ORIGINAL RESEARCH

A Modified Mini Percutaneous Nephrolithotomy (m^2PCNL) for Staghorn Calculi

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Objectives: Modifications in endourologic methods of stone removal are aimed at increasing stone clearance while minimizing complications and morbidity. Our study seeks to evaluate the efficacy, safety, and morbidity of a modified mini-percutaneous nephrolithotomy (m^2PCNL) in patients with staghorn calculi.

Materials and Methods: A modified mini PCNL procedure was done using a 19F nephroscope without a secondary sheath, through a 22F Amplatz Teflon access sheath. Standard PCNL equipment were used for stone fragmentation and evacuation. A DJ stent was placed in an antegrade manner, after which a nephrostomy tube was also placed. Outcomes of m2PCNL done in our first 28 patients with staghorn caculi were reviewed for this study.

Results: Our results showed a (27/28) 96.4% primary stone-free rate with m2PCNL for stones > 4cm^2 in surface area. Patients were followed up at 3 and 6 months post operatively and were still stone free. Average operative time was 55 minutes, average blood loss was 50 cc and average hospital stay was 3.5 days. Two patients had urinary tract infection, while one patient had sepsis post operatively. No other morbidities were noted.

Conclusion: Modified mini PCNL has a well-defined role in many patients. It is a safe procedure with a high stone-free rate and with minimal associated morbidity. We recommend m^2PCNL for patients with moderate to large stone burdens (4-6 cm^2 cross sectional area) and for patients with calculi in a calyceal diverticulum. From our experience, patients with larger stone burdens (even stones with >6 cm^2 in cross-sectional area) can also be considered candidates for m^2PCNL.

Key words: percutaneous nephrolithotomy, stagorn calculi

Introduction

Percutaneous nephrolithotomy (PCNL) is now considered the standard of care for large renal calculi unsuitable for extracorporeal Shockwave lithotripsy (ESWL) since its introduction in the 1970's.[1] This has been a result of rapid development of higher resolution videoendoscopic equipment and more efficient intracorporeal lithotripters. Parallel to this is a better understanding of renal anatomy which translated to a higher quality of surgical technique which provided variation in the technique of renal tract dilation, decreased duration and size of nephrostomy tubes, variations of tubeless procedures, combined antegrade and retrograde access, and second-look flexible nephroscopy. All of these were aimed to enhance stone clearance while minimizing complications and post-operative morbidities.[2] With miniaturization and improvements in fiberoptics, use of smaller endoscopes and the addition of the holmium:YAG laser to the armamentarium of intracorporeal lithotripsy, the time is ripe to build on our percutaneous renal surgery foundations.

Although there is great variability in described techniques during mini PCNL, the majority utilize specialized miniature instruments that are able to fit in the smaller tract sizes. The "miniaturization" of the standard PCNL components however, may impact the procedure as a whole in several ways. It addition to potentially decreasing visibility and irrigation, it precludes the use of standard PCNL equipment, thereby requiring the acquisition of new scopes and accessories, which can be costly.[3] A modified mini-PCNL (m2PCNL) is defined as a PCNL technique using a small working sheath, performed using a 19F Nephroscope through a 22F percutaneous renal access tract. The use of a smaller-sized 22F percutaneous tract compared to the standard 28-30F percutaneous tract for standard PCNL has the potential advantage of decreased bleeding and trauma to renal parenchyma, which may effectively reduce intraoperative and postoperative morbidity.[4,5,6]

Limited studies report the application of mini PCNL on large stone burdens, mainly citing prolonged operative time and the degree of technical difficulty in using a smaller tract.[4,7,8] Abdelhafez, et al. even reported a lower stone-free rate (76.3%) using mini PCNL compared to conventional PCNL for renal calculi > 2cm.[7] To date, no study has yet reported on the use of a modified mini PCNL (m2PCNL) with a 22F access sheath in the management of staghorn calculi.

This study describes a "modified mini PCNL" (m2PCNL) technique that utilizes standard PCNL equipment through a smaller nephrostomy tract (22F), and present our preliminary experience with this modification. This study aimed to evaluate the efficacy, safety, and morbidity of m2PCNL for staghorn stones.

Materials and Methods

Patient Selection

The authors retrospectively reviewed their experience in their first 28 patients with staghorn calculi using m2PCNL. The indications for PCNL included failed ESWL and/or medical therapy. Patients with a staghorn calculus of more than 4cm^2 cross sectional area were included in the study. Patients with concomitant ureteropelvic junction obstruction, calyceal diverticulum, and/ or ureteral strictures who were treated for these conditions at the time of PCNL were excluded from the study. This series represents the experience of a single surgeon (DGL, at a tertiary referral medical center), and the decision of using this modified technique with the standard PCNL equipment was at the surgeon's discretion with written informed consent from the patient and/ or a legal guardian.

