ISSN Print: 2394-7500
ISSN Online: 2394-5869
Impact Factor: 5.2
IJAR 2016; 2(7): 746-750
www.allresearchjournal.com
Received: 18-05-2016
Accepted: 19-06-2016

Dr. Kailash R. Gindodia
MBBS, Ms, Diploma In Urology (Germany)
Associate Professor,
Dept. of General Surgery,
ACPM Medical College, Dhule, Maharashtra, India.

Dr. Aditya Arvind Manekar
Junior Resident,
Dept. of General Surgery,
ACPM Medical College, Dhule, Maharashtra, India.

Correspondence
Dr. Kailash R. Gindodia
MBBS, Ms, Diploma In Urology (Germany)
Associate Professor,
Dept. of General Surgery,
ACPM Medical College, Dhule, Maharashtra, India.

A study of 3000 cases of urinary calculi treated by extracorporeal shock wave lithotripsy (ESWL)

Dr. Kailash R Gindodia and Dr. Aditya Arvind Manekar

Abstract
We hereby present a study of 3000 cases of renal calculi treated using ESWL (Extracorporeal Shock Wave Lithotripsy) over a period of 15 years from 2000 – 2014. This is a retrospective and an observational study. The lithotripter used was "Dornier Compact Alpha", a latest state of art, from Germany – a gold standard in the Extracorporeal Shock Wave Lithotripsy therapy. Ultrasound was used as a sole imaging modality, thus picking up even small and radiolucent stones in radiograph of kidney, ureter and bladder (X-ray KUB). The energy source in the lithotripter used was an electromagnetic generator with isocentric focussing technique. Our ESWL machine has a mobile therapy head and a stable patient table, thus making it versatile and convenient to treat even vesical calculi and ureteric calculi, along with large renal calculi. The results with ESWL therapy are comparable to the endoscopic surgeries with ESWL having the advantage of being non invasive and having lesser number of complications than the latter.

Keywords: ESWL, Renal calculi, ureteric calculi, vesical calculi, ureteroscopy, non-invasive

1. Introduction

Extracorporeal shock wave lithotripsy (ESWL) is a non-invasive treatment of kidney stones [1] (urinary calculi) and biliary calculi (stones in the gallbladder or in the liver) using an acoustic pulse. It is also reported to be used for salivary stones [2] and pancreatic stones. It was first used by physicians from the university hospital Großhadern (Munich, Germany) and technicians from Dornier System (Friedrichshafen, Germany) in 1980. The device used is now displayed in the Deutsches Medizinhistorischen Museum in Ingolstadt.

The lithotriptor makes an attempt to fragment the stone with minimum amount of collateral damage by using a focused and externally applied high-intensity acoustic pulse. The patient, who is sedated or anaesthetised is made to lie down on the apparatus' bed, with a water-filled coupling device supporting the back placed at the level of kidneys. The stone is focussed by a fluoroscopic xray system or a ultrasonography is used on which the further treatment is aimed. The first generation lithotriptor known as the Dornier HM3 (Human Model 3), has a half ellipsoid-shaped piece that opens toward the patient. The acoustic pulse is generated at the ellipsoidal focal point that is furthest from the patient and the stone positioned at the opposite focal point receives the focused shock wave. The treatment usually starts at the equipment's lowest power level, with a long gap between pulses, in order to accustom the patient to the sensation. The length of gap between pulses is also controlled to allow cavitation bubbles to disperse minimizing tissue damage. Second and later generation machines use an acoustic lens to focus the shock wave. This functions much like an optical lens, focusing the shock wave at the desired loci. The frequency of pulses are currently left at a slow rate for more effective comminution of the stone and to minimize morbidity while the power levels are then gradually increased, so as to break up the stone. The final power level usually depends on the patient's pain threshold and the observed success of stone breakage. If the stone is positioned near a bone (usually a rib in the case of kidney stones), this treatment may be more uncomfortable because the shock waves can cause a mild resonance in the bone which can be felt by the patient. The sensation of the treatment is likened to an elastic band twanging off the skin. Alternatively the patient may be sedated during the procedure. This allows the power levels to be brought up more quickly and a much higher pulse frequency, often up to 120 shocks per minute.

