MMJ

Malta Medical Journal, 2026; 38(1)
http://mmsjournals.org/index.php/mmj/47

ORIGINAL ARTICLE

Stone Free Rates following Ureteroscopy at Mater Dei Hospital

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Introduction: Renal calculi pose a huge burden on health care systems and their rising prevalance has led to an increased reliance on surgery, particulary for upper urinary tract stones. Techincal advancements has made ureterscopy (URS) a mainstay treatment for both renal and ureteric stones. Despite its increase use, reported stone free rates following URS vary considerably owing to the different imaging modalites used and the different defintions of stone free. The aim of this audit is to assess the stone free rates of patients who underwent a URS at Mater Dei Hospital, Malta.

Methods: All patients who underwent a URS for stones between January 2019 and December 2020 were included. Data was collected retrospectively by reviewing records on two main online hospital systems: Isoft Clincal Manager (ICM) and Picture Archiving and Communication System (PACS).

Results: A total of 588 patients were selected for data analysis after applying inclusion/exclusion criteria. CT KUB was most common imaging modality for both diagnosis (83%, n=496) and follow-up (64%). At first follow-up, 418 patients (71%) were stone free when using the 5mm cut off, while 298 patients (50%) were stone free when using the 2mm criteria. At first follow-up, 209 (66%) of pre-stented patients were stone free when using the 5mm cut off, while 148 (47%) patients were stone free when using the stricter 2mm criterion. Patients with ureteric stones had better stone free rates at first follow-up at both 2mm (0.01) and 5mm cuts offs ($p=0.013$). Stone free rates were worse for patients who had stones higher up in the calyces of the kidney ($p=0.01$). The distribution of HU was the same across all categories of stone free at first follow-up when considering 2mm cut off ($p=0.544$). A total of 22 patients sufferred post-operative complications. 13 of these were re-admitted within 30 days of surgery and one patient died.

Conclusion: Different stone parameters as well as different imaging techniques influence stone free rates. Ureteroscopy is now the most commonly performed stone removing procedure. Efforts should be made to render patients stone free, as this will reduce the requirements for future secondary interventions.

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Renal calculi pose a huge burden on health care systems and their rising prevalance have been attributed to increased rates of diabetes, obesity and metabolic syndrome.[1] Prevalence rates are particularly high (>10%) even in countries with a high standard of living such as Sweden or the USA.[2] This increase in prevalance has led to an increased reliance on surgery for the treatment of such stones, especially those within the upper urinary tract.

With the availability of both rigid and flexible ureteroscopy (URS), all areas the of the urinary tract can be readily accessed. Technical advancements including better optical quality, endoscope miniaturisation, improved deflecton mechanism and the introduction of disposables has made URS a mainstay treatment for both renal and ureteric stones.[3] Despite its increased use, there has been alot of variations in the reported stone free rates following URS. These discrepancies are often the result of inconsitencies in the definition of 'stone free'. This is often attributed to variations in the type of imaging used in assessing for residual stones postoperatively, as well as the timing of the assessment. Other potential factors that might account for such variations of stone free rates include size and postion of stone.[4]

AIM

The aim of this audit was to assess the stone-free rates of patients with renal and ureteric stones who were treated with URS at Mater Dei Hospital. The primary outcome is the stone free rate after URS at first and last follow-up using 2 and 5mm cut-off points. Other outcomes include type of diagnostic imaging modality used, stone parameters, interval to follow-up imaging, re-admissions and post-operative complications.

MATERIALS AND METHODS

The audit was conducted between January 2019 and December 2020. A proforma with no patient identifiers was used and all data was anonymised; stored internally on a hospital p-drive folder; and deleted after audit completion. Data protection clearance and ethics approval were obtained prior to the start of data collection.

All individuals who underwent a URS for stones over this two-year period were included. Patients were excluded if they were lost to follow-up; if there was any incomplete information or missing data; if radiology images were not available on the online hospital system; and if the URS was not primarily done for stone extraction. For those who met the inclusion criteria, data was collected in a retrospective fashion by reviewing records on two main online hospital systems: Isoft Clincal Manager (ICM) and Picture Archiving and Communication System (PACS).

