ESWL FOR RENAL AND URETERAL STONES

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ABSTRACT

Objective: *To report patient characteristics and results of Huikang HK-V extracorporeal shockwave lithotripsy (ESWL) machine for renal and ureteral stones.* ***Material & methods:*** *We retrospectively analyzed medical records of all patients treated with ESWL using HK-V device at Department of Urology Soetomo Hospital from May 2011 - February 2012.* ***Results:*** *There were 241 selected patients, consisted of 148 men (61.4%) and 93 women (38.6%). Mean age was 47.8 years (range 7-87). ESWL was conducted to 130 single stones and 111 multiple stones, using fluoroscopy as guidance for 166 patients, ultrasound for 31 patients (12.9%) and both for 44 patients (18.3%). Stone location was 109 in lower pole (41%), 69 in middle pole (26%), 41 in proximal ureter (16%), 28 in upper pole (11%), 14 at renal pelvis (5%), 1 at distal ureter (0.3%) and 2 staghorn stone (0.7%). There were 130 patients with stone less than 10 mm (53.9%), 102 with stone 10-20 mm (42.3%), and 9 more than 20 mm (3.7%). There were slightly more left-sided treatment was 141 patients (58.5%). Of 181 patients with hydronephrosis (75%), 104 had DJ stent inserted (43.2%). Overall, we found 158 patients (65.5%) were stone free after treatment, 49 patients (20.3%) with residual stones less than 4 mm and 34 patients (14.1%) had more than 4 mm residuals.* ***Conclusion:*** *ESWL is the treatment of choice for simple renal and ureteral stones less than 20 mm (opaque and non opaque).*

Keywords: *Extracorporeal Shockwave Lithotripsy, renal stones, ureteral stones.*

ABSTRAK

Tujuan : *Mengetahui karakteristik pasien dan hasil terapi extracorporeal shockwave lithotripsy (ESWL) untuk batu ginjal dan batu ureter.* ***Bahan & Cara:*** *Kami menganalisa secara retrospektif 241 rekam medis pasien batu ginjal dan ureter yang mendapat terapi ESWL menggunakan lithotriptor HK-V di Departemen Urologi RSUD Dr. Soetomo selama periode Mei 2011 - Pebruari 2012.* ***Hasil:*** *241 pasien mendapat terapi ESWL, dengan 148 laki-laki (61.4%) dan 93 perempuan (38.6%). Usia rerata pasien 47.8 tahun dengan rentang usia 7-87 tahun. ESWL dilakukan pada 130 pasien dengan batu tunggal dan 111 pasien dengan batu multiple, panduan fluoroskopi pada 166 pasien (68.9%), USG pada 31 pasien (12.9%) serta kombinasi keduanya pada 44 pasien (18.3%). 264 batu mendapat terapi, yaitu batu pole bawah ginjal 109 kasus (41%), pole tengah ginjal 69 kasus (26%), batu ureter proksimal 41 kasus (16%), batu pole atas ginjal 28 kasus (11%), batu pyelum 14 kasus (5%), batu ureter distal 1 kasus (0,3%), batu staghorn 2 kasus (0.7%). Ukuran batu < 10 mm pada 130 pasien (53.9%), 10-20 mm pada 102 pasien (42.3%), dan > 20 mm pada 9 pasien (3.7%), dengan sisi kiri lebih dominan (141/58.5%). Hidronefrosis didapatkan pada 181 pasien (75%), pada 104 diantaranya dilakukan pemasangan DJ stent sebelum tindakan (43.2%). Setelah terapi, pada 158 pasien tidak terdapat batu sisa (65.5%), 49 dengan batu sisa < 4 mm (20.3%) dan 34 pasien dengan batu sisa > 4 mm (14.1%).* ***Simpulan:*** *ESWL merupakan modalitas pilihan untuk terapi batu ginjal dan batu ureter sederhana (opak maupun non-opak) yang berukuran < 20 mm.*

Kata Kunci: *Extracorporeal shockwave lithotripsy, batu ginjal, batu ureter.*

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INTRODUCTION

Urolithiasis is one of the most prevalent urological disorder. In USA, it is the third most common urinary tract disease after prostate disease and urinary tract infection.[1] Although there is no data on the certain incidence of urinary tract stones in Indonesia, in Urology Department of Dr. Soetomo Hospital urinary tract stones has become the second most common disease after prostate disease, with approximately 577 cases annually.[2]