The successive shock wave pressure pulses result in direct shearing forces, as well as cavitation bubbles surrounding the stone, which fragment the stones into smaller pieces that then can easily pass through the ureters or the cystic duct. The process takes about an hour. A ureteral stent (a kind of expandable hollow tube) may be used at the discretion of the urologist. The stent allows for easier passage of the stone by relieving obstruction and through passive dilatation of the ureter.

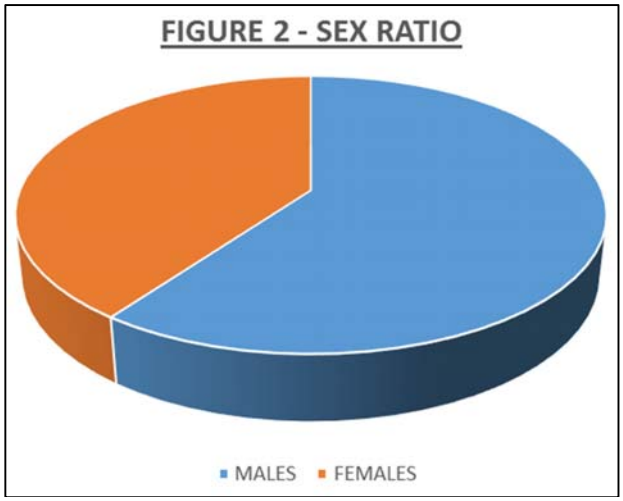
Extracorporeal lithotripsy works best with stones between 4 mm and 20 mm (0.4 cm and 2.0 cm) in diameter that are still located in the kidney. ESWL can be used to break up stones located in ureters as well, but with a lower rate of success.

Fig 1: ESWL Machine (Dornier Compact Alpha)

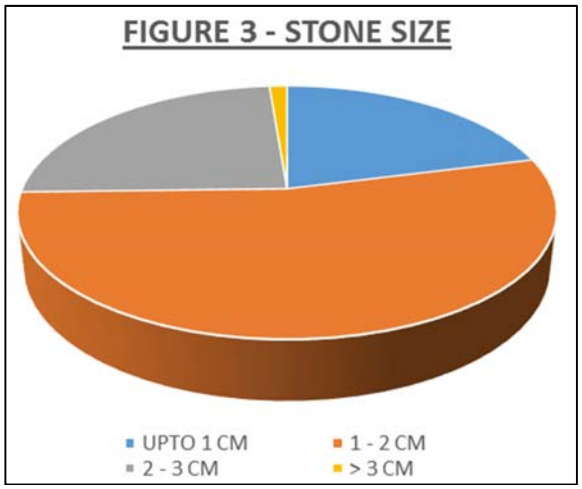
2. Observations

In our series, there were:

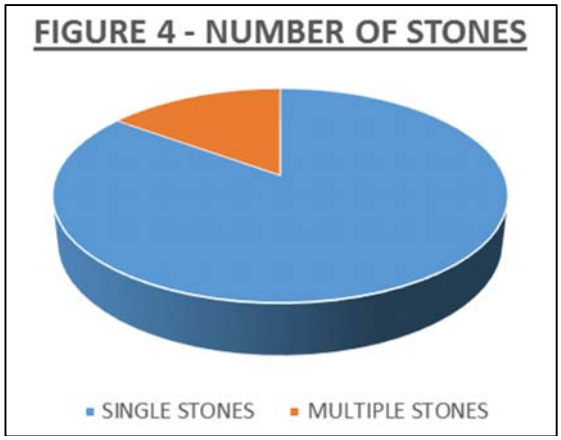
1) Sex Ratio (see Figure 2)
a. 40% Females,
b. 60% Males