Stones were classified according to size, position, density and compostion. Stone size was measured in millimeters (mm) using the measurement tool and stratified into groups of up to 5mm, 6-10, 11-15, 16-20, 21-25, 26-30 and >30mm in largest diameter. Stone location was defined according to anatomical position: upper, middle or lower calyx; renal pelvis, pelvic-ureteric junction (PUJ), upper, middle or lower ureter; and vesico-ureteric junction (VUJ). Stone density was given in hounsfield units (HU) and estimated using an ellipticial annotation tool that measures density over the particular area of interest. The number of patients who were stented prior to the URS was recorded and stone free-status was determined at first imaging following the URS. Stone free status was defined as clinically insignificant stone fragments 5mm or less. A stricter definition of stone free was also defined as stone fragments 2mm or less. Stone parameters were analysed using the Chi-squared test for catergorical variables while the Mann-Whitney U test was used for continous variables. A p value of less than 0.05 was considered to be statistically significant.

When available, laboratory renal calculi analysis was used to establish stone type and composition. Length of stay was defined as the time from completion of the URS to discharge from hospital. Electronic case summaries were manually screened to check for any re-admissions and record any associated post-surgical complations. The severity of the post-operative complications was graded using the Clavien-Dindo Classification. In cases where prolonged hosptial stay was multifactorial, the predominant reason for the prolonged stay was taken as the cause.

RESULTS

Between January 2019 and December 2020 a total of 739 patients underwent a URS at MDH. After applying inclusion/exlcusion criteria 588 patients were selected for data analysis. Of the 151 exluded patients, 86 patients had URS which was not primarily done for stones, while the rest either had inadequate follow-up/incomplete information or radiology investigations were not available.

The most common diagnostic imaging modality was a non-contrast CT KUB (83%, n=496) followed by a contrast CT Abdomen/Pelvis (7%, n=43). Again, CT KUB was the preferred modality to assess stone burden after URS (64%, followed by ultrasound of the kidneys, 21%). The mean time to URS from imaging was 78.6 days while the mean time to first follow-up imaging after URS was 138.1 days.

The mean length of stay was 1 day (minimum of LOS of 0 and maximum of 31 days). At first follow-up, 418 patients (71%) were stone free when using the 5mm cut off. This number was reduced to 298 patients (50%) when using the 2mm criteria.

A total of 316 patients had a ureteric stent insertion prior to the URS. At first follow-up, 209 (66%) of pre-stented patients were stone free when using the 5mm cut off, while 148 (47%) patients were stone free when using the stricter 2mm criterion (Figure 1 and Figure 2). For those who did not have prior stent insertion, a lower percentage of 49% and 36% were stone free at first follow-up when using the 5mm and 2mm cut offs respectively. The difference between pre-stented and non-stented stone free rates was statistically signficant (p=0.003).

A total 56% (n=329) of the treated stones occurred inside the ureter, with the distal third of ureter being the most common location (n=136, 23%), followed by the proximal third (n=128, 21%). Patients with ureteric stones had better stone free rates at first follow-up at both 5mm (p=0.013) and 2mm cut offs (0.01) (Figure 3 and Figure 4). Stone free rates were worse for patients who had stones higher up in the calyces of the kidney (p=0.01).

The average stone density was 592 HU, with the majority of stones possessing a density which was less then 1000 HU ((n=242 <500 HU), (n=233, 501-1000 HU), (n= 57 >1000 HU)) (Figure 5). The distribution of

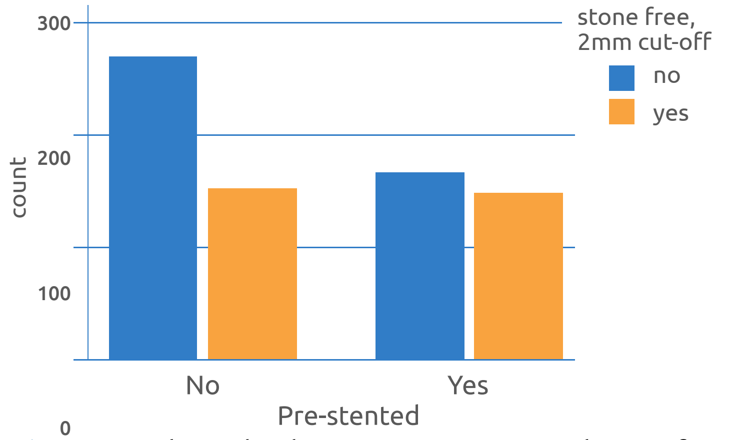

Figure 1 *Relationship between pre-stenting and stone free status using the 2mm cut off*

