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A Single Center Comparison between URS, ESWL and Uretherolithotomy for Ureteral Stone Management

Ahmad Nadhir[1], Tarmono Djojodimejo[1]
Department of Urology Dr. Soetomo General Hospital, Surabaya, Indonesia[1]

Abstract— **Introduction**, Ureterolithiasis is the most common type of all urolithiasis. The management characteristics and efficacy of ureterolithiasis management using URS, ESWL, and ureterolithotomy in Dr. Soetomo General Hospital Surabaya are evaluated in this study. **Material and Method** This study used a descriptive study with a retrospective design. All medical record data of patients with reteral stone who were treated at Dr. Soetomo General Hospital Surabaya from 2014-2019. **Result**There were 801 patients included in the study.The highest incidence of ureteral stones was in the 51-60 years old age group (31.08%), predominantly among male patients (67.79%). URS was the most commonly performed procedure (61%). There were 270 patients with stone size < 1 cm. The procedures performed were URS and ESWL. The URS group showed significantly higher postoperative treatment (3.4 ± 2.1 days) compared to the ESWL group ($p<0.05$). There were 531 patients with stone size > 1 cm. The procedures performed in this group were URS, ESWL, ureterolithotomy. The shortest mean operation duration was in the ESWL group (61.56 minutes, $p<0.05$).**Conclusion**, The highest stone-free-rate (SFR) was discovered in the ureterolithotomy group (97.1%, $p<0.05$). ESWL had the shortest postoperative treatment duration (1 day, $p<0.05$). Ureterolithotomy generated the highest SFR. However, the patients had a greater hb change compared to URS.

Keywords— Ureteral stone, URS, ESWL, Ureterolithotomy, Stone-free rate

1. Introduction

Urolithiasis is the third most common disease among adult urologic patients after urinary tract infections and benign prostatic enlargement(1). Data in Indonesia shows that urolithiasis currently holds the second position as the most frequent urinary disease after urinary tract infections. It is also a urological problem that requires the most surgical interventions. The prevalence of urolithiasis in adults is increasing throughout the world and in Indonesia(2). The incidence and prevalence of urolithiasis in Indonesia among adult patientsare still unknown. Urinary stones occur in 7-10 of 1000 patients admitted to the hospital.

Men have a triple risk of getting urolithiasis than women with the most cases at the age of 20-40 years(3). One of the most commonly found types of urolithiasis is ureterolithiasis, affecting millions of people worldwide with an enormous burden financially (4). The management usually includes acute pain management using analgesics and stone expulsion facilitation. Based on the stone's location and size, spontaneous expulsion or medical expulsive therapy (MET) can be chosen (5). Apart from conservative approaches, active stone removal procedures in the setting of large or obstructing stones are frequently required. The choice for interventions includes Ureterorenoscopy (URS), extracorporeal shock wave lithotripsy (ESWL), or ureterolithotomy(6). Our objective was to evaluate the profile, duration of surgery, duration of treatment after surgery, hemoglobin (hb) change, and stone-free rate (SFR) of URS, ESWL, and ureterolithotomy procedures in Soetomo General Hospital Surabaya from January 2014 to December 2019.

2. Material and Methods

2.1 Study Design

This study used a descriptive study with a retrospective design. All medical record data of patients with ureteral stone who were treated at Dr. SoetomoGeneral Hospital Surabaya from 2014-2019 were collected

and analyzed.

2.2 Study Sample

The sample in this study was the medical records of all ureteral stone at Dr. Soetomo in January 2014 to December 2019. The sampling technique is total sampling.

The collected data are grouped and will be displayed descriptively in the form of tables and narratives

3. Results

3.1 Study Subject Demography

Basedonthe medical record data fromJanuary 2014 toDecember 2019, there were 801 casesofureteralstonesdisplayed in table 1. The highest incidence of ureteral stone cases was in the age group 51-60 years old with 249 cases (31.08%) out of 801 patients, which was followed by the age group 41 - 50 years old with 231 cases (28.83%) and the age group of > 60 years old with 155 cases (19.35%). The patients consisted of 543 men (67.79%) and 258 women (32.21%).