The management of urolithiasis was revolutionized by the introduction of Extracorporeal Shockwave Litothripsy (ESWL) by Chaussy in 1980. ESWL has become the treatment of choice for most patients with upper urinary tract calculi. Compared to other endoscopic modalities, ESWL is safe, effective, minimally invasive, reduce x-ray and anastehestic exposure and show similiar stone-freerate for certain patients.[3,4]

Shockwave lithotripsy can be performed with the aid of either fluoroscopy or ultrasound (US). Fluoroscopy, which is familiar to most urologist, involves ionizing radiation to visualize calculi is excelent for detecting and tracking calcified and otherwise radioopaq stones both in the kidney and ureter. While some stones in the proximal and distal ureter can be imaged with US, this imaging modality clearly limits SWL application in the ureter when compared to fluoroscopy. Ultrasonographic localization allows for visualization of both radioopaq and radioluscent renal stones and real time monitoring of lithotripsy. However, a combination of both fluoroscopy and US can facilitate stone location and minimize radiation exposure.[4,5]

Extracorporeal Shockwaves Lithotripsy (ESWL) is a treatment of choice to most patients with upper urinary tract calculi. The American Urological Association Stone Guidelines Panel has classified ESWL as potential first-line treatment for ureteral and renal stones smaller than 2 cm.[6]

ESWL can clear more than 90% renal and ureteral stones in adults. The success rate and complications of this treatment depends on several factors including stone size, stone location and composition, the type of lithotriptor, shockwave energy and rate, and anatomical characteristic.[6]

OBJECTIVE

This study aim to report patient characteristics and results of Huikang HK-V extracorporeal shockwave lithotripsy (ESWL) machine for renal and ureteral stones in our institution.

MATERIAL & METHOD

We retrospectively reviewed all medical records of patients with kidney and ureteral stones treated with ESWL using HK-V deviced at Dr. Soetomo Hospital from May 2011 to February 2012.

All patients were evaluated radiographically preoperative and 1 until 2 weeks post ESWL, including plain abdominal x-ray, excretory urogram and renal ultrasound. Stone diameter was measured by the longest length on plain abdominal photo or ultrasound. Stone-free was defined as no stone appearance radiographically on the follow-up.

RESULT

From 241 patients, 148 were men (61.4%) and 93 were women (38.6%). Mean age was 47.8 years (ranged 7-87). Stone location was 109 stones in lower pole of the kidneys (41%), 69 in middle pole (26%), 41 in proximal ureter (16%), 28 in upper pole (11%), 14 at renal pelvis (5%), 1 in distal ureter (0.3%) and 2 staghorn stone (0.7%). 130 patients with stone less than 10 mm (53.9%), 102 with stone 10-20 mm (42.3%), and 9 more than 20 mm (3.7%). There were slightly more left-sided treatment in 141 patients (58.5%). Of 181 (75%) patients with hydronephrosis, 104 had DJ stent inserted (43.2%). 143 patients only have one ESWL session (59.3%), 78 patient (32.4%) has two session, 16 patient (6.6%) got 3 session and 4 patients (1.7%) got 4 session of ESWL treatment. Overall, we found 158 patients (65.5%) were stone free after treatment, 49 patients (20.3%) with residual stones less than 4 mm and 34 patients (14.1%) had more than 4 mm residuals (table 1).

We found stone free rate as high as 80%, 45% dan 0% for upper pole kidney stones less than 10 mm, 10-2 mm, and > 20 mm. Stone-free rate for middle pole kidney stone was 80% for stones less than 10 mm, 69% for 10-20 mm and 0% for stones > 20 mm. Lower pole renal stones showed SFR as high as 78% for stones less than 10 mm, 38% for stone 10-20 mm dan 0% stone >20 mm. SFR for renal pelvis stone is 50%, 38%, 50% for stone < 10 mm, 10-20 mm, > 20 mm. Proximal ureter stones < 10 mm, 10-20 mm, > 20 mm showed SFR as high as 88%, 73%, 0% while distal ureteral stone less than 10 mm stone free rate was 100%, no bigger distal ureteral stone was treated with ESWL in our institution during this period. ESWL for 2 staghorn stones in this study showed unsatisfiying outcome, both patients have > 4 mm residual fragment after treatment (table 2).

