Factors Predicting Outcomes Following Surgery in Patients with Renal Failure with Renal Calculi

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ABSTRACT

Introduction: Renal calculus disease is one of the most common afflictions of the modern society. The overall morbidity and mortality associated with stone disease has decreased progressively. Despite these advances neglected Urolithiasis remains a common in developing countries. Urolithiasis in a patient with renal failure requires a tailor made management. There are multiple factors, which influence the recovery of renal function postoperatively in these situations. Current research aimed_to study the clinical profile of patients and management of patients with bilateral renal calculi associated with renal failure and the extent of improvement in their renal function following stone clearance and factors influencing the outcomes.

Material and methods: Patients with bilateral renal calculi and renal failure (Sr Creatinine>1.5 mg/dl) admitted for intervention or calculus in a single functioning kidney with renal failure are included in the study. Study included 50 patients in a span of 5 years.

Results: 32 patients had >20% postoperative fall in serum creatinine. Serum creatinine >4mg/dl, infective HDN/ Pyonephrosis and preoperative positive urine culture, bilateral Cortical atrophy <5mm, stone size >3cm and proteinuria had negative impact while duration of symptoms, number of PCNL tracts, residual fragments and solitary kidney did not significant influence.

Conclusion: Most patients presenting with renal insufficiency due to calculus disease experience improvement or stabilization of renal function with early aggressive intervention aimed at complete stone clearance.

Keywords: Urolithiasis, Renal Failure, Renal Function Postoperatively

INTRODUCTION

Renal calculus disease is one of the most common afflictions of the modern society.[1] Neglected renal calculi are fraught with multiple complications such as recurrent urinary tract infections, pyonephrosis and eventual end stage renal damage.[2-7] This is more so in case of stag horn calculi with 50% incidence of renal function loss in a time span of 2 years if no intervention is done.[8,9] Studies conducted in India have shown Urolithiasis to be the 2nd most common cause of renal failure. The possible reason for this may be due to chronic negligence of symptoms, ignorance, poverty and delay in approaching health care. There are multiple factors, which influence the recovery of renal function postoperatively in these situations.[3,4]

Urolithiasis constitutes about 10% to 25% of the total work load in the urological practice. In about 5% of the patients presenting with acute renal failure, the cause is obstructive uropathy and urolithiasis is the most common cause of obstruction. Many patients with bilateral stones have oliguria. Calculus anuria is a urological emergency due to bilateral obstructive calculus impaction or unilateral calculus impaction of solitary kidney or the only functioning kidney. After the onset of obstruction, there is increased intrapelvic pressure, resulting in pyelolymphatic and pyelovenous urine back flow as well as fornix rupture and urine extravasation. Therefore, the obstruction of the urinary tract causes significant kidney damage. Prompt and early intervention can save the patient from developing irreversible renal damage. The pathophysiological changes occurring in calculous obstruction is similar to the obstruction due to congenital obstructions, which have been extensively studied.

Urolithiasis is not a common cause of renal failure. Occur in bilateral stone with obstruction, solitary functional kidney,associated risk factors that cause renal injury. Risk factors include Diabetes Mellitus,

Hypertension, struvite staghorn calculi(increased risk of proteus infection,recurrence of stone if not cleared,chances of complete obstruction), Urinary tract infections, Percutaneous and extracorporeal urological methods (chronic deterioration of renal function if treated with multiple therapeutic sessions).Predictors of renal function in Urolithiasis:

1) Preoperative:Duration of symptoms,Solitary functioning kidney,bilateral stone disease,Coexisting hypertension and diabetes,Stone burden,Atrophic renal cortex, NSAID intake, functional or anatomical urological anomalies.
2) Intraoperative: Number of PCNL tracts, ESWL—sessions.

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How to cite this article: Ramachandraiah G, Devraj R, Reddy GM, Reddy CR, Amancherla K, Ausekar V. Factors predicting outcomes following surgery in patients with renal failure with renal calculi. International Journal of Contemporary Medical Research 2021;8(5):E1-E5.