Patient Preparation and Ureteral Access

Induction with general anesthesia was done, after which, patient was placed on dorsal lithotomy position and draped. Cystoscopy was performed and a 0.035 or 0.038 guidewire is inserted into the ureter of interest under direct vision. After confirmation of correct wire positioning by fluoroscopy, a 6F open-ended access ureteral catheterTM (Boston Scientific) was gently advanced over the wire in a retrograde fashion, and the tip of catheter was placed at the renal pelvis. Retrograde urography was performed to delineate the calyceal anatomy. A 16 Fr Foley catheter was inserted and secured to the ureteral catheter with a 2-0 silk tie to prevent migration during patient positioning.

Percutaneous Access

After ureteral access, the patient was repositioned to the prone position, in concert with the anesthesia team. Pillows were placed under the patient's chest and abdomen to act as bolsters, facilitating respiration as well as stabilizing and preventing migration of the kidney. The head, ankles and knees were supported with paddings and/or smaller pillows. Distilled water was used as irrigant using continuous flow.

An appropriate site for percutaneous access was made after a careful consideration of the patient's pelvocalyceal anatomy and stone location and orientation. Under fluoroscopic guidance, a percutaneous access was obtained using a 17 cm, 18-gauge diamond tipped brachytherapy needle. Average percutaneous access time was 20 to 30 seconds, from puncture to confirmation of tip placement in the renal pelvis by fluoroscopy or with egress of urine through the needle. A PTFE coated guidewire 0.038" (0.97mm) x 150-cm J-wire (Boston Scientific) was inserted through the upper pole calyx, and advanced down the ureter (whenever possible) or or coiled inside the the calyx. Once coiling of the wire in its desired location was confirmed with fluoroscopy, the access needle was removed. A scalpel was then used to incise the skin and fascia with the guidewire in place. Next, a NephromaxTM balloon dilating set (Boston Scientific) was inflated at 10 atm for 5 minutes while the tip of the balloon was at the level of the desired calyx. This was done to radially dilate the tract and place the included Amplatz 22F Teflon sheath.

Nephroscope Setup

A 19F rigid nephroscope without the outer sheath (Brand: Generic) was used for the m2PCNL procedure. Without the outer sheath, the 19F nephroscope was easily accommodated by the smaller tract via a 22F Amplatz sheath. For patients undergoing the m2PCNL procedure no further modifications in the pneumatic lithotripter probe, ultrasonic probe, grasper, and suction probe were necessary, as these devices were able to negotiate the 9F working port of the nephroscope.

Stone Fragmentation and Retrieval

The remainder of the m2PCNL was then performed through the smaller tract. Stone fragmentation was achieved using pneumatic lithotripters or ultrasonic lithotripter. Average stone fragmentation time was at 20 minutes. Large fragments (<6mm) were removed systematically with graspers while smaller and finer fragments were extracted with a specially designed suction device/evacuator device. Evacuation of stone fragments was accomplished within 10 minutes. At the completion of the procedure, a double-J stent (5F/26 cm) with a tether (3-0 size nylon string, as provided by the manufacturers) attached to its cephalic end, was introduced over the guidewire in an antegrade fashion. The tether was brought out to the skin via the nephrostomy tract. This was followed by insertion of a 16F nephrostomy tube which was removed routinely within 48 hours. The area around port site was infiltrated with local anesthetic prior to anchoring the nephrostomy catheter. Imaging studies were not obtained prior to nephrostomy tube removal unless intraoperative findings suggested significant extravasation or residual calculi. Nephrostomy tubes were clamped when the urine was clear and removed 24 hours later unless the patient reported flank pain. The stent was pulled out through the nephrostomy tract by its tether upon follow up, after 7 to 10 days.

Results

Twenty-eight patients with a mean stone diameter of 20.0mm (range 1.9mm-50.0mm) underwent modified Mini PCNL (m^{2}PCNL) using a 22F Amplatz sheath with standard PCNL equipment and a customized suction device to facilitate stone clearance. Except for one patient, all patients were stone-free at the end of the procedure, for a 96.4% primary stone-free rate. This one patient had a 0.3cm retained stone fragment which could not be accessed nor evacuated using a rigid nephroscope. Patient chose to undergo medical management and was eventually rendered stone free on the fourth month of follow-up. Repeat imaging using KUB ultrasound was done at 3 months and 6 months post operatively for surveillance. Most of the patients were stone-free on follow-up at 3 months and remained stone free even beyond 6 months.

