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Factors Influencing the Outcome of ESWL in Upper Urinary Tract Stones.

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I. Aims And Objectives

To study the success rate of ESWL in treatment of upper urinary tract stones measuring less than 2cm**.**
To study the various factors influencing the outcome of ESWL in upper urinary tract stones

II. Materials And Methods

STUDY DESIGN
This is a Prospective study of 100 Patients with upper tract stones treated with ESWL at Government Rajaji Hospital, Madurai Medical College from September 2016 to February 2018

INCLUSION CRITERIA
- Upper urinary tract stones ≤ 2cms

EXCLUSION CRITERIA
- Upper urinary tract stones > 2cms
- Pregnant women
- Bleeding diathesis
- Distal obstruction

In all patients history and physical examination were done. Baseline investigations included Complete Haemogram, RFT, urine C/S, X-ray KUB, USG KUB, IVU and CT KUB. Stone location, stone size, calyceal anatomy and Hounsefield unit of the stone , presence of obstruction and hydronephrosis will be notedBleeding profile (Platelet count, Bleeding time, Clotting time and Prothrombin time), Body mass index (BMI) will also be recorded for each patient .

Patients were explained about the study, ESWL procedure and informed consent were obtained. ESWL was done as outpatient procedure at Government Rajaji Hospital, Madurai Medical College, Madurai. ESWL was done using Dornier Compact Delta II (Electromagnetic Generator) Machine. Patients were administered sedation IV Fortwin (20mg), 30 minutes before procedure.

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.

