A New Assessment Tool to Predict Stone Free Rates in Ureteroscopic Laser Lithotripsy

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ABSTRACT:

BACKGROUND:

Holmium: YAG laser lithotripsy shows a high successful rate in fragmentation of ureteric stones , The S.T.O.N.E. Score is a novel assessment tool to predict stone free rate (SFR)in patients undergoing Ureteroscopic Lithotripsy(URS).

OBJECTIVE:

To develop a user friendly system (S.T.O.N.E. Score) to quantify and describe stone characteristics provided by computed axial tomography scan to predict ureteroscopic lithotripsy outcomes and to evaluate the characteristics that are thought to affect stone free rate.

PATIENTS AND METHODS:

The S.T.O.N.E. score consists of 5 stone characteristics: (S)ize ,(T)opography (location of stone), (O)bstruction, (N)umber of stones present, and (E)valuation of Hounsfield Units. Each component is scored on a 1-3 point scale. The S.T.O.N.E. Score was applied to 50 ureteroscopic procedures performed , patients with anatomical abnormalities such as duplicated ureters, horseshoe kidney, ureteral strictures and renal failure were excluded from the study, postoperatively patient were evaluated by KUB,U/S and CT scan to assess stone free status.

RESULTS:

The mean patient age was(37.3±_12.5)year. 58% were male patients and 42% were female patients. mean stone size was13±3.9. Stones locations: 20(40%)stones were located in the lower ureter,13(26%) in the mid ureter ,17(34%) in the upper ureter. Mean operative time was 26.9±18.3 minutes. The overall SFR was 84%. Results of stone size on percent of stone destruction was very significant (p-value=0.001). Also the results of stone location on percent of stone destruction was very significant (p-value =0.002). whereas hydronephrosis, stone number, stone HU unite were not significant(p-value 0.8, 0.54, 0.61. respectively). Results of stone score with SFR was significant (p-value 0.003).

CONCLUSION:

The S.T.O.N.E. Score is a new assessment tool to predict SFR in patients who require URS for the surgical therapy of ureteral disease. The features of S.T.O.N.E. are relevant in predicting SFR with URS. Stone size, location were statistically significant factors in multivariate analysis. The S.T.O.N.E. Score establishes the framework for future analysis of the treatment of urolithiasis .

KEY WORDS: stone score, stone ,ureteroscopy,laser ureteroscopic lithotripsy.

INTRODUCTION:

The development of statistics Provides physicians with new insight into patient planning and counseling. Furthermore, models typically standardize terminology and improve communication in reports. In stone disease, features affecting the success of ESWL such as skin-to-stone distance, optimal location, density (Hounsfield Units), and size have all been adequately reported .[1-3]On the other hand, there is presently a paucity of nomograms or score systems to predict stone free rates for URS .[4,5]

The S.T.O.N.E. Score is a user friendly model to predict Stone free rate (SFR) post URS with laser lithotripsy. It further establishes a standardized terminology for reporting urolithiasis characteristics. We attempt to identify the five most important preoperative radiological features that could be related to surgical outcomes in URS: (S)ize, (T)opography/location, (O)bstruction, (N)umber of stones, and (E)valuation of Hounsfield Units.[6,7].

PATIENT AND METHODS:

A prospective study was carried out in the Urology department of Medical City, surgical specialties

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hospital from March 2014 to September 2015. Fifty patients with ureteral stones selected after informed consent. Inclusion criteria consisted of patients with ureteral stones with preoperative non- contrast computed axial tomography(CT-KUB). Patients with anatomical abnormalities such as duplicated ureters, horseshoe kidney, ureteral strictures and patients with renal failure were excluded from the study . All patients underwent thorough process of history, physical examination, and laboratory investigations (which include blood urea, serum creatinine , hemoglobin , urinalysis and urine culture). Radiological evaluation with plain film of the kidney, ureter and bladder(KUB) , ultrasonography, Intravenous urography (IVU) and unenhanced Computarized Tomography(CT) scan were preoperatively performed to confirm the diagnosis and determine the size and location of the stone . Negative urine cultures were mandatory in every patient of both groups. All patients received a single shot of pre-operative antibiotic(1 g third generation cephalosporin) and continued for 24-48 hours postoperatively. General or spinal anesthesia was employed in all patients. The patient was placed in dorsal lithotomy position with the ipsilateral leg somewhat straighter and lower than the contralateral leg. For ureteroscopic laser lithotripsy . A Hol: YAG laser which operates at a wavelength of 2140 nm was used. All the patients were treated with a 600 µ m quartz end fiber. Frequency was usually set between 6 and 10 Hz (usually 8 HZ) at a power of 1.2 joule.

