ISSN (Print) : 2348–263X
ISSN (Online) : 2348-2648
MVP Journal of Medical Sciences, *Vol 4(2), 126–134, July-December 2017* DOI: 10.18311/mvpjms/2017/v4i2/746

Clinical Profile of Patients with Renal Calculi in a Tertiary Care Centre

Sagar P Kolhe[1] and Sudhir D Bhamre[2*]

[1]PG Resident, Department of General Surgery, Dr. Vasantrao Pawar Medical College Hospital & Research Centre, Nashik - 422003, Maharashtra, India; ragasehlok@gmail.com

[2]Professor & Head, Department of General surgery, Dr. Vasantrao Pawar Medical College Hospital & Research Centre, Nashik - 422003, Maharashtra, India; sudhir_bhamre@yahoo.com.

Abstract

Aims: To study the clinical profile of patient diagnosed with renal calculi. To study various Ultrasonographic findings of renal calculi. To study early complications associated with various management techniques. **Materials and method:** Total of 73 subjects will be included in present study after they satisfy inclusion and exclusion criteria. Intra and post operative complication if any was noted. **Results:** Ureter is the most common site of renal calculi followed by renal pelvis. complications with minimal invasive procedures is less as compare to open surgical procedure group with shorter hospital stay as early return to work. **Conclusions:** Ureter being the most common site, URSL was the most common intervention performed followed by PCNL. As compared to open techniques; in minimal invasive procedures rate of post interventional complications, duration of analgesics and days of hospital stay are low, improving the patient acceptance of the procedures.

Keywords: Profile, Renal Calculi, Tertiary care centre

1. Introduction

Renal calculi are the third most common condition of urinary tract exceed only by Urinary tract infection and pathological cases of prostate. They have plagued humans since the earliest records of civilization.

Renal calculi affect 5-15 % of population world wide[1] with 12% in men and 6% in female[6]. There is life time risk of passing a kidney stone of about 8-10 %[3]. Age of onset around 20 years in male which peak at 40-60 years.

Presentation varies according to geographical areas and seasonal factors with high incidence in warmer climate and also with the anatomical abnormalities of urinary tract[2].

They are formed by aggregation of crystals with noncrystalline protein matrix[8]. These crystals clump together to form a stone. They move when they reach certain site and pass down to ureter causing colic symptoms.

There are various types of stones based on its content. 80% of stones contain calcium that too 60% in oxalate and 20% in phosphate form[8].

Renal calculi are also associated with various medical disorders such as primary hyperparathyroidism, myeloproliferative disorders, and renal tubular acidosis etc[5].

Previous stone formation is also a risk factor with 30-40 % chance of recurrence.

Patient most commonly present with renal colic i.e., sudden onset pain in loin at costo-vertebral angle with nausea and vomiting with concomitant infection is also present often. Patient with uncomfortable pain should undergo radiological urinary examination and specific blood investigations to reach upto final diagnosis.

Here we look forward to get a better understanding of this multifactorial disease process in a hope of developing an effective line of management.

2. Material and Methods

2.1 Eligibility Criteria

2.1.1 Inclusion Criteria

Subjects more than 18 years of age irrespective of sex clinically and radiologicaly confirmed cases of renal calculi irrespective of size and location of calculi.

*Author for Correspondence

2.1.2 Exclusion Criteria

- Patient with incidentally found renal calculi on ultrasonography.
- Any other co-morbid renal condition apart from renal calculi.

3. Methodology

The study will be conducted in Department of Surgery of a medical college and tertiary health care centre.

Total of 73 subjects will be included in present study after they satisfy inclusion and exclusion criteria.

Written and informed consent will be taken from all the subjects for participation in study.

For present study subjects with renal calculi will be diagnosed on Ultrasonography conducted in all study subjects as a primary diagnostic investigation tool with information providing number, site, size, shape and other pathological or anatomical specifications. Calculus may be present in renal pelvis, ureter, uretero-vasicle junction, urinary bladder or urethra.

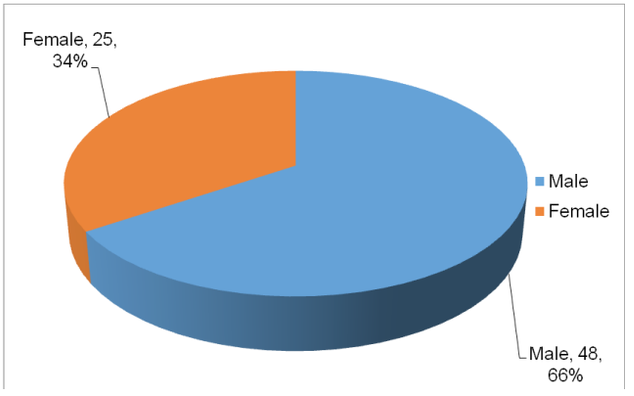
Detailed history, general examination findings and investigational findings will be noted in the proforma.