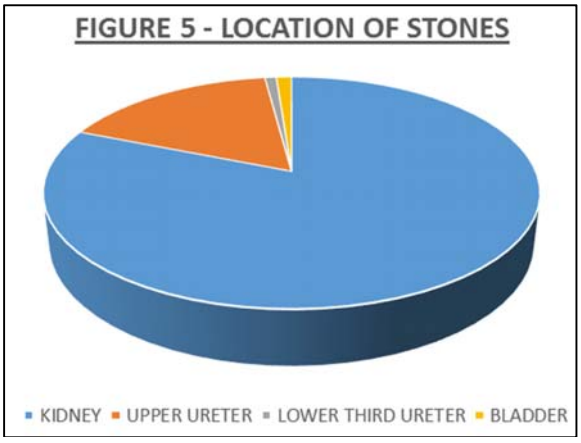
2) Stone size (see Figure 3)
a. upto 1 cm - 20%,
b. 1-2 cm – 51%,
c. 2-3 cm – 23%
d. >3 cm – 6%



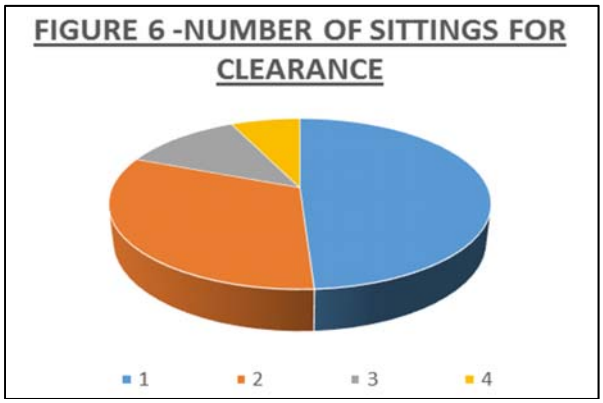
3) Single stones were found in 85% while multiple were found in 15% (see Figure 4)



4) Location of Stones (see Figure 5)
a. 82% - kidney
b. 17% - Upper ureter
c. 0.9% - Lower third ureter
d. 0.1% - Bladder



5) Number of sittings for clearance (see Figure 6)
a. 1 sitting – 49%
b. 2 sittings – 32%
c. 3 sittings – 12%
d. >3 sittings – 7%



We had excellent results with 98% clearance in renal calculi and a 90% clearance in the stones at other locations. In our series, because of good machine, exact focussing and an electromagnetic generator, less sittings and less shockwaves were needed per patient (On an average, 3 cm^2 of a stone needed 2000 shocks). Even bigger stones have been treated like 29% of our patients were having stones > 2 cm. Minimal auxiliary procedures were required as only 8% of our patients required DJ stenting or other procedures. Patients having bladder stone (1 – 2 cm) were retrovirus positive and hence a non-invasive modality was preferred in our series.

3. Complications

5% of our patients had more than 2 episodes of haematuria, rest had only 1 or 2. Only 1 patient of ureteric stone had fever with chills and rigors due to impacted fragments for which ureteroscopy and DJ stenting was done. 90% of our patients experienced mild colic in the post ESWL period, out of which only 10% needed antispasmodic injections.

4. Discussion

Theoretically, all stones can be treated by ESWL. However, due to better understanding of the limitations of ESWL and the improved outcomes of competing endourological procedures, ESWL is best applied in certain selected situations. The ideal situation will be a stone of size less than 2cm presenting in a normal urinary tract. ESWL, especially in an anaesthesia-free outpatient setting, remains the first-line treatment option for renal calculi upto 2.5cm. [3] It offers an acceptable Stone Free Rate, few complications and a low recurrence rate. [4, 5]

ESWL, percutaneous nephrolithotomy (PCNL) and ureteroscopic stone removal (URS) are all effective methods to remove renal or ureteral stones in given clinical situations. PCNL is superior to SWL or ureterorenoscopy in the treatment of large stone burdens and staghorn calculi. [6]

ESWL is efficacious in fragmenting and clearing most renal stones up to 2.5 cm in size. [7] The optimum management of lower pole renal calculi is controversial;[8, 9] the only prospective, randomized trial of SWL and PCNL reported that for lower pole stones of 1 cm or less in size the stone-free rates were 63% and 100%, respectively [9].

