

Original article

A comparison between ultrasonic and pneumatic lithotripsy in percutaneous nephrolithotomy – Our experience in Prince Hussein Bin Abdallah the II center of urology and organ transplantation

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Abstract

Objective: Percutaneous nephrolithotomy (PCNL) is a procedure that is now routinely used to treat large and complex renal stones. Since first described by Frenstorm and Johanson, many advances to the surgical technique were developed including the lithotripters used to fragment and remove stones. In this study we compared the efficacy and safety of PCNL using pneumatic and ultrasonic lithotripsy..

Methods: the study was carried in Prince Hussein Bin Abdallah the II Center of urology and organ transplantation. Two groups of patients who underwent PCNL between July 2013 and June 2014 were compared. Group A ,50 patients, underwent PCNL using pneumatic lithotripsy. And group B, 53 patients underwent PCNL using ultrasonic lithotripsy. The 2 groups were compared in terms of stone size, location, operative time, hospital stay, blood loss and stone free rats.

Results: there were no significant differences in stone size, location or stone free rates. But the ultrasonic lithotripsy group (group B) had significantly lower operative time, number of hospital days and average blood loss.

Conclusion: PCNL is a safe procedure, and the use of ultrasonic lithotripsy significantly decreased operative time, hospital stay and blood loss.

Keywords: *Percutaneous nephrolithotomy, renal stones, pneumatic lithotripsy, ultrasonic lithotripsy.*

Introduction

The technique of establishing a percutaneous tract specifically to remove a stone from the kidney was first described by Frenstorm and Johansson in 1976. Subsequently, the percutaneous nephrolithotomy procedure was established and is now a routinely used technique to treat patients with large or even complex renal stones (1) (2).

This surgical technique and related technology have improved dramatically allowing the percutaneous removal of kidney stones with increasing efficiency, and is now replacing open nephrolithotomy and pyelolithotomy as it is superior in terms of morbidity, convalescence and cost (2) (3) (4).

What is PCNL? It is a surgical procedure, usually done under general anesthesia, but can be done

under spinal anesthesia, aimed at removing kidney or renal pelvis stones. It starts while the patient is in a lithotomy position, retrograde cystoscopy is done, the urethra and the urinary bladder are evaluated and a retrograde catheter is inserted to the targeted kidney, a foley catheter is inserted to the urinary bladder and the patient is turned to the prone position. Contrast is injected into the kidney using the retrograde catheter to opacify the pelvicalyceal system and under fluoroscopic guidance and through a small puncture wound in the loin the nephrolithotomy needle is passed to the kidney and a guide-wire is inserted to the pelvis of the kidney, and the needle is withdrawn. Over the guide-wire dilators are passed into the kidney and the tract is created. A working sheath is introduced

to the kidney. Using the nephroscope the stone is visualized and different lithoclasts probes can be used to fragment and remove the stone (5).

In our center we use two types of lithotripters, the pneumatic lithotripter and the ultrasonic that was introduced later. The objective of this study is to evaluate the effectiveness of both types of lithotripters we use. We evaluated stone size and location, and compared the two types in terms of hospital stay, operative time, blood loss and stone free rates.

Method

We reviewed the medical records of 103 patients who underwent PCNL between July 2013, and June 2014. The patient history and details, the procedure, the post-operative results (operative time, hospital stay and stone free rates) and complications (we evaluated for bleeding) were recorded.

Of the 103 patients, 50 patients underwent PCNL using pneumatic lithotripsy, and 53 patients underwent PCNL using ultrasonic lithotripsy.

The patient ages didn't differ significantly between the two groups with an average age of 49.3 years for group A, and 47.9 years for group B patients.

The stone size for all patients was documented preoperatively by noncontrast renal computed tomography, and inclusion criteria included the presence of stones 2 centimeter and larger, lower group calyx stones, middle group calyx stones, and partial or complete staghorn stones.

All patients were admitted a day before surgery, had sterile urine proved by a negative urine culture done a week before surgery, and all were started on antibiotics the day before surgery.

All patients had the PCNL tract done by the interventional radiologist through the middle or lower group calyx to minimize chest complications. Group A patients underwent PCNL using the pneumatic lithotripter, and the stone fragments were removed using forceps and suction. Group B patients underwent PCNL using the ultrasonic lithotripter and stone fragments were removed by the applied continuous suction. In both patient groups a nephrostomy tube was placed post-operatively and kept until there was no gross hematuria draining and there was no leak 4 hours after the nephrostomy was clamped.

The following parameters were evaluated:

1- Operative time: was recorded as the time from the start of lithotripsy to the end of the procedure (the time consumed in cystoscopy and insertion of retrograde catheter and the time taken by interventional radiologist to create the PCNL was not calculated).

2- Hospital stay: referred to the total number of days the patient stayed in hospital after the procedure.

3- The total blood loss: assessed by hemoglobin values pre- and post-operatively, and by the need for transfusion in each group.

4- Stone free rates: evaluated by a KUB, and sometimes non-contrast computed tomography renal scans done 2-4 weeks post-operatively. And referred to the absence of any residual stones or small tiny calyceal stones that do not require intervention.

Results

A total of 103 patients were included in this study, the mean age of the patients was 48.4 years, 50 patients (group A) underwent PCNL using pneumatic lithotripsy and 53 patients (group B) underwent PCNL using ultrasonic lithotripsy.

The stone size did not differ significantly between the two groups, the average stone size was 27.6 millimeters for group A patients, and 31.2 millimeters for group B patients. This was determined by pre-operative non contrast renal computed tomography as mentioned previously.

