Print ISSN: 2321-6379
Online ISSN: 2321-595X

Original Article

Study of Renal Function in Patients with Modified Anatrophic Nephrolithotomy

Ritesh Kumar Gupta[1], Vinod Kumar[2], Pankaj Tejasvi[1]

[1]Senior Resident, Department of Urology and Renal Transplant, Andhra Medical College, Vishakhapatnam, Andhra Pradesh, India, [2]Senior Resident, Department of Urology and Renal Transplant, VMMC and Safdarjung Hospital, New Delhi, India

Abstract

Introduction: Anatrophic lithotomy (ANL) with its excellent stone clearance rate is a reasonable option in cases in which if a reasonable number of percutaneous approaches are not likely to be successful or several endourological approaches have been attempted unsuccessfully. Although excellent stone-free rates can be achieved with ANL, there is possibility of a reduction in renal function postoperatively. In this study, we assess the functional results after anatrophic nephrolithotomy.

Materials and Methods: The study was prospective and observational in nature and carried over a period of 2 years. A total of 50 patients (meeting the inclusion and exclusion criteria) underwent open modified ANL for partial or complete staghorn calculus and were assessed during the study period.

Results: The study included 50 patients with a mean age of 47.26 ± 7.17 years of which 62% (31) were males and 38% (19) were females. The percentage change in dimercaptosuccinic acid differential renal function postoperatively was 8.66% and creatinine level was 11.65%, both of which were statistically significant ($P < 0.001$). Complete stone clearance occurred in 94% (47) and 6% (3) had incomplete stone clearance postoperatively. Complications occurred in 14 patients out of 50 postoperatively. All complications were managed conservatively. No patient died during this study period.

Conclusion: Although associated with slight decrease in renal function postoperatively, ANL is the most appropriate method for one-stage management of a selected group of patients with large staghorn calculi and is associated with the highest stone-free rates.

Key words: Anatrophic nephrolithotomy, Renal function, Stone

INTRODUCTION

The surgical treatment of urolithiasis has changed significantly over the past 30 years. Previously, most patients requiring stone removal underwent open surgery.[1] Advances in the endoscopic management of stone disease have made open stone surgery second or third-line treatment option which is being done in only 1–5.4% of cases.[2] However, if a reasonable number of percutaneous approaches are not likely to be successful or several endourological approaches have been attempted unsuccessfully, open surgery might be a valid primary treatment option.

Access this article online

www.ijss-sn.com

Month of Submission : 05-2022
Month of Peer Review : 06-2022
Month of Acceptance : 06-2022
Month of Publishing : 07-2022

According to the European association of urology guidelines, the most common indications for open surgery are – failure of ESWL or PCNL or URSL; intrarenal anatomical abnormalities such as infundibular stenosis; stone in the calyceal diverticula; obstruction of the ureteropelvic junction; obesity; skeletal deformity; concomitant open surgery; and non-functioning lower pole when partial nephrectomy is indicated or nonfunctioning kidney where nephrectomy is required; patient's choice following failed minimally invasive procedures and stone in an ectopic kidney where percutaneous access and ESWL might be difficult or impossible.[3]

According to American Urological Association's guidelines (AUA guidelines), the current indications for anatrophic nephrolithotomy (ANL) are in unusual situations when a struvite staghorn calculus is not expected to be removed by a reasonable number of percutaneous lithotripsy or ESWL procedures.[4]

Corresponding Author: Vinod Kumar, Safdarjung Enclave, New Delhi, India.

Although excellent stone-free rates can be achieved with ANL, some drawbacks may be of concern. Morbidity related to intraoperative and post-operative complications is one of them. Another great concern is the possibility of a reduction in renal function related to the procedure itself. This may be related to nephron injury during nephrotomy and parenchymal closure or to ischemic injury. In this study, we assess functional results after anatrophic nephrolithotomy.

MATERIALS AND METHODS

The study was conducted at the Department of Urology, King George Hospital, Andhra Medical College, Visakhapatnam, Andhra Pradesh over a period of 2 years from January 2019 to December 2020. It was a prospective and observational study and included a total of 50 patients who were assigned to undergo open modified ANL for partial or complete staghorn calculus and were assessed during the study period. Inclusion criteria included all patients more than 18 years of age and presenting with partial or complete renal staghorn calculus who underwent modified ANL. Exclusion criteria included patients with bilateral renal calculus, patients with anomalous kidney or solitary functioning kidney, patients who have undergone previous renal surgery, patients with non-functioning kidney (dimercaptosuccinic acid [DMSA] function <20%), patients with uncured coagulopathies or sepsis, pregnant women, and patients not giving consent for open surgery. Patients meeting the inclusion and exclusion criteria underwent thorough evaluation with history, examination, hematological, and radiological investigations. The patients underwent open modified ANL. All patients were evaluated with non-contrast computed tomography scan and DMSA scan preoperatively and 1-month postoperatively to assess the change in renal function. All the data collected were analyzed through Microsoft Excel 2007 Software. Statistical data were analyzed through SPSS Software Version 26. The pre- and post-operative creatinine and DMSA values were compared using a paired *t*-test. Categorical variables were examined using a simple Chi-square analysis. $P < 0.05$ was considered statistically significant.

