Original Article

นิพนธ์ต้นฉบับ

Efficacy Comparison between Laser Lithotripsy (LL) and Pneumatic Lithotripsy (PNL) for Distal Ureteric Calculi

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Abstract The objective of this study was to compare the efficacies and complications of Laser Lithotripsy (LL) and Pneumatic Lithotripsy (PNL) in the treatments of distal ureteric calculi by ureterorenoscopic techniques for patients admitted to the hospital in a prospective randomized controlled trial. They underwent either control trial ureterorenoscopic technique auxillary with ureteric fragmentation Laser Lithotripsy (LL) or Pneumatic Lithotripsy (PNL) depending on surgical indications. Patients were all randomized by labeled case by case, proceeded to under go surgical procedure either by spinal or general anaesthesia. Statistical analyse of surgical results were conducted by comparing of stone free rates and complications of both surgical techniques.

From May 31, 2012 to January 7, 2013, 84 patients were enrolled into this study. While 42 patients underwent Laser Lithotripsy and the others 42 patients with Pneumatic Lithotripsy. Overall efficacy of both techniques in stone free rate were not statistically different 97.62 percent of Laser Lithotripsy and 92.86 percent by Pneumatic Lithotripsy. Nevertheless complications of Pneumatic Lithotripsy were higher in multiple aspects of 19.05 percent stone retropulsion, 21.43 percent requiring auxillary introduced double - J ureteric stent insertion, 2.38 percent urosepsis and 2.38 percent incidentally sustained severe postoperative pain.

In conclusion, Laser Lithotripsy and Pneumatic Lithotripsy were not different in efficacy of stone fragmentation but serious complications were found higher in the Pneumatic Lithotripsy group.

Key words: **Laser Lithotripsy, Pneumatic Lithotripsy, distal ureteric calculi, ureterorenoscopy**

Introduction

For decades, treatment of urinary calculi has been changed in all aspects including to initial diagnosis, imaging assisted mandatory equipment and definitive treatments of calculi in any part of urinary system.[1] Stone disease was initially difficult and reluctant for many surgeons to manipulate in case of abnormal and unusual stone burdens with anatomical abnormalities such as large staghorn calculi, double collecting system, horseshoe kidney, calyceal diverticulum and more complex in various majority cases of abnormal urinary tract systems. First line treatment of stone disease such as renal calculi, ureteric calculi, vesical calculi and urethral calculi for patients who registered to

be operated was open technique procedure.[2] However currently ongoing and progress towards çminimal invasive procedureé changed visions of surgeons. In stead of open surgical technique, noninvasive surgery by “Endoscopic Surgery” or “Endourology” or “Endoscopic Urosurgery” has been introduced. As such, Laparoscopic surgery, Percutaneous Nephrolithotomy (PCNL), Ureterorenoscopy (URS) and Electromagnetic Shockwave Lithotripsy (ESWL) were new choices of the procedures for urinary calculi treatment.[3,4,5] In the aspect of ureteric calculi evaluation based on of treatment outcomes, knowledge of Lithotripsy that not only clinical endoscopic aspects of all procedures that influenced efficacy of treatment, but also their power to fracture stone should have been consequently taken into consideration .

Knowledge of power sources for stone fragmentation have been in a progressed as such, Ultrasonic Lithotripsy, Pneumatic Lithotripsy, Laser Lithotripsy and Electromagnetic Lithotripsy were all sources of Lithotripsy in a currently day.[6,7] Ureteric calculi could be manipulated with multimodality power to make stone fragmentation subsequently as well as treatment of calculi in general population. Auxillary ureterorenoscopy with Pneumatic Lithotripsy or Laser Lithotripsy and extracorporeal shock wave Lithotripsy were previously assessed in a retrospectively analysis on the aspects of treatment results for stone fragmentation in many multicenter institutional hospital.[8,9,10] Although the treatment efficacy of ureteric calculi manipulated with three major sources of Lithotripsy have been reported. Analyzed data seemed like that fragmentation of Laser Lithotripsy has been shown to be superior to other modalities but analyzed data were not significantly sufficient to justify the result of treatments.[11] In this aspect, the effective treatment for ureteric calculi with fragmentation modality for laser power and pneumatic power fragmentation were compared.

Methods

The study was approved by the Institutional Ethics Review Board of Bhuddasothorn hospital, ID number EC - CA 033/2555. Patients affected with distal ureteric obstruction and having indications for surgical intervention were enrolled in to this study from May 31, 2012 to January 7, 2013. Case by case prospective label randomized controlled trial was interpreted to specify a source of Lithotripsy either Laser Lithotripsy or Pneumatic Lithotripsy. Inclusion criteria were a patient aged 18 - 60 years who diagnosed with ipsilateral single ureteric calculi obstruction, with less than 2 centimeter size of stones located at distal part of ureter. Intravenous Pyelography (IVP), Retrograde Pyelography (RP) or Ultrasonography (USG) were confirmed for diagnosis in each specific individual patient in case of normal renal function. Exclusion criteria were a patient who could not control any of active underlying problems six weeks before protocol started such as Diabetes Mellitus (DM), Hypertension (HT), Congestive Heart Failure (CHF), Ischemic Heart Disease (IHD) and Chronic Obstructive Pulmonary Disease (COPD). Congenital anomalies of urinary system or previous surgery in urologic system before study had been also ruled out. All patients were evaluated by plain KUB films at the end of second and fourth week after surgery had been completed. Stone free was defined as fragmented stones pieces having been washed out from ureter that invisible from plain KUB films. All patients were treated with standard hospital health care nursing system protocol, antibiotics were used only in the first 24 hours postoperatively but if situation indicated that postoperative fever remained; antibiotic has been prolonged until clinically improved.

