Original Article

Comparison of holmium: Yag laser and pneumatic lithoclast in percutaneous nephrolithotomy

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Abstract

Objective: To compare holmium Yag laser with lithoclast in patients with renal stones undergoing percutaneous nephrolithotomy (PCNL).

Methods: A comparative cross sectional study was performed on 60 patients undergoing PCNL. Patients with a 2.5 cm stone in renal pelvis, having preoperative negative urine culture, no coagulopathy and fit for general anaesthesia were included, pregnant females were excluded. They were randomly divided into 2 groups of 30 cases each depending on the energy source used. Group A included cases of PCNL subjected to laser treatment and group B had patients undergoing PCNL with pneumatic lithoclast. For each group duration of procedure, any per operative or postoperative complication, residual stone, duration of hospital stay and cost of each procedure were recorded.

Results: The average operative time was 125.7± 31.1 minutes in group A and 98.5± 18.7 minutes in group B (P=0.0001). The overall complication rate was similar in both groups being 13.3% in group A and 23.3% in group B. Residual stone was observed in 17% cases in group A and 13% cases in group B (P= 0.5). The mean postoperative hospital stay was 3.17 ± 1.6 days in group A and 4 ± 2.3 days in group B (P=0.4). Cost analysis showed that the initial capital cost of equipment was 40,000 Euro in laser and 24000 Euro in pneumatic lithoclast. However because of reuse of fiber the per procedure cost was 60 Euro in laser and 50 Euro in lithoclast group.

Conclusion: In our experience we found that Holmium: YAG laser and pneumatic lithoclast are both effective and safe lithotriptors for percutaneous stone removal. More operating time was required in laser, more complications encountered with pneumatic lithoclast and a high initial cost of laser. However with increasing experience with laser, more promising results are expected with this new technology. The cost can be compensated by using it in other procedures especially at a public sector hospital. (JPMA 57:385:2007).

Introduction

Management of nephrolithiasis has been revolutionized by non invasive and minimally invasive technology in the form of Extracorporeal shock-wave lithotripsy and percutaneous nephrolithotomy (PCNL). Percutaneous nephrostomy was a procedure known since 1955. However, it was not until 1976 when the first percutaneous nephrostomy for the specific purpose of removing a kidney stone was performed by Fernstrom and Johannson.[1] Over the next few years, Smith and colleagues at the University of Minnesota, Alken and Marberger in West Germany and Wickham and colleagues in the United Kingdom began to remove selected stones from the renal pelvis and ureter via percutaneous route.[1] By the early 1980s, it was apparent that it was possible to remove renal stones safely and reliably through percutaneous route.[1] The use of PCNL in treating renal stones in different patient groups, such as children, obese patients, patients with renal congenital anomalies, patients who had previous open renal surgery and patients who have undergone renal transplantation, are always of high interest.[2]

Some form of energy source is required to disintegrate the stone into manageable fragments. The options available are ultrasonic lithotripsy, electrohydraulic lithotripsy and pneumatic lithotripsy.[1] Since the holmium:yttrium -aluminium-garnet(YAG) laser was introduced into clinical practice in 1990, it has been successfully used in various urologic conditions. The holmium: YAG laser energy produces smaller fragments than pneumatic energy or electrohydraulic source. It has been proved to be an effective and safe treatment modality for the endoscopic management of urolithiasis.[3] The photothermal effect of the holmium: YAG laser is confined to less than 1 mm so that, even if the laser were fired directly onto the renal mucosa, the thermal injury would be confined to a small volume of the tissue.[4] In addition to its excellent abilities to pulverisation of stone, the holmium: YAG laser has haemostatic properties that would be beneficial for treating patients with bleeding disorders.[5]

Lithoclast (LC) lithotripsy uses the principle of a pneumatically driven bullet. Stone fragmentation is not influenced by the composition of stone and multiple clinical

trials have shown the technique to be safe and effective.[6]

The aim of this study was to compare Laser with pneumatic lithoclast in patients with renal stones undergoing PCNL at a tertiary care hospital in Karachi. To our knowledge and through literature search, no such comparative study has been reported from Pakistan and abroad.

Patients and Methods

We performed a comparative cross sectional study from September 2006 to February 2007 at the Sindh Institute of Urology and Transplantation. All patients with renal pelvic stone and candidates for PCNL were evaluated for inclusion into the study. Single stone of a size of 2.5cm, no coagulopathy and a negative urine culture was the criteria for the procedure. Pregnant females were excluded. A brief history was taken, clinical examination performed and various tests like blood complete picture, urea, creatinine and electrolytes, clotting profile, urine culture and IVP were undertaken. A written consent was taken.