Appropriate management technique will be chosen for each study participant. Intra and post operative complication if any will be noted as it directly influence the outcome of the management technique.

4. Results

Table 1. Sex distribution

Sex	Frequency	Percentage
Male	48	65.75%
Female	25	34.25%
Total	**73**	**100.00%**

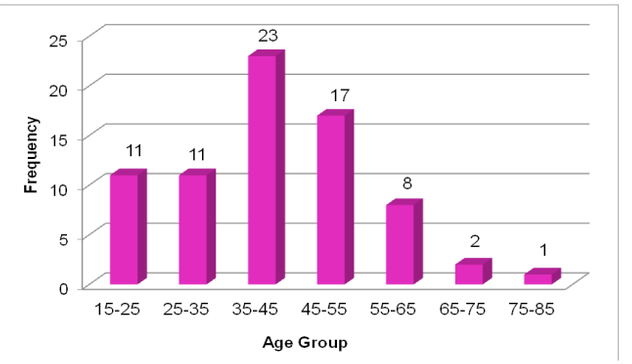


Graph/Chart 1. Sex distribution pie chart.

In our study 48 male patients (65.75%) were found to have renal calculi whereas female population was 25 (34.25%) suggesting that males are more prone for formation of renal calculi.

Table 2. Age distribution

Age Group	Frequency	Percentage
15-25	11	15.07%
25-35	11	15.07%
35-45	23	31.51%
45-55	17	23.29%
55-65	8	10.96%
65-75	2	2.74%
75-85	1	1.37%
Total	**73**	**100.00%**

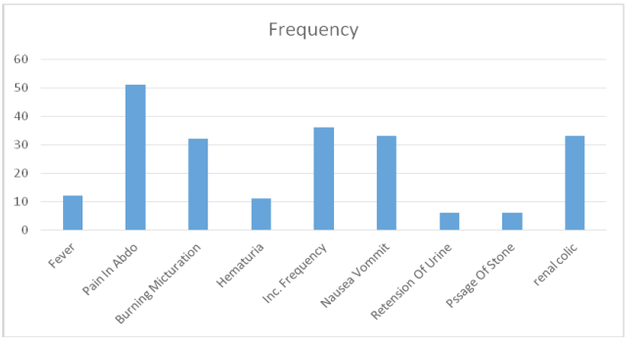


Graph/Chart 2. Age distribution.

In our study, the peak incidence of renal calculi was found in age group 35-45years followed by it was age group 45-55 years. The mean age in male patients was 43.63±4.54 years and for females it was 41.76±7.83years. Extremes of age groups were comparatively stable.

Table 3. Chief presenting complaints

Chief Complaints	Frequency	Percentage
Fever	12	16.44%
Pain In Abdo	51	69.86%
Burning Micturation	32	43.84%
Hematuria	11	15.07%
Inc. Frequency	36	49.32%
Nausea Vommit	33	45.21%
Retension Of Urine	6	8.22%
Pssage Of Stone	6	8.22%
renal colic	33	45.21%

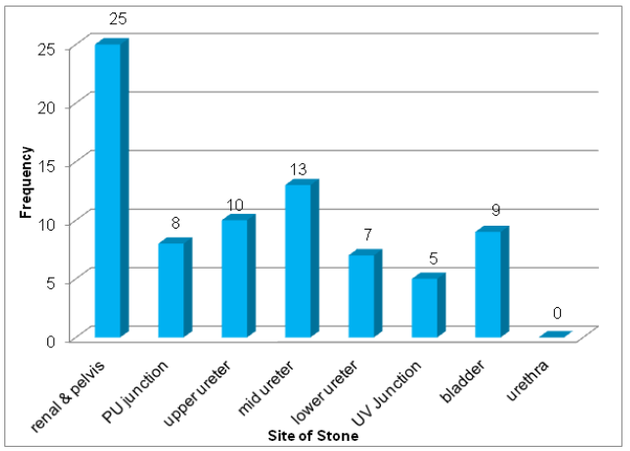


Graph/Chart 3. Chief presenting complaints.

In our study abdominal pain is the most common complaint patient presented with, which was associated with other complaints in combinations. Classical renal colic was seen in 33 patients.

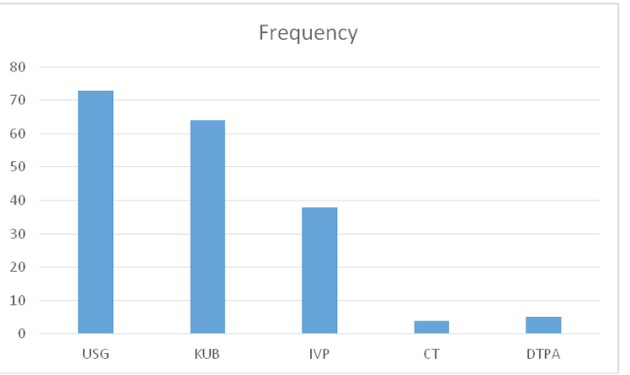
Table 4. Site of calculus

Site of calculus	Frequency	Percentage
renal & pelvis	25	34.25%
PU junction	8	10.96%
upper ureter	10	13.69%
mid ureter	13	17.80%
lower ureter	7	9.59%
UV Junction	5	6.85%
Bladder	9	12.33%
Urethra	0	0.00%



Graph/Chart 4. Site of calculus.