Table 1. Basic Characteristics of Ureteral Stone Patients in Dr. Soetomo General Hospital 2014-2019

	Number of Cases (n)	**Percentage of Cases (%)**
Age (years old)		
18 - 30	45	5,61
31 - 40	121	15,10
41 - 50	231	28,83
51 - 60	249	31,08
> 60	155	19,35
Sex		
Male	543	67,79
Female	258	32,21
Procedure for < 1 cm Stones		
ESWL	145	53,7
URS	125	46,3
Ureterolithotomy	0	0
Procedure for > 1 cm Stones		
URS	361	67,98
ESWL	105	19,77
Ureterolithotomy	65	12,24

*ESWL: Extracorporeal shock wave lithotripsy, URS: Ureterorenoscopy

801 subjects underwent ureteral stone surgery, 486 patients (61%) underwent URS procedures, 250 subjects (31%) underwent ESWL procedures, and 65 subjects (8%) underwent ureterolithotomy procedures. Of all the subjects, 270 subjects had < 1 cm stone size, while 531 subjects had > 1 cm stone size. In the case of ureteral stones <1 cm, ESWL was the most performed procedure (n=145, 53.70%) patients with 0.4 cm as the smallest stone size and 0.92 cm as the largest stone size, followed by URS (n=125, 46.30%) with the smallest stone size of 0.4 cm and the largest stone size of 0.95 cm. Ureterolithotomy was not performed for stone <1 cm.In the case of ureteral stones size of >1 cm, URS was the most performed procedures (n=361, 67.98%) with the smallest stone size of 1 cm and largest stone size of 1.9 cm, followed by ureterolithotomy

(n=105, 19.77%) with the smallest stone size of 1.5 cm and the largest stone size of 5 cm. ESWL was performed in 65 patients (12.24%) with the smallest stone size of 1 cm and the largest stone size of 1.4 cm.

3.2Outcomes of Proscedure based on Stone Size

Table 2. Outcomes of Procedures based on stone size

< 1 cm Ureteral Stone	URS	ESWL	Open Ureterolithotomy	p-value
Duration of surgery				
Minutes (SD)	71.8 (43.6)	61.4 (7.3)	-	0.59
N	125	145	-	
Duration of treatment after surgery				
Days (SD)	3.4 (2.1)	1	-	**<0.05**
N	125	145	-	
Changes in Hemoglobin				
Mean (SD)	0.36 (1.15)	-	-	-
N	125	-	-	
SFRs				
Mean (%)	113 (90.4)	134 (92.4)	-	0.64
N	125	145	-	
> 1 cm Ureteral Stone				
Duration of surgery				
Minutes (SD)	120,4 (72,6)	61,6 (6,4)	102.8 (61.5)	**<0.05**
N	361	65	105	
Duration of treatment after surgery				
Days (SD)	3.9 (2.4)	1 (0)	4.2(3.4)	**<0.05**
N	361	65	105	
Changes in Hemoglobin				
Mean (SD)	0.4 (1.3)	-	0,9 (1.9)	**<0.05**
N	361	-	105	
SFRs				
Mean (%)	323 (89,4)	56 (87,6)	102 (97.1)	**<0.05**
N	361	65	105	

*ESWL: Extracorporeal shock wave lithotripsy, SD: Standard Deviation, SFR: Stone-Free Rate, URS: Ureterorenoscopy

Table 2 classified the patients into two subgroups according to stone size, which was < 1 cm and > 1 cm. In the stone size group > 1 cm, there were significant differences between three procedures in the duration of surgery ($p < 0.05$) with an average ESWL duration of 62 minutes, ureterolithotomy procedure were approximately 103 minutes, and the mean average of URS procedure time was 120 minutes. Among the < 1 cm stone group, there weren't any significant differences in operation time between the two procedures ($p = 0.59$).The duration of treatment after surgery was significantly different between the two groups ($p < 0.05$).