RESULTS

The study included 50 patients with a mean age of 47.26 ± 7.17 years (range of 32 years to 62 years) of which 62% (31) were males and 38% (19) were females. The left-sided stone disease was present in 42% of patients and 58% had right-sided disease with only 4% (two cases) having history of prior ipsilateral stone surgery. Pre-operative positive urine culture was present in 68% of patients who received antibiotics in accordance with the culture and sensitivity report. Only 32% of patients had sterile urine culture preoperatively. In this study, the mean operative time for modified ANL was 180.40 ± 14.70 min with a range of 150–210 min. The mean duration of cold ischemia was 36.62 ± 3.74 min with a range of 25 to 42 min. The mean pre-operative creatinine level was 1.03 ± 0.16 mg/dl and post-operative creatinine level was 1.15 ± 1.15 mg/dl. The percentage change in creatinine level postoperatively was 11.65% which was statistically significant ($P < 0.001$). The mean pre-operative hemoglobin levels were 11.52 ± 1.65 g/dl and post-operative hemoglobin levels were 10.58 ± 1.45 g/dl. The percentage change in hemoglobin level postoperatively was 8.88% which was statistically significant ($P < 0.001$). The mean pre-operative DMSA differential function of the diseased kidney was 39.02 ± 3.44, and post-operative DMSA function was 35.64 ± 3.49. The percentage change in DMSA differential renal function postoperatively was 8.66% which was found to be statistically significant ($P < 0.001$). Out of 50 patients, eight patients had no change in DMSA renal function (16%), three patients had improved renal function (6%), and 39 patients had decreased DMSA renal function (78%) 1 week after surgery. No correlation was found between cold ischemia time and post-operative DMSA renal function. The above relationship was also found to be statistically insignificant ($P > 0.05$). No correlation was found between post-operative creatinine level and cold ischemia time and the above relation was also found to be statistically insignificant ($P > 0.05$). Complete stone clearance occurred in 94% (47) and 6% (3) had incomplete stone clearance postoperatively. These three patients required later additional procedure for complete stone clearance. Complications occurred in 14 patients out of 50 postoperatively. Most of the patients had a single complication. Three patients developed more than one complication. About 12% of patients developed acute kidney injury, 10% developed fever, 6% had hematuria, 4% had surgical site infection, and 2% had a urinary leak. All complications were managed conservatively. No patient died during this study period. Table 1 representing the various complications and there frequency.

DISCUSSION

The treatment of patients with staghorn calculus is a complex and challenging problem. Management options include minimal access procedures such as ESWL and PCNL, open nephrolithotomy, and ANL. ANL has been found to be more reliable than ESWL or PCNL in terms of stone removal when treating a large staghorn calculus with stone-free rates of 80–100% having been reported.[5,6] The better stone free rate comes at the cost of decrease in renal function postoperatively. In our study, we performed

Table 1: Various complications and there frequency

Complications	Frequency	Percentage
Acute kidney injury	6	12.00
Fever	5	10.00
Haematuria	3	6.00
Surgical site infection	2	4.00
Urinary leak	1	2.00

the modified ANL in 50 patients and prospectively studied the change in renal function following the procedure.

In our modification, we avoided dissection of the renal artery and its branches and made the parenchymal incision along the kidney's avascular plane between the anterior and posterior vascular segments because the segmental blood supply to the kidney is relatively constant and is not affected by the number of renal arteries thereby minimizing the danger of vasospasm of renal artery.[7] We approximated the collecting rather than closing as our opinion is that meticulous closure of the pelvicalyceal system carries the risk of compromising blood supply by ligating the vessels around the caliceal infundibuli.[8] We also avoided using various instruments (drum elevators, nerve hooks, and brain spatulas) and techniques suggested by others because our philosophy was to reduce renal ischemia time by avoiding unnecessary manipulations.[9,10]

In our study, the majority of patients were between the age group 40–60 years. About 48% of total patients were between 41–50 years and 32% of total patients were between 51–60 years. The mean age of the patients in the study was 47.26 ± 7.17 years which included 68% males and 32% females. The patient characteristics were similar to study done by Morey *et al.* (1999), Melissourgos *et al.* (2002), and Aminsharifi *et al.* (2016).[11-13]

About 4% of our study's total patients had recurrent stone. The recurrent rate was quite low because staghorn stones are more commonly infectious. If completely removed and infection completely eradicated, they tend to recur less compared with other metabolic stones.