Ureter was found to be the most common site of renal calculi. Middle part of ureter contains maximum number of stones among the three parts. Renal pelvis was the second most common site for calculi. PUJ and UVJ calculi were significant in number and symptomatic due to the obstructive symptoms.



Graph/Chart 5. Investigation required.

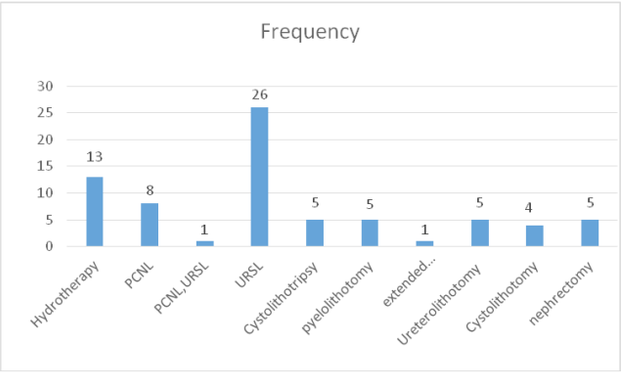
Table 5. Investigation required

Investigations	Frequency
USG	73
KUB	64
IVP	38
CT	4
DTPA	5

In our study, USG was used as basic investigation to include in the study. Specific investigations like KUB x-ray, IVP, CT or DTPA scan were performed additionally as per indication. KUB x-ray was most common additional investigation performed followed by IVP. DTPA scan was done to confirm the non-functioning kidney. CT though highly specific was not routinely done due to high cost & institutional workload.

Table 6. Type of intervention performed

Intervention	Frequency	Percentage
Hydrotherapy	13	17.81%
PCNL	8	10.96%
PCNL,URSL	1	1.37%
URSL	26	35.62%
Cystolithotripsy	5	6.85%
Pyelolithotomy	5	6.85%
extended Pyelolithotomy	1	1.37%
Ureterolithotomy	5	6.85%
Cystolithotomy	4	5.48%
Nephrectomy	5	6.85%



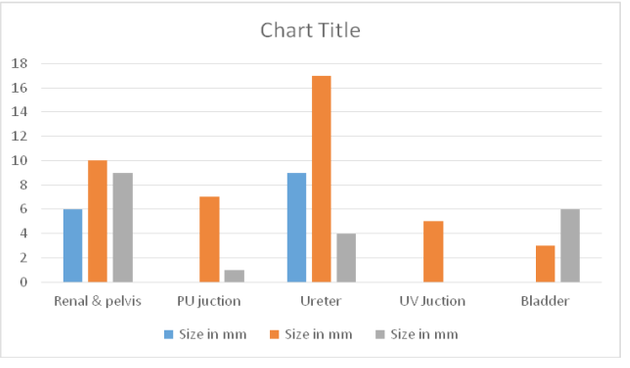
Graph/Chart 6. Type of intervention performed.

Ureter being the most common site URSL was highest performed intervention endourologically.

Among open procedures all procedures almost equally performed in the patients. 13 patients were managed conservatively by giving medical therapy.

Table 7. Site and size of calculus

Site of Calculus	Size in mm			Total
	<10	10_20	>20	
Renal & pelvis	6	10	9	25
PU juction	0	7	1	8
Ureter	9	17	4	30
UV Juction	0	5	0	5
Bladder	0	3	6	9
Total	**15**	**42**	**20**	**77**

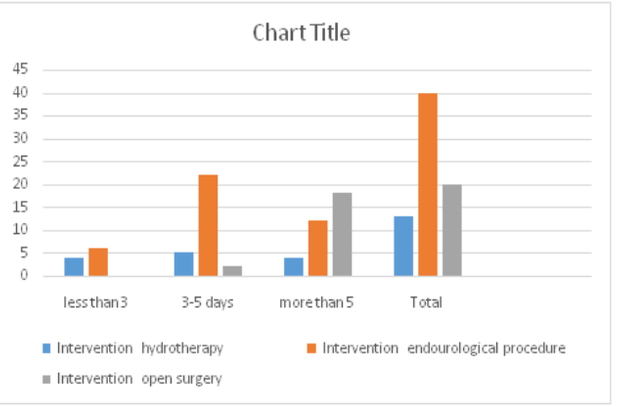


Graph/Chart 7. Site vs size of calculus.