Prophylactic intravenous antibiotics such as 3rd generation cephalosporin were administered before surgery. The patient was placed in lithotomy position under general anaesthesia and ureteric catheterization was done to opacify the collecting system. PCNL was performed in prone position, access was gained into the collecting system and fragmentation of calculi was performed.

Patients were divided into two groups depending on the energy source used. First eligible patient was randomly allocated the group ie patient was offered 2 folded pieces of papers bearing letter A and B and was requested to take one of these two and the group was allocated accordingly. Further allocation was made to both the groups in such a manner that patients were matched for age, sex, occupation, residential area so as to minimize the effect of confounders. Group A included cases of PCNL with laser and group B of patients undergoing PCNL with pneumatic lithoclast.

For each group, duration of the procedure, any per operative or post operative complications like fever, bleeding, urine leakage, residual stone, average postoperative hospital stay and cost of each procedure were recorded.

Data entry and statistical analysis was done using Epi Info 6.0. t-test was used for procedure duration and post operative hospital stay. Chi square test was applied to compare proportion difference for per operative complications, post operative complications, residual stone and stone clearance. P-value <0.05 was considered level of significance.

Results

The mean patient age was 35.2± 15.9 years (range 6 to 60) in Group A and 42.5 ± 13.5 years (range 16 to 79) in Group B (p value < 0.06).Male to female ratio was 1.7 to 1in Group A and 2 to 1 in Group B.

The procedure duration was measured starting from placement of ureteric catheter to completion of operation. The mean operative time was 125.7 ± 31.1 minutes (60 to 180 minutes) in Group A and 98.5 ± 18.7 minutes(70 to 150 minutes) in Group B (P=0.0001).

Complication rates were similar in both groups. Fever was observed in one patient (3.3 %) in group A and 2 patients (6.7 %) in group B. Haematuria occurred in 3 patients (10 %) in group A and 2 patients in group B (6.7 %). No case in group A had urinary leakage after removing nephrostomy tube while it was observed in three patients (10%) in group B requiring stenting in one patient.

The stone clearance rate was 83% in group A and 87% in group B (p < 0.5). Residual stones were more common in the laser group, 5 (17%) in group A vs. 4 (13%) in group B.

Length of stay however was the same in both groups. Group A staying for an average of 3.17± 1.6 days (range 1 to 10 days) and Group B for an average of 4 ± 2.3 days (range 1 to 17 days) p<0.4.

Cost analysis showed that the initial capital cost of equipment was 40,000 Euro in laser and 24,000 Euro in pneumatic lithoclast. However because of reuse of fiber the per procedure cost was 60 Euro in laser and 50 Euro in lithoclast group.

Discussion

As shown in the results, the average operative time was 125.7 ± 31.1 minutes in laser group and 98.5 ± 18.7 minutes in lithoclast group. Jou et al[3] reported an average operative time of 99±38 minutes in the procedure with laser. Cuellar et al[7] reviewed 71 patients undergoing 90 percutaneous procedures with laser. The average operative time was 167 minutes.

Feng et al[8] did standard PCNL with a stone burden of 1.5 cm in length or greater and reported a mean operative time of 128 minutes. Lahme et al[9] performed conventional PCNL with a mean stone size of 2.4 cm. The average operating time was 99.2 minutes. The operative time in laser group in our study was more as compared to lithoclast group which was similar to the results of both modalities published in international literature.

In this study the overall complication rate was 13.3% in group A and 23.3% in group B. In group A, 3.3% had fever more than 100°F with a positive urine culture

postoperatively requiring treatment with appropriate antibiotics and 10% had significant haematuria requiring blood transfusion. In a study conducted with holmium laser, Jou et al[10] had a postoperative urine infection rate of 5.1% while 5% patients had significant haematuria requiring blood transfusion. In group B, 6.7% patients had fever, 6.7% had haematuria and 10% had urinary leakage (Overall 23.3%). In a study conducted by Agrawal[1] the overall complication rate was 15.2% while Basiri et al[11] encountered an overall complication rate of 14.5%. (Infection 9.4% and bleeding 5.1%). Shoma et al[12] in their study reported an overall complication rate of 12% while doing procedure with pneumatic lithoclast. (Fever 5%, Bleeding 4% and urinary leakage 3%). In our study the laser group had less complications as compared to lithoclast group but overall complications were higher in this study as compared to other studies. This may be PCNL procedure related and not due to the fragmenting device and also due to our learning curve.