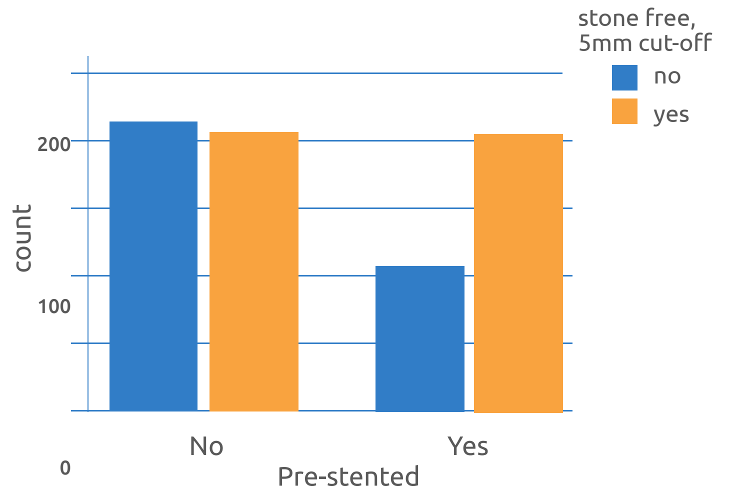

Figure 2 *Relationship between pre-stenting and stone free status using the 5mm cut off*