In our findings majority of stones were between size 10-20 mm common in ureter followed by pelvis. Stones more than 20 mm were present in renal pelvis and bladder. Most of the subcentimetric calculi were non obstructive and managed conservatively.

Table 8. Hospital stay against type of intervention performed

Stay in days	Intervention			
	hydrotherapy	endourological procedure	open surgery	Total
less than 3	4	6	0	10
3-5 days	5	22	2	29
more than 5	4	12	18	34
Total	**13**	**40**	**20**	**73**

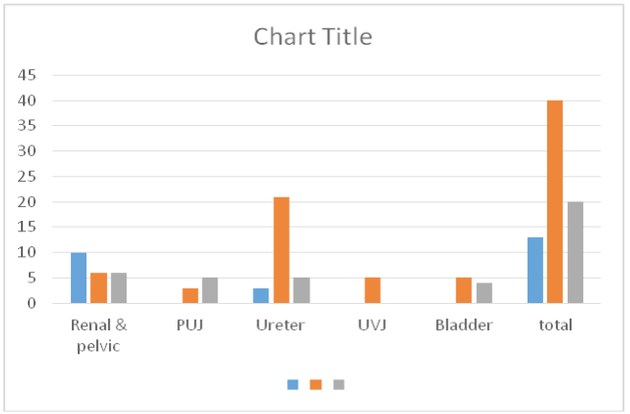


Graph/Chart 8. Hospital stay against type of intervention performed.

Out of 73 patients, 13 were managed conservatively on medical and symptomatic treatment. 40 patients received minimal invasive intervention like PCNL, URS and Cystolithotripsy. 20 patients were managed by open surgical procedures like Pyelolithotomy, ureterolithotomy, cystolithotomy and nephrectomy in 5 patients for non-functioning kidney.

Table 9. Intervention performed as per site of calculus

site	Intervention peformed		
	Medical	Endourological	Open surgical
Renal & pelvic	10	6	6
PUJ	0	3	5
Ureter	3	21	5
UVJ	0	5	0
Bladder	0	5	4
Total	**13**	**40**	**20**

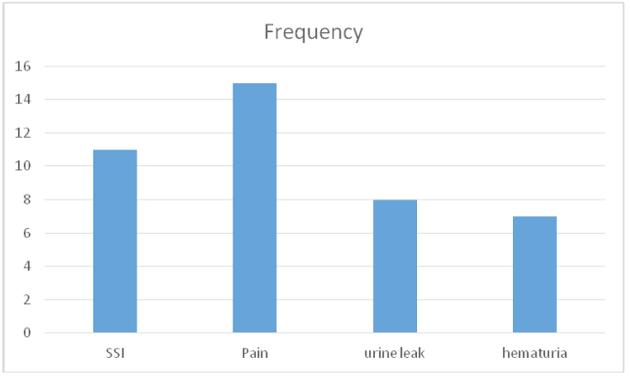


Graph/Chart 9. Intervention performed as per site of calculus.

URSL was the most common intervention performed in ureter. Medical therapy was useful for non-obstructive calculi. Open surgical procedures were performed for complicated stones as per the expert advice. Overall endourological procedures were common performed than the open surgical procedures irrespective of the site of calculi.

Table 10. Post intervention complication

Post intervention Complication	Frequency	Percentage
Surgical site infection	11	15.07%
Pain	15	20.55%
Urine leak	8	10.96%
Hematuria	7	9.58%



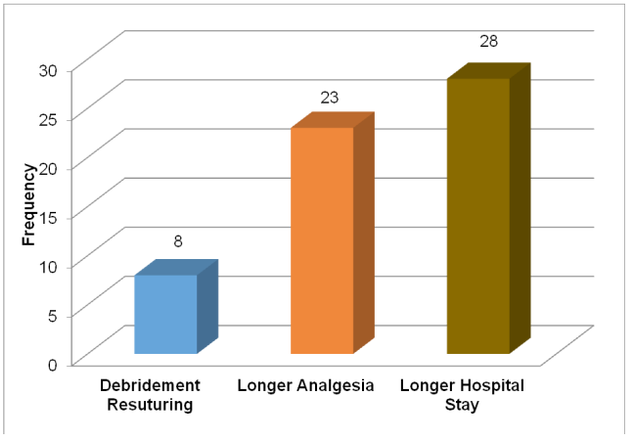
Graph/Chart 10. Post intervention complication.

Post-operative pain was the most common complication in our study followed by surgical site infection. Both caused highest increase in morbidity for the patient.

Hematuria and urine leak were noted in less than 10 patients and managed conservatively without much increase in expected hospital stay.

Table 11. Post interventional complications

Post intervention complications	Frequency	Percentage
Debridement Resuturing	8	10.96%
Longer Analgesia	23	31.51%
Longer Hospital Stay	28	38.36%



Graph/Chart 11. Post interventional complications.

