

Comparison of Outcome of SWL versus PCNL in Solitary Lower Pole Calculus

AUTHORS- Dr Vivek Kothari¹, Dr Shivadeo S Bapat², Dr Deepak Kirpekar³, Dr Sunil Gora⁴

¹Assistant Professor, Department of Urology and Transplantation Surgery, Institute Of Kidney Disease and Research Centre, Institute of Transplantation Sciences, Civil Hospital Campus, Gujarat

²MBBS, MS (General Surgery), Fellowship in Urology, Founder trustee of Maharashtra Medical Foundation and Ratna Memorial hospitals, Ex-Professor and Head, Department of Urology, Maharashtra Medical Foundation's, Pune, Maharashtra

³MBBS, MS (General Surgery), Fellowship in Urology, Past President of Urology Society Pune, Guide and P.G teacher, Department of Urology, Maharashtra Medical Foundation's, Pune, Maharashtra

⁴MBBS, MS (General Surgery), DNB (Urology), Gora Urology Clinic, Shramdan Marg, Sikar, Rajasthan

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Corresponding Author: Dr Vivek Kothari, Department of Urology and Transplantation Surgery, Institute Of Kidney Disease and Research Centre, Institute of Transplantation Sciences, Civil Hospital Campus, Gujarat

E-mail addresses: dr.vivekkothari@gmail.com, researchguide86@gmail.com

Abstract

Background and Aim: The goal of lower pole calculus (LPC) management is to achieve maximal stone clearance with minimal morbidity Management of LPC is still a dilemma for the urologist. Both PCNL and SWL are done routinely in Department of Urology at Medical Foundation. This has led us to study and compare efficacy of Shock Wave Lithotripsy (SWL) and Percutaneous Nephrolithotomy (PCNL) in management of solitary LPC of 10mm to 20mm size.

Material and Methods: A total of 60 patients coming to the medical Hospital were recruited in this prospective study. In all patients, a detailed history was taken and a physical examination was done. Routine laboratory investigations were done. Radiological evaluation was done in the form of plain X - ray of kidney, ureter and bladder (KUB) and ultrasound of the abdomen. Patients were asked to choose any one, out of 60 34 patients chose SWI and 26 chose PCNL. Number of shock waves used and number of sessions required, cumulative procedure time that is total time taken in all the session required to treat one patient was calculated. Any complication or need for any ancillary treatment was also noted.

Results: There is no significant difference in the stone size (mm) between the SWL group and PCNL group. Mean LIA was found to be 53.22 and 54.96 in SWL and PCNL group respectively. Mean IW was found to be 6.75 mm and 6.25 mm in SWL and PCNL group respectively. Mean IL was found to be 19.59 mm and 19.54 mm in SWL and PCNL group respectively. There is no significant difference in the IL between the SWL group and PCNL group.

Conclusion: SWL achieves similar stone free rates as compared to PCNL. It is advantageous over the PCNL in terms of procedure time. However other than stone size LIA may have impact on stone clearance but is not statistically significant. SWL has more complications in treating > 15mm stone than in treating < 15mm stone.

Key Words: Lower pole calculus, Percutaneous Nephrolithotomy, Shock Wave Lithotripsy, Stone

Introduction

Due to its particular anatomical position below the ureteropelvic junction, the lower pole calculus (LPC) plays a special role in the treatment of nephrolithiasis. The goal of LPC management is to achieve maximal stone clearance with minimal morbidity. Management of LPC is still a dilemma for the urologist. The preferred approach is extracorporeal shockwave lithotripsy (SWL) for stones < 1cm and percutaneous nephrolithotomy for stones > 2cm¹. Controversy still remains in the treatment of 1-2 cm LPC and no single method is preferred. SWL, PCNL, and flexible ureteroscopy (RIRS) are the currently used therapeutic methods.^{1,2} SWL: Since its introduction in 1980 SWL became the preferred treatment option in majority of renal calculi because of its non invasive nature and low potential of complications. But there has always been a controversy regarding its use in LPC.^{3,4}

