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FACTORS INFLUENCING THE OUTCOME OF ESWL IN UPPER URINARY TRACT STONES

Urology

Dr Manu Chaudhary* Assistant Professor, Urology, SAIMS Indore *Corresponding Author

Dr Shree Patel 2nd Year Resident, Urology, SAIMS Indore

ABSTRACT

Background: Although stone disease is one of the most common afflictions of modern society, it has been described since antiquity. With Westernization of global culture, however, the site of stone formation has migrated from the lower to the upper urinary tract. Surgical treatments, although they remove the offending stone, do little to alter the course of the disease. Revolutionary advances in the minimally invasive and non-invasive management of stone disease over the past few decades have greatly facilitated stone removal. **Materials & Methods:** 100 patients with upper urinary tract stones treated with ESWL in this prospective study were studied on the basis of various characteristics. Stone location, stone size, calyceal anatomy and Hounsefield unit of the stone, presence of obstruction and hydronephrosis was noted for application of ESWL. **Conclusion:** ESWL is a useful, non invasive modality of treating certain types of upper urinary tract calculi with overall success rate of ESWL in this study amounting to 62 % in treating upper urinary tract calculi. The prognostication of the success of ESWL is possible by identifying certain factors which enable us to easily select the patient group for whom this treatment can be given.

KEYWORDS

Shockwave Lithotripsy, Urolithiasis, Electromagnetic, Stone burden, Stone Free Rate

INTRODUCTION

The prevalence of stone disease is very high (1-15%) in most parts of India because of its geography, dietary habits, temperature and humidity superimposed on their intrinsic factors predisposing to stone formation varying by age, sex and race. For men, incidence begins to rise after age 20, peaks between 40-60 years and then begin to decline. For women incidence rates seem to be higher in late 20s and then decreasing to 1/1000/year at the age of 50. The incidence and prevalence of stone disease is increasing in recent years, may be due to increased detection of asymptomatic stones discovered with the greater use and higher sensitivity of imaging studies.

Calcium is the most common component of urinary stones comprising about 75% of all stones. Calcium oxalate (60%), mixed calcium oxalate and hydroxyapatite (20%) and Brushite stones (2%). Uric acid and Struvite stones occur in 10%. Cystine stones are rare comprising 1%.

Stone disease can be easily diagnosed using imaging studies like X-ray KUB, USG KUB, IVU and CT KUB. Plain radiography detects radio opaque calculi with limitations being bowel gas, bone shadow overlapping the stones, and radiolucent stones. USG KUB can detect calculi in the renal area and associated obstruction and dilatation of pelvi calyceal system. Limitations are obesity, bowel gas and poor sensitivity for ureteric calculi. IVU provides both anatomical and functional details. IVU helps in assessing the Infundibulo-pelvic angle and Infundibular width in lower pole stones. Disadvantage being the risk of contrast allergy and contrast induced nephropathy. NCCT KUB is a simple method to detect renal and ureteric calculi, it helps to assess stone burden, stone density and dilatation of pelvicalyceal system, particularly during an episode of acute colic.

Stone disease of the urinary tract is common, and many forms of treatment has been in vogue. Until early eighties open surgery and other endoscopic techniques were the treatment modalities available for urolithiasis [1]. ESWL was introduced by Christian Chaussay in 1980. Since the mid 1980's ESWL has been established as a minimally invasive procedure for a wide indications of urinary stones. This revolutionized the management of the stone disease throughout the world. ESWL is a safe, effective method to treat urolithiasis. ESWL is usually an outpatient procedure. The success rate in ESWL depends on stone location, size, number, and fragility as well as calyceal anatomy and patency of the urinary tract . ESWL as a modality was recommended for stones less than 2 cm in size. This limit was set in view of high treatment failures and steinstrasse for bigger calculi [2]. Comparing with surgical techniques ESWL only fragments the stone and does not completely remove them from the urinary tract. These fragments should then be passed out spontaneously [3]. The duration for this spontaneous passage varies and the fragments may cause obstruction to the ureter, leading to complications such as hydronephrosis, renal colic and renal failure . The use of Double -J stents has contributed to successful stone passage and reduced post ESWL morbidity . Hence the double–J–ureteric stent may be used in those patients having stones larger than 2.5cm [4]

Factors Affecting Management

- Stone related factors - Stone size, number, volume of stone, composition of the stone and location of the stone within the kidney influence the indications for treatment.

Stone Burden Influencing Treatment

Stone burden has an inverse relationship with stone free rate. Stone burden is not based only on the basis of the largest stone size, but also the total number of stones present. Patients with stones ranging 10-20 mm are treated oftenly with ESWL as the first-line management. Poor outcomes following ESWL as monotherapy are seen in patients with renal stones >2 cm. This was recognized nearly 20 years back in an NIH Consensus Conference 1988.