In this study loner hospital stay was the most common effect of complication due to pain or infection at surgical site. Longer need of analgesia for better pain relief was the next common indication for prolonged morbidity. The complications were more common with patients who underwent open surgical procedures. Hospital stay for patients undergoing minimally invasive procedures was less.

5. Discussion

All the 73 patients admitted and investigated to determine the number site size condition of kidney and ureter to plan the modality of the treatment for the patient.

Due to unavailability of ESWL machine and the technical expertise this treatment modality is not included in the current study.

The management of kidney stone disease has changed dramatically over last 20 years as a result of technical advances however the population based studies describing the change are lacking. The effect of these technological advances and subsequent changing trends in kidney stone treatment on patient outcome such as post-operative morbidity and retreatment have not been accurately assessed in practical world. Studying these practice patterns and treatment outcomes on large scale helping identify potential public health concern.

To our knowledge this study represents population

level data accurately describe and quantify utilisation of available treatment modality according to pattern of presentation, patient preference, surgeon's advice and cost of treatment modality.

6. Demographics

6.1 Age

In our study the age range of peak incidence of kidney stone is between 35-55 age strata. The rate in young strata (15-35) and oldest age strata (>55) remained stable. The mean age of male patient was found to be 43.63+/-4.54 years and for female it was 41.76+/-7.83 years respectively. The first peak of is seen in 35-45 age group and the second peak was between 45-55 years. These findings are quite similar to study conducted by Baker et al.[34], Levan et al.,[35] and Peter Hughes[36].

Table 12. Studies showing peak incidence age group (yrs)

Study	Peak incidence
Baker et al	50-60
Peter Hughes	41-65
Levan et al	30-49
Our study	35-45

6.2 Sex

In our study, male to female ratio is 1.91:1 where 65.75% (n=48) patient were male and 34.25% (n=25) patients were female. The difference was significant (P<0.01). Male preponderance was found in all other studies conducted around the world as shown in the Table.

Table 13. Studies showing Sex distribution for renal calculi

STUDY	M:F Ratio
Baker et al.	1.20:1
Levan et al	1.17:1
Chand RB et al	1.35:1
Pearl MS et al	1.7:1
Lieske JC et al	1.47:1
Our study	1.91:1

However our results for changing demographics over time are contrary to a population based study in UK by Turner BW et al., who did not demonstrate any change in percentage of stone formers across age groups[26]. This may be due to the age grouping difference and the interpretation of their results is limited by fact that they only report proportion and not rate over time.

6.3 Signs and Symptoms

In our study the pain in abdomen particularly on the side of renal calculi was the chief complaint of the patient found in 69.86% (n=51). The pain was sometimes associated with Backache, signs of UTI, nausea and vomiting in combinations. Renal colic was seen in 33 number of patients. Early Symptomatic relief followed by management of etiology of complaint was performed in our study for the patients.

6.4 Site of Calculi

Table 14. Studies showing common sites for renal calculi

Study	Most common site	2nd common site
Chand RB et al	Kidney & Pelvis	Ureter
Our study	Ureter	Kidney and pelvis

Out of 77 calculi found, 35 were from ureter and UVJ, 33 stones in kidney and PUJ. 9 stones present in the bladder. In present study, Ureter found to be the most common site of calculi which is in contradiction with study conducted by Chand RB et al., according to whom kidney is the most common site for calculi[37].

6.5 Investigations

Table 15. Validity of various tests in renal calculi

	Sensitivity	Specificity	Accuracy	PPV	NPV
CT	94	97	95	98	89
USG	44	97	45	92	38
IVU	52	94	66	94	50

High sensitivity of non-enhanced helical CT for renal calculi has been established. Yilmaz et al.,[43] has demonstrated superiority of CT for diagnosis of ureteric calculi to both USG and IVU. Specificity of USG was found to be 90% as per Middleton et al. and 97% as per Smith et al.[44] which concludes as CT is better than IVU for diagnosis of calculi and obstruction in the tract.

In our study USG was used as basic diagnostic tool for inclusion in study and x-ray KUB, IVU, CT or DTPA scan were performed as additional investigations for further information.

According to Sommer et al.,[45] spiral CT is a preferred investigation now a days, however main disadvantage of spiral CT is inability to give information on renal function. High dose of radiation, high cost and heavy workload we believe that it will be more realistic to use spiral CT when USG and IVU fail to show a reason for renal colic.

With availability of advanced radiological investigations, the diagnosis of stones along with site and

size has become easy which helps in planning selection of treatment option for the patient beforehand. In chronic obstructive uropathy the function of kidney may be reduced and patient may require nephrectomy for chronic non-functioning kidney due to obstructive uropathy[38].

6.6 Site and Size of Calculi

In our study ureter is the most common site of renal calculi followed by renal pelvis. Size of stone is also an important factor for deciding treatment modality for the patient after site of calculus.