PCNL: Even after > 30 years of its introduction PCNL remains a milestone technique in field of endourology with high success rate and acceptably low percentage of complications. The success of PCNL for treatment of LPC does not depend on anatomic factors that usually affect outcome of SWL and RIRS⁵. Now with introduction of Mini PCNL (Miniperc) this approach has become more appealing.^{5,6}

RIRS: Role of flexible ureteroscopy in urologist's armamentarium has undergone a significant revolution due to improvement in fibre optics, decreasing size of instrument , better irrigation system . Hence there is increase interest in using RIRS for LPC .^{7,8}

Both PCNL and SWL are done routinely in Department of Urology at Medical Foundation. This has led us to study and compare efficacy of SWL and PCNL in management of solitary LPC of 10mm to 20mm size.

MATERIALS AND METHODS

A total of 60 patients coming to the medical Hospital were recruited in this prospective study. An adult patient with isolated, lower calyceal calculi of size 10-20mm was included in the study.

Exclusion criteria:

Patients with concomitant calculi on same or opposite side , urethral stricture or ureteropelvic junction obstruction , infundibular stenosis or calyceal diverticulitis associated with targeted

stone , a transplant , pelvic or solitary kidney , renal insufficiency (sr . creat > 2.0mg / dl) , pregnancy , urinary diversion , impassible urethral stricture , active urinary tract infection or immune - compromised state . We also excluded patients with age < 18 years or those having surgical contraindications. Patients with uncorrected coagulopathy and morbidly obese patients were also excluded from the study. Patients with a history of previous PCNL or open surgeries in the retroperitoneum were also excluded.

All patients included in the study were evaluated as per 1). In all patients, a detailed history was taken and a physical examination was done. Routine laboratory investigations were done. These included hemogram, renal function tests, blood sugar level, coagulation profile, urinalysis and urine culture and sensitivity. Appropriate antibiotics were given preoperatively in cases where urine culture showed evidence of infection. Radiological evaluation was done in the form of plain X - ray of kidney, ureter and bladder (KUB) and ultrasound of the abdomen. The stone size was defined as the larger of the two dimensions calculated by measurement of the length and width of the stone on a preoperative plain X - ray KUB. All patients underwent an intravenous urography (IVU) prior to the procedure to assess the collecting system and those not eligible for the study were excluded.

Once participation and inclusion of the patients in the study was confirmed patient were explained regarding both SWL and PCNL procedure and asked to choose any one, out of 60 34 patients chose SWI and 26 chose PCNL. After confirmation of procedure, the LP infundibular length (IL), width (IW) and lower infundibulopelvic angle (LIA) were measured on preoperative intravenous urography, using the method described by Elbahnasy et al (Figure 1). We used cut - offs to discriminate between the favourable and unfavourable lower calyx anatomical parameters : 55 ° for the LIP angle , 20 mm for IL , and 7 mm for IW .In SWL group:

All cases were treated on day care bases without any anaesthesia. DJ stent was not inserted in any patient. Dornier Sigma (third generation) an electromagnetic shock wave lithotripter was used. Patients were given supine position on lithotripsy table. Both X - Ray and USG were used for localization of stone. All sessions were performed by single technician under supervision of consultant. Shock waves were delivered at a rate of 60-80 per minute with a maximum of 2500 shocks per one session of treatment. Maximum of 4 sittings were given. A gap of 10 to 14 days was kept between two sittings. All patients were advised to drink lots of fluids and to follow active lifestyle and jumping exercises if possible. Study end points included stone free status which was defined as either no visible fragments or fragments less than 4 mm, which were considered as clinically insignificant residual fragments, as determined by both X - Ray KUB and USG KUB for maximum of 3 month after last sitting . Number of shock waves used and number of sessions required, cumulative procedure time that is total time taken in all the session required to treat one patient was calculated. Any complication or need for any ancillary treatment was also noted.