Stone Composition Determining Treatment Modality

When adjusted for size, cystine and brushite calculi were the most resistant to SWL followed by calcium oxalate monohydrate as reported by Saw and Lingeman17 in 1999. Other stones in descending order of resistance to fragmentation are struvite > calcium oxalate dehydrate > uric acid stones.

Renal Anatomic Factors

Congenital anomalies are relatively common in the upper urinary tract and the majority of defects affecting the drainage of the collecting system are associated with an increased incidence of stone disease. Examples of congenital abnormalities include PUJO, horseshoe kidney, calyceal diverticula and other ectopic or fusion anomalies. Hydronephrosis due to distal obstruction leads to a failure to clear stone fragments after SWL.

Calculi In Lower Pole Of Kidney

Lower pole having multiple infundibula will have poor drainage resulting in a lesser chance of clearance of residual stone fragments than that of an inferior pole drained by a single infundibulum receiving fused calyces. Also small diameter of the lower pole infundibulum might hinder passage of stone fragments including the angle formed between the lower infundibulum and the renal pelvis and hypothesized that an obtuse angle will facilitate better drainage of fragments from the lower pole.

- **Clinical Factors -** All coexisting clinical factors which may affect the safety and the efficacy of the selected treatment must be considered.

Urinary Tract Infection

Urinary tract infection associated with renal calculi, will be difficult to eradicate until the offending stones are completely removed. The risk of sepsis increases if the urine culture demonstrates bacterial growth

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before SWL. Furthermore, presence of obstruction increases the risk of sepsis. Therefore, SWL should be advised and performed only if there is no distal obstruction and urine is sterile.

Morbid Obesity
SWL is very difficult for morbid obesity patients because of weight limitations on the lithotripter table or gantry, failure to target the stone radiographically, or the skin to stone distance will be more. BMI is a inverse relation and important factor for stone clearance after ESWL. It was reported that for SSD below or more than 9 cm, the success rate were 79% versus 57% respectively.

Spinal Deformity Or Limb Contractures
Using lithotripter it becomes very cumbersome to position patients with spinal problems and having contractures of limbs.

Uncorrected Coagulopathy
After correcting bleeding diathesis in uncorrected coagulopathy patients, SWL as a treatment can be followed.

Other Groups
The adverse effects of shockwaves will be increased when SWL is used for elderly, children, hypertensive and renal failure patients. To overcome this problem we have to reduce the energy and number of shockwaves.

MATERIALS & METHODS

Study Design
Prospective study of 100 patients with upper tract stones treated with ESWL at Sri Aurobindo Institute of Medical Sciences from September 2023 to February 2025

Inclusion Criteria
Upper urinary tract stones ≤ 2cm

Exclusion Criteria
Upper urinary tract stones > 2cm
Pregnant women
Bleeding diathesis
Distal obstruction

In all patients history and physical examination were done. Baseline investigations were done. Stone location, stone size, calyceal anatomy and HU of the stone, presence of obstruction and hydronephrosis was noted. Patients were followed up after 2 weeks and at 4 weeks, Xray KUB and USG KUB were done to look for residual fragment. Absence of calculi or calculi <4mm will be considered as clearance.

RESULTS

Table 1 : Age group Outcome Table

Age group (years)	Outcome		Total
	0	1	
<30	14	6	20
30-40	16	15	31
40-50	18	10	28
>50	14	7	21
Total	62	38	100

Table 2 : Sex Outcome Table

Sex	Outcome		Total
	0	1	
Male	27	21	48
Female	35	17	52
Total	62	38	100

Table 3 : BMI Outcome Table

BMI	Outcome		Total
	0	1	
<25	44	17	61
25-30	18	16	34
>30	0	5	5
Total	62	38	100

Table 4 : Stone size Outcome Table

Stone size (cm)	Outcome		Total
	0	1	
<1.5	27	11	38
>1.5	35	27	62
Total	62	38	100

Table 5 : HU Outcome Table

HU	Outcome		Total
	0	1	
<750	38	9	47
>750	24	29	53
Total	62	38	100

Table 6 : Location Outcome Table

Stone Location	Outcome		Total
	0	1	
Lower calyx	7	22	29
Mid calyx	18	6	24
Pelvis	17	6	23
Upper Calyx	16	4	20
Upper Ureter	4	0	4
Total	62	38	100

Here, Outcome = 0 signifies stone free state and favourable outcome
Whereas Outcome = 1 signifies residual stone state and unfavourable outcome

DISCUSSION

The ultimate goal of any modality of treatment of upper urinary tract stones is to achieve a 100% stone clearance without causing any morbidity to the patient. The current treatment modalities include PCNL, ESWL, RIRS and in rare cases laparoscopic or open stone surgery.