Table 1. Data characteristic.

	Cathegories	Frequency	Percentage
Sex	male	148	61 .4
	female	93	38 .6
	total	241	100
Age	10-20 y.o *	1	0.4
	21 -30 y.o	12	5
	31 -40 y.o	55	22.8
	41 -50 y.o	68	28.2
	51-60 y.o	70	29
	61 -70 y.o	28	11.6
	71 -80 y.o	5	2.1
	> 81 y.o	2	0.8
	total	241	100
Stone location	upper pole	28	11
	middle pole	69	26
	lower pole	109	41
	pyelum	14	5
	proximal ureter	41	16
	distal ureter	1	0
	staghorn	2	1
	total	264	100
Stone side	left side	141	58.5
	right side	93	38.6
	right side & left side	7	2.9
	total	241	100
Number of stone	single	130	53.9
	multiple	111	46.1
	total	241	100
Hydronephrose	(+)	60	24.9
	(-)	181	75.1
	total	241	100
DJ stent insertion	(+)	104	43.2
	(-)	137	56.8
	total	241	100
Stone opacity	opaq	166	68.9
	semi radioopaq	44	18.3
	non radioopaq	31	12.9
	total	241	100
Number of ESWL	1 x	141	59
	2 x	78	32.2
	3 x	16	6.6
	4 x	4	1.7
	total	241	100

*y.o = years old

Table 2. Stone free rate based on stone position and size.

Stone position		SFR							
		Number	(-)	%	< 4 mm	%	> 4 mm	%	Total
Upper pole	< 10 mm	15	12	80	2	13	1	7	100%
	10-20 mm	11	5	45	5	45	1	9	100%
	> 20 mm	2	0	0	1	50	1	50	100%
	total	28	17	61	8	29	3	11	100%
Middle pole	< 10 mm	40	32	80	4	10	4	10	100%
	10-20 mm	26	18	69	5	19	3	12	100%
	> 20 mm	3	0	0	1	33	2	67	100%
	total	69	50	72	10	14	9	13	100%
Lower pole	< 10 mm	58	45	78	7	12	6	10	100%
	10-20 mm	48	18	38	18	38	12	25	100%
	20 mm	3	0	0	1	33	2	67	100%
	total	109	63	58	26	24	20	18	100%
Pyelum	< 10 mm	4	2	50	1	25	1	25	100%
	10-20 mm	8	3	38	4	50	1	13	100%
	20 mm	2	1	50	0	0	1	50	100%
	total	14	6	43	5	36	3	21	100%
Prox ureter	< 10 mm	24	21	88	2	8	1	4	100%
	10-20 mm	15	11	73	3	20	1	7	100%
	20 mm	2	0	0	0	0	2	100	100%
	total	41	32	78	5	12	4	10	100%
Distal ureter	< 10 mm	1	1	100	0	0	0	0	100%
	10-20 mm	0	0	0	0	0	0	0	0%
	20 mm	0	0	0	0	0	0	0	0%
	total	1	1	100	0	0	0	0	100%
Staghorn	< 10 mm	0	0	0	0	0	0	0	0%
	10-20 mm	0	0	0	0	0	0	0	0%
	> 20 mm	2	0	0	0	0	2	100	100%
	total	2	0	0	0	0	2	100	100%

DISCUSSION

Extracorporeal Shockwave Lithotripsy (ESWL) has become favorable treatment of choice for most patients with simple stones. The concept of using shockwaves in fragmenting the stones has been introduced in Rusia in 1950s, but until then Dornier Co., a space craft company from Germany, found that it can be applied for human body. In 1980 The Dornier Hm3, originally designed to test supersonic aircraft parts, was first shockwaves lithotriptor introduced. It has been developed and updated to some new models of ESWL device now.[1,4]

Fragmentation of stone caused by shock-waves is though to occur through a combination of methods, including spall fracture, compressing and tensile forces, shear stress, superfocusing, acoustic cavitation and dynamic fatique.[1] Of this various forces, the generation of compresive and tensile forces are thought to be the most important.[3]