DOI: http://dx.doi.org/10.21276/ijcmr.2021.8.5.18

3) Postoperative:Residual fragments,Recurrent infection, Proteinuria, Recurrence of calculus.

Management of urolithiasis patients with obstruction and infection-

Emergency settings

- Correct dehydration.
- Renal function tests to assess renal function.
- Treat urinary infections –start the patient on empirical 3rd generation cephalopsporins.
- Avoid using medications that may be detrimental to renal function.
- Identifying patients with a solitary functional kidney
- Reduce risks of acute renal failure from contrast nephrotoxicity, particularly in patients with preexisting azotemia (creatinine >2 mg/dL), diabetes, dehydration, or multiple myeloma
- Choosing imaging studies that do not require intravenous contrast (eg, ultrasound, abdominal flat plate radiographs, noncontrast CT scans)
- Relieve obstruction-PCN OR Double J stenting.
- Definitive treatment-once sepsis settles.

The study aims at understanding the surgical management of patients with bilateral renal calculi related renal failure. The study also aims at understanding the various factors, which play a role in determining the final long-term outcome with regards to renal function.

MATERIAL AND METHODS

A retrospective study of the patients who presented with bilateral renal calculi or solitary kidney with calculus and renal from 20th September 2018 to 20th january 2021

Inclusion criteria

Patients with bilateral renal calculi and renal failure (Sr Creatinine >1.5 mg/dl) admitted for intervention or calculus in a single functioning kidney with renal failure.

Patients were divided into two groups of recovered (Group 1) vs non recovered (Group 2) based on post operative serum creatinine.

Exclusion criteria

- Patients with known medical renal disease.
- Patients with calculi in location other than within kidney. (Associated ureteric/vesical calculi excluded).
- Patients with unilateral renal calculus with contralateral normal
- functioning kidney.
- Special population (Minors <18yrs, Pregnant Females

Patient workup

Data was obtained from records of all the patients who have undergone treatment for renal calculus disease during the defined period. Data regarding the clinical history and physical examination was obtained. The following data from the investigations done was obtained and analysed (preoperatively done routine blood investigations Complete blood count, Serum Urea, and Serum creatinine and serum electrolytes, and urinary examination), Preop X ray KUB (plain and digital) data regarding maximal stone size. USG (Ultrasonography) KUB data to assess renal size, parenchymal thickness, corticomedullary differentiation and infective hydronephrosis. NCCT of the KUB region. Post percutaneous nephrostomy urinary volume, urinary ph, urinary Na, creatinine clearance. Postoperative data regarding urine culture, CBP, serum creatinine, creatinine clearance done at periodic intervals will be assessed.

Variables to be analyzed and Definitions

1. Renal insufficiency: defined by a baseline nadir serum creatinine of 1.5 mg/dL or higher (a minimum of two equal lowest values).
2. Age = 20-40 yrs, 40-60 yrs, >60 yrs
3. Sex= male /female
4. Stone size= <3 cm / >3cm - largest stone diameter in the kidney with better parenchymal thickness will be considered.
5. Proteinuria = The patients were divided into two groups <3+ >_ 3+
6. Parenchymal thickness: Renal parenchymal thickness is defined as the distance from the outer renal cortical margin to the outer border of the sinus echoes. In our study the renal parenchymal thickness of the better kidney was taken as the representative value. Division of groups will be done into groups with parenchymal thickness greater than or less than 5 mm
7. Infective HDN: based on USG findings.
8. Urine C/s: In our study pre-operative urine culture was performed prior to surgery, to look for impact of UTI.
   Protein dipstick grading
   Approx. amount
   Designation Concentration Daily
   Trace 5–20 mg/dL
   1+ 30 mg/dL Less than 0.5 g/day
   2+ 100 mg/dL 0.5–1 g/day
   3+ 300 mg/dL 1–2 g/day
   4+ More than 1000 mg/dL More than 2 g/day
9. Duration of symptoms: duration of symptoms prior to surgery is considered and were divided into two groupsgreater than or less than 6 months.
10. Initial creatinine: the serum creatinine level that is obtained upon initial presentation to the hospital.
11. Baseline creatinine: To eliminate the influence of reversible acute renal obstruction as a cause of elevated creatinine, the nadir serum creatinine concentration (a minimum of two equal lowest values) after adequate relief of obstruction with DJS/PCN was considered the baseline. Patients were divided into three groups <2mg/dl, 2-4 mg/dl, >4mg/dl.
12. Post procedure serum creatinine: the creatinine level 1 month after bilateral stone removal measured.
13. Recovery: recovery was defined as serum creatinine decrease more than 20% of the baseline creatinine. Serum creatinine decrease <20% was considered non recovery. Patients divided into two groups those with serum creatinine decrease >20%= recovery and those