In PCNL group :

Under general or spinal anaesthesia, the patient was given lithotomy position on fluoroscopic table . A 5 Fr ureter catheter was passed into the pelvicaliceal system under fluoroscopic guidance over a 0.035 inch guide wire. A 12 Fr PVC Neaten catheter was placed into the urinary bladder and fixed to the skin with adhesive tapes. The patient was then made prone

and the surgical field was prepped and draped. Puncture of the lower calyx was done under fluoroscopic control with an 18 - gauge tracer needle. A 0.035 - inch J - tipped PTFE guide wire was then introduced into the renal collecting system via the puncture needle and positioned in the ureter or else in the superior calyx. A second working guide wire was then passed into the collecting system. Then the decision of doing either a standard PCNL or Miniperc was taken by operating surgeon.

For Standard PCNL, the nephrostomy tract was dilated by serial dilators to 28 F and an Amplatz sheath was passed. A 26 Fr Nephroscope (Karl Storz , Germany) was then introduced in the pelvi - calyceal system . Pneumatic lithoclast (Swiss Lithoclast) or Holmium: YAG laser were used to fragment the stones . Stone fragments were then retrieved using biprong forceps.

For Miniperc , the tract was dilated with a 15 or 16.5 Fr metal bougie and a 15 or the 16.5 Fr nephroscopy sheath was then screwed over the bougie . The 12 Fr nephroscope (Karl Storz , Germany) was then introduced in the renal collecting system . Renal stones were fragmented with Holmium: YAG laser using a 365 - μm fibre. The stone fragments were retrieved by exploiting the irrigation flow and the resultant vacuum cleaner effect. This effect exists without any increase in the intrapelvic pressure. The stone fragment to be removed is focused in front of the tip of the nephroscope . The vacuum cleaner effect causes it to remain attached to the tip of the nephroscope which is then slowly retracted . Once the endoscopy demonstrated the absence of calculi, the renal collecting system was examined under fluoroscopy to confirm absence of any residual stones.

At the end of both the procedures, a 6 Fr double - J stent was placed in the ureter in an ante grade fashion . Decision of placement of nephrostomy was left to the discretion of the operating surgeon . A tubeless PCNL (double J stenting but no nephrostomy) was done if the following criteria were met i.e. no perforation of collecting system , minimal bleeding , complete stone clearance as assessed by intraoperative nephroscopy and fluoroscopy at the end of the procedure . For a tubeless procedure, the flank was compressed for 10 min .

In case a tubeless procedure was not planned , a 22 Fr or 24 Fr nephrostomy tubes was kept after a standard PCNL while a 12 Fr nephrostomy tube was kept after a Miniport . The urethral catheter was removed on postoperative day (POD) 1. On the POD 2 an X - ray KUB was performed to look for the presence of any clinically significant residual calculi , defined as stones $> 4\text{mm}$. After confirmation of absence of any residual calculi on an X - ray KUB , the nephrostomy tube was removed on POD 2 and the patient was discharged . The double - J stent was removed at end of 3-4 weeks after confirming a stone free status on an X - ray KUB and USG KUB . Stone free status was defined as either no visible fragments or fragments less than 4 mm which were considered as clinically insignificant residual fragments on an X - ray KUB and USG KUB. A second stage PCNL if employed to clear residual fragments was documented. Other ancillary methods such as extracorporeal lithotripsy (SWL) or retrograde intra renal surgery (RIRS) if done for any residual stone fragments were also documented. Any complications either intra operative or postoperative were also noted. Type of anaesthesia, procedure time , that is time required from start of anaesthesia to completion of dressing , was also noted.

Statistical analysis

The data was analyzed by using microsoft excel sheet and Graph Pad's software . The data was reported as number and percentage or mean and standard deviation , as appropriate . Paired t - test was performed for statistical analysis of quantitative variables . Categorical and qualitative data between the groups was analyzed by Fisher's exact test from a 2X2 contingency table . Level of significance was expressed as probability value (P - value) . P - value of < 0.05 was considered statistically significant .

