

Shock wave lithotripsy in patients with renal calculi

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ABSTRACT

الأهداف: لإظهار قدرة جهاز التفتيت (SWL) دولي (Dornier Doli U/50) في تفتيت حصوات الكلى لـ 1647 مريض.

الطريقة: أجريت عمليات تفتيت حصوات الكلى (SWL) لـ 1647 حالة تنويم يومية في مستشفى جامعة الملك عبد العزيز - جدة - المملكة العربية السعودية، خلال الفترة ما بين أكتوبر 2001م وحتى يوليو 2007م، وذلك باستخدام مهدئات البسيدين 1mg/kg والميدازولام 10-5mg في (85.5%) من المرضى. تم تحليل نتائج تفتيت 2241 حصوة بالكلى طبقاً لحجم ومكان الحصوات، ومن ثم تقسيم الحصوات إلى خمسة مجاميع طبقاً لحجم الحصوة. تراوحت فترة متابعة المرضى من 6-18 شهراً بمعدل 13 شهراً.

النتائج: تمت إزالة الحصوات من الكلى في 2154 حالة (89.5%) في فترة الثلاثة أشهر الأولى من المتابعة. كان معدل المرضى الذين لزم إعادة تفتيت للحصوات لديهم (57.2%) لكل مجموعة. المجموعة الأولى عدد المرضى 132 (23.5%)، المجموعة الثانية 254 مريضاً (36.1%)، المجموعة الثالثة عدد المرضى 473 (85.5%)، والمجموعة الرابعة 278 مريضاً (100%)، أما المجموعة الخامسة 147 مريضاً (100%). فشلت عمليات تفتيت الحصوات في 87 مريضاً يعانون من حصوات ذات أحجام تتراوح من 20-29mm. في ثلاثون مريضاً تراوحت أحجام الحصوات من 30-39mm. ستة وخمسون حصوة كانت في حوض الكلى عولجت باستخدام مناظير الحالب، في حين أن 31 حصوة كانت قد عولجت بطرق أخرى كاستخدام (PCNL). يعتبر الالتهاب الحاد بالكلى دون وجود انسداد من أهم المضاعفات التي نتجت من عملية التفتيت.

خاتمة: أظهرت النتائج أن تفتيت حصوات الكلى (SWL) الأول كان ناجحاً مع اختلاف أحجام الحصوات في 89.5% من الكلى المعالجة.

Objectives: To demonstrate the efficacy of shock wave lithotripsy (SWL) in the primary treatment of 1647 patients with renal calculi using a Dornier Doli U/50 lithotripter.

Methods: One thousand and six hundred forty-seven patients underwent SWL as day-cases at King Abdulaziz University Hospital in Jeddah, Saudi Arabia between

October 2001 and July 2007, using intravenous sedation (Pethidine 1mg/kg and Midazolam 5-10mg) for analgesia in 85.5% of the patients. The treatment outcome of 2241 renal calculi was analyzed and stratified according to the size and the site of the stones. Recorded data included shock waves intensity, number of shocks, treatment time, analgesia, stone related factors such as size, site, number, nature, composition, and any related complications. The stones were grouped into 5 groups according to the largest stone size in the kidney. Patients were followed up for 6-18 months, mean of 13 months.

Results: Complete clearance of the stones occurred in 2154 kidneys (89.5%). At 3-months follow up. The overall re-treatment rate was 57.2% and for each group it was 132 (23.5%) for Group I, 254 (36.1%) for Group II, 473 (85.5%) for Group III, 278 (100%) for Group IV and 147 (100%) for Group V. Treatment failed in 87 patients with stone size of 20-29mm in 57 patients, and in 30 patients with stone size of 30-39mm. Fifty-six were solitary pelvic stones treated with ureteroscopy, while 31 were calyceal stones treated by other modalities such as per-cutaneous nephro-lithotomy. The most common complication was pyelonephritis with or without obstruction.

Conclusion: Shock wave lithotripsy treatment was a successful primary management of renal stones of variable sizes in 89.5% of the treated kidneys.

Saudi Med J 2008; Vol. 29 (8): 1180-1183

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Received 8th April 2008. Accepted 9th July 2008.