Mean reported operative time was 55 minutes (Range 45-150 min) and mean blood loss was only 50cc, for which no blood transfusion was required. Average hospital stay was 3.5 days and there was minimal complaint of pain post operatively, which was easily controlled by intake of an average of 3.5 doses (1 tab q8 as needed) of oral analgesics. A DJ stent with a tether at its cephalic end was inserted in all patients and was removed upon follow-up after an average of 8 days (Range 7 to 10 days).

The most common post-operative complication observed in this case series was infection with two patients having UTI and one patient having sepsis. Culture-guided antibiotics were given to those who had UTI with prompt resolution of symptoms and return of ancillary procedures to normal after one week. Preoperative urine culture of the patient who had sepsis was negative. However, patient had fever and leukocytosis post operatively. Stone specimen obtained during the procedure was sent for culture and sensitivity, which showed Escherichia coli growth. Blood cultures also showed E.coli growth. Appropriate antibiotic was given and patient eventually improved. No other morbidity was observed, except for the retained stone which was earlier discussed.

Discussion

Percutaneous nephrolithotomy remains the gold standard for the endourologic management of renal calculi unsuitable for shockwave lithotripsy. However, increased stone number and size, calyceal location, staghorn calculus as well as moderate to severe hydronephrosis have been reported to be associated with decreased stone rates in Mini PCNL.[3] First procedure stone-free rate for mini PCNL ranged from 74% to 96% in different studies.[7,8,9] Still, Mini-PCNL has been shown to be more advantageous in terms of stone free rate for smaller calculi (< 2cm) and multiple calyceal stones, when compared with standard PCNL.[3,4,7] The primary stone free rate for the m2PCNL in our study was at 96.3%. This demonstrates m2PCNL's potential as a primary endoscopic procedure even for staghorn calculi, with reproducible results. Because of the size of the tract used (22F), we were able to use standard PCNL equipment with minor modifications, and no further equipment acquisition was needed to perform the procedure (Figures 4 to 7). M^{2}PCNL offers another advantage in that it may also facilitate completion of ancillary procedures such as antegrade endopyelotomy at the time of removal of calyceal calculi.[4]

Operative time in mini PCNL is significantly increased compared with standard PCNL. Cheng, et al. in a randomized trial involving 69 patients (72 renal units), reports that mini PCNL for staghorn stones took an average of 134 minutes to complete (versus 118 minutes for standard PCNL).[10] In our experience however, average operative time for the modified mini PCNL procedure was only 55 minutes. Multiple factors have contributed to this end, but the slightly larger tract (22F) used in this study compared to mini PCNL (13F-19F), which facilitated irrigation, intraoperative visibility, and stone extraction may be considered as a crucial contributor to the shorter operative time reported in this study. Multiple m^{2}PCNL accesses may also facilitate complete stone clearance in patients with complex stones or even a staghorn calculus. While it may further increase operative time and risk of bleeding, multiple access results in better stone clearance and decreased need for second procedures. Furthermore, bleeding is decreased by the smaller size of the tract created.[7,11,12]

Increased risk and incidence of bleeding, post-operative pain and prolonged hospital stay are recognized disadvantages for use of conventional PCNL in staghorn calculi.[1,6,10] Septicemia and bleeding requiring blood transfusion are considered major complications for PCNL, and these represent 1.1% and 2.7% of PCNL morbidities respectively.[10] Minor complications include pain, fever, UTI and renal colic.[10] There was no significant bleeding noted in our cases with average blood loss amounting only to 50cc. With the m2PCNL procedure, there is a 56% reduction in the volume of renal parenchyma that is dilated by a 22F sheath compared with traditional 30F sheaths.[5] This reduction in size of the access sheath should decrease perioperative bleeding and pain, as well as postoperative parenchymal scarring.[4,5] Infectious complications of m^{2}PCNL were noted in our series, which were compatible with published data. Meticulous preoperative preparation and prompt treatment with culture guided antibiotics will minimize post procedural infections in the future.

Conclusion

Surgical management of urinary tract calculi is continuously evolving and modifications of recent advances further improve outcomes for afflicted patients. We believe that the Modified mini PCNL has a well-defined role in many patients. It is a safe procedure with a high stone-free rate with minimal associated morbidity. Based on the data we have gathered from our initial experience, we recommend m2PCNL for patients with moderate to large stone burdens (4-6 cm^2 cross sectional area) and for patients with calculi in a calyceal diverticulum. From our experience, patients with larger stone burdens (even stones with >6 cm^2 in cross-sectional area) can also be considered candidates for m^2PCNL. Further research will be done comparing outcomes this procedure with standard endourologic techniques in a local setting. We also plan to evaluate analgesic requirements, preservation of renal function, and hematologic parameters in future studies.

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