RESULTS

A prospective randomized study of 60 patients of solitary LPC treated with SWL PCNL (n = 26) was carried out in Department of Urology , of (n = 34) during a period of 20 month. We recorded patient related factors that could have contributed to study outcome like age, gender and co morbidity.

Age distribution:

Patients taken in study were all adults (> 18 yrs) . In SWL group the range of age distribution was 26-58 years with mean of 39.68 years . In PCNL group age distribution was 24-54 years with mean of 38 years . The Comparison of age was done in SWL group and PCNL group. By using the paired t - test , P - value was 0.42 , therefore there is no significant difference between the age (years) in SWL group and PCNL group .

Gender distribution:

In our study out of total 60 patients 24 were female and 36 were male . In SWI group male accounted 65 % (22/34) whereas female accounted 35 % (12/34) . In PCNL group male accounted 54 % (14/26) whereas female accounted 46 % (12/26) . By using the Fisher's exact test, P - value was found to be 0.4352 ; therefore there is no significant difference between the proportion of gender in SWL group and PCNL group .

Out of 60 patients a total of 14 patients were having co morbidities mainly in form of diabetes mellitus, hypertension or ischemic heart disease. Of which 8 were in SWL group and 6 in PCNL group. By using the Fisher's exact test , P - value was found to be 1.0 ; therefore there is no significant difference between the proportion of co morbidities in SWL group and PCNL group .

We recorded the distribution of patient with respect to side of stones as determined on X - RAY or USG. Out of 60 patients a total of 28 (47 %) patients were having left sided LPC and 32 (53 %) were having right sided LPC. By using the Fisher's exact test , P - value was 1.0 ; therefore there is no significant difference between the SWL and PCNL group with regard to the distribution of patients in respect to the side of stone .

Stone size:

Stone size in both SWL and PCNL were compared and found that SWL had stone size from 11-20mm with mean size of 15.32mm and PCNL had stone size ranging from 11-20mm with mean size of 15.27mm. By using the unpaired t - test, P - value was 0.93 ; therefore there is no significant difference in the stone size (mm) between the SWL group and PCNL group .

Lower Infundibular Angle (LIA) :

As it has been found that LIA has effect on stone clearance we calculated distribution of LIA in both groups. Mean LIA was found to be 53.22 " and 54.96⁰ in SWL and PCNL group

respectively. By using the unpaired t - test, P - value was 0.33; therefore there is no significant difference in the LIA between the SWL group and PCNL group .

Infundibular Width (IW) :

Also it has been found that IW has effect on stone clearance we calculated distribution of IW in both groups. Mean IW was found to be 6.75 mm and 6.25 mm in SWL and PCNL group respectively.

Infundibular Length (IL) :

It has also been found that IL has effect on stone clearance we calculated distribution of IL in both groups. Mean IL was found to be 19.59 mm and 19.54 mm in SWL and PCNL group respectively. By using the unpaired t - test , P - value was 0.94 ; therefore there is no significant difference in the IL between the SWL group and PCNL group. Thus from the above analysis we found that our both groups SWL and PCNL were not statistically different with respect to both patient and stone characteristics.

Table 1: Characteristics of patients and stone in both the groups

characteristics		SWL group (n = 34)	PCNL group (n = 26)	P - Value
Mean age(years)		39.68	38.0	0.42
Gender	MALE	22	12	0.29
	FEMALE	12	12	1.0
Co morbidity		8	6	1.0
Stone Side	Right	18	14	1.0
	Left	16	12	
Mean Stone Size (cm)		15.32	15.27	0.93
LIA		53.32	54.96	0.33
IW (mm)		6.75	6.25	0.43
IL (mm)		19.59	19.54	0.94

Stone Free Status

On comparing the stone free status of patients in both the groups it was found the out of 34 patients only 8 patients were found not to be stone free at end of months after last session . In this group we also included patient who didn't had a fragments left in kidney but stone fragments seen in course of ureter . Whereas PCNL group out of 26 patients only 3 were found not to be stone free .