For stones larger than 1 cm, the stone-free rates were only 21% for SWL and 91% for PCNL. Although PCNL resulted in a higher stone-free rate and less need for re-treatment compared with SWL, the complication rate was higher and hospital stay was longer. For smaller lower pole stones, URS or SWL provide comparable stone-free rates of 35% and 50%, respectively, and both are acceptable options. [10]

Analysis of health-care costs has been used to estimate surgical trends in the handling of stones. Pearle and colleagues [11] suggest that throughout the 1990s in the USA SWL was used in about 50% of cases, URS in 40% and PCNL in about 4%, with not much change in this distribution over time. In a similar assessment covering approximately the same period, Kerbl and co-authors[12] found a similar rate for PCNL (4–6%), but a somewhat higher prevalence of SWL (70–80%) and a lower rate for URS (14–22%), although this represented a nearly 60% increase in the use of URS over the study period.

Absolute contraindications for ESWL include uncontrolled urosepsis, uncontrolled hypertension, distal obstruction for stone passage and pregnancy. There are also some situations, either related to the stone or to the patient, that are relatively not suitable for ESWL. Stone burden greater than 2 cm size will have higher retreatment rate and auxiliary procedure rate. It may also result in the steinstrasse (Stone Street) due to the production of large amount of small fragments causing ureteric obstruction. Cystine stone is well known for its resistance for ESWL, and therefore, it is not advisable to offer ESWL to someone with known cystinuria. [13]

Patient's factors that are relatively less favourable for ESWL include obesity and abnormal renal anatomy. Due to the limitation of the geometric configuration of machine generator and focusing system, it may be sometimes difficult, if not impossible, to put the stone into the focal zone of the generator. Congenital urinary tract conditions, including horseshoe kidney, ureteropelvic junction obstruction, calyceal diverticulum etc, may affect the drainage of the urinary tract and result in suboptimal outcome. Unfavourable lower caliceal anatomy, such as a narrow or long infundibulum, or an acute infundibulopelvic angle, may lead to poor clearance of stone fragments and therefore alternative treatments may be preferred. [14] Also there are evidences suggesting that elderly patients may have poorer treatment result and also have higher complication rate. [15]

How shock waves are delivered can have a significant effect on outcomes and the occurrence of adverse effects. In brief, well-substantiated evidence indicates that the shock wave dose should be kept as low as possible and that treatment should be performed at a slow shock wave rate.[7, 16, 17]

Damage to the kidney in a single session is dose-dependent for pulse amplitude and shock wave number, and an increased risk of long-term adverse effects is associated with multiple lithotripsies.[18-24] The current standard is treatment at low-to-moderate acoustic pressures with as few shock waves as possible, to minimize acute and lasting tissue injury, and at a slow shock wave rate (60 shock waves per min or slower), to enhance stone breakage and reduce tissue damage.[7]

In addition to being one of the first-line treatments for urolithiasis for the past two decades, shock waves have been used in other branches of medicine. Other stones that can be fragmented by shock waves include bile duct stones [25, 26] and pancreatic and salivary gland stones. [27] Shock wave therapy for gallstones is not effective, however, because of their tendency to multiply and their frequent recurrence secondary to underlying gall bladder dysfunction.[26] Shock waves are also used for treatment of other urological conditions, including Peyronie's disease [28, 29] and chronic pelvic pain syndrome.[30]

5. Conclusion

ESWL is an excellent way to treat stone disease, especially stones in the kidney. A major advantage is that there is no renal damage. There is a negligible chance of any residual stone fragments with an acceptable failure rate. There is no pain during or after the procedure as only 10% of our patients required antispasmodic injections in the post ESWL period. Rest were treated by oral medications. The procedure involved no surgical or anaesthesia complications. Another major advantage was that the patients could return to work early as the treatment is ambulatory or an OPD procedure. The procedure is less expensive as compared to surgery or endoscopic surgery. However, staghorn stones, infected stones and impacted stones are difficult to treat by ESWL. ESWL is also the modality of choice for treatment in recurrent calculi.

