Comparative Study of Renal Function between Standard and Modified Anatrophic Nephrolithotomy by Radionuclide Renal Scans

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Objective : *To compare the changes in renal function after surgery between standard and modified anatrophic nephrolithotomy using the technetium 99m-DTPA renal scan in patients with complex staghorn calculi.*
Material and Method : *From July 2001 to March 2002, standard anatrophic nephrolithotomy (sANL) was performed in 7 patients with complex staghorn calculi and modified anatrophic nephrolithotomy (mANL) was performed in another group of 8 patients with the same condition. Preoperative and postoperative renal function were assessed by technetium 99m-DTPA renal scan.*
Results : *Mean patient age was 41 years in the sANL group and 45 years in the mANL group. Male to female ratio was 4:3 in the sANL group and 5:3 in the mANL group. Median operative time was 205 minutes in the sANL group compare with 180 minutes in the mANL group (P = 0.03). Median estimated blood loss was 300 ml. in the sANL group and 275 ml. in the mANL group (P = 0.17). Median percent reduction of GFR on the operated kidney was 9.13 (-30.03 to -3.15) in the sANL group and 27.25 (-41.81 to -1.55) in the mANL group (P = 0.13). Residual small stone was seen in one patient of the sANL group and ESWL was performed for stone fragmentation. There were no serious short-term complications.*
Conclusion : *The average operative time of sANL was longer than mANL however, sANL preserved more renal function than mANL. This study suggested that sANL should be the procedure of choice in patients who have compromised renal function.*

Keywords : *Anatrophic nephrolithotomy, Staghorn calculi, Renal scan*

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Since the 1980s less invasive management of staghorn calculi have become increasingly prevalent[1-4]. Endourological approaches have almost replaced open nephrolithotomy in contemporary management[5]. Because complex, high volume staghorn calculi (renal stone which extended into all major calyxes) frequently mandate multiple endourological procedures, the authors believe that open surgery has a role in the management of this group of patients.

In the open surgery of staghorn calculi, the preservation of renal function is of utmost importance. The standard procedure for the treatment of staghorn calculi was anatrophic nephrolithotomy described by Boyce and Smith since 1967[6]. Although this procedure can preserve renal function after surgery, it is also more time consuming and requires extensive vascular dissection performed by a skillful surgeon. Currently, most surgeons prefer a modified operation called modified anatrophic nephrolithotomy[6,7] . This procedure is simpler and requires less operative time than standard anatrophic nephrolithotomy but there is no previous study to compare the postoperative renal function of both procedures. The objective of the present study was to compare the renal function between standard and modified anatrophic nephrolithotomy in patients with complex staghorn calculi by using the technetium 99m-DTPA renal scan.

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Material and Method

This study was a randomized prospective controlled trial approved by the ethics committee of Ramathibodi Hospital. From July 2001 to March 2002, 7 patients with complex staghorn calculi were enrolled for standard anatrophic nephrolithotomy (sANL) and 8 patients with the same conditions were enrolled for modified anatrophic nephrolithotomy (mANL) at RH. All patients had no other underlying disease and no history of any previous surgery. All the operations were performed by the same surgical team. Patient age ranged from 28 to 58 years (mean 41) in the sANL group and 25 to 62 years (mean 45) in the mANL group. Male to female ratio was 4:3 in the sANL group and 5:3 in the mANL group. All patients had complex high volume staghorn renal calculi that were too complicated for treatment by any combination of percutaneous nephrolithotomy (PCNL) and/or extracorporeal shock wave lithotrypsy (ESWL) (Fig.1).

All patients were evaluated with routine plain radiography of the abdomen and intravenous pyelography. Renal function defined in terms of the glomerular filtration rate (GFR) before and 6 weeks after surgery was measured quantitatively by the technetium 99m-DTPA renal scan.

With the patient in the lateral decubitus position, the kidney was exposed through an extra-peritoneal flank incision in both groups. The proximal ureter was occluded with a silastic loop to prevent distal migration of small stone fragments. The kidney was completely mobilized on all surfaces to expose the entire renal capsule.

In the sANL group, the renal artery was dissected and the posterior branch of the renal artery was identified. The bulldog clamp was temporary placed on the posterior branch and 1% methylene blue 10 ml was injected intravenously. The demarcation line for the nephrolithotomy incision could be seen when the methylene blue had stained the anterior portion of the kidney (Fig. 2). After the demarcation line was marked, the bulldog clamp was released.