ESWL being a non-invasive technique has added an important dimension to the treatment of stone disease wherein the vast majority of small calculi within the renal system (80 - 85%) can be managed satisfactorily. ESWL is the preferred modality of treatment for renal stones less than 2cm. However stone free rate (SFR) after treatment has never been near 100% and has been in the range of 65-75%. But its non invasive nature along with high efficacy has resulted in outstanding patient and surgeon acceptance. Factors affecting stone clearance can be classified into to stone factors (size, composition, number, location), renal factors pertaining to anatomy and factors related to the patient.

BMI >30 is a significant factor affecting the success of treatment of upper tract stones. The utility of BMI in predicting successful ESWL is variable. Pareek et al [5] studied the effect of BMI on stone clearance rates. An increased BMI was associated with poor outcomes, which was comparable to this study. Thomas & Cass also reported an overall stone free rate of 68% in obese patients compared to 80 - 85% in non-obese patients. In the contrary, Hammad Ather et al [6] did not find BMI to be a predictor for ESWL outcome.

Size of the stone was one of the most important factors determining success of ESWL. Stone size was a significant predictor of a favourable outcome in this study with 71% success reported for stones <1.5cms and 56% for stones >1.5cms. Khalil et al [7] in their analysis of stone free rates after ESWL based on stone location and stone size reported stone free rates for stones less than 1 cm, 1-2 cm, and >2 cm at 50.2, 39.6, and 10.2% respectively. Abdel-Khalek et al reported stone free rate as 89.7% for stones <15 mm and 78% for stones >15 mm. All the above studies concluded that size of the stone was one of the most important predictive factor for successful outcome of ESWL.

Stone density has an inverse relation with the ESWL success rate, and CT stone density has a positive correlation with the number of shockwaves needed for fragmentation as concluded from various studies. Gupta et al [8] showed that the worst outcome of ESWL was in patients with calculus densities >750HU and diameters >1.1cm, and their clearance rate was only 60% while it was 90% for densities <750HU.

The rate of disintegration for stones in the lower calyx treated by ESWL is comparable with stones in other locations within the urinary tract. But the spatial anatomy of the lower calyx in unfavourable for the complete clearance of the fragments. Obek et al [9] in their study about patients with isolated lower pole calculi treated with ESWL reported a stone-free rate of 63%. Psihramis and colleagues reported a higher success rate for lower-calyceal (53%) than for middle- (43%) and upper- (45%) calyceal stones. Öbek and associates in their study reported stone-free rate of (71%) for upper, (73%) for middle and (63%) for lower calyceal stones. Graff and colleagues had similar results, with stone-free rates of 78%, 76%, and 58% for upper pole, middle and lower pole calculi.

The stone-free rates for renal pelvic stones varied from 80% for stones measuring less than 10 mm to 56% for larger stones. Pace et al reported a significantly better response to shock wave application in proximal and midureteric stones than to those in the distal ureter. Park et al [10] managed 301 patients with upper ureteral stones with ESWL. The success rate achieved was 84.3% for stones < 10 mm after a single session. The results for stones measuring > 20 mm were not comparable. The average stone size in the group treated successfully was 12 mm in comparison to 17 mm in the group that required ancillary treatment. ESWL was successful for upper ureteral stones < 10 mm in various series. The 1997 AUA Ureteral Stone Clinical Guidelines recommend ESWL as the first line of management for stones <1cm in the proximal ureter, while the ideal treatment for stones > 1 cm still is debatable with both ESWL and ureteroscopy being acceptable options. All these authors were of common opinion that location of the stone was one of the most important predictive factor for successful outcome of ESWL. In this study lower pole calyceal stone clearance was significantly less than that of stones in other locations and is comparable to the above studies.

CONCLUSION

ESWL is a useful, non invasive modality of treating certain types of upper urinary tract calculi. With overall success rate of ESWL in this study was 62 % in treating upper urinary tract calculi. The prognostication of the success of ESWL is possible by identifying certain factors which enable us to easily select the patient group for whom this treatment can be given. Age and sex of the patient have no role in predicting the successful outcome of ESWL. BMI of the patient had a significant inverse correlation with successful outcome of ESWL. Calculi with lower density (HU<750) and smaller size (<1.5cm) have a better success rates with ESWL. Calculi of the upper ureter, upper, middle calyces and renal pelvis had a good response rate to ESWL when compared to lower pole calculi.

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