Complications

On analyzing complications in both the groups it was found that in SWL group a total of 25 patients didn't have any complications whereas 9 had complications of which 3 had colics , 4 had stienstrase and 2 had urinary tract infections . On the contrary in PCNL group it was found that out of 26 only 6 patients had complications of which 3 had intra - op bleeding , 2 had intra - op pelvic perforations , 1 had post - op hematuria and one patient had urinary tract infections.

Ancillary Procedure

Requirement of ancillary procedure in both SWL group was recorded. It was found that ancillary procedure was required in SWL group in 29.4 % (10/34) and in PCNL it was found to be 20 % (4/20) . In SWL group all patient who had stienstrasse underwent URS whereas 2 patients with colic required DJ stent to be inserted , 3patient required PCNL as stone didn't fragmented in spite of 4 sitting and in 1 RIRS was required due to non clearance of stone . In PCNL group 2 patient required re - look PCNL and I required SWL for a significant residual fragment , 1 patient who had hematuria post - op was found to have A - V malformation and required angioembolisation .

Subgroup Analysis

For better understanding of our results we divided both SWL and PCNL in two groups each one having stone size less than or equal to 15mm and other having more than 15mm .

On analyzing both the groups we found that in SWL group 55.9 % patient had stone size < 15mm and 44.1 % had stone size > 15mm . In PCNL group 57.7 % patient had stone size < 15mm and 42.3 % had stone size > 15mm .

Stone free rate :

We compared stone free rates in both < 15mm and > 15mm group using both SWL and PCNL method and found that with SWL in stone < 15mm stone free rate was 94.7 % (18/19) and for stone > 15mm it was 53.33 % (8/15) . In PCNL group stone free rate was found to be 100 % (15/15) and 72.7 % (8/11) in < 15mm and > 15mm group respectively .

Table 2: Stone free rates

GROUP	< 15mm	> 15mm	P – VALUE
SWL	94.7 %	53.33%	0.0113
PCNL	100%	72.7%	0.0635
P – VALUE	1.0	0.423	

Complications

Complication rate in SWL and PCNL was determined in both stone < 15mm group and > 15mm group . It was found that complication rate in SWL group for stone size < 15mm was 10.53 % (2 out of 19) and for stone size > 15mm was 46.67 % (7 out of 15) . In PCNL group for stone size < 15mm complication rate was 13.33 % (2 out of 15) and for stone size > 15mm was 36.36 % (4 out of 11) .

Ancillary Procedure

We analyzed number of ancillary procedure required in both SWL and PCNL for stone size < 15mm and > 15mm . It was found that only 1 patient required ancillary procedure for stone < 15mm and 9 patients required ancillary procedure for stone size > 15mm in SWL group . In PCNL group requirement of ancillary procedure was 0 for stone size < 15mm and 4 for stone size > 15mm .

Table 3: Ancillary Procedure rates

GROUP	< 15mm	> 15mm	P – VALUE
SWL	1	9	0.0015
PCNL	0	4	0.0221
P – VALUE	1.00	0.428	

By using fisher's exact test it was found that difference between ancillary procedure rate in SWL group for stone size $< 15\text{mm}$ and $> 15\text{mm}$, P - value was 0.0252 which was statistically significant . Whereas in PCNL group the difference between ancillary procedure rate for stone size $< 15\text{mm}$ and $> 15\text{mm}$, P - value was 0.0221 which was also statistically significant . But the difference in ancillary procedure rate between SWL and PCNL was not significant in both $< 15\text{mm}$ and $> 15\text{mm}$ group.

Effects of Anatomical Factors

We also compared the difference in stone free rate in both SWL and PCNL group due to anatomical factors like Lower Infundibular Angle (LIA) , Infundibular Width (IW) , Infundibular Length (IL) .