Our study found that 68% of patients had positive pre-operative urine culture for bacterial growth. In comparison, only 32% of patients had sterile urine culture preoperatively. Out of positive patients – 70.59% were positive for *Proteus mirabilis*, 17.65% for *Escherichia Coli*, and only 11.76% for *Pseudomonas aeruginosa*. Melissourgos *et al.* (2002), in their study, found that all 24 patients had positive pre-operative urine culture (*P. mirabilis*, $n = 15$; *P. aeruginosa*, $n = 3$; and *E. coli*, $n = 6$) which was very similar to ours.[12]

In our study, mean cold ischemia time is 36.62 ± 3.74 min and there was no significant correlation between cold ischemia time and post-operative creatinine or post-operative DMSA function which was similar to the study by Melissourgos *et al.* (2002).[12] El-Nahas *et al.* (2018) studied the effect on renal function after ANL in 50 patients, and the mean cold ischemia time in their study for 29 patients was 45.2 min and for the remaining 21 patients was 54.8 min probably because they performed complete pelvicalyceal reconstruction in every surgery.[14] Similarly, Aminsharifi *et al.* (2016) ANL and recorded an average ischemia time of 32.8 min in their study, rather quite close to our studies.[13]

In our study the percentage change in pre-operative and post-operative creatinine level was 11.65% which was statistically significant. The previous studies by Morey *et al.* (1999), Melissourgos *et al.* (2002) and El-Nahas *et al.* (2018) showed similar result as ours.[11,12,14] It may be probably due to AKI in the immediate post-operative period or some renal function loss due to permanent nephron loss in open surgery. The long-term result of the change in creatinine function post-surgery is unknown; it may need further studies in the future.

In our study, the mean pre-operative DMSA differential function of the diseased kidney was 39.02 ± 3.44, and post-operative DMSA function was 35.64 ± 3.49. This difference was found to be statistically significant ($P < 0.001$). The percentage reduction in DMSA differential renal function postoperatively was 8.66% in our study. Reduction of renal function may be attributed to injury during renal parenchymal incision and closure or due to renal ischemia during clamping of its blood supply.[15] The long-term evaluation after PCNL for staghorn stones showed better results than ANL, as deterioration of the affected kidney function was reported in 8.5–20%.[14] As shown in Table 2, the most of the previous studies also showed a decline in renal function postoperatively.

The main disadvantage of ANL is the high rates of complications that are mainly related to the open approach through a long muscle cutting lumbar incision. In the present study, the overall complication was 34% which is more than complication rates of 22–32.5% reported for PCNL in the treatment of staghorn stones.[18,19] The need for blood transfusion (18%) after ANL was also more than the reported rates of 9–14% blood transfusion in the PCNL series.

In our study, a total of 14 patients out of 50 developed complications postoperatively. Most of the patients had a single complication. Three patients developed more than one complication; 12% of patients developed acute kidney injury, 10% developed fever, 6% had hematuria, 4% had surgical site infection, and 2% had a urinary leak. No patient died during this study period. All the complications were managed conservatively.

Table 2: Comparison of change in DMSA renal function of various studies

Name of study	Mean % change in renal function	Remark
Our study	8.66	Decline
Morey *et al*.[11]	4	Decline
Melissourgos *et al*.[12]	4	Decline
Aminsharifi *et al*.[13]	8.66	Decline
Kawamura *et al*.[16]	12	Decline
Ramakrishnan *et al*.[17]	NA	55% stable, 32% improved, 13% worsened (% of cohort)

DMSA: Dimercaptosuccinic acid

Renal function improvement may occur after stone treatment. Possible mechanisms related to the increase in renal function are the relief in obstruction, resolution of infection and inflammatory process, and compensatory hypertrophy of the remaining tissue. Nevertheless, the stone-extraction procedure may itself negatively compromise the functional condition of the surgically treated kidney.

Regarding ANL, a decrease in renal function may occur because of direct injury to parenchymal tissue, leading to a permanent scar at the nephrotomy site. Another possible mechanism is the ischemia-reperfusion injury related to occlusion of the renal artery and vein. Protection measures as ice-slush hypothermia and mannitol have been used, as well as restriction of ischemia time to no longer than 30 min. However, the impact of those measures on renal function is not fully known.

Despite the emphasis placed on minimally invasive approaches, we believe that ANL, although still a major operative procedure and associated with slight decrease in renal function postoperatively, is the most appropriate method for one-stage management of a selected group of patients with large staghorn calculi and is associated with the highest stone-free rates.