Stone score is proposed system to predict the stone free status of patient from pre operative characteristic available on CT-KUB:(S)size of stone,(T)topograghy or location,(O) degree of obstruction of urinary system,(N) number of stones ,and(E) evaluation of Hounsfield units. Higher scores indicate higher complexity and assumingly lower stone free rates. Each feature from CT was graded on a 1-3 point scale .(Table 1):

Table 1: S.T.O.N.E. Score [7].

Feature	1 Point.	2 Points.	3 Points.
(S)ize	< 10mm	10-15mm	> 15mm
(T)opography	Distal Ureter	Mid ureter	Proximal Ureter
(O)bstruction	Preoperative Stent or No Hydronephrosis	Grade 1-2	Grade 3-4
(N)umber of stones	1 stone	2 stones	≥ 3stones
(E)valuation of HU	< 750HU	750-1000HU	> 1000HU

RESULTS:

A total of 50 URS procedures from March 2014 to September 2015 were assessed by the S.T.O.N.E. Score. The mean patient age was (37.3± 12.5) year, percent of male patients was (58%) and percent of female patients was (42%) with male to female ratio was 1.3:1, mean stone size was 13±3.9mm with a range of 7mm to 21mm . Most common age group was 26-35 year age old.

As far as location is concerned, we divided the ureter into proximal, mid and distal portions as per standard anatomical landmarks ; 20(40%) of stones were located in lower ureter,13(26%)of stones were located in mid ureter and 17(34%) of stones were located in upper ureter .

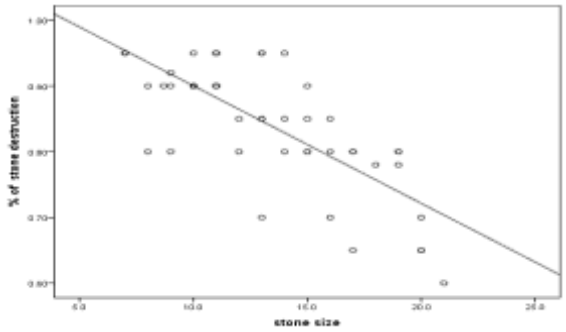
Fifteen patients had stone size <10mm, 21 patients had stone size 10-15mm and 14 patients had stone size >15mm.(Table).

Twenty patients had stone HU<750,15 patients had stone HU 750-1000 and15 patients had stone HU >1000 .

The mean operative time (time of destruction only)was(26.9±18.3) minutes . The overall SFR was 84% . The Result of stone size on percent of stone destruction was very significant (p-value=0.001) and Pearson correlation=0.750, this mean when stone size increase , the percent of stone destruction decrease, figure(1). Also the result of stones location on percent of stone destruction was very significant (p-value =0.002), this means more proximal stones were more difficult to destruct , figure(2) . Whereas hydronephrosis, stone number and stone HU unite were not statistically significant (p-value 0.8,0.54,0.61 respectively).

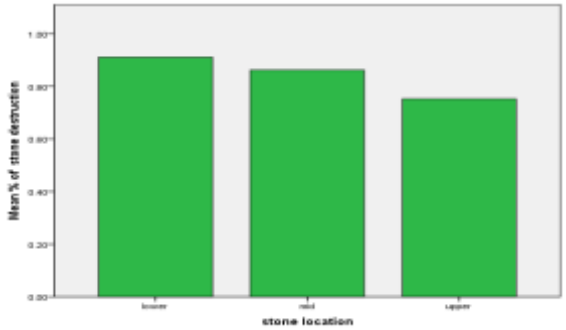
The Result of stone score with SFR was statistically significant (p-value 0.003) and Pearson Correlation= 0.661,this means when stone score increase the SFR decrease, figure(3).

Also we did correlation of HU unite with time of destruction, the result was statistically significant (p-value =0.004),this mean when HU unite increase the time of destruction increase, but no effect on SFR.
Total number of patients who needed post operative DJ insertion was 32(64%). The total percentage of complication (perforation 2%, irritative voiding symptom 10%, upwared stone migration 6% (All in the upper ureteric stones) and hematuria10% , fever and urospsis 4%).



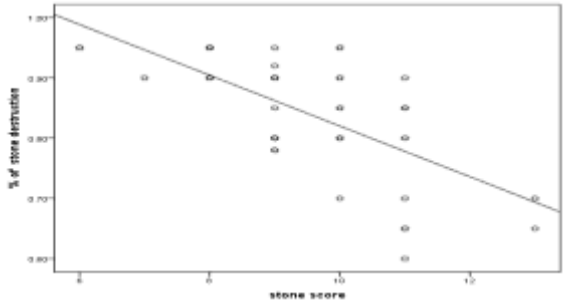
Pearson Correlation= -0.750, p-value= 0.001

Figure1 : Correlation of stone size with Percentage of stone destruction.



p-value =0.002

Figure 2: Relationship of stone location with % of stone destruction.