with serum creatinine fall <20% or those with deteorating creatinine level were grouped as nonrecovery.

14. Number of PCNL tracts: the number of intraoperative PCNL tracts. Patients were divided into 2 groups those with 2 or lesser tracts and those above 2 PCNL tracts.
15. Complete clearance: defined as no visible fragment on KUB films and renal ultrasonography at 1-month follow-up.

STATISTICAL ANALYSIS

1. Means and averages
2. Analysis will be done using the odds ratio and ROC curves with p value<0.05 being considered as significant. The statistical software being used will be SPSS 24.0

RESULTS

Table 1- The age of our patients ranged from 19 to 82. 12 patients aged between 20-40 years,29 patients between 41-60 years,8 patients between 61-80years, 1 patient more than 80 years. Table 2 shows patients were divided into 4 groups based on basline serum creatinine group A (1.5-2), group B(2-4), group c(4-6), group d(>6). Table 3- based on stone size patients were divided into two groups size >3cm and size <3cm, stone size was statistically significant in determining post operative fall in serum creatinineTable 4- based on pre operative proteinuria patients were divided group 1 <3+/<300mg/dl, group 2 >3+/300mg/dl, more patients in group 1 had fall in post operative serum creatinine(statistically significant)Table 5- presence(8) or absence(42) of infective hydronephrosis significantly affected post operative fall in serum creatinine Table 6- less number of patients with preoperative positive(25) urine culture had fall in serum creatinine (10) whereas in patients with negative urine culture(25) more patients (22) had fall in serum creatinine proving to be significant association table 7- postoperatively 8 patients had residual fragments and 42 patients had complete clearence, its association with fall in serum creatinine was not statistically significant.

	Recovered	Not recovered	Total
20-40	8	4	12
41-60	18	11	29
61-80	5	3	8
>80	1	0	1
Total	32	18	50

Table-1: Age distribution of patients and outcome related to age

	Recovered	Not recovered	Total
Group A = serum Cr 1.5- 2 mg/dl	6	3	9
Group B= serum Cr2-4 mg/dl	18	5	23
Group C= serum Cr 4-6 mg/dl	8	5	13
Group D= serum Cr >6 mg/dl	0	5	5
Total	32	18	50

Table-2: Baseline creatinine

	Recovered	Not recovered	Total
Size <3cm	28	6	34
Size >3 cm	4	12	16
Total	32	18	50
On applying odds ratio, a p value of 0.003 was obtained (significant)			

Table-3: Stone size

	Recovered	Not recovered	Total
<3+/<300mg/dl	25	2	27
>3+/>300mg/dl	7	16	23
Total	32	18	50
On applying the odds ratio, a p value of 0.0001 was obtained (significant)			

Table-4: Proteinuria

	Recovered	Not recovered	Total
Present	1	7	8
Not present	31	11	42
Total	32	18	50
On applying the odds ratio, a p value of 0.008 was obtained (significant)			

Table-5: Infective HDN

Urine C/S	Recovered	Not recovered	Total
Positive	10	15	25
No growth	22	3	25
Total	32	18	50
On applying the odds ratio, a p value of 0.0012 was obtained (significant)			

Table-6: Urine C/s

	Recovered	Not recovered	Total
No residual fragments	27	12	42
Residual fragments present	5	6	8
Total	32	18	50
On applying the odds ratio, a p value of 0.1547 was obtained (non-significant)			

Table-7: Residual fragments

DISCUSSION

Our study included 50 patients in a span of 5 years. 32 patients had >20% postoperative fall in serum creatinine. There were 40 males and 10 females in our study. The increased presence of males in our study is similar to other studies. The possible reason for this may be due to the overall high prevalence of urolithiasis in males compared to females. Serum creatinine recovered postoperatively in 28 males (70%) and 4 females (40%) post operatively. Statistical analysis however did not show any significant relation of gender with poor post-operative outcome.The age of our patients ranged from 19 to 82. Majority of our patients were from the 3rd, 4th and 5th decade. This finding corresponds to other studies which show high prevalence in the 3rd and 4th decade of life.