The duration of postoperative treatment was shorter in the URS procedure with a mean duration of 3.4 days in stones < 1 cm and 3.9 days in stones > 1 cm compared to ureterolithotomy procedures for 4.2 days in stones > 1 cm. ESWL has the shortest postoperative treatment duration compared to the other groups, with an average duration of 1 day in both stone sizes. There were also significant hb changes in the > 1 cm group between the URS and ureterolithotomy, with the most considerable mean change in the ureterolithotomy procedure of 0.9 g/dl. The effectiveness of the three procedures was significantly different in stones > 1 cm, with the largest stone-free rate for the ureterolithotomy procedure (97.1%) and lowest in the ESWL procedure (87.6%). There was no significant difference between the URS and ESWL procedure among the < 1 cm group ($p = 0.64$). However, there was a considerable difference in the mean duration of operation between URS and ESWL procedures among the > 1 cm group, in which the ESWL procedure was 60 minutes faster.

4. Discussion

Over the past several decades, management for urolithiasis has undergone several developments. Some of the latest procedures currently use a minimally invasive approach, such as endoscopy and ESWL. With this latest procedure option, the need for open operations is now diminishing (7). Stone size is the most significant factor in influencing SFR after the intervention of ureteral stone (8). Therefore, the researchers separated the two stone groups based on size, < 1 cm and > 1 cm stones. Recenttechnologicaladvanceshavemadeureteroscopy (URS), and ESWL gives a more optimal impressiononproximaluretericstoneswith a diameter exceeding 1 cm. ThelargestSFR in this studywasachieved by theureterolithotomyprocedure (97.1%) in the >1 cm group. Theseresultswereconsistentwithpreviousstudiescomparing ESWL, URS, andureterolithotomyprocedures in urolithiasispatients. In this study, theureterolithotomyprocedure hadthehighest SFR (97.1%) in allstonesizes, whereas ESWL resulted inthelowestSFR comparedtothe otherthreeprocedures (87.6%)(9).The findings in this studywere superior totheSFRofotherstudies, in whichureterolithotomy, URS, and ESWLachieved 83.3%(10); 84.5% (11); and68.8 - 72.7% (7) respectively. The study claimed that URS generated higher SFR for stones less than or equal to 1 cm ureteral stones located distally and 1 cm ureteral stones located proximally (7). Ureterolithotomy holds an important position in the management of stone urolithiasis conditions. It has a vital and necessary role in complicated cases and complex stone burdens. Therefore, Ureterolithotomy could be an alternative if the endourology technique has not produced results. The main indications regarding ureterolithotomy were complex stone burdens, a history of treatment failure with a less invasive modality of action, and anomalies in the anatomical structure of the collective system (7).

The duration of surgery difference between the three procedures among stones > 1 cm found in this study was significant. The mean duration of operation time was 62, 103, and 120 minutes for the ESWL ureterolithotomy, URS procedures, respectively. Among the < 1 cm stone group, no apparent difference was seen between the three procedures ($p = 0.59$). These results were consistent with this study in accordance with previous studies, which prove that the difference in duration of surgery between ESWL and URS was insignificant. However, empirical evidence showed that URS is superior to ESWL in terms of SFR. Despite its shortcomings, some urologists recommended URS as a first-line treatment for ureter stones more than 1 cm in diameter (12). ESWL is routinely performed in outpatients daily, but it has some disadvantages such as long recovery time, high retreatment rate, and poor patient compliance (13). In this study, the lowest SFR was discovered in the ESWL procedure (87.6%). However, the procedure was proven to be quite useful in managing stones < 1 cm, indicated by similar findings between URS and ESWL ($p = 0.64$).