Pearson Correlation= -0.661, p-value= 0.003
Figure 3:Correlation of stone score with % of stone destruction.

DISCUSSION:

The development of statistics Provides the physicians with new insight into patient planning and counseling. Furthermore, models typically standardize terminology and improve communication in reports. In stone disease, features affecting the success of ESWL such as skin-to-stone distance, optimal location, density (Hounsfield Units), and size have all been adequately reported [4-6]On the other hand, there is presently a paucity of nomograms or score systems to predict stone free rates for URS.

The S.T.O.N.E. Score is a user friendly model to predict SFR post URS with laser lithotripsy. It further establishes a standardized terminology for reporting urolithiasis characteristics, we attempt to identify the five most important preoperative radiological features that could be related to surgical outcomes in URS: (S)ize, (T)opography/location, (O)bstruction, (N)umber of stones, and (E)valuation of Hounsfield Units[7,8,9].

Stone size is an important factor in the success of URS, in our study we found stone size inversely related to SFR and this relationship was clinically and statistically significant (P-value =0.001). In 2010 Turnuc T et al, also found that stone size inversely related (negative correlation) with SFR (P-value=0.007).[10] This correlation also confirmed by Michael Ordon et al, 2015; and Glenn M et al, 2016;([11,12]).So stone size regarded as independent inversely related factor with SFR and one of important component of stone score.

Stone location is another important factor use to assess success of stone fragmentation by URS. In this study we found that final stone clearance rate after ureteroscopic stone treatment was higher in lower ureteric stone than in middle and upper ureteric stones (P-value=0.002). In 2007 Christian Seitz et al, a study of 543 patients with ureteral stones treated by Ho:YAG ureterolihiotripsy confirmed this correlation of stone location and SFR(P-value <0.0001) [9]. This correlation also revealed by Michael Ordon et al,2015; and Glenn M et al, 2016;[11,12] Therefore stone location is considered one of most distinct entities of stone score and has statistically significant correlation with SFR.

The presence of hydronephrosis may be an indirect indicator of stone impaction. Although impacted stones are difficult to be evaluated on CT preoperatively[13]. . In 2007 Christian Seitz et al, found stone impaction correlated significantly with SFR(P-value<0.0001), and that presence and degree of hydronephrosis did not correlate with treatment success(P-value =0.4 ,P-value=0.8) for distal and proximal ureter , respectively.[9] This means that hyderonephrosis may indicate stone impaction but not always. In this study we did not find statistical significant correlation of hyderonephrosis with stone free rate(P-value=0.8). This is my be due to small sample size.

The number of stones had been shown to be significant in other studies, Toshifumi Kurahashi et al,2007; Study 2129 patients and the results was a significant correlation of stone number with SFR[14] . In 2013 Jai Prakash et al, and According to the univariate analysis, the stone number was significantly correlated with SFR(P-value=0.01), but according to the multivariate analysis, stone number had no significant influence on the SF status[15]. In our study we did not find significant correlation of stone number with SFR(p=0.54).

Stone hardness and Hounsfield Units (HU) evaluated by CT scan had often been overlooked in URS. Hounsfield Units has commonly been reported to be a significant factor in shock-wave lithotripsy, Chung et al, 2010; found statistical difference between successful and unsuccessful ESWL at HU(675.29) versus (1075.00), respectively [16]. This trend had been observed in URS but without statistical significance . in this study we did not find correlation of UH with stone free rate (P-value=0.61) this result explained by fact that Holmium laser lithotripsy worked primarily through a photo thermal mechanism that caused stone vaporization and had the ability to fragment all types of stones regardless of composition[17]. This relation of HU with SFR also revealed by Christian Seitz et al, 2007; who found that SFR for radio-opaque versus radiolucent stones in proximal ureteric stones were 79.6% versus77.9%(P-value=0.8) and 97.6% versus 96.2% in distal ureteric stones(P-value=0.5). [9]

In this study the HU had strong correlation with time of destruction (P-value=0.004) this mean that when HU was high the time of destruction would increase. In 2014 Wilson R. Molina et al, also revealed a positive significant association of HU and time of destruction[18].

In this study we found that stone score significantly correlated with SFR (P-value=0.003).So when stone score increased the SFR would decrease. Imamura Y et al,2013; Christian Seitz et al, 2007; Wilson R. Molina et al, 2014; Turnuc T et al, 2010; Michael Ordon et al, 2015 also confirmed this strongly positive relation of stone score and SFR , So stone score can be considered as corner

stone to predicate SFR from preoperative image.[18-21].

CONCLUSION:

The S.T.O.N.E. Score is a novel assessment tool to predict SFR in patients undergoing URS and laser. Features of S.T.O.N.E. (stone size, location) were relevant in predicting SFR with URS. The S.T.O.N.E. Score establishes the framework for future analysis for the treatment of urolithiasis.

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