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Effect of Percutaneous Nephrolithotomy on Renal Function Measured by Tc-99m- Dimercapto-Succinic Acid Renal Scan

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Abstract

Background and Aims: Nowadays, percutaneous nephrolithotomy (PNL) is a common method for removal of renal and ureteral stones. Although renal parenchymal damage occurs during this procedure, but the burden of this damage to the kidney function is not clearly understood. dimercapto-succinic acid (DSMA) renal radioisotopes scan is one of the best methods for analyzing parenchymal kidney function. In this study we are going to show the extent of kidney function before and after PNL procedure.

Methods: In this study, we collected 37 symptomatic patients with renal calculi who were candidates for the removal of these renal calculi by PNL procedure. They underwent DMSA renal scan before and after the PNL by with 99m technetium dimercapto-succinic acid (Tc-99m DMSA SPECT). The kidney function and the extent of parenchymal damage compared and analyzed by SPSS 13.

Results: Our results showed that mean renal split function was 62.95% in the healthy (not operated) kidney and 37.05% in the affected (operated) kidney before PNL. After PNL the mean of renal split function were 63.30% in the healthy kidney and 36.71% in the affected kidney. The renal functional changes were not significant before and after PNL (P. Value > 0.05).

Conclusions: The renal parenchymal function preserved after PNL. These results advocate treating patients with symptomatic renal stone disease by PNL without any concern about parenchymal damage.

Keywords: Kidney, Lithotripsy, Percutaneous, Renal Calculi, Radionuclide Imaging

Introduction

The goal of surgical treatment of renal stone disease, which may lead to renal parenchymal damage due to obstruction, inflammation and subsequent scarring, is to remove the stone creating the pathological condition while preserving the renal parenchymal tissue as much as possible. Management of nephrolithiasis has been changed by creating percutaneous nephrolithotomy (PNL)(1-3) .

PNL is a safe and effective treatment modality, however, some adverse effects as frequently seen with it. The most undesirable effects of Nephrolithotomy are renal parenchymal damage, scarring, hypertension and aggravation of renal failure. Detecting renal parenchymal loss and destruction, which are supposed to occur after Nephrolithotomy, is possible with99m technetium dimercapto-succinic acid (99m Tc-DMSA) scintigraphy, which is widely used to examine the

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renal parenchyma for other disease processes (4-7).

In this study, we present our data comparing the difference between preoperative and postoperative 99mTc-DMSA scintigraphic evaluation of kidneys treated with Nephrolithotomy for stone disease.

Materials and Methods

We studied 19 female and 18 male patients 3 to 77 years old (mean age 43.11) who underwent percutaneous nephrolithotomy for renal stone disease from April 2003 to September 2004.The basic preoperative workups included: IVP, ultrasonography, complete blood count, platelet count, blood urea nitrogen, serum creatinine, urinalysis, and urine culture. Preoperative Renal DMSA scan was done before admission, too. Inclusion criteria were the large stone burden, multiple stones or history of failed SWL. Patients with recent history of upper urinary tract manipulation, SWL and complete ureteral obstruction were excluded.

Informed consent was taken from the patients. The PNL procedure was performed under general anesthesia (GA).

Contrast medium was injected through ureteral catheter to high light collecting system. Access to the collecting system was created by urologists in the operating room via 18 gauged needle, under control of C-arm fluoroscopy. Best calyx was selected and punctured to get best access to whole of or most part of stone burden. We would get more access tracts to make the patient stone free, if it were necessary.

A nephrostomy tube was left in place at the end of the surgery in order to drain secretions and make it possible to repeat the procedure if there was any residual stone.

A plain abdominal film and an ante grade pyelography (nephrostogram) were performed on the first or second post-operative day to check for residual fragments. If any fragments were found with the potential to descend and block the ureter, PNL would repeat through the same tract(s) or a new one. Otherwise, the ureteral and urethral catheters were removed the day after and nephrostomy tube removed 48 hours after operation and the patient was discharged. Patients were followed up for two months and finally assessed by an ultrasound scan and DMSA scintigraphy.

Scintigraphic evaluations were repeated at 45 to 60 days (mean: 52) following the surgery. Scintigraphic evaluations were done with planar and Single Photon Emission Computerized Tomography (SPECT) images after intravenous injection of 37 to 185 MBq.99m Tc-DMSA. Planar scintigraphic images were obtained with the patient supine at 4 hours after injecting 99m Tc-DMSA for 1 and 5-minute images at posterior projections. Planar images were used for calculating the renal parenchymal uptake and renal split function. Preoperative and follow-up scans were did in same institute, by same machine and the renal scan was reported by a same person and all data analyzed by T test and paired T test and P value less than 5% was considered significant.

Results

Thirty-seven patients were enrolled in the study during an 18 months period. Nine cases had staghorn stone and 14 had multiple stones (calices and renal pelvis). Eleven patients (29.7%) only had renal pelvic calculi and 3 patients (8.1%) had ureteral stone. Stone diameter was 20 mm or less in 4 cases (10.8%), more than 20 mm in 24 (64.9%), and 9 patients (24.3%) had staghorn calculi. All 4 cases with stone less than 20 mm had history of failed SWL. In 19 patients the renal stone was on the right side, while 18 patients had left renal stones. Two tracts were needed in 5 cases. Re-PNL was necessary in 3 cases with staghorn stone through the same tracts. Size of operating sheath was 28Fr in 35 cases and 30Fr in one and 22Fr in one case.