Stone factors to be considered in treatment of patients with renal and uretel a stones include stone burden (size and number), stone composition and stone location. Stone burdenis perhaps the single most important factor in determining the appropriate treatment modality. However, cut-off points for stones size that would chategorize those who should be treated by ESWL have not been definitevely determined.[7]

In our study, ESWL was done mostly to man in third to sixth decade of age. The modality was choosen to treat mostly for single stones compared to multiple stones, and left side is the a predominant side. Only few comparative studies has been done about the different lithotriptors due to difficulty with variable patient selection, the definition of success and follow up methodology.[8]

We used fluoroscopy as a guidance to localize most stones in this study because radioopaq stones are treated dominantly. For some patients, ultrasound was used as guidance since the stones was non-radioopaq (radioluscent). The combination of US and fluoroscopy was used to provide better localization of semi radioopaq stones.

Stone size usually mentioned in milimeter, using one or two dimension. Stone could be stratified as: less than 5 mm, 5-10 mm, 10-20 mm and > 20 mm.[6] We stratified the patients as 3 groups based on stone size (one dimension) in this study, which is stone less than 10 mm, 10-20 mm and more than 20 mm.

There is a general aggreement that stone-free rate is the most rigorous definition of successfull outcome of any stone removal procedure, and that complete stone clearance should be the preferred goal of any intervention. However, because ESWL outcome is dependent on spontaneous stone clearance, treatment result are often reported in terms of success which may be defined as patients who are either stone-free or who have asymptomatic, small residual fragment. Various cut-off points between 2 and 5 mm are used in literature to define the size of the fragment.[7] In this study, we evaluated residual stone by stratifying it into less than 4 mm and more than 4 mm. Streem et all reports 4 mm as cut-off point for clinically insignificant stone fragments after ESWL and found about 12-30% of patients.[9]

Most renal and ureteral stones size treated with ESWL in this study was ≤ 20 mm. Shock waves for stones more than > 20 mm was only conducted to 9 (3.7%) patients with special consideration from reffering urologist. This result is consistent with guidelines from The American Urological Association Stone Guidelines Panel, which classified ESWL as potential first line treatment for ureteral and renal stones less than < 2 cm.[4]

DJ stents was inserted to some patients, considering several reason including post renal obstruction or previous prosedure in removing the stone. In modern setting, the indication for stenting prior to definitive treatment are much fewer including: obstructed pyelonephritisor pyelitis, newly onset renal insufficiency or failure, in these situation the stent help to ensure internal dranage and allows passive dilatation of the ureter.[4] The European Assosciation of Urology does not recommend DJ stent insertion as part of ESWL for ureteral stones. Several studies shows routine DJ stent insertion before ESWL did not improve stone free rate, reduce obstructive and infective complication.[5,6]

The number of shockwaves needed to fragment the stones depends on 1). Stone composition, 2). Shockwave focusing, 3). Energy density, 4). Fluid interface.[7]

A few prospective randomized trial shows that lowering shockwaves frequency from 120 until 60-90 shockwaves a minute can increase stone free rate especially for stone more than 100 mm.[2] A meta analysis shows the same result to the smaller stones.[6] Greensteinet al., in their study explain that the use of shockwaves with 60 triggers per minutes is more effective in fragmenting stones than 30, 90 or 120 triggers per minute.[8] The number of shocwaves that can be delivered at each session depends on the type of lithotriptor and shockwave power. There is no consensus on the maximum number of shockwaves, but generally the number of shockwaves recommended is 3000-3500. Optimal frequency of shockwave is 1.0.10 Starting ESWL on a lower energy setting with stepwise power (and SWL sequence) ramping can achieve vasoconstriction during treatment which prevent renal injury.[6,11]

We found that small stone show higher stone free rate.[12] This finding is consistent with report of a study conducted by Elsobky et al., who found that smaller stone less than 10 mm has fewer residual fragments after ESWL than stone bigger than 10 mm.[13] Markus J. Badder also mention that repeated ESWL after initial treatment failure have a low success rate. In this study we reported stone free rate as high as 68% after one ESWL, and become 46% and 31% after second and third ESWL.[14] Stone composition can meaningfully affect the result of ESWL. Uric acid and stone calcium oksalat dihydrath as better fragmentation cooficient compared to calcium oksalat monohydrat and sistin, but there was no data on stone composition in this study.[7]