For analysis we divided all patients in 2 groups for all the above three criteria's . For LIA groups were divided as those less than 55° ($< 55^\circ$) and those more than or equal to 55° ($> 55^\circ$) . For IW the division was those less than 12mm ($< 12\text{mm}$) and those more than or equal to 12mm ($> 12\text{mm}$) . And for IL the division was less than 25mm ($< 25\text{mm}$) and those more than or equal to 25mm ($> 25\text{mm}$) .

Lower Infundibular Angle

In $< 55^\circ$ group there were 23 patients in SWL group of which 15 were able to achieve stone free status and 8 were not able to achieve stone free status . Similarly in PCNL group total of 15 patients were having LIA $< 55^\circ$ of which 14 achieve stone free status and 1 was not able to achieve stone free status .

In $> 55^\circ$ group SWL group had 11 patients and all got stone free and PCNL had 11 patients of which 9 got stone free .

By using fisher's exact test we found that the difference between stone free rate between SWL group and PCNL group in LIA $< 55^\circ$ was having P - value of 0.0611 which was statistically not significant . Similarly in LIA $> 55^\circ$ stone free rate difference between SWL and PCNL group showed P - value of 0.4762 , which was also statistically not significant . But in SWL group on comparing stone free rate between LIA of $< 55^\circ$ and LIA $> 55^\circ$, P - value was found to be 0.0339 which is statistically significant whereas in PCNL group similar comparison showed a P value of 0.5558 which is statistically not significant .

Infundibular Width

In $< 7\text{mm}$ group there were 16 patients in SWL group of which 11 were able to achieve stone free status and 5 were not able to achieve stone free status . Similarly in PCNL group total of 16 patients were having IW $< 7\text{mm}$ of which 15 achieve stone free status and 1 was not able to achieve stone free status .

In $> 7\text{mm}$ group SWL group had 18 patients and 15 got stone free and PCNL had 10 patients of which 8 got stone free.

By using fisher's exact test we found that the difference between stone free rate between SWL group and PCNL group in IW $< 7\text{mm}$ was statistically not significant , having P - value of 0.1719 . Similarly in IW $> 7\text{mm}$ stone free rate difference between SWL and PCNL group showed P - value of 1.00 , which was also statistically not significant . But in SWL group on comparing stone free rate between IW of $< 7\text{mm}$ and IW $> 7\text{mm}$, P - value was found to be

0.429 which is statistically not significant whereas in PCNL group similar comparison showed a P - value of 0.5385 which is also statistically not significant .

Infundibular Length

In < 20mm group there were 19 patients in SWL group of which 17 were able to achieve stone free status and 2 were not able to achieve stone free status . Similarly in PCNL group total of 15 patients were having IL < 20mm of which 13 achieve stone free status and 2 was not able to achieve stone free status . In > 20mm group SWL group had 15 patients and 9 got stone free and PCNL had 11 patients of which 10 got stone free .

By using fischer's exact test we found that the difference between stone free rate between SWL group and PCNL group in IL < 20mm was statistically not significant , having P - value of 1.00 . Similarly in IL > 20mm stone free rate difference between SWL and PCNL group showed P - value of 0.1783 , which was also statistically not significant . In SWL group on comparing stone free rate between IL of < 20mm and IL > 20mm , P - value was found to be 0.100 which is statistically not significant whereas in PCNL group similar comparison showed a P - value of 1.00 which is also statistically not significant.