In our study the average stone free rate was 83 % in laser group and 87% in lithoclast group. Teichman et al[4] reported an overall stone free rate of 67 - 84% while using laser whereas it increased to 87.5% if the stone size was decreased to 1.9 cm.[10] In a preliminary experience with holmium: YAG laser, Razvi et al[13] achieved a complete stone fragmentation in 85% of cases while Skolarikos et al[2] reported a stone free rate of 70- 100% with pneumatic lithoclast similar to our study.

In our study the average post operative hospital stay was 3.17 ± 1.6 days in laser group and 4 ± 2.3 days in lithoclast group. Jou et al[10] reported an average post operative hospital stay of 5.9 days when procedure was done with laser. Feng et al[8] described an average length of hospital stay of 4.1 days in standard PCNL whereas Skolarikos et al[2] reported an average hospital stay of 3-6 days. In a study conducted by Holman et al[14] the hospital stay was 4.3 (3-8) days for simultaneous bilateral PCNL and 4 (3-8) days for the unilateral procedure. In laser group the hospital stay was shorter than lithoclast. This is important in our set up because of large number of stone patients at our centre.

Cost analysis showed the higher initial cost of Holmium laser than the pneumatic lithoclast while the procedure cost was similar because of reuse. The laser fiber can be used on an average in 50 procedures. The initial higher cost of laser can be compensated by its use in other procedures like TUIP, Laser TURP, Laser incision of urethral strictures and Endopyelotomy at our centre. The individual cost of surgeons fee, theatre charges and hospital stay was not calculated in this study because this is a public sector hospital and is free of cost for all patients.

Conclusion

In our experience we found that Holmium: YAG laser and pneumatic lithoclast are both effective and safe lithotriptors for percutaneous stone removal with more operating time in laser, little more complications with pneumatic lithoclast and high initial cost for installation of laser. However with increasing experience with laser promising results are expected. The cost can be compensated by using it in other procedures at a public sector hospital.

Acknowledgement

We sincerely thank Dr. Faisal Mahmood, Mr. Imran Ayub and Ms. Sakina Yousuf for their cooperation and help during data collection, conduction of procedures and statistical analysis.

References

1. Agarwal MS. Percutaneous nephrolithotomy. BHJ 2002; 44: 185-91.
2. Skolarikos AG, Alivizatos G, MCH de la rota JJ. Percutaneous nephrolithotomy and its legacy. Eurpean Urology 2005; 47: 22-8.
3. Jou Y, Shen J, Cheng M, Lin C, Chen P. Percutaneous nephrolithotomy with holmium; yttrium-aluminium-garnet laser and fiber guider-report of 349 cases. Adult Urology 2005; 65: 454-8.
4. Teichman JM. Laser lithotripsy. Curr Opin Urol 2002; 12: 305-9.
5. Watterson JD, Girvan AR, Cook AJ, Bieko DT, Nott L, Auge Bk, et al. Safety and efficacy of holmium; YAG laser lithotripsy in patients with bleeding diasthesis. J Urol 2002; 168: 442-5.
6. Olbert P, Weber J, Hegele A, Varga Z, Heidenreich A, Hofman R. Combining lithoclast and ultrasound power in one device for percutaneous nephrolithotomy: in vitro results of a novel and highly effective technology. Urology 2003; 61: 55-9.
7. Cuellar DC, Averch TD. Holmium laser percutaneous nephrolithotomy using a unique suction device. J Urol 2004; 18:780-2.
8. Feng MI,Tamaddon K,Mikhail A,Kaptein JS,Ballman GC.Prospective randomized study of various techniques of Percutaneous nephrolithotomy. Adult Urology 2001;58:345-50.
9. Lahme S,Bichler KH,Strohmaier WL.Minimally invasive PCNL in patients with renal pelvic and calyceal stones.Eur Urol 2001;40:619-24.
10. Jou Y,Shen J,Cheng M,Lin C,Chen P.High Power Holmium: Yttrium-aluminium-Garnet laser for percutaneous treatment of large renal stones.Adult Urology 2007;69:22-6.
11. BasiriA,KarramiH,MoghaddamSMH,ShadpourP.Percutaneous nephrolithotomy in patients with or without a history of open nephrolithotomy. J Endourol 2003;17:213-6.
12. Shoma AM,Eraky I,El-kenawy MR,El-kappany HA.Percutaneous nephrolithotomy in the supine position;Technical aspects and functional outcome compared with the prone technique. Urology 2002;60:388-92.
13. Razvi HA, Denstedt JD, Chun SS, Sales JL. Intra corporeal lithotripsy with the holmium:YAG laser. J Urol 1997; 158:186-7.
14. Holman A,Khan AM,Pasztor I,Toth C.Simultaneous bilateral compared with unilateral percutaneous nephrolithotomy. BJU Int 2002;89:334-8.