Regarding the stone location, also determined by pre-operative non contrast renal computed tomography, there were no significant differences between the two groups. 15 group A patients (30%) had staghorn or partial staghorn stones, 30 patients had renal pelvic stones (60%), and 5 patients (10%) had isolated calyceal stones located at the lower group calyx or middle group calyx.

16 group B patients (30.19%) had staghorn or partial staghorn stones. 33 (62.26%) patients had renal pelvic stones, and only 4 patients (7.55%) had isolated calyceal stones located in the lower group calyx or middle group calyx.

The operative time recorded as the time from the start of lithotripsy till the end of the procedure (excluding the time taken from the beginning of anesthesia, cystoscopy and insertion of retrograde catheter, and the time taken to create the PCNL tract by the interventional radiologist) differed significantly between the two groups. It averaged about 45 minutes for group B patients, and this was much less than the average operative time for group A patients that was 70 minutes.

Blood loss evaluated by hemoglobin levels pre-operatively and post-operatively and the need for blood transfusion also differed significantly between the 2 groups. 5 group A patients (10%), and 2 group B patients (3.8%) experienced bleeding that required blood transfusion.

2 patients, one from each group developed persistent bleeding that required embolization to

treat, and was shown to be due to the development of arterio-venous fistulae.

The hospital stay, referring to the total number of days the patient remained in hospital after the procedure was also evaluated, and it was significantly less for group B patients with an average of 2.2 days, while that of group A patients averaged 3.4 days.

Clearance rates and residual stones evaluated by KUBs, and sometimes by non-contrast renal computed tomography done 2-4 weeks post operatively was also evaluated, and it did not differ significantly between the 2 groups. Only 8 group A patients (16%), and 7 group B patients (13.2%) had clinically significant residual stones.

Discussion

Kidney stones is a common disease, requiring management according to stone size and location in the pelvicalyceal system. Urologic techniques improved and stone management revolutionized proved by the excellent stone free rates and less complications (5) (6).

Like other surgical techniques PCNL improved dramatically, success rates increased and associated complications and morbidities decreased. One of the advances that lead to this is the development of new lithotripter techniques that allow clearance of larger and harder kidney stones nowadays (6).

Historically, the first intracorporeal lithotripter was the electrohydraulic lithotripter invented in 1955 by Ytkin. It was used to treat urinary bladder, ureteral and kidney stones(5) (7). Although it is a powerful lithotripter as it successfully fragments 90% of stones, it is not preferred now because it causes mucosal injuries to tissues and perforations more than other lithotripter techniques (8) (9).

The Holmium : Yttrium – aluminum – garnet (Ho : YAG) laser lithotripter, is a high – energy – pulse – solid state laser lithotripter that transmits its energy through a flexible fiber, which allows treating stones through the entire collecting system. Its major disadvantage is its high cost, it can also cause strictures and perforations but when used cautiously these are rare. Its major advantage is that it allows fragmentation of all stones regardless of composition (2).

The ultrasonic lithotripter is commonly used in PCNL procedures, the probe tip causes the stone to resonate at high frequency by the ultrasonic waves it generates, allowing the stone to break while the continuous suction removes stone fragments. This type of lithotripter requires much irrigation to prevent overheating of the stone. Its major advantage is that it causes minimal tissue damage because tissue does not resonate (2) (3) (4).

The pneumatic lithotripter is an old one but is still widely used to treat almost all urinary stones

whether bladder, ureteral or kidney stones. It is suitable for harder stones and when applied cautiously causes minimal tissue damage. However a disadvantage of this technique is that the stone fragments must be removed using graspers which is very time consuming (5) (10).

In this study carried out in Prince Hussein Bin Abdallah the II of urology and organ transplantation we compared between the 2 major types of lithotripters we use in PCNL procedures, this is the first study from Jordan to evaluate this.

All patients are admitted through the out-patient department usually one day pre-operatively and their medical, surgical history is evaluated, and lab tests are done including a CBC, KFT, and bleeding profile.

The pneumatic lithotripter was the only used type until 5 years ago when the ultrasonic lithotripter was introduced to our center, and since then we were using both types in PCNL procedures.

In this study all patients were evaluated preoperatively and we didn't analyze the relation of the patient's sex to result, also stone composition was not evaluated which might be drawbacks of this study that may affect results. But the study showed that the ultrasonic lithotripter is better in terms of length of hospital stay, operative time and blood loss. Both lithotripter types were effective in achieving satisfactory and comparable stone free rates.

All procedures were done by consultant urologists of same practice level and experience to minimize personal variation contribution to results. Another factor that contributes to the success of PCNL is achieving a tract that allows access to the targeted stone with minimal complications and in this study the tract was always done by the same interventional radiologist with negligible complications related to the tract.

As with any surgical procedure PCNL has its complications and in this study we evaluated for blood loss, which is the most important complication related to PCNL (3). blood loss during this procedure was much less in group B patients who underwent the procedure using the ultrasonic lithotripter and this correlates with the less tissue damage this system causes, however bleeding could be related to the tract but all of our patients didn't have clinically significant bleeding at the start of lithotripsy and after the tract was made.

2 patients developed persistent bleeding requiring embolization and this again emphasizes the fact that PCNL is a surgical procedure that might result in major complications that require recognition and treatment sometimes only in a specialized center(5) (8).

There is no conflict of interest.

Conclusion

Percutaneous nephrolithotomy is the procedure of choice for removing most kidney stones, because it is safe with less morbidity compared to open surgical techniques. This study showed that using pneumatic or ultrasonic lithotripsy during PCNL achieves satisfactory and comparable stone free rates. But the use of the ultrasonic lithotripter significantly reduced operative time, hospital stay, and blood loss when compared to pneumatic lithotripsy.

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