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The introduction of shock wave lithotripsy (SWL) in early 1980 revolutionized the surgical management of Urolithiasis.¹ The advancement in the technology led to minimizing the indication of other invasive modalities in treatment of urolithiasis, reduced the morbidity and the period of hospitalization. During the last 25 years improvement centered on lithotripters design, shock wave generation, shock wave coupling and stone imaging to allow for treatment of all types of renal calculi.¹⁻⁴ Doli U50 lithotripter was designed for a broad range of therapeutic and diagnostic applications, it is equipped with an electromagnetic shock wave emitter (EMSE) which is characterized by aperture of 22mm (740), maximum depth of 145mm, and focal size ranges from 43x2.3mm at 10% power to 85x3.3mm at 100% power. The power varied 5% steps from 10-100% shock releaser/trigging. The maximum release frequency is 120 shock wave/min, coupling angle 900 vertical and 470 laterals and pressure in therapy focus (Imotec probe) 52-75MPa. The EMSE is mounted on a support which allows it to be placed in parking positions or in either vertical position for SWL treatment with US or lateral oblique position for SWL treatment with x-ray or combination of x-ray and US. Our study proved the efficacy and safety of SWL in treatment of renal stones.

Methods. One thousand and six hundred forty-seven patients (with a total of 2241 kidneys with stones) underwent SWL with Doli U/50 lithotripter between October 2001 and July 2007 as day-cases at King Abdul-Aziz University Hospital (KAUH). The study cleared ethically by our local committee. All patients received 1mg/kg pethidine (Mepridine) intravenously 15minutes prior to the procedure in addition to Midazolam (5-10mg) in divided doses. General anesthesia given to 239 (14.5%) patients who were either children or adults who could not tolerate the procedure with sedation. Recorded data included shock waves intensity, number of shocks, treatment time, analgesia, stone related factors such as size, site, number, nature, composition, and any related complications. The renal calculi were classified into calyceal, pelvic and pelvi-ureteric and were divided into 5 groups according to the stone size in each kidney

Table 1 - Groups of patients according to size of the largest stone.

Group	Stone size (mm)	No. of stones
I	≤9	561
II	10-19	702
III	20-30	553
IV	30-39	278
V	>40	147

(Table 1). Four thousand and two hundred and seventy-two SWL sessions were required to treat 2241 kidneys with stones in 1647 patients. Patient age ranged was 5-76 years (mean 40.5 years) with male/female ratio of 2.8: 1. There were 1448 (64.6%) calyceal stones of which 483 (21%) were situated in the lower calyx, 695 (31%) were pelvic and 98 (4.4%) were stag horn stones. Solitary stones were found in 1068 (47.7%) kidneys while 1173 (53.3%) had multiple stones. Localization of the stone was made by fluoroscopy in 1245 (55.5%) kidneys, ultrasonography in 883 (39.5%) and by both modalities in 113 (5%) kidneys. The time required for SWL treatment was 35-65 minutes (average 43 min). The procedure was performed under sedation in 1408 (85.5%) while general anesthesia was required in 239 (14.5%) who were either adults who could not tolerate the procedure otherwise or children. The maximum intensity varied between 70 and 100% in adult patients while a lower intensity was used in children (50-70%). Three thousand to five thousand shock waves (average 4000) per treatment were given to adults while in children the number of shock waves did not exceed 3000. Patients are checked at 4 weeks post-SWL with plain kidney, ureter, and bladder (KUB) x-ray to judge the need for further treatment. After the total clearance of the stones, the patients were checked with ultrasound and plain KUB x-ray every 3 months during the first

Table 2 - Retreatment rate.

Group	Second sessions	Third sessions	Fourth sessions	Fifth sessions	Sixth sessions
I	132 (10.3)				
II	254 (19.8)				
III	414 (32.2)	59 (4.6)			
IV	82 (6.4)	178 (13.9)	18 (1.4)		
V			8 (0.6)	98 (7.6)	41 (3.2)

Data are expressed as number and (percentage).

Table 3 - Show the composition of the stones in 352 patients.

Stone composition	No. of stones (%)
Calcium oxalate	116 (33.0)
Ca. oxalate + uric acid	57 (16.2)
Ca. oxalate + MgNH ₄ P	48 (13.6)
Ca. oxalate + Ca phosphate	89 (25.3)
Ca oxalate + NH ₄ Urate	30 (8.5)
Ca. phosphate + MgNH ₄ P	5 (1.4)
Ca. oxalate + Ca phosphate + cystine	1 (0.3)
Cystine	5 (1.4)
Uric ACID	1 (0.3)

year and then every 6 months for 18 months with mean of 13 months.