KEYWORDS: ESWL, URETERIC STONES, URINARY TRACT STONES

III. Summary Of Results

Chart 1: Age Group*Outcome

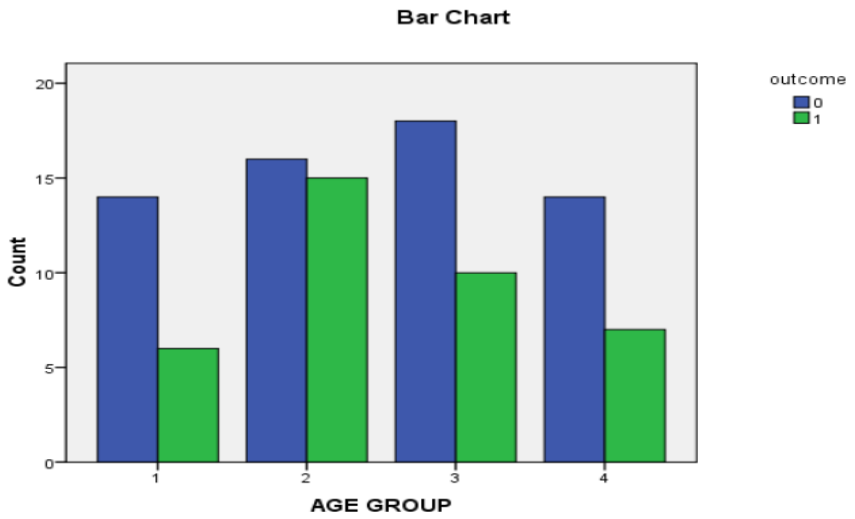


Chart 2: Sex Distribution

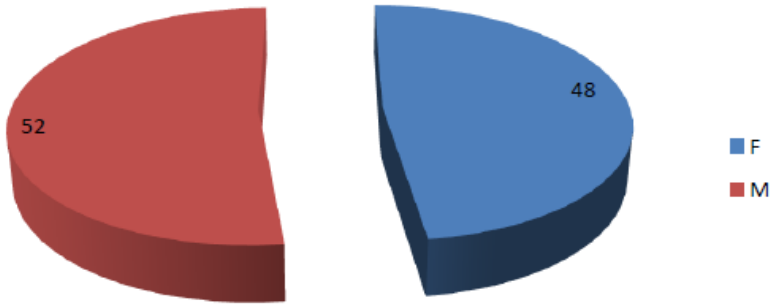


Chart 3: BMI*Outcome

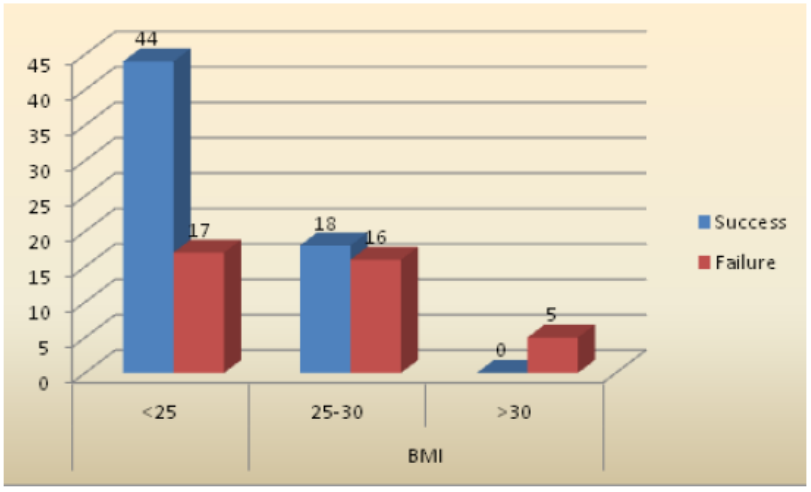


Chart 4: Stone Size*outcome

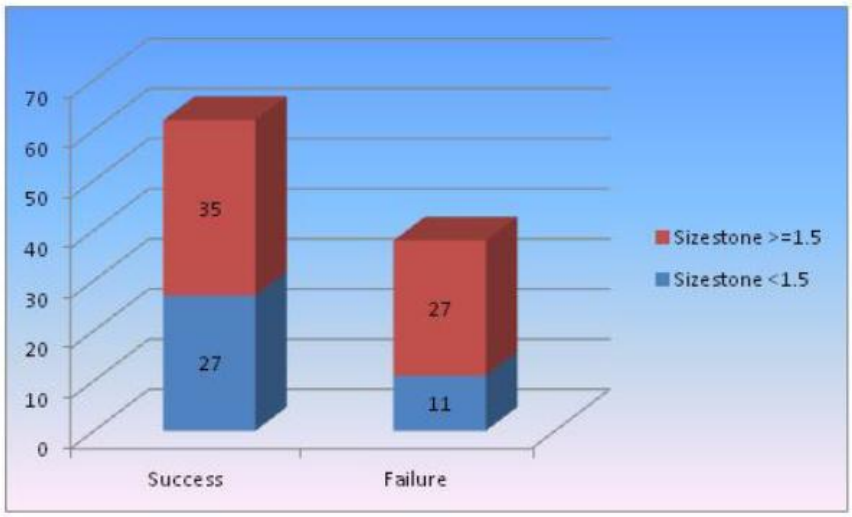


Chart 5: HU*Outcome

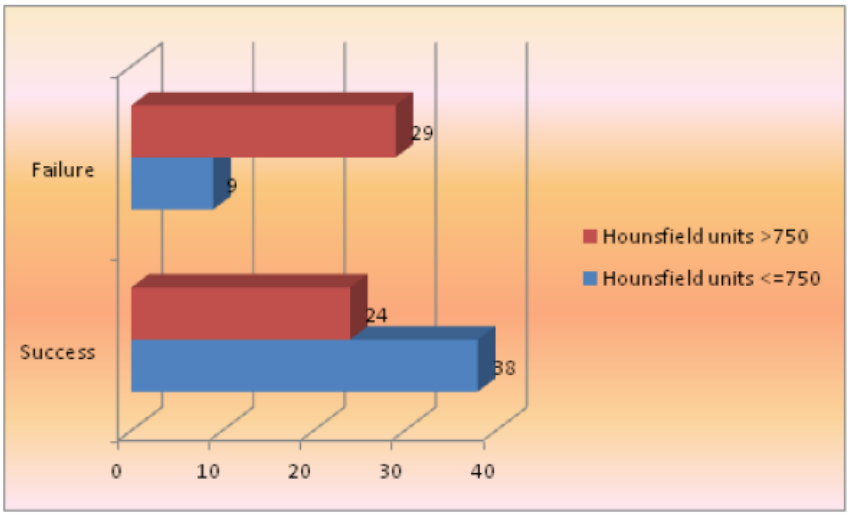
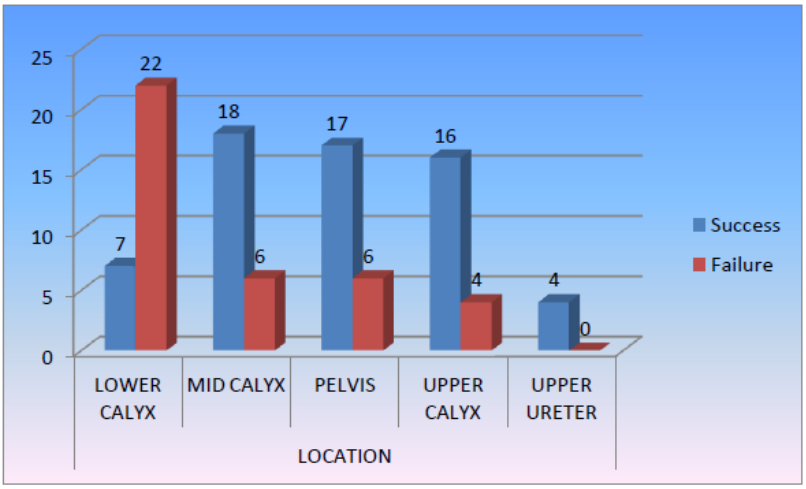