The significance of baseline creatinine was assessed in our study. The baseline creatinine in our study was defined as the lowest prevailing value within one month of presentation after the obstruction has been relieved by either DJS/PCN. For statistical analysis, the patients were classified in 3 groups (<2 mg/dl, 2 to 4 mg/dl and >4 mg/dl. The number of patients in <2mg/dl, 2 to 4 mg/dl and > 4 mg/dl groups were 9, 23 and 18 respectively. The mean baseline creatinine in the patients was 1.81 mg/dl in group-A (Sr Cr 1.5-2 mg/dl), 3.07 in group-B (Sr Cr 2-4 mg/dl), 6.19 in group-C (Sr Cr >4 mg/dl). Successful outcome was seen in 6 out of 9 (66.6%),18 out of 23 (78.2%), and 8 out of 18(44.5%) patients in >2mg/dl, 2 to 4 mg/dl, and > 4 mg/dl groups respectively. On statistical analysis, significant difference was seen between group B and group C (p= 0.04). However, no significant difference was seen between group A and group B (p=0.4) and as well as between group A and C (p=0.03). This finding of our study is may be due to small sample distribution among groups A and C. The possible reason for this may be because a higher baseline serum creatinine implies extensive parenchymal damage and may predict poor chance of recovery. The mean serum creatinine in patients with postoperative creatinine recovery (n=32) was 3.39. The mean serum creatinine in patients with non recovery (n=18) was 4.52. These results were similar to the outcomes achieved in the study done by kukreja et al [10]

Ultrasound plays a major role in renal evaluation. Multiple parameters such as renal parenchymal thickness, renal length and cortical echogenictiy may help in determining the potential of renal recovery post-operatively. In our study the renal parenchymal thickness of the better kidney was taken as the representative value. We had 20 patients with a parenchymal thickness of less than 5mm. Out of them only 4 patients had serum creatinine recovery postoperatively and 16 patients did not have recovery. We had 30 patients with a parenchymal thickness greater than 5mm. Out of them 28 patients had serum creatinine recovery postoperatively and only two patients did not have recovery. On statistical analysis, significant difference was seen between the two groups (p value<0.0001). Parenchymal thickness is inversely proportional to parenchymal and tubular atrophy. Thinned out parenchyma implies significant thinning and loss of renal tissue. Multiple studies support our findings.

Infected hydronephrosis may complicate stone disease. Patients are usually ill with associated fever,chills, flank pain and tenderness. Pyonephrosis may be associated with total loss of renal function. In our study, infected hydronephrosis was diagnosed in 8 patients based on clinical findings and USG evaluation. These patients were treated with IV antibiotics and decompression with either DJS or PCN was done wherever indicated. Post-operatively 7 patients (86.6%) were found to have poor recovery and only1 patient had improvement of serum creatinine. On statistical analysis, significant difference was seen between the two groups (p value<0.008) suggestive of presence of infective HDN had negative impact on serum creatinine recovery. Karthik Sridhar etal[11] in their study showed that infected hydronephrosis to be a significant risk factor. The suggested reason for this may be the high incidence of extensive pyonephrosis in these studies, which results in loss of functional renal tissue. This is concordant with the results obtained in our study.

Symptom duration may influence outcome of surgery. The symptom duration refers to the duration of patient's presenting complaints, which could be flank pain, vomiting, fever, fatigue, pedal edema and decreased urine output. Multiple studies have shown that a delayed presentation with symptoms may be associated with a poor outcome. We divided our patients into 2 groups based on symptom duration (< 6 months and > 6 months). 12 patients had symptoms for more than 6 months and out of them 6 patients (50 %) did not have recovery of serum creatinine following surgery. However statistical analysis showed symptomatic duration more than 6 months is not a significant risk factor (p value =0.2518).