Mannitol 12.5 g was given intravenously. The main renal artery was clamped and the kidney was packed in ice for 5 minutes, to obtain a core temperature of ten degrees Celsius. Once the kidney was sufficiently cooled, an incision was made through the capsule at the demarcation line. The stone was identified and removed. After the stone was removed, the calyx was closed with fine chromic suture. The renal parenchyma and capsule were closed with interrupted chromic suture. A nephrostomy and silastic drain were used in all cases.

Fig. 1 Preoperative scout film in a patient with complex staghorn calculi on the left side (renal stone which extends into all major calyxes)

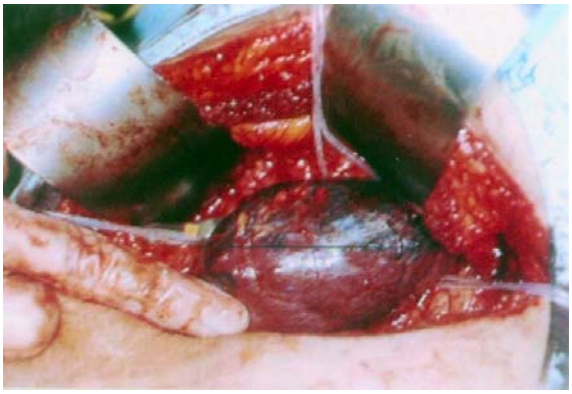

Fig. 2 Demarcation between anterior and posterior segment after methylene blue injection (line)

In the mANL group, after mannitol injection, the renal artery and vein were identified. Satinski's clamp was placed on both the renal artery and renal vein simultaneously.

The kidney was cooled in the same manner as in sANL group. This procedure did not require the use of methylene blue so there was no demarcation line on the kidney. The renal capsule and renal parenchyma were longitudinally incised approximately 2 cm posterior to the convex surface of the kidney, this is the so called Brodel's line. This line was assumed to be the avascular line where the anterior segmental artery of the kidney met the posterior segmental artery. The stone was removed and the renal parenchyma and capsule were closed in the same

manner as the sANL group. A nephrostomy and silastic drain were used in all cases.

Statistical Analysis

The Wilcoxon rank sum test was used for comparing all continuous outcomes between the sANL and the mANL groups.

Results

Median estimated blood loss was 300 ml (range 300 to 700) for the sANL group and 275 ml (range 150 to 500) for the mANL group (P = 0.17). The cold ischemic time was generally about 45-50 minutes in both groups. No patient required blood transfusion. The duration of surgery was 205 minutes (range 180 to 240) in the sANL group and 180 minutes (range 120 to 190) in the mANL group (P = 0.03). Perioperative complications were minor. The average length of hospital stay was 7 days in both groups.

Stone composition analysis revealed 5 struvite and 2 calcium oxalate stones in the sANL group, 6 struvite and 2 calcium oxalate in the mANL group. A small residual stone was detected in one patient of the sANL group and ESWL was performed for stone fragmentation. All patients had post-operative renal function at 4 to 6 weeks. Overall median serum creatinine level increased from 1.3 to 1.5 mg/dl in the sANL group and 1.4 to 1.6 mg/dl in the mANL group.

By technetium 99-DTPA renal scan, median preoperative total GFR (both kidneys of each patient) was 74.00 ml./min. (range 49.00 to 90.40) in the sANL group and 61.20 ml./min. (range 48.20 to 107.00) in the mANL group (P = 0.73). Median preoperative GFR on the operated kidney was 29.40 ml/min (range 25.40 to 66.60) in the sANL group and 29.60 ml/min (range 14.90 to 64.10) in the mANL group (P = 0.42). Median percent change in the total GFR was -1.90 (i.e. a reduction of 1.90%) (range: -23.78 to 7.04) in the sANL group and -14.61 (range: -33.82 to 1.34) in the mANL group (P = 0.25). Median percent change in the GFR on the operated kidney was -9.13 (range: -30.03 to -3.15) in the sANL group and -27.25 (range: -41.81 to -1.55) in the mANL group (P = 0.13). All of the data are summarized in Table 1 and Table 2.