Considering all above points, ESWL is the first modality of treatment for renal calculi upto 2.5 cm to 3 cm and upto 1.5 cm ureteric calculi.

6. References

1. Srisubat A, Potisat1 S, Lojanapiwat B, Setthawong V, Laopaiboon M. Extracorporeal shock wave lithotripsy (ESWL) versus percutaneous nephrolithotomy (PCNL) or retrograde intrarenal surgery (RIRS) for kidney stones. The Cochrane Library. 2014; 11:CD007044. doi:10.1002/14651858.CD007044.pub3. PMID 25418417.
2. Rogers J, McCaffrey TV. Inflammatory disorders of the salivary glands. In: Cummings CW, Flint PW, Haughey BH, *et al*, eds. Otolaryngology: Head & Neck Surgery. 5th ed. Philadelphia, Pa: Mosby Elsevier; 2010, 86.
3. Argyropoulos AN, Tolley DA. Optimizing shock wave lithotripsy in the 21st century, Eur Urol. 2007; 52:344-352.
4. Juan YS, Chuang SM, Wu WJ, Shen JT, Wang CJ, Huang CH. Impact of lower pole anatomy on stone clearance after shock wave lithotripsy, Kaohsiung J Med Sci. 2005; 21:358-364.
5. Riedler I, Trummer H, Hebel P, Hubmer G. Outcome and safety of extracorporeal shock wave lithotripsy as first-line therapy of lower pole nephrolithiasis, Urol Int. 2003; 71:350-354.
6. AUA guideline on management of staghorn calculi: diagnosis and treatment recommendations. Preminger GM, Assimos DG, Lingeman JE, Nakada SY, Pearle MS, Wolf JS Jr, AUA Nephrolithiasis Guideline Panel) J Urol. 2005; 173(6):1991-2000.
7. Lingeman JE. In: Stone Disease: Second International Consultation on Stone Disease. 21. Denstedt J, Khoury S, editors. Heath Publications; Paris, 2008, 85-135.
8. Lingeman JE, Matlaga BR, Evan AP. In: Campbell–Walsh Urology. Wein AJ, Kavoussi LR, Novick AC, Partin AW, Peters CA, editors. W. B. Saunders; Philadelphia, 2007, 1431-1507.
9. Albala DM, Assimos DG, Clayman RV, Denstedt JD, Grasso M, Gutierrez-Aceves J *et al*. Lower pole I: a prospective randomized trial of extracorporeal shock wave lithotripsy and percutaneous nephrostolithotomy for lower pole nephrolithiasis-initial results. J Urol. 2001; 166(6):2072-80.
10. Pearle MS, Lingeman JE, Leveillee R, Kuo R, Preminger GM, Nadler RB *et al*. Prospective randomized trial comparing shock wave lithotripsy and ureteroscopy for lower pole caliceal calculi 1 cm or less. J Urol. 2008; 179(5 Suppl):S69-73.
11. Pearle MS, Lingeman JE, Leveillee R, Kuo R, Preminger GM, Nadler RB *et al*. Prospective, randomized trial comparing shock wave lithotripsy and ureteroscopy for lower pole caliceal calculi 1 cm or less. J Urol. 2005; 173(6):2005-9.
12. Kerbl K, Rehman J, Landman J, Lee D, Sundaram C, Clayman RV. Current management of urolithiasis: progress or regress? - J Endourol. 2002; 16(5):281-8.
13. Chiu PKF, Chan ESY, Hou SM, Ng CF. Cystinuria: a rare diagnosis that should not be missed. Hong Kong Medical Journal. 2008; 14(10):399-401.
14. Albala DM, Assimos DG, Clayman RV. JR. Lower pole I: a prospective randomized trial of extracorporeal shock wave lithotripsy and percutaneous nephrostolithotomy for lower pole nephrolithiasis initial results. J Urol. 2001; 166:2072-80. Erratum in: J Urol 2002; 167:1805.