Stone burden has been found to a significant factor in determining the postoperative outcome. In our study we divided patients into 2 groups based on the maximal stone diameter seen on the CT KUB (<3cm and >3cm). There were 16 patients with a stone diameter>3cm in our study. Out of them 12 patients (75%) did not show recovery of creatinine following surgery. Statistical analysis showed a stone burden > 3cm to be a significant factor in predicting the postoperative outcome (p value= 0.003). A larger stone burden is associated with significant obstruction, risk of infection and renal parenchymal damage. The stone burden also determines the type of surgical management that the patient will undergo. Larger stones may need PCNL or open surgery for management. PCNL may contribute to the nephron loss and parenchymal damage independently thereby becoming a determining factor in the final outcome. Teichman and coworkers [12] reported solitary kidneys to be more frequently associated with renal deterioration in patients with staghorn calculi. Patients with a solitary kidney (functional or anatomical) may have a worse outcome compared to patients with B/l functional kidneys. In our study we had 5 patients with solitary kidney (4 anatomical and 1 functional). Functional solitary kidney was diagnosed on the basis of the presence of loss of cortico-medullary and the presence of a shrunken opposite kidney. 1 patient (20%) did not show creatinine recovery following surgery. Many studies have shown presence of solitary kidney to be associated with poor postoperative outcomes. These findings may be due to be due to the presence significantly lower amount of functional renal parenchyma in a patient with a solitary kidney. Any amount of renal damage in such an individual may present in an exaggerated manner. In our study however statistical analysis showed the presence of a solitary kidney is not significant factor in determining the postoperative outcome (p= 0.44). This may be due to seeking if early medical care in patients known to have anatomical solitary kidney and more frequent use of ultrasound.

Pre-operative urinary tract infection may be associated with a poor outcome. In our study pre-operative urine culture was

performed on initial encounter in the outpatient. We found 25 patients to be having a positive urine culture preoperatively. Out of them 15 patients (60%) did not show improvement in serum creatinine postoperatively. Odds ratio analysis showed this to be statistically significant (p value= 0.0012). The possible reason for this is that persistent infection may cause continuous renal damage and functional deterioration in spite of obstruction relief.

Significant proteinuria and cortical atrophy indicate extensive glomerular and tubular functional loss[3,13]. In our study we have divided

patients into two groups bases on proteinuria <3+ and >3+ on urine dipstick test. 23 patients had proteinuria >3+ and out of them only 7 had recovery of creatinine value post operatively and 16 patients did not have recovery. p value of 0.0001 (significant) was found and higher level of proteinuria was associated with poor recovery.This outcome is comparable to the results in the study done by Rajdoss et al.[3]

The number of PCNL tracts and the number of residual fragments and the presence of comorbidities were not found to be significant in influencing the postoperative outcomes. These results are similar to the outcomes in the study performed by kukreja et al[10].

CONCLUSION

1. Most patients presenting with renal insufficiency due to calculus disease experience improvement or stabilization of renal function with early aggressive intervention aimed at complete stone clearance.
2. Serum creatinine- was the most important predictor of renal recovery. High baseline creatinine indicated severity of renal damage and postoperative creatinine showed only moderate decrease in these patients.
3. Infective HDN/Pyonephrosis and Preoperative positive urine culture are associated with poor recovery.
4. Cortical atrophy = <5mm –if associated with bilateral obstruction,the recovery is poor.
5. Patients with Larger stone size and proteinuria are found to have poor recovery even after surgery.
6. Comorbidities are found to have no influence on renal recovery in patients with renal failure due to stone disease.
7. Duration of symptoms, Number of PCNL tracts, Residual fragments and solitary kidney did not have any significant impact on the recoverability post operatively

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Source of Support: Nil; **Conflict of Interest:** None

Submitted: 29-03-2021; **Accepted:** 26-04-2021; **Published:** 30-05-2021