential complications, including hypertension and decreased renal function are not yet matured\(^{(4)}\).

Patients and methods
This was a prospective cross-sectional, hospital-based study conducted in the period from January 2010 to January 2011 at Soba University Hospital. Sixty paediatric patients from all paediatric age groups, 32 males and 28 females, with renal stones treated with ESWL monotherapy using a third generation Dornier lithotripter with a shock wave dose ranged from 111 to 2555 (mean of 1333 shock wave per session). Pre-treatment plain radiograph and IVU were done to all patients. Stone fragmentation was assessed at the time of the procedure by flouroscopy and stone clearance was assessed six weeks later by ultrasonography and plain radiographs. Di Mercapto Succinic Acid scan was done for seven patients (11.7%) in the last month of the study before and after the procedure.

Results
Complete stone clearance was achieved in 63.3% of patients, 26.7% were partially cleared and 10% were not cleared. All the children who underwent DMSA scan pre and post ESWL showed normal results. 68.3% of the patients had a single renal stone, while 31.7% of them had multiple stones. The clearance rate among them is shown in Table 1.
Table 1: Correlation between the number of stones and clearance rate among the study population.

<table>
<thead>
<tr>
<th>No. of stone</th>
<th>Completely cleared</th>
<th>Partially cleared</th>
<th>Not cleared</th>
</tr>
</thead>
<tbody>
<tr>
<td>Single</td>
<td>78%</td>
<td>17%</td>
<td>5%</td>
</tr>
<tr>
<td>Multiple</td>
<td>31.5%</td>
<td>47.3%</td>
<td>12.2%</td>
</tr>
</tbody>
</table>

P. value (0.005)

93.3% of stones were less than 2 cm in diameter, while 6.7% of them were more than 2 cm, 2.9cm in maximum diameter. The clearance rate among them is shown in Table 2.

Table 2: Correlation between the size of stones and clearance rate among the study population.

<table>
<thead>
<tr>
<th>Size of stone</th>
<th>Completely cleared</th>
<th>Partially cleared</th>
<th>Not cleared</th>
</tr>
</thead>
<tbody>
<tr>
<td>&lt; 2 cm</td>
<td>66%</td>
<td>26.7%</td>
<td>7.3%</td>
</tr>
<tr>
<td>&gt; 2 cm</td>
<td>25%</td>
<td>25%</td>
<td>50%</td>
</tr>
</tbody>
</table>

P. value (0.020)

Table 3 showing the correlation between stone location and clearance rate.

Table 3: Correlation between stone location and clearance rate among the study population.

<table>
<thead>
<tr>
<th>Stone location</th>
<th>Completely cleared</th>
<th>Partially cleared</th>
<th>Not cleared</th>
</tr>
</thead>
<tbody>
<tr>
<td>Upper calyx</td>
<td>100%</td>
<td>0.0%</td>
<td>0.0%</td>
</tr>
<tr>
<td>Middle calyx</td>
<td>66.6%</td>
<td>33.3%</td>
<td>0.0%</td>
</tr>
<tr>
<td>Lower calyx</td>
<td>33.3%</td>
<td>66.6%</td>
<td>0.0%</td>
</tr>
<tr>
<td>Pelvic</td>
<td>70%</td>
<td>17.5%</td>
<td>12.5%</td>
</tr>
<tr>
<td>Upper ureter</td>
<td>66.6%</td>
<td>33.3%</td>
<td>0.0%</td>
</tr>
<tr>
<td>Middle ureter</td>
<td>100%</td>
<td>0.0%</td>
<td>0.0%</td>
</tr>
<tr>
<td>Lower ureter</td>
<td>50%</td>
<td>16.6%</td>
<td>33.4%</td>
</tr>
</tbody>
</table>

P. value (0.270)

Mild, self-limiting complications were encountered in 61.7% of patients, while no complications were noted in 38.3% of the patients as shown in Fig 1.

Discussion

In most of the studies, the overall success rate of ESWL is higher than 90% for stone clearance, with patients remaining stone-free for up 2 years\(^4\), while in this study 63.3% of stones were completely cleared, 26.7% were partially cleared and only 10% of stones were not cleared from a single session of ESWL. This may be due to appropriate stone/patient selection. Compared with ureteroscopic removal of stones, ESWL leads to less complications and shorter hospital stays. However, ureteroscopy was shown in one review to achieve a greater clearance rate than ESWL\(^5\).

The normal results of pre and post ESWL DMSA scan indicate the safety of ESWL, similar outcomes were reported by Newman and associates in 1990 showing not only the high efficacy, but also the short-term and long-term safety of paediatric ESWL\(^2\).

A recent study by Fayad et al demonstrated an equivalent renal growth at one year in children who underwent ESWL compared to a healthy control group who did not have the intervention\(^6\).

Sheir et al (2003) deemed ESWL to be considered the primary treatment option for stones less than 2 cm in length\(^7\). This was similarly demonstrated in this study, Table 2. As the degree of stone burden increases and size exceeds 2 cm, the clearance rate drops significantly. In patients with stones sized...
2-3 cm, the clearance rate with ESWL monotherapy is typically 50%. The clearance rates in patients with larger stones (complete and incomplete staghorn calculi) are correspondingly lower.\(^{(6)}\) The location of the stone also affects the efficacy of ESWL. Although ESWL can fragment stones in the lower calyx of the kidney, the resulting clearance rate is decreased because of the difficulty in passing stones from this location. The clearance rate in the lower calyx stones (Table 3) is lower than what was reported in the literature. In the meta-analysis of 2,927 patients from 14 centers, Lingeman et al (1996) found that the clearance rate for all lower-pole stones treated with ESWL (59.2%) was lower than the clearance rate associated with PCNL (90%)\(^{(8)}\).

Some studies have suggested that selected patients with appropriate renal collecting system anatomy may see good results with ESWL despite lower-pole location. In these studies, the overall stone-free rate was approximately 50%, with stone-free rate of 85% in patients with favorable anatomy versus 7% in those with unfavorable anatomy. It was also found that ESWL fragmentation of proximal ureteric stones was more effective than mid or distal ureteric stones. The clearance rates in the ureter (Table 3) were conforming to what was reported in the literature.

Advances in CT have allowed better determination of internal stone architecture and Hounsfield unit (i.e., density unit of material on CT) of renal stone that could predict stone free-rates of patients treated with ESWL, thereby limiting the need for multiple sessions or procedures.

The reported complications in the literature after ESWL were relatively few. The most frequently observed were haematuria, which is almost always mild and transient and does not require medical or surgical treatment, steinstrasse due to stone fragments stacking, urethral obstruction and urinary tract infection which were noted in approximately 7% of patients undergoing ESWL and was more likely encountered in patients with infection-related stones. Clinical sepsis was less common and developed in less than 1%. Sometimes these complications overlap, generating symptoms such as renal colic with or without fever. Subcapsular, intrarenal and perirenal haematomas were also reported.\(^{(9,10,11)}\) The complications in the study, though frequent, were mild, transient and self-limiting (Fig 1).

ESWL is a safe and an effective procedure in the management of paediatric urolithiasis. Renal stones up to 2.9 cm in size (largest stone size encountered in the study), those multiple in number and at any location in the upper urinary tract can be treated with ESWL with variable stone clearance rates and as the degree of stone burden increases and exceeds 2 cm, the clearance rate drops significantly.

References