Table 16. Common site of renal calculi in this study

Site	Chand RB et al. (n=345) (%)	Our Study (n=73) (%)
Renal and pelvis	71.59	34.24
PUJ	6.37	10.95
Ureter	13.62	41.09
UVJ	9.56	6.84
Bladder	1.73	12.32

In our study stones more than 2 cm are seen in 20 patients (26.02%) out of which 11 patients underwent open surgical procedures while stones less than 2 cm successfully managed with endourological procedures in 39 patients (70.3%). Increase in the size of stone is associated with more blood loss, reduced stone free rate and longer operative time as shown by the study of Michael L et al.,[42] and Khaled M et al[40].

6.7 Intervention

In present study the intervention which patient underwent are divided into two types as medical therapy and surgical intervention. Surgical intervention further divided into minimal invasive endourological intervention and open surgical exploration and chosen as per the standard guidelines by European Association of Urology (2014).

Table 17. Studies showing different managements in renal calculi

Study	Medical treatment (%)	Endourological intervention (%)	Open surgery (%)
Khaled et al	16.3	65.1	18.6
Charig CR et al	17.58	66.73	15.68
Current study	19.17	53.44	27.39

17.43% (n=13) patients were offered medical treatment and managed conservatively while 56.42 % (n=40) patient underwent minimally invasive endourological procedures including PCNL, URS, Cystolithotripsy alone or in combinations. Open surgery was performed in 27.39% of patients. Most common indication for open procedure was complex stone burden followed by anatomical abnormalities. Ureter being the most common site of stone in our study URS was most common intervention followed by PCNL. 5 patients required nephrectomy due to chronic obstructive non-functioning kidney.

Due to high stone free success rate and quicker convalescence and lower rate of complications along with patient satisfaction, minimal invasive procedures are gaining popularity over traditional open proedures. These findings in current study are much similar to the study conducted by Joshua D et al.,[39] Khaled M et al.,[40] and CHARIG CG et al[41]. However the choice of treatment ultimately depends on individual surgeon's preference and available level of expertise.

6.8 Post Interventional Complication and its Management

In our study post-operative pain is the most common complication seen in around 30% of patients which caused longer use of analgesia for the patient. Second common was surgical site infection more common with open surgical procedures which was also associated with urine leak from operative site causing longer duration of hospital stay and morbidity to the patient.

Sometimes debridement followed by resuturing also required as in 9.6% patients. Overall open surgical procedures are associated with more post procedure complication as compared with endourological procedures which is again coinciding with the study of Khaled M et al.,[40] which suggest complications with minimal invasive procedures is 18. 6% as compare to open surgical procedure group as 31.1% with shorter hospital stay as early return to work.

7. Summary and Conclusion

The summary regarding clinco-pathological study of 7 3 cases of Nephrolithiasis studied in Department of Surgery.

In the present series 73 patients with renal calculi have been studied in detail. Ureter is most common site nexttoit was renal and pelvis. The incidence is most common between 3rd and 4th decade. Male to female ratio is approximately 1.91:1 with male preponderance. This may be due to the proportionate ratio of population in this locality.

In the 73 cases the presenting complaint was pain in the lumbar region or loin in 69.86% subjects. The character of the pain was colicky in nature in patients and remaining

Table 18. Studies showing post interventional complications and its management

	Khaled M et al.,[40]		Our study	
	Endourological intervention	Open surgery	Endourological intervention	Open surgery
Complications	18.6%	31.11%	10.95%	35.61%
Hospital stay	6.4+- 4,2	10+- 4.2	4.2+-2.7	11+-3.9

it was dull aching. 33 Patients complained vomiting in association with pain which is 45% of all subjects. Patients complain of fever with chills rigors which is one of the signs of urinary tract infection which favours stone formation. There was frank haematuria in 1 1 patients which is due to irritation of mucosal wall seen in 15% population.

The preliminary investigation done in all the cases was USG followed by plainx-ray KUB which revealed radio-opaque shadows in renal area in most of the cases. IVU was very useful in determining the function and condition of the kidney and exact location of pelvis and stone.

Ultrasound was useful in knowing size, shape and number of calculus associated with hydronephrosis. DTPA scan done to confirm the non-functioning status of the kidney. Ureter is the most common site in our study. Majority of stones are of size 1cm to 2 cm. stones more than 2cm seen commonly in bladder and renal pelvis equally.

Conservative management was given to 13 patients using Hydrotherapy according to the site, size of stone and ruling out the obstructive signs on investigations.

Ureter being the most common site, URSL was the most common intervention performed followed by PCNL according to patient preference and availability of infrastructure and experities.

Post interventional pain was most common complaint followed by surgical site infection for open procedures resulting in prolonged hospital stay and longer duration of analgesics after intervention. However with the minimal invasive procedures rate of post interventional complications, duration of analgesics and days of hospital stay are low, improving the patient acceptance of the procedures.