Chart 6: Location*Outcome



- 100 patients were included in this analytical study
- Statistical analysis was done using SPSS software version 20 and MEDCALC.
- Univariate analysis for various risk factors influencing the outcome of ESWL was done.
- Logistic regression model using multiple variable was done to calculate ROC curve.
- This study included 100 patients, falling in the age group of 19 to 74 years with a mean age of 40.74 years.
- Age as an independent factor did not significantly correlate to the outcome of ESWL (p value 0.528).
- The next factor considered was the sex of the patient in relation to the outcome of ESWL. In this study there were 52 male patients and 48 female patients.
- Sex of the patient as a univariate factor also did not correlate significantly to the success of ESWL (p value 0.255).
- BMI of the study group was classified into three groups { < 25(61 patients), 25-30(34 patients) and > 30(5 patients)}. The rate of successful ESWL in
- these groups were 72%, 52.9% and 0% respectively. The P value according to the Chi square test was 0.002 which showed a significant correlation of BMI with regard to the outcome of ESWL.
- The fourth factor studied was the size of the stone in predicting the outcome of ESWL. The patients were divided into two groups based on the stone size (< 1.5cm and ≥ 1.5).
- 38 patients had stone size < 1.5 cm. This particular group showed a successful outcome of 71%. 62 patients had stone size ≥ 1.5 cm with a success rate of 56% which correlated significantly to the outcome of ESWL (p value using T-test 0.020).
- The fifth factor analysed was the density of the stone as assessed by the Hounsefield Units.
- Patients were classified under two categories based on HU value of less or greater than 750 HU. 47 patients had stones with HU less than 750. 80.9% of these patients had a successful outcome of ESWL. The remaining 53 patients had HU more than 750.They had a significantly reduced success rate of 45.3% (p value using T-test- 0.000).
- The next factor considered in the study was the location of the stone in relation to the outcome of ESWL.
- Patients were divided into five groups based on whether the stone was
- situated in the upper, middle, lower calyx, renal pelvis or upper ureter.
- 29 patients had lower calyceal stone and 24.1% had a successful outcome in this group following ESWL.
- 23 patients had a stone in renal pelvis and 73.9% had a successful outcome.
- 24 patients had stone in middle calyx with a 75% successful outcome.
- 20 patients had a stone in the upper calyx and 80% of these patients had a successful outcome.
- 4 patients had a stone in the upper ureter and all had a successful outcome.
- This proved conclusively that the location of the stone as an independent factor can significantly predict the positive negative outcome of ESWL, the upper ureteric stones having the best prognosis and the lower calyceal stones having the least successful outcome (P value using chi-square tests – 0.000).
- Model for multivariate analysis was done using logistic regression analysis to create an ROC curve.
- The factors included in this model were BMI, location and Stone density to predict the outcome following ESWL in upper urinary tract stones < 2 cms. Location of the stone was the most significant factor in this model (p value <0.0001). The model derived has a sensitivity and specificity of 86.8% and 83.9% respectively in predicting the success rate following ESWL.