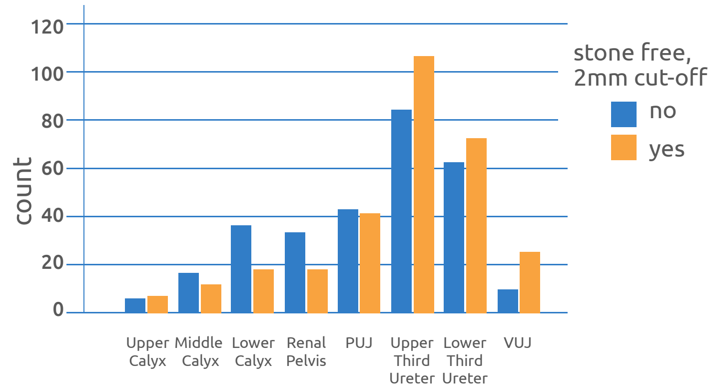

Figure 3 *Stones free rates on first follow up using the 2mm cut off*

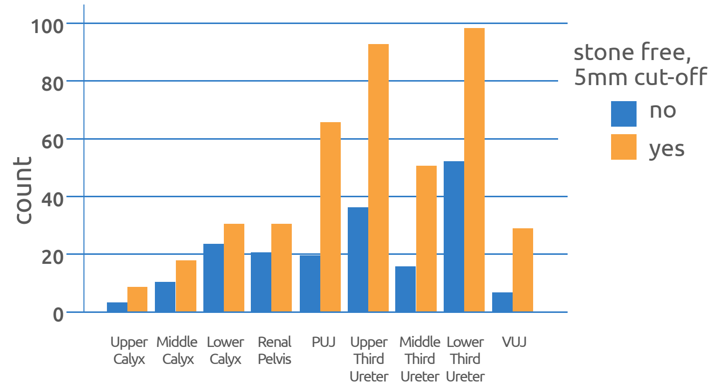

Figure 4 *Stones free rates on first follow up using the 5mm cut off*

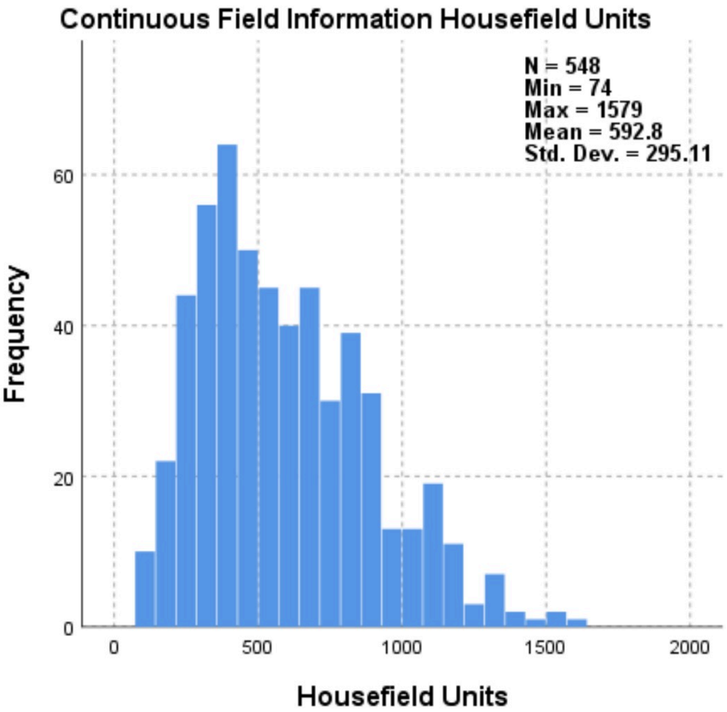

Figure 5 *Stone Densities*

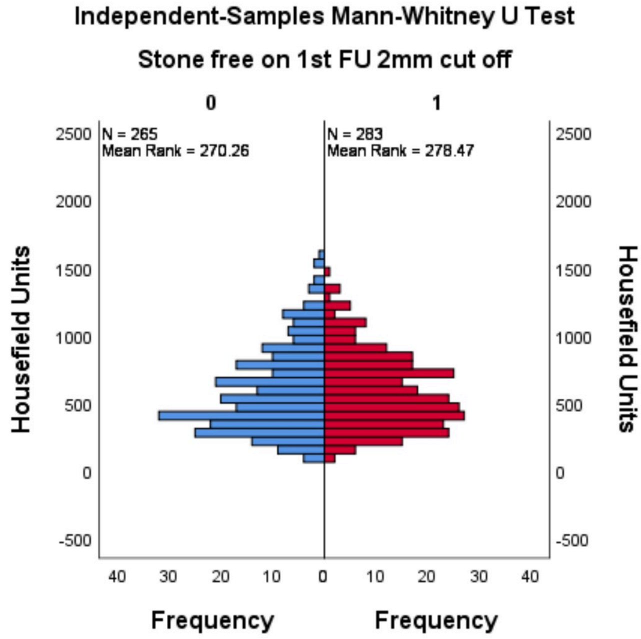

Figure 6 *Relationship between density and stone free status using 2mm cut off*

HU was the same across all categories of stone free at first follow-up when considering 2mm cut off (p=0.544). Stones with a HU of less than 1000 were associated with better stone free rates, however, this finding was not statistically significant (Figure 6). Median stone density was 534 Hounsfield units (HU) in stone-free patients and 526 HU in non–stone-free patients. The median difference in stone density was 8 HU, with a 95% bootstrap confidence interval ranging from −64 to 96 HU, indicating no clinically meaningful difference between groups. Consistent with this, the effect size was negligible (Cliff's δ = 0.03; 95% CI −0.07 to 0.13), suggesting that stone density alone had limited discriminatory value for predicting stone-free outcome at first follow-up. The most common stone size ranged between 6-10mm (n=339, 58%) followed by 11-15mm (n=114, 19%). Stone free rates increased with decreasing stone size (p=0.033).

22 patients sufferred post-operative complications (severe sepsis [n=9], septic shock [n=5], urinary tract infection [n=6], ureteric obstruction [n=2]. 13 of these were re-admitted within 30 days of surgery and one patient died. Taking into account the Clavien-Dindo classification of surgical complications there were five cases of Clavien-Dindo 4 complications and one 5 complication. This corresponds to an overall complication rate of around 4%, which is lower than rates reported in the existing literature. However, complication data were collected retrospectively from electronic case summaries, and therefore minor or self-limiting events that were not documented in formal clinical records may have been missed. As such, the true complication rate may be underestimated, particularly for low-grade complications not requiring intervention.