The postoperative duration was shorter in the URS procedure with an average duration of 3.4 days in stones < 1 cm and 3.9 days in stones > 1 cm compared with the ureterolithotomy procedure, which was 4.2 days in stones > 1 cm. This finding was significantly different in the two groups ($p < 0.05$). The results of this study showed a longer duration of postoperative care, compared to the study by Jones, which stated that the duration of treatment after surgery was 1.2 days during 8 years of treating ureterolithiasis patients with URS at a tertiary center in the United Kingdom (14). Whereas the study by Cakici, showed the average duration

of hospitalization for patients undergoing ureterolithotomy was around 5.5 days (10).

There were significant differences in hb changes among the groups, with the most significant change in the ureterolithotomy procedure of 0.9 mg / dL in the stone group > 1 cm. The results of ureterolithotomy in this study were also superior compared to the study by Cakici, which showed an approximately 1.8 (0.3-4.7) mg / dL decrease in postoperative hb levels (10).

ESWL and URS remainthemostcommonmodalitiesforureteralstonetherapy; thereisstilldebatebetweenacademicsandmedicalpractitionersregardingthebesttreatmentmodalities(15).ESWL isthemostcommoninterventionforuretericstoneswith size<1 cm rangingfromsuccessratesaccordingtotheliteraturerangingfrom 85% to 93% (16). However, itseffectivenessdecreaseswhenthestonesizeis>12 mm (thepercentagedropsbelow 60%).

We foundthetreatmentmodalityof URS tobeveryuseful in handlinglargerureteralstones (>1 cm). Soit hasimplicationsforthechoiceofmanagementmodalities in Soetomo General HospitalJanuary 2014 - December 2018, which in thecaseofuretericstonessize>1 cm, themost URS wasperformed in 361 patients (67.98%), withthesmalleststonesize was 1 cm, thelargeststonesizewas 1.9 cm, andtheaveragestonesizewas 1.4 cm. In thecaseofureteralstone size<1 cm, themost ESWL wasperformed in 145 patients (53.7%), withthesmalleststonesizewas 0.4 cm, thelargeststonesizewas 0.92 cm, andthemeanstonesizewas 0.65 cm. Thisfindingwas in linewithresearchbyAboutaleb, whichshowedthat in ureteralstone diameter >1 cm, thetherapeuticoptionsused were mostly URS, in whichthere were 81 patientswithanaveragestonesizeof 18.2 mm, compared to ESWL with 65 patientswithanaveragestonesizeof 1.7 mm(12).

ESWL was the procedure with the shortest time of 61.6 minutes (p = <0.05) in patients with stone size > 1 cm and the quickest postoperative treatment in both groups, which was 1 day on average (p = <0.05). Ureterolithotomy procedure in the stone size > 1cm group had the highest haemoglobin change, which was 0.9mg / dL (p = <0.05). The highest SFR was in the ESWL for stones size <1cm (92.4%; p = 0.64) and in the stones size >1 cm, ureterolithotomy had the highest SFR (97.1%; p = <0.05). Our results showed that ureterolithotomy was only performed on > 1 cm stones, with a total of 105 patients (19.77%). This is in accordance with other studies which showed that ureterolithotomy was classified as rare; the indications used today are, in cases related to anatomic abnormalities in the ureter, large stones, and the failure of minimally invasive methods (9). Research by Takazawa showed that there was a decrease in the SFR in ureteral stone size >40 mm (67% SFR), compared with 20-40 mm ureter stone size (100% stone-free size), so that follow-up is needed in the form of the operative procedure (17).

Eachmanagement modality has certain advantages and disadvantages, with various factors affecting treatment options. Urologists who advocate the use of ESWL generally base their preferenceson a non-invasive approach. The decision to choose URS is usuallybased on minimal invasive procedure considerations and objectives to produce a greater success rate on specific stone sizes and indications.