IV. 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 percutaneous nephrolithotomy (PCNL), extracorporeal shock wave lithotripsy (ESWL), retrograde intrarenal surgery (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 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** 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 al34 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 more than 2 cm at 50.2, 39.6, and 10.2% ($P < .05$) respectively.

Abdel-Khalek et al35 reported stone free rate as 89.7%for stones <15 mm and 78% for stones >15 mm ($p<0.0001$).

Lalaket al32 in their series reported an overall stone-free rate of 76%, 66% and 47% for stones of size less than 10 mm, 10 to 20 mm and more than 20 mm respectively. **Newman D et al33** in their study found than success rate was 80% with 0-10 mm stones whereas it declined to 60% with size of the stone greater than 30 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 al37 showed that the worst outcome of ESWL was in patients with calculus densities of more than 750 Hounsfield units and diameters of more than 1.1 cms, and their clearance rate was only 60% while it was 90% for densities below 750 .

Ouzaid et al 40 in a prospective study concluded that patients who became stone free or had clinically insignificant stone fragments had a lower density compared with stones in patients with residual fragments [mean (SD) 715 (260) vs. 1196 (171) HU, $P < 0.001$].

Perks et al39 in his study on the role of ESWL for a solitary renal stone of 5–20 mm found the stone attenuation of the successfully treated patients (stone free and complete fragmentation groups) was 837 +/- 277 versus 1092 +/-254 HU for those with treatment failure (incomplete fragmentation; $P < 0.01$).
Pareek et al38 in another prospective study found the difference in the mean HU values for the stone-free patients was 577.8 +/- 182.5 and residual stones groups were statistically significant (910.4 +/-190.2).

Joseph et al36 reported a 95% success rate for calculi $<$1,000 HU vs. 55% for stones $>$1,000 HU ($p<0.01$).

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 al44 in their study about patients with isolated lower pole calculi treated with ESWL reported a stone-free rate of 63%.

Chen and Streem45 reported a stone-free rate at 1 month following ESWL was 48% and a longer-term stone-free rate after ESWL was 54.3% with isolated lower pole calculi .

In a study by **Lingeman et al46** the limitations of ESWL for lower pole stones are highlighted. Patients who underwent ESWL were reviewed and the result was a poor overall stone clearance rate of 60% against 90% for PCNL. Furthermore, higher re-treatment rate was observed when comparing the lower calyx with other intrarenal locations. Successful outcomes for stones measuring less than 10 mm, 10-20 mm and more than 20 mm were 74%, 56%, and 33%, respectively.

Netto and coworkers47 in their study had an overall success rate of 79% for lower calyceal stones. The success rates were 78% for stones <10 mm, 85% for stones measuring 11-20 mm and 50% for stones measuring >20 mm.

Talic and El Faqih43 had a 56% stone free rate for all lower calyceal calculi 3 months following ESWL.

However , **Psihramis and colleagues48** reported a higher success rate for lower-caliceal (53%) than for middle- (43%) and upper- (45%) caliceal stones.
Öbek and associates44 in their study reported stone-free rate of 71% for upper, 73% for middle and 63% for lower caliceal stones.

Graff and colleagues49 had similar results, with stone-free rates of 78%, 76%, and 58% for upper pole, Middle and lower pole calculi stones residing in upper pole calyces, as well as the renal pelvis and ureteropelvic junction, are associated with the best stone-free rates when treated by SWL.
An analysis was done considering 9 different published series on the management of 8000 stones with ESWL. 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 al51 reported a significantly better response to shock wave application in Proximal and midureteric stones than to those in the distal ureter.

Park et al52 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 Guidelines53 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.

The results of treatment for proximal ureteral calculi either in situ or after stent placement range from 57 to 96% with a high re-treatment rate of 5 to 60%
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.

V. Conclusion

- ESWL is a useful, non invasive modality of treating certain types of upper urinary tract calculi.
- The 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 lesser density(HU<750) and smaller size(<1.5cm) have a better success rates with ESWL.
- Calculi of the upper ureter,upper,milddle calyces and renal pelvis had a good response rate to ESWL when compared to lower pole calculi.

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