Visual evaluation of the area showing DMSA uptake on preoperative scintigrams did not change in size. Preoperative renal split function by DMSA uptake decreased in 19 patients (51.4%) and increased in 18 patients (48.6%) in the postoperative period. Our results show that the mean of renal split function was 62.95±13.2% (46.8-95) in the healthy (opposite side) kidney and 37.05±13.2% (5-53) in the affected (operated) kidney before PNL. After PNL mean renal split function were 63.30±13.02% (44.9-94.9) in the healthy kidney and 36.71±13.4% (5.1-55.1) in the operated kidney. Mean renal split function decreased by 0.35± 0.12%, but the difference was not significant (P= 0.41). Renal functional changes in operated kidney with one tract before and after surgery was 0.1±4 and in cases that operated with 2 tracts (5 cases) was 0.5±3 (P= 0.23), so number of tracts did not have any effect on renal split function. We did not find any scar in isotopic scans of our patients. In addition, we did not face with any major complications.

Discussion

99m Tc-DMSA provides good renal imaging, and has been used for the evaluation of renal cortical function, diagnosis and follow-up of pyelonephritis, as well as evaluation of ectopic kidneys and differential diagnosis of renal masses, such as fetal lobulation, lobular compensatory hypertrophy and Bertini's columns from tumor, abscess, hemorrhage and infarction (5-7).

99m Tc-DMSA is particularly taken up by renal cortex, which is useful in quantitative evaluation of preoperative and postoperative residual renal function, and detection of the morphological changes in the cortex caused by renal calculus (8-11).

99m Tc-DMSA, which is used as a renal imaging agent, is taken up by and accumulates in the renal cortex in large amounts, and results in good renal cortical imaging. The renal uptake rate of DMSA represents cortical functioning mass depending on renal blood flow, and provides a quantitative evaluation of individual kidney function (5). When 99m Tc-DMSA is considered as a static renal imaging agent, the images obtained 2 hours after injection are accepted to represent renal anatomy in normal individuals (12). The images obtained 24 hours after injection are preferred as target-to-background ratio increases and the radioactivity in urine of renal collecting system decreases (13). However, Older et al showed that there is a minimal and insignificant difference between 4 and 24-hour images even in patients with nephropathy (7). In our study it was not possible to obtain the 24-hour images, because the patients would undergo surgery the next day. DMSA, which accumulates in renal tubular cells, has a good correlation with renal functional parameters, such as serum BUN and creatinine levels, and effective renal plasma flow. However, these correlations weaken when renal function is severely impaired (12-14).

By comparing preoperative and postoperative 99m Tc-DMSA uptake, the effect of surgical techniques on 55 patients who underwent nephrolithotomy for renal staghorn calculi was investigated, and patients who underwent nephrolithotomy or nephropyelolithotomy showed no change at 3 to 6 months of follow-up (5). Although no pathological changes were noted on quantitative renal scintigraphy after renal surgery in patients with staghorn calculi (6) BUN and serum creatinine levels might increase temporarily following renal stone surgery secondary to operative trauma and these levels returned to normal within 3 months (15). In another study a series of 88 patients with a mean age of 47 ± 16 years were studied by sequential QDMSA examinations before and 1.5 to 24 months after PNL. Among the 67 patients (76%) in whom PNL was performed using upper- or lower-pole access, the function of the affected and unaffected poles of the treated kidney was calculated separately. There was no statistically significant difference in the uptake by the treated kidneys before versus after PNL (16). Chatham studied renal parenchymal injury by 99mTc-MAG3 nuclear renography, 19 patients underwent PNL. The mean patient age was 49 years (range 11 to 75). All participants completed a quantitative assessment of differential renal function preoperatively and postoperatively. Renal function, for the entire group, increased from 36.8% preoperatively to 38.5% postoperatively. Renal function was preserved in 16 (84%) of 19 patients, including improvement of function in 7 (37%) of 19 patients (17). Dawaba and colleagues measured renal function before and after PNL by DMSA and diethylenetetraminepentaacetic acid (DTPA) scans and showed that none of the kidneys had scarring on DMSA renal scan. All of the kidneys except 1 showed improvement or stabilization of the corresponding GFR determined by DTPA renal scan (18).

In our prospective study, patients who underwent PNL were examined by 99m Tc-DMSA renal imaging before and 2 month after surgery. Our results show that the mean renal split function was 62.95% in the healthy side kidney and 37.05% in the affected (operated) kidney before PNL. After PNL the mean renal split function were 63.30% in the healthy kidney and 36.71% in the affected kidney. The renal function differences were not statistically significant before and after PNL (P= 0.41). Our study had some limitations such as short term follow-up, different stone burden and number and impaired renal function before surgery in some cases. We recommend a study in cases with a single non-obstructive stone in normal functional kidney or in patients with single kidney.

Conclusions

99m Tc-DMSA scan revealed no significant changes in renal cortical function after percutaneous renal stone surgery. The renal parenchymal function was preserved after PNL. These results advocate treating patients with symptomatic renal stone disease by PNL without major concern about parenchymal damage.

Conflict of interest: Supported by Deputy of Research, Hamadan University of Medical Sciences

Conflict of Interest

None declared.

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