15. Ng CF, Wong A, Tolley D. Is extracorporeal shock wave lithotripsy the preferred treatment option for elderly patients with urinary stone? A multivariate analysis of the effect of patient age on treatment outcome. BJU International. 2007; 100:392-395.
16. McAteer JA, Evan AP, Williams JC Jr, Lingeman JE. Review Treatment protocols to reduce renal injury during shock wave lithotripsy. Curr Opin Urol. 2009; 19(2):192-5.
17. McAteer JA. Renal Stone Disease 2: Proceedings of the 2nd International Urolithiasis Research Symposium. In: Evan AP, Lingeman JE, McAteer JA, Williams JC Jr, editors. AIP Proceedings. 2008; 243-248:1049.
18. The acute and long-term adverse effects of shock wave lithotripsy. McAteer JA, Evan AP Semin Nephrol. 2008; 28(2):200-13.
19. Willis LR, Evan AP, Connors BA, Shao Y, Blomgren PM, Pratt JH, Fineberg NS, *et al*. Shockwave lithotripsy: dose-related effects on renal structure, hemodynamics, and tubular function. J Endourol. 2005; 19(1):90-101.
20. Krambeck AE, Gettman MT, Rohlinger AL, Lohse CM, Patterson DE, Segura JW. Diabetes mellitus and hypertension associated with shock wave lithotripsy of renal and proximal ureteral stones at 19 years of followup. J Urol. 2006; 175(5):1742-7.
21. Parks JH, Worcester EM, Coe FL, Evan AP, Lingeman JE. Clinical implications of abundant calcium phosphate in routinely analyzed kidney stones. Kidney Int. 2004; 66(2):777-85.
22. Connors BA, Evan AP, Blomgren PM, Willis LR, Handa RK, Lifshitz DA, *et al*. Reducing shock number dramatically decreases lesion size in a juvenile kidney model. J Endourol. 2006; 20(9):607-11.
23. Connors BA. The effect of discharge voltage on renal injury and impairment caused by lithotripsy in the pig. J Am Soc Nephrol. 2000; 11:310-318.
24. McAteer JA. In: Renal Stone Disease: Proceedings of the First International Urolithiasis Research Symposium. Evan AP, Lingeman JE, Williams JC Jr, editors. American Institute of Physics; Melville, NY: 2007, 287-301.
25. Delius M, Ueberle F, Gambihler S. Destruction of gallstones and model stones by extracorporeal shock

waves. Ultrasound in Medicine & Biology. 1994; 20(3):251-258.
26. Vergunst H, Terpstra OT, Brakel K, Lameris JS, van Blankenstein M, Schroder FH. Extracorporeal shockwave lithotripsy of gallstones. Possibilities and limitations. Annals of Surgery. 1989; 210(5):565-575.
27. Delius M. Twenty years of shock wave research at the Institute for Surgical Research. European Surgical Research. 2002; 34(1-2):30-36.
28. Hauck EW, Altinkilic BM, Ludwig M, Ludecke G, Schroeder-Printzen I, Arens C *et al*. Extracorporal shock wave therapy in the treatment of Peyronie's disease. First results of a case-controlled approach. European Urology. 2000; 38(6):663-669.
29. Husain J, Lynn NN, Jones DK, Collins GN, O'Reilly PH. Extracorporeal shock wave therapy in the management of Peyronie's disease: initial experience. BJU International. 2000; 86(4):466-468.
30. Zimmermann R, Cumpanas A, Hoeltl L, Janetschek G, Stenzl A, Miclea F. Extracorporeal shock-wave therapy for treating chronic pelvic pain syndrome: a feasibility study and the first clinical results. BJU International. 2008; 102(8):976-80.