Data on the patients who developed post-operative complications or required further auxiliary interventional procedures was documented. Shock wave lithotripsy treatment success is the patient who had stone free status or residual fragments smaller than 4mm. The non responders to SWL treatment were offered either ureteroscopy with holmium laser fragmentation of the stones for 30 kidneys or per-cutaneous nephrolithotomy (PCNL) in 31 kidneys.

Results. The overall stone-free rate was 89.5% which was directly related to the size of the stone at various sites. A total of 4272 sessions were performed, retreatment were 1284 (57.2%) renal stone with an average of 1.9 session for each stone varied according to the different groups (Table 2). Eighteen patients (1.1%) required hospitalization due to acute pyelonephritis or severe pain. Eighteen patients developed acute obstruction and were treated with intravenous antibiotics and analgesics, 6 of whom required percutaneous nephrostomy. Transient hematuria occurred in 1433 (87%) patients, while renal and peri-renal hematoma occurred in 8 (0.3%) of the kidneys. Steinstrasse developed in 63 (2.8%) patients, while stone analysis was performed on 352 patients, who were able to provide us with fragments they passed, using the standard chemical quantitative analysis. 346 (98.3%) patients had calcium calculi while only 6 (1.7%) had non calcium stones (Table 3).

Discussion. The third generation lithotripter had decreased the need for open surgical procedures.⁵ The dual real-time localization facility and focusing system had enabled accurate localization of the renal stones. Focusing the power generated at F2, limited the severity of pain and made possible to have the procedure under sedation rather than general anesthesia. Only 14.5% of our patients required general anesthesia. Elhilali et al have reported the effectiveness and safety of Dornier compact lithotripter in treating 169 patients with renal stones under sedation and analgesia. Many others have also demonstrated the tolerance of the patients to SWL under sedation.⁶⁻¹¹ Cass¹² found stone-free rate of 81.5%, Portis et al¹³ 56% and Tan et al¹⁴ 82% while our study showed a higher stone-free rate. However, Sofras et al,¹⁵ showed higher stone free rate of 90% and our re-treatment rate was higher than that of the other centers which is probably due to the strategy of fragmentation of large stone by reducing the intensity and increasing the number of sessions to get better chance of fragmentation into small fragments.¹²⁻¹⁶ We have shown higher incidence of oxalate stone than that reported by others. In Londergan et al¹⁷ study,

the calcium stones were 85%, while Tiselius¹⁸ reported an incidence of 70-80% of calcium stones. There are some patients whose stones may not crumble even by repeated SWL which would warrant interventional procedures. The success rate of SWL is influenced by many factors such as stone size, location, composition, impaction and radiodensity. To avoid wasting further SWL sessions it is advisable to determine which patient will have an unsuccessful outcome. We consider it as treatment failure, stones which did not show any appreciable changes after 2 sessions of SWL (SWL non-responders). This was less than what was reported by Abdelkhalik et al¹⁹ and Bina et al²⁰ (who showed a failure rate of 7.3% and 4.7% respectively). Pain during SWL usually depends on the type of energy source and the amount of energy used. Need for analgesia is higher in women, younger patients, and patients for whom a higher voltage was applied, and it is directly related to the patient anxiety.^{21,22} Patients feel more pain during the first session of SWL which becomes more tolerated in the second session. We usually start the session at a low voltage which is increased gradually. With the first generation of SWL the incidence of developing pyelonephritis or urosepsis was high (15.5%) which had decreased by placing DJ stents. It is almost impossible to predict which patient will develop pyelonephritis post SWL as bacteruria may play a role as an important risk factor and was found in 7.7-23.5% of the patients undergoing SWL.²³ Hematoma is direct due to SWL trauma to parenchymal and intrarenal vessels. It has become less frequent by using the newer generation of SWL machines. Histological studies confirmed that the veins and capillaries are more susceptible to SWL than the arteries.²⁴ The incidence of developing post SWL hematoma in our cohort was comparable to that reported in the literature.²⁵

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