8. References

1. Shah J, Whitfield HN. Urolithiasis through the ages. BJU International. 2002; 89(8):801–10. https://doi.org/10.1046/j.1464-410X.2002.02769.x PMid:11972501
2. Chakravorty RC. The treatment of wounds and abscesses Sutrasthanam of the Sushrutsamhita. Indian Journal of Surgery. 1969; 31:261–6.
3. Chakravorty RC. Urinary stones: Their cause and treatment, as described in SUSHRUTSAMHITA.
4. Dimopoulos C, Gialas A, Likourinas M, Androutsos G, Kostakopoulos A. Hippocrates: Founder and pioneer of urology. Br J of urol. 1980; 52(2):73–4. https://doi.org/10.1111/j.1464-410X.1980.tb02931.x
5. Riches E. The history of lithotomy and lithotrity. Annals of Royal College of Surgeons of England. 1968; 43(4):185–99. PMid:4880647 PMCid:PMC2312308
6. Urquhart-Hay D. The knife and the stones. Aus and NZ J Surg. 1999; 69(4):267–75. https://doi.org/10.1046/j.1440-1622.1999.01565.x
7. Abder-Halim RE, Altwaijiri AS, Elfaqih SR, Mitwalli AH. Extraction of urinary bladder stones as described by Abdul Qasim khalaf Ibn Abbas Alzahrawi (albucasis) (325-404 H, 930-1018 AD) A translation of original text and commentary. Saudi Med J. 2003; 24(12):1283–91.
8. Kirkup JR. The history and evolution of surgical instruments. Annals of Royal College of Surgeons of England. 1981; 63(4):279–85. PMid:7018356 PMCid:PMC2493802
9. Ellis H. A history of bladder stones. J of Royal Society of Med. 1971; 45(1):76–9.
10. Herr HW. Cutting for the stones: The ancient art of lithotomy. BJU Int. 2008; 101(10):1214–16. https://doi.org/10.1111/j.1464-410X.2008.07510.x PMid:18284407
11. Verit A, Aksoy S, Kafali H, Verit FF. Urologic technique of serefeddin Sabuncuoglu in the 15th century Ottoman period. Urology. 2003; 62(4):776–8. https://doi.org/10.1016/S0090-4295(03)00004-9
12. Kiefer JH. Frere Jacques Beaulieu (1651-1714). Investigative Urol. 1970; 7(6):543–4.
13. Antonello A, Bonfante L, Favaro S, et al. Hermann boerhaave and lithotomy: What he thought about it. American J of Nephro. 2002; 22(2-3):290–4. https://doi.org/10.1159/000063776 PMid:12097755
14. Kiefer JH. Jean Civiale (1792-1867). Investigative Urol. 1968; 6(1):114–7.
15. Bigelow HJ. Lithotrity by a single operation. American J of Med Sci. 1879; 75(149):117–34. https://doi.org/10.1097/00000441-187801000-00010
16. Moll F, Rathert P. The surgeon and his intention: Gustav Simon (1824-1876), his first planned nephrectomy and contribution to urology. World J of Urol. 1999; 17(3):162–7. https://doi.org/10.1007/s003450050125
17. Martin DC. A Le Dentu (1841-1926). Investigative Urol. 1974; 12(1):82–3.
18. Lingeman JE, Lifshitz DA, Evan AP. Surgical management of urinary lithiasis. Walsh PC, Retik AB, Vaughan ED, Wein AJ, editors. 8th ed. Campbell's Urology; 2002. p. 3361–451.
19. Schultheiss D, Engel RM, Crosby RW, Lee GP, Truss MC, Jonas U. Max Brodell (1870-1941) and medical illustrations