Discussion

Most of the renal calculi at Ramathibodi Hospital over the past few years were treated by percutaneous nephrolithotomy (PCNL) and/or extracorporeal shock wave lithotrypsy (ESWL)[8]. Therefore, the 7 and 8 cases for sANL and mANL respectively were patients who had poor renal functions with stone bulk beyond the PCNL or ESWL treatment.

Previously, Morey et al reported that mANL could preserve renal function[5] but to the authors' knowledge, there was no previous study that compared postoperative renal function between sANL and mANL by using technetium 99m-DTPA renal scan.

The operative blood loss in sANL and mANL was 300 ml. and 275 ml. respectively. The difference was insignificant. Although the number of cases in the present series was small, the intravenous methylene blue clearly showed that Brodel's avascular line could be along mid-convexity to 2 cm. posteriorly. Blunt dissection along this

Table 1. Results of preoperative and postoperative total GFR, GFR of the operated kidney, blood loss, and operative time in the patients of the sANL group

	Age(y)	Sex	Total GFR (ml/min)			GFR on operated kidney (ml/min)			Blood Loss(ml)	Time (min)	Cold isch. Time(min)
			Pre-op	Post-op	% change	Pre-op	Post-op	% change			
Pt 1	38	M	49.00	48.00	-2.04	25.80	24.00	-6.98	700	180	45
Pt 2	35	M	59.70	63.90	+7.04	28.00	27.00	-3.57	400	190	50
Pt 3	33	M	63.00	61.80	-1.90	29.40	23.50	-20.07	300	205	50
Pt 4	51	F	74.00	72.90	-1.49	25.40	24.60	-3.15	500	180	40
Pt 5	58	M	78.40	78.00	-0.51	50.40	45.80	-9.13	300	230	55
Pt 6	47	F	84.00	75.30	-10.36	42.60	32.40	-23.94	300	240	50
Pt 7	28	F	90.40	68.90	-23.78	66.60	46.60	-30.03	300	205	45

% change = percent change in GFR, Pre-op = Preoperative, Post-op = Postoperative
(+) = increase, (-) = decrease, isch. = ischemic

Table 2. Results of preoperative and postoperative total GFR, GFR of operated kidney, blood loss, and operative time in the patients of the mANL group

	Age(y)	Sex	Total GFR (ml/min)			GFR on operated kidney (ml/min)			Blood Loss(ml)	Time (min)	Cold isch. Time(min)
			Pre-op	Post-op	% change	Pre-op	Post-op	% change			
Pt 1	60	M	48.20	31.90	-33.82	25.30	15.70	-37.94	200	190	45
Pt 2	62	M	49.70	40.30	-19.16	26.20	18.50	-29.39	500	170	50
Pt 3	47	F	53.40	44.50	-12.55	14.90	10.50	-29.53	250	190	55
Pt 4	55	M	55.00	48.10	-16.67	23.10	17.30	-25.11	200	180	45
Pt 5	35	M	67.40	68.30	+1.34	38.80	38.20	-1.55	450	190	50
Pt 6	48	F	82.40	79.10	-4.00	33.00	25.70	-22.12	350	180	50
Pt 7	28	F	104.00	104.00	0.00	47.60	41.60	-12.61	150	120	35
Pt 8	25	M	107.00	86.50	-18.91	64.10	37.30	-41.81	300	165	45

% change = percent change in GFR, (+) = increase, (-) = decrease, Pre-op = Preoperative, isch. = ischemic Post-op = Postoperative

potential avascular line should not injure many arterial arcades. Anatrophic concept is thus maintained. In the present series of both sANL and mANL, the blood loss was minimal. Backbleeding from the renal vein in sANL was not a problem in the present series.

The median percent reduction of GFR was 9.13% (-30.03 to -3.15) in sANL and 27.25% (-41.81 to -1.55) in mANL. In the present series, the reduction in GFR postoperatively between sANL and mANL was obvious. Further study is required to confirm strict adherence to the "water-shed" Brodel's avascular line during the nephrotomy.

In the present series, sANL used on average 25 minutes more operative time than mANL (P value = 0.03, statistically significant). The cold ischemic time was generally about 45-50 minutes in both groups. The increase in operative time did not increase any morbidity. There was no mortality in the present series.