REFERENCES

1. Assimos DG. Should one perform open surgery in 1994? Semin Urol 1994;12:26-31.
2. Honeck P, Wendt-Nordahl G, Krombach P, Bach T, Hacker A, Alken P, *et al.* Does open stone surgery still play a role in the treatment of urolithiasis? Data of a primary urolithiasis centre. J Endourol 2009; 23:1209-12.
3. Turk C, Knoll T, Petrik A, Sarica K, Skolarikos A, Straub M, *et al*. Guidelines on Urolithiasis 2014: European Association of Urology Guidelines; 2014. Available from: http://www.uroweb.org/gls/pdf/22 Urolithiasis_LR.pdf
4. Preminger GM, Assimos DG, Lingeman JE, Nakada SY, Pearle MS, Wolf JS Jr., *et al.* Chapter 1: AUA guideline on management of staghorn calculi: Diagnosis and treatment recommendations. J Urol 2005;173:1991-2000.
5. Clayman RV, Surya V, Miller RP, Castaneda-Zuniga WR, Amplatz K, Lange PH. Percutaneous nephrolithotomy. An approach to branched and staghorn renal calculi. JAMA 1983;250:73-5.
6. Assimos DG, Wrenn JJ, Harrison LH, McCullough DL, Boyce WH, Taylor CL, *et al.* A comparison of anatrophic nephrolithotomy and percutaneous nephrolithotomy with and without extracorporeal shock wave lithotripsy for management of patients with staghorn calculi. J Urol 1991;145:710-4.
7. Redman JF, Bissada NK, Harper DL. Anatrophic nephrolithotomy: Experience with a simplification of the smith and Boyce technique. J Urol 1979;122:595-7.
8. Stubbs AJ, Resnick MI, Boyce WH. Anatrophic nephrolithotomy in the solitary kidney. J Urol 1978;119:457-60.
9. Smith MJ, Boyce WH. Anatrophic nephrotomy and plastic calyrhaphy. J Urol 1968;99:521-7.
10. Assimos DG. Anatrophic nephrolithotomy. Urology 2001;57:161-5.
11. Morey AF, Nitahara KS, McAninch JW. Modified anatrophic nephrolithotomy for management of staghorn calculi: Is renal function preserved? J Urol 1999;162:670-3.
12. Melissourgos ND, Davilas EN, Fragoulis A, Kiminas E, Farmakis A. Modified anatrophic nephrolithotomy for complete staghorn calculus disease—does it still have a place? Scand J Urol Nephrol 2002;36:426-30.
13. Aminsharifi A, Irani D, Masoumi M, Goshtasbi B, Aminsharifi A, Mohamadian R. The management of large staghorn renal stones by percutaneous versus laparoscopic versus open nephrolithotomy: A comparative analysis of clinical efficacy and functional outcome. Urolithiasis 2016;44:551-7.
14. El-Nahas AR, Elsawy AA, Abdelhalim A, Elsaadany MM, Osman Y. Long-term effects of anatrophic nephrolithotomy on selective renal function. Urolithiasis 2019;47:365-70.
15. Abreu LA, Camilo-Silva DG, Fiedler G, Corguinha GB, Paiva MM, Pereira-Correia JA, *et al.* Review on renal recovery after anatrophic nephrolithotomy: Are we really healing our patients? World J Nephrol 2015;4:105-10.
16. Kawamura J, Itoh H, Okada Y, Higashi Y, Yoshida O, Fujita T, *et al.* Preoperative and postoperative cortical function of the kidney with staghorn calculi assessed by 99mtechnetium-dimercaptosuccinic acid renal scintigraphy. J Urol 1983;130:430-3.
17. Ramakrishnan PA, Al-Bulushi YH, Medhat M, Nair P, Mawali SG, Sampige VP. Modified anatrophic nephrolithotomy: A useful treatment option for complete complex staghorn calculi. Can J Urol 2006;13:3261-70.
18. El-Nahas AR, Eraky I, Shokeir AA, Shoma AM, El-Assmy AM, El-Tabey NA, *et al.* Corrigendum to "Percutaneous nephrolithotomy for treating staghorn stones: 10 years of experience of a tertiary-care centre" [Arab J. Urol. 10 (2012) 324-329]. Arab J Urol 2016;14:72.
19. Desai M, De Lisa A, Turna B, Rioja J, Walfridsson H, D'Addessi A, *et al.* The clinical research office of the endourological society percutaneous nephrolithotomy global study: Staghorn versus nonstaghorn stones. J Endourol 2011;25:1263-8.

How to cite this article: Gupta RK, Kumar V, Tejasvi P. Study of Renal Function in Patients with Modified Anatrophic Nephrolithotomy. Int J Sci Stud 2022;10(4):35-38.

Source of Support: Nil, **Conflicts of Interest:** None declared.