in urology. The Journal of Urology. 2000; 164(4):1137–42. https://doi.org/10.1016/S0022-5347(05)67128-5 PMid:10992353
20. Fitzpatrick JM, Sleight MW, Braack A, et al. Intrarenal access: Effects on renal function and morphology. Br J of urol. 1980; 52(6):409–14. https://doi.org/10.1111/j.1464-410X.1980.tb03078.x
21. Young HH, Mckay RW. Congenital valvular obstruction of the prostatic urethra. Surgery, Gyenacology and Obstetrics. 1929; 48:509–12.
22. Grocela JA, Dretler SP. Intracorporeal lithotripsy: Instrumentation and development. Urologic clinics of North America. 1997; 24(1):13–9. https://doi.org/10.1016/S0094-0143(05)70351-7
23. Mulvaney WP. Attempted disintegration of calculi by ultrasonic vibrations. The Journal of Urology. 1953; 70(5):704–5. https://doi.org/10.1016/S0022-5347(17)67971-0
24. Fernstrom I, Johannson B. Percutaneous nephrolithotomy: A new extraction technique. Scandinavian Journal of Urology and Nephrology. 1976; 10:257–61. https://doi.org/10.1080/21681805.1976.11882084 PMid:1006190
25. Chaussy C, Fuchs G. Extracorporeal shock wave lithotripsy: The evolution of a revolution. Urology A. 1989; 28(3):126–9.
26. Turney BW, Reynard JM, Noble JG, Keoghane SR. Trends in urological stone disease. BJU Int. 2012; 109(7):1082–7. https://doi.org/10.1111/j.1464-410X.2011.10495.x PMid:21883851
27. Bandi G, Best SL, Nakada SY. Current practice patterns in the management of upper urinary tract calculi in north central United States. J Endourol. 2008; 22(4):631–6. https://doi.org/10.1089/end.2007.0186 PMid:18366318
28. Preminger GM, Tiselius HG, Assimos DG, et al. Guidelines for the management of ureteral calculi. J Urol. 2007; 178(6):2418–34. https://doi.org/10.1016/j.juro.2007.09.107 PMid:17993340
29. Irby PB, et al. Percutaneous access techniques in renal surgery. Tech Urol. 1999; 5:29. PMid:10374792
30. Cracco CM, et al. New developments in percutaneous techniques for simple and complex branched renal stones. Curr Opin Urol. 2011; 21(2):154–60. https://doi.org/10.1097/MOU.0b013e3283436d32 PMid:21252683
31. Drach GW, et al. A report of the United states co-operative study of extracorporeal shockwave lithotripsy. J Urol. 1986; 135:1127. https://doi.org/10.1016/S0022-5347(17)46015-0
32. Bagley DH: Removal of upper urinary tract calculi with flexible ureteroscopy. Urology. 1990; 35:412. https://doi.org/10.1016/0090-4295(90)80083-Y
33. Herrera-Gonzalez G, et al. Effectiveness of single flexible ureteroscopy for multiple renal calculi. J Endourol. 2011; 25(3):431–5. https://doi.org/10.1089/end.2010.0233 PMid:21401396
34. Baker PW, Coyle P, Bais R, et al. Influence of season age and sex on renal stone formation in South Australia. Med J Aust. 1993; 159:390–2. PMid:8377690
35. Lavan JN, Neale FC, Posen S. Urinary calculi: Clinical biochemical and radiological studies in 619 patients. Med J Aust. 1971; 2:1049–61. PMid:5127485
36. Hughes P. Kidney stones epidemiology. Nephrology J. 2007; 12:s26–s30. https://doi.org/10.1111/j.1440-1797.2006.00724.x PMid:17316273
37. Chand RB, Shah AK, Pant DK, Paudel S. Common site of urinary calculi in kidney ureter and bladder region. Nepal Med Coll J. 2013; 15(1):5–7. PMid:24592784
38. Peterson R, FernandezA, Razvu H, Sutton R. Evaluation and medical management of kidney stone patient. Can UrolAssoc J. 2010; 4(6):375–9. https://doi.org/10.5489/cuaj.10166
39. Joshua DW, Ghiculete D, Honey RJ, Pace KT. A comparison of treatment modalities of renal calculi between 100 and 300 mm2: Are shockwave lithotripsy, Ureteroscopy, and percutaneous nephrolithotomy equivalent. J Endourol. 2011; 25(3):481–5. https://doi.org/10.1089/end.2010.0208 PMid:21351888
40. Khaled M, AL-Kohlany, Ahmed A, Mosbah A, Mohsen T, Shoma AM, Eraky I, EL-Kappany. Treatment of complete staghorn stone: A prospective randomised comparison of open surgery versus percutaneous nephrolithotomy. J Urol. 2005; 173(2):469–73. https://doi.org/10.1097/01.ju.0000150519.49495.88 PMid:15643212
41. Charig CR, Webb DR, Payne SR, Wickham JE. Comparison of treatment of renal calculi by open surgery, percutaneous nephrolithotomy and extracorporeal shockwave lithotripsy. Br Med J. 1986; 292:879–82. https://doi.org/10.1136/bmj.292.6524.879
42. Michael LP, Wainstein MA, Spimak P, Hample N, Resnick MI. Current indications of open stone surgery in the treatment of renal and ureteral calculi. J Urol. 1998; 159(2):374–9. https://doi.org/10.1016/S0022-5347(01)63922-3
43. Yilmaz S, Sindel T, Arslan G, Ozkaynak C, Karaali K, Kabaalioglu A, Luleci E. Renal colic: comparison of spiral CT, US and IVU in the detection of ureteral calculi. Eur Radiol. 1998; 8:212–7. https://doi.org/10.1007/s003300050364 PMid:9477267
44. Smith RC, Rosenfield AT, Choe KA, Essenmacher KR, Verga M. Lange RC. Acute flank pain: comparison of non-contrast enhanced CT and intravenous urography. 1995; 194:789–94.
45. Sommer FG, Jeffrey RB, Rubin GD, Napel S, Rimmer SA, Benford J. Detection of ureteral calculi in patients with suspected renal colic: Value of reformatted non contrast helical CT. AJR. 1995; 165:509–13. https://doi.org/10.2214/ajr.165.3.7645461 PMid:7645461