The operative technique of sANL was not much different from that of mANL. The classical sANL is more difficult to perform in the patients who had previous surgery. Sometimes the posterior branch of the renal artery is difficult to find, requiring a skillful surgeon to identify the arterial branches. Renal artery injury or spasm may occur. Intravenous methylene blue may fail to demarcate the posterior segment of the kidney. In such cases, the surgeon may have to perform mANL. Otherwise sANL seems to be the procedure of choice in patients who have a single kidney, diabetes mellitus, disease that affects renal function or bilateral renal calculi.

Conclusion

sANL seemed to preserve more renal function than mANL. sANL required only 25 minutes more operative time than mANL. In patients with poor renal function or a single kidney, sANL should be the procedure of choice. However the study is limited by the small sample size. Further study should be done to confirm the results of the present study.

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การศึกษาเปรียบเทียบการทำงานของไตระหว่างวิธีการผ่าตัด Standard Anatrophric Nephrolithotomy และ Modified Anatrophric Nephrolithotomy โดยใช้ Radionuclide Renal Scans

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วัตถุประสงค์ *: เพื่อเปรียบเทียบการทำงานของไตก่อนและหลังการผ่าตัดระหว่างวิธีการผ่าตัด standard anatrophric nephrolithotomy (sANL) และ modified anatrophric nephrolithotomy (mANL) โดยใช้ technetium 99-DTPA renal scan ในผู้ป่วยที่เป็นนิ่วที่ไตชนิดเขากวาง (staghorn)*

วิธีการศึกษา *: ในช่วงเดือนกรกฎาคม ปี 2544 จนถึงเดือนมีนาคม ปี 2545 ทำการศึกษาโดยเลือกผู้ป่วยที่เป็นนิ่วที่ไตชนิดเขากวางจำนวน 7 ราย ให้รับการผ่าตัด (sANL) และผู้ป่วยจำนวน 8 รายได้รับการผ่าตัด (mANL) โดยที่ผู้ป่วยทั้งสองกลุ่มได้รับการเปรียบเทียบการประเมินการทำงานของไตก่อนและหลังการผ่าตัดโดยใช้ technetium 99-DTPA renal scan*

ผลการศึกษา *: อายุเฉลี่ยในกลุ่ม sANL อยู่ที่ 41 ปี ในกลุ่ม mANL อยู่ที่ 45 ปี สัดส่วนเพศชายต่อเพศหญิงในกลุ่ม sANL คือ 4:3 ในกลุ่ม mANL คือ 5:3 ค่าเฉลี่ยของระยะเวลาการผ่าตัดในกลุ่ม sANL อยู่ที่ 205 นาที ในขณะที่กลุ่ม mANL อยู่ที่ 180 นาที (P = 0.03) ค่าเฉลี่ยของการสูญเสียโลหิตในกลุ่ม sANL อยู่ที่ 300 มิลลิลิตร ในกลุ่ม mANL อยู่ที่ 275 มิลลิลิตร ในเรื่องการทำงานของไตพบว่าหลังการผ่าตัดโดยวิธี sANL โดยเฉลี่ยไตมีการทำงานลดลงร้อยละ 9.13 (ระหว่าง -30.03 ถึง -3.15) สำหรับการผ่าตัดโดยวิธี mANL โดยเฉลี่ยไตมีการทำงานลดลงมากถึงร้อยละ 27.25 (ระหว่าง-41.81 ถึง -1.55) ผู้ป่วยทั้งหมดไม่พบว่ามีภาวะแทรกซ้อนที่เป็นอันตราย มีผู้ป่วยจำนวน 1 รายพบว่ามีนิ่วค้างและสามารถใช้วิธีสลายนิ่วรักษาได้*

สรุปผล *: การผ่าตัดโดยวิธี sANL มีแนวโน้มที่จะรักษาการทำงานของไตได้ดีกว่าถึงแม้ว่าจะใช้ระยะเวลาในการผ่าตัดมากกว่า แต่ระยะเวลาที่ใช้มากขึ้นเพียงประมาณ 25 นาที น่าที่จะคุ้มค่าในการรักษาการทำงานของไต โดยเฉพาะในกลุ่มคนไข้ที่มีความบกพร่องการทำงานของไต*