DISCUSSION

URS success rates quoted in literature vary considerably from 59% to 95%.[5] However, these outcomes can be misleading due to different variety of imaging techniques used and different defintions of stone free rates.

In patients with suspected acute urolithiasis, a non contrast enhanced CT has become the standard imaging and is significantly more accurate than IVU or US.[6] A non-contrast CT can determine stone diameter, density, skin to stone distance and surrounding anatomy, all of which play an important part in selection of treatment modality.[7] In pregnant women, US is the preferred method of imaging for suspected renal colic. MRI can also be used, usually a second line-option, but also to define level of obsruction in the urinary tract and to visualise stones as a filling defect.[8]

Owing to its minimally invasive nature, URS generates alot of in situ fragmentation, hence, residual fragments are not always passed. This finding contrasts traditional open surgery, where stones were removed in toto. The term clinicially insignifcant residual stone fragments started being used for asymptomatic stones which were less then 5mm in size, and this metric was adopted by many studies when reporting stone free rates after URS. This idea started being questioned when a large proportion of patients who had insignifcant residual stones developed significant symptoms or required additional interventions during their follow-up period.[9] In view of this, we used both 5mm and 2mm cut-off points, as we thought that the 2mm cut-off might be more appropriate for establishing the true clinical significance of stone-free.

Elective stenting is not necessary prior to URS, however, a recent meta-analysis [10] found that pre-stenting may improve stone free rates of URS for renal stones but not ureteric stones. This is thought to be due to a dilatation effect of a double J stent which relieves obstructed ureters and improves access to the upper tracts at the time of the URS. Although it might improve ureterscopic management of stones and placement of ureteric access sheath, pre-stenting does not significantly decrease the risk of intra-operative complications.[11] Moreover, stenting causes the patient to experience stent-related symptoms and might be associated with higher patient morbidity and costs.[12] Routine stenting after uncomplicated URS is also not recommended and stents should only be inserted in patients who are at risk of adverse events such as bleeding, perforation, UTIs, residual stones and ureteral trauma.[13]

Size is an important parameter when considering stone free rates after URS. With increasing stone sizes, obtaining complete clearance during URS is more challenging and sometimes patients might required multiple (staged) URS to achieve acceptable outcomes.[14] Also, when actively picking up residual stones using dormia basket after the primary stone has been fragmented with laser, smaller stone fragments might be easily missed or difficult to retrieve.

Stone location might also affect complete stone clearance. Treatment of lower pole calculi might be hampered by the limited flexion of the ureterscope that occurs when a laser fiber or a dormia basket is in place. In addition to possible scope damage, it might also reduce stone clearance.[15] Research has shown significance of HUs with regards to stone free rates after URS.[16] However, in our audit stone density did not really discriminate outcomes. This showed that outcomes after URS are multifactorial and influenced by other factors beyond stone density.

While in many centres worldwide URS is a day case procedure [17], locally, the majority of patients who undergo a URS for stones are kept for an ovenight stay and discharged the day after, following trial without catheter (TWOC). This is reflected in a mean length of stay of 1 day. The timing of follow-up imaging may also influence stone free rates. Small residual fragments may pass days or weeks following URS while new calculi may form weeks or months after surgery. Late follow-up imaging may increase the risk of potential contamination form new stone formation. Prolonged operation times are associated with increased risk of complications following URS, and efforts should be made to keep operation time below 90 minutes.[18]

A limitation of this audit is the small number of complications recorded. This might be related to the retrospective nature of this study which can lead to recall bias and potential missing or inaccurate data from exisitng records. Another possible cause might be linked to the Clavien-Dindo classification system which might have not captured all possbile URS complications, leading to an underreporting of minor self-limiting complications. We also focused on complications occuring during the first 30 days post-operatively. This limited follow-up might have missed the development of delayed complications, such as ureteral strictures, which can occure weeks or months after the procedure.

CONCLUSION

URS is a widely used stone removal procedure.[3] Efforts should be made to ensure that the patient is stone free, decreasing the need of future surgical interventions. Different stone parameters and different imaging techniques affect stone free rates after URS. Different defintions of stone free might also impact stone free status , hence a standard defintion of stone free should be used in future studies.[19]

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