Discussion

The true incidence of LPC has not been established . Cass et al⁹ reported an incidence of 30-36 % stones treated with SWL was located in Lower Pole calyx . In general , it is recognized that small - sized calculi < 1 cm are treated successfully with SWL while for larger ones > 2 cm the method of choice is PCNL . Stones in the range of 1-2 cm represent an area of ongoing controversy regarding the respective roles of SWL , PCNL and ureteroscopy⁹. Stone in lower pole still catches attention because of its unique anatomical characteristics of lying below . the uretero - pelvic junction.^{10, 11}

Main goal of any procedure for calculus disease is to achieve complete stone clearance . Failure in achieving this goal can be due to various factors related to patient , stone , technique used . Thus many factors determine stone clearance rate in a patient. SWL is the initial treatment of choice for most renal calculi because of its non-invasive nature , requirement of minimal anaesthesia , and tolerability by patients and physicians . Although SWL has become the preferred treatment modality for the majority of upper urinary tract stones , its results in LP stones are unsatisfactory.¹²

Since Lingeman et al¹³ described inferior results of SWL in LPC in his meta analytic study , many investigators have studied various factors which influence the stone clearance of LPC using SWL . Factor most strongly associated with poor stone clearance rate was found to be stone size.¹⁴ Albala et al¹⁵ found lower calyceal anatomy as confounding factor in clearance of LPC by SWL . Method to measure , the LP infundibular length (IL) , width (IW) and lower infundibulopelvic

angle (LIA) , on preoperative intravenous pyelography (IVU) , was described by Elbahnasy et al . But other investigators like Madbouly et al¹⁶, didn't find that lower calyceal anatomy affected stone clearance significantly . McCullough et al¹⁷, Brownlee et al,¹⁸ D'A Honey et al and others described various postural manoeuvres to improve stone clearance post SWL for LPC .

Use of PCNL in LPC was strongly supported by Albala et al who noted the stone clearance rate was significantly more by using PCNL than SWL for LPC. Other investigators like Havel et al¹³, May et al² also found superiority of PCNL over SWL in treating LPC.

Despite the lower stone-free rates achieved with SWL therapy, a number of clinicians advocate this modality for the treatment of patients with lower pole calculi. In fact, a survey performed by Gerber found that 65% of urologists would use SWL for lower pole stones 1 to 2 cm in size and 2% would treat stones greater than 2 cm with SWL. Also the use of PNL may be limited for the general population as this procedure involves invasive renal parenchymal puncture to access the renal calyceal stones, and should be performed under anaesthesia with the patient in a prone position. Therefore, SWL still plays an important treatment option for the management of LPC because it does not require any anaesthesia. The rapid development of technical devices also makes SWL an attractive treatment modality.

This study was carried out to compare the outcome of SWL versus PCNL in patients having solitary LPC of 1-2 cm size. Of the 60 patients included in our study, 34 patients underwent a SWL while 26 patients underwent a PCNL.

The mean age of patients in the SWL and PCNL group was 39.68 ± 9.18 and 38.0 ± 9.68 respectively with no significant difference between the two groups ($P = 0.41$). The male to female ratio was 11 : 6 and 7 : 6 in SWL and PCNL group respectively with no significant difference between the two groups ($P = 0.44$). The co-morbidity rate was 23.53% in SWL group and 23.08% in PCNL group ($P = 1.00$). Thus both the groups were comparable with respect to the age, gender and co-morbidity profile of the patients.

In the SWL group 16 (47.06%) patients had stones in their left kidneys and 18 (52.94%) patients had stones in their right kidneys while in the PCNL group 12 (46.15%) and 14 (53.85%) patients had stones in their left and right kidneys respectively. The difference in the two groups with regard to the side of the stone was not significant ($P = 1.00$).

The mean stone size in the SWL and PCNL group were 15.32mm and 15.27mm respectively ($P = 0.94$). The difference between the two groups with regard to the stone size was not statistically significant ($P > 0.05$).

In the SWL group mean LIA was 53.22° and 23 (67.65%) had $LIA < 55^\circ$ whereas 11 (32.35%) had $LIA > 55^\circ$. In PCNL group mean LIA was 54.96° and 15 (57.69%) had $LIA < 55^\circ$ whereas 11 (42.31%) had $LIA > 55^\circ$ ($P = 0.33$). Similarly the mean IL was 19.59mm in SWL group and 19.54mm in PCNL group ($P = 0.94$), with 19 (55.88%) in SWL and 15 (57.69%) in PCNL group having $IL < 20mm$. The mean IW in SWL group was 6.75mm and in PCNL group it was 6.25mm ($P = 0.45$) with total of 16 (47.06%) and 16 (61.54%) patient having $IW < 7mm$ in SWL and PCNL group respectively. Thus both groups were comparable in terms of lower calyceal anatomy.