ESWL show high SFR for stone smaller than 20 mm in any intra renal location except for lower pole, and it is has become the treatment of choice for these stones.[6] We found stone free rate as high as 80%, 45%, and 0% for upper pole kidney stones which size is < 10, 10-2 mm, dan > 20 mm. A similiar result have been reported by other studies in literatures. Can Obek et al., repot SFR for stone < 10 mm is 84% (64-92%), 10-20 mm is 77% (59-81%).[15] Graff et al., report 78% of SFR in this location. Stone-free rate for middle pole of the kidney stone is 80% for stone < 10 mm, 69% for stone 10-20 mm and 0% for stone > 20 mm. Can Obek et al., report a similiar value for this location which is 73%, while Graff et al., report SFR as high as 76%.[15,16]

The efficacy of ESWL as first line treatment for lower pole is controversial. Some studies report lower stone free rate range between 25-85%, even lower for many patients, therefore they suggested to consider using a percutaneous approach (PNL) rather than ESWL for these stones.[17] Stone clearance rate for lower pole kidney stones after ESWL is lower than any other intra renal location.[6] Although ESWL can fragmen stones in the lower pole of the kidney, the resulting stone free rate is decresed becouse of the difficulty in passing stones from this location. Can Obek et al., reported stone free rate based on stone size in lower pole: 74% for stone less than 10 mm, 56% for 10-20 mm, and 33% for stone more than 20 mm.[15] Graf et al., report SFR as high as 58% for lower pole renal stones after ESWL,[16] while Lingeman et al., who conducted a meta analysis of 13 studies on management for lower pole renal stone by ESWL report average short time stone-free rate are 70%.[18] In our study, we report SFR for lower pole renal stone is 78% for stone size < 10 mm, 38% for stone 10-20 mm dan 0% stone > 20 mm. Recent studies have delineated renal morphology associated with decresed stone free rate e.g. infindibulopelvic angle of < 70, an infundibular lenght of > 3 mm an infundibular width of < 5 mm.[3]

SFR for renal pelvis stone is 50%, 38%, 50% for stone < 10 mm, 10-20 mm, > 20 mm. A quite different result from some studies reported, bigger renal pelvic stone (> 1.5 cm) shows stone-free rate as high as 75% after 3 month, for small pelvic kidney stone (< 1.5 cm) stone-free rate increase to 90%.[1] Ozgur et al., conclude that average stone size and stone burden for pelvis renalis is the most significant factor influencing SRF for pelvic kidney stone.[19]

SFR for proximal ureter stones < 10 mm, 10-20 mm, > 20 mm in this study are 88%, 73%, 0%. Several literatures reported stone-free rate for proximal ureteral stones is 82%, and there is no significant different with DJ stent.[17] Bigger stone size (> 20 mm) reduce stone free rate and increase complication and the need for auxillary procedure.[19] Shun Fa Hung found SFR as high as 86.5% from 319 patients with proximal ureteral stones which average size is 6.1 mm treated by ESWL.[20] For proximal ureteral stone less than 10 mm, ESWL was superior to URS, while for stone more than 10 mm, ESWL was inferior to URS. For distal ureteral stone URS still shows highest SFR than other stone removal procedures including ESWL.[6] We found SFR for distal ureteral stone as high as 100% for stone less than 10 mm, no bigger stone was treated with ESWL in our institution during this period.

ESWL for 2 staghorn stones in this study showed unsatisfiying outcome, both patients have > 4 mm residual fragment after treatment. This result consistent with some literatures stating that patients with renal calculi greater than 2 cm who are treated with ESWL monotherapy commonly experience poor treatment outcome. The 2 cm threshold is still valid in the present day.[8]

CONCLUSION

ESWL is the treatment of choice for simple renal and ureteral stones less than 20 mm (opaque and non opaque). ESWL shows highstone-free rate (SFR) for renal and ureteral stones less than 20 mm.

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