5. Conclusion

URS was the most common procedure performed among adult ureterolithiasis patients in Dr. Soetomo General Hospital. The ESWL group had the shortest duration of the operation and postoperative treatment duration among patients with more than 1 cm stone in size. Ureterolithotomy generated the highest SFR. However the patients had the higherhb change compared to URS.

6. References

[1] 1. Marshall stoller. Smith's General Urology 18th Edition: Urinary Stone Disease. Smith's General Urology. 2010.
[2] 2. Pearle MS, Lotan Y. Urinary lithiasis: etiology, epidemiology, and pathogenesis. Campbell-walsh Urol. 2007;2:1363–92.
[3] 3. Pahira JJ, Pevzner M. Nephrolithiasis. In: Penn Clinical Manual of Urology. 2007.
[4] 4. Glazer K, Brea IJ, Vaitla P. Ureterolithiasis. StatPearls [Internet]. 2020;
[5] 5. Türk C, Knoll T, Seitz C, Skolarikos A, Chapple C, McClinton S, et al. Medical expulsive therapy for ureterolithiasis: the EAU recommendations in 2016. Eur Urol. 2017;71(4):504–7.
[6] 6. Türk C, Neisius A, Petrik A, Seitz C, Skolarikos A, Thomas K, et al. EAU Guidelines on Urolithiasis. Eur Assoc Urol. 2020;
[7] 7. Iqbal N, Malik Y, Nadeem U, Khalid M, Pirzada A, Majeed M, et al. Comparison of ureteroscopic pneumatic lithotripsy and extracorporeal shock wave lithotripsy for the management of proximal ureteral stones: A single center experience. Turkish J Urol. 2018;
[8] 8. Cho KS, Jung H Do, Ham WS, Chung DY, Kang YJ, Jang WS, et al. Optimal Skin-to-Stone Distance Is a Positive Predictor for Successful Outcomes in Upper Ureter Calculi following Extracorporeal Shock Wave Lithotripsy: A Bayesian Model Averaging Approach. PLoS One. 2015;
[9] 9. Etafy M, Morsi GAM, Beshir MSM, Soliman SS, Galal HA, Ortiz-Vanderdys C. Management of lower ureteric stones: A prospective study. Cent Eur J Urol. 2013;
[10] 10. Çakici ÖU, Ener K, Keske M, Altinova S, Canda AE, Aldemir M, et al. Open stone surgery: A still-in-use approach for complex stone burden. Cent Eur J Urol. 2017;
[11] 11. Ghani KR, Wolf JS. What is the stone-free rate following flexible ureteroscopy for kidney stones? Nature Reviews Urology. 2015.
[12] 12. Aboutaleb H, El-Shazly M, Marzouk M. Management of upper ureteral stones exceeding 15 mm in diameter: Shock wave lithotripsy versus semirigid ureteroscopy with holmium: YAG laser lithotripsy. Eur Urol Suppl. 2016;
[13] 13. Kadyan B, Sabale V, Mane D, Satav V, Mulay A, Thakur N, et al. Large proximal ureteral stones: Ideal treatment modality? Urol Ann. 2016;
[14] 14. Jones P, Rob S, Griffin S, Somani BK. Outcomes of ureteroscopy (URS) for stone disease in the paediatric population: results of over 100 URS procedures from a UK tertiary centre. World J Urol. 2020;
[15] 15. Bader MJ, Eisner B, Porpiglia F, Preminger GM, Tiselius HG. Contemporary management of ureteral stones. European Urology. 2012.
[16] 16. Wiesenthal JD, Ghiculete D, Honey RJDA, Pace KT. A comparison of treatment modalities for renal calculi between 100 and 300 mm2: Are shockwave lithotripsy, ureteroscopy, and percutaneous nephrolithotomy equivalent? J Endourol. 2011;
[17] 17. Takazawa R. Appropriate kidney stone size for ureteroscopic lithotripsy: When to switch to a percutaneous approach. World J Nephrol. 2015;