The three most significant outcome measurement of any procedure are the stone free rates, requirement of ancillary procedures and the associated complications. Many studies have compared success rates after SWL and PCNL for LPC.

As different studies have different definitions of success the success in different studies are likely to be different. Some authors strictly means success as no stone fragment visualized by using CT scan, whereas other include clinically insignificant residual fragments (CIRF) of

less than 4mm as visualized on X - ray KUB or USG KUB . We have included CIRF in stone free status and hence our study apparently shows better results of SWL as compared to other studies . Many authors have compared the complication rates while using SWL and PCNL in LPC.

Main complications in our study were found to be steinstrasse , colic and UTI in SWL group whereas in PCNL group it was bleeding , pelvic perforation and UTI . Also complication rates were significantly more in stone size > 15mm in SWL group (P = 0.01) , but in PCNL group the difference in complication rate in stone size > 15mm and size < 15mm was not found (P = 0.64) .

Few investigators have also compared ancillary procedure requirement in treating 10-20mm LPC by SWL and PCNL. They have found that SWL procedure require more ancillary procedure as compared to PCNL . SWL PCNL

In our study the requirement of ancillary procedure between SWL and PCNL group was not significantly different (P = 0.24), one of the reason for this may be that various study consider 2nd sitting if SWL as ancillary procedure but we have not consider it as ancillary procedure . Also it was found that requirement of ancillary procedure was significantly more both in SWL and PCNL group when treating stone > 15mm size (P = 0.002) and (P = 0.022) , respectively .

Procedure time required in SWL and PCNL have also been compared in various studies and have found that SWL generally required less time as compared to PCNL. Also hospital stay was found to be more in PCNL group as compared to SWL group as no patient in SWL group required hospitalisation .

Thus in concordance with other studies our study also found that PCNL requires more time than SWL for treating LPC of 10-20mm size , which was statistically significant (P < 0.0001). Also as expected time to treat stone of > 15mm size was more than time to treat < 15mm stone in both the groups. As we didn't admit any patient in SWL group we were not comparing hospital stay .

As mentioned previously many investigators have found that lower calyceal anatomy does hamper the stone free rate in LPC treated with SWL , whereas others have refuted it . We in our study also found that lower calyceal anatomy doesn't play much role in determining stone free rate in SWL for LPC . Effect of IL and IW was found to be statistically not significant when comparing stone free rate between PCNL and SWL in patients having IL > 20mm , IW < 7mm . Also stone free rates by SWL in patients having IL < 20mm v / s IL > 20mm and IW < 7mm v / s IW > 7mm was found to be not significant . Stone free rates were more in PCNL as compared to SWL in group with LIA < 55 ° but it failed to reach level of significance though marginally (P = 0.06) . But difference in stone free rate in SWL group in patient with LIA < 55 ° and in patients with LIA > 55 ° was statistically significant (P = 0.03) .

The findings from our study thus support use of SWL in LPC of stone size 10 20mm . The erroneous perception of futility of SWL in LPC of 10-20mm among many urologists, which make them perform more PCNL in LPC , should undergo correction . Patients should be informed about possibility of requiring more than 1 sitting of SWL and need to follow active lifestyle and jumping exercises if possible , with lots of fluid consumption . This may lead to better stone clearance rate .

Conclusion

- SWL achieves similar stone free rates as compared to PCNL.
- It is advantageous over the PCNL in terms of procedure time.
- However other than stone size LIA may have impact on stone clearance but is not statistically significant.
- SWL has more complications in treating > 15mm stone than in treating < 15mm stone.

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