Surgical techniques

All patients were performed under single urosurgeon with minimal endourologic surgery by

using semirigid ureterorenoscopy under spinal anaesthesia or general anaesthesia depended on anaesthetic patient problems. Pneumatic Lithotripsy was conducted by central pipe line air pressure system. Laser Lithotripsy was regulated by Homium laser Lithotripsy powered setting at 12 watts, frequency 10 Hertz, energy 1.20 Joule Homium fiber of 550 micrometers. Duration of Laser Lithotripsy procedure time started from the first pulsion of laser power has been released to fragment stone and Pneumatic Lithotripsy was started from first pulsion of pneumatic power has been released as well as Laser Lithotripsy. Operative time of both procedures proceeded until size of stone had fragmented to minimal pieces that could be flushed out spontaneously. Fragmented stones after fragmentation have been conducted were not removed in order to evaluate passing stone rates, augmented medications for stone pulsion were not indicated. Efficacy of treatment was evaluated by overall stone free rate.

Statistic analysis

Data were analyzed by statistic analysis. Descriptive results of continuous variables were expressed as mean, standard deviation (SD) and categorical variables were expressed as number and percent. Statistical comparisons were made using independent paired t - test for average stone size and time of fragmentation and Fisher's exact test for comparison of overall stone free rate with the p - value of less than 0.05 was considered statistically significant. The calculated number of patients was based on preliminary data from previously study in these modalities.

Results

Between May 31, 2012 and January 7, 2013, overall 84 patients were enrolled in this study for surgical ureterorenoscopic stone fragmentation with 42 randomized patients labeled to Laser Lithotripsy and 42 patients were labeled to Pneumatic Lithotripsy. Average age was 41.857 , 8.784 SD in Laser Lithotripsy group and 41.691, 8.518 SD in Pneumatic Lithotripsy group, males were more affected with ureteric calculi obstruction than females in both Laser and Pneumatic Lithotripsy group (73.81% : 26.19% in Laser Lithotripsy and 80.95% : 19.05% in Pneumatic Lithotripsy) which total overall male : female was 77.38 percent : 22.62 percent. The data showed that 73.81 percent of ureteric calculi were on the left side and 26.19 percent were on the right side in Laser Lithotripsy group. Meanwhile 64.29 percent of ureteric calculi were on the left side and 35.71 percent were on the right side in Pneumatic Lithotripsy group yet the average stones sizes were 0.755 cm, 0.167 SD in Laser Lithotripsy group and 0.664 cm, 0.188 SD in Pneumatic Lithotripsy group. The largest stone size was 1.20 centimeters in both the Laser Lithotripsy group and Pneumatic Lithotripsy group as shown in (Table 1). The study showed overall stone free rate was 97.62 percent in Laser Lithotripsy group and 92.86 percent in Pneumatic Lithotripsy group. Time to be stone free was found in 95.24 percent at the end of second week and 2.38 percent at the end of the fourth week in the Laser Lithotripsy yet 71.42 percent at the end of second week and 21.43 percent at the end of the fourth week in the Pneumatic Lithotripsy. After the fourth week some stones remain in 2.38 percent of the Laser Lithotripsy group and 7.15 percent of the Pneumatic Lithotripsy. They diminished after the twelveth week of the follow up. The complications were found stone retropulsion (19.05%) leading needs of auxillary double J ureteric stent (21.43%), and urosepsis (2.38%). Severe postoperative pain remained 2.38 percent in both Laser Lithotripsy and Pneumatic Lithotripsy group (Table 2).

It was shown that Laser Lithotripsy was more effective for stone fragmentation than Pneumatic Lithotripsy based on the overall stone free rate of 97.62 percent and 92.86 percent respectively (Table 2) but

Table 1 Characteristics of the patients

Parameters	Number (%)	
	Laser Lithotripsy (n = 42)	**Pneumatic Lithotripsy (n = 42)**
Average age, SD (years) (range)	41.857, 8.784 (27 - 59)	41.691, 8.518 (26 - 59)
Sex		
Male	31 (73.81)	34 (80.95)
Female	11 (26.19)	8 (19.05)
Stone site		
Right	11 (26.19)	15 (35.71)
Left	31 (73.81)	27 (64.29)
Average stone size (centimeter)	0.755, 0.167	0.664, 0.188
Largest stone size (centimeter)	1.20	1.20

Table 2 Comparison of overall stone free rates and complications of both procedures

Parameters	Number (%)	
	Laser Lithotripsy (n = 42)	**Pneumatic Lithotripsy (n = 42)**
Surgical times (minutes)	13.039, 5.630	7.943, 5.143
Time to stone free (weeks)		
2	40(95.24)	30 (71.42)
4	1 (2.38)	9 (21.43)
12	1 (2.38)	3 (7.15)
Overall stone free rate	97.62	92.86
Complications		
Stone retropulsion	0 (0)	8 (19.05)
Auxillary D - J ureteric stent	0 (0)	9 (21.43)
Urosepsis	0 (0)	1 (2.38)
Severe postoperative pain	1 (2.38)	1 (2.38)

Table 3 Comparison of the stone fragmentation of Laser Lithotripsy and Pneumatic Lithotripsy

Effectiveness	**Laser Lithotripsy**	**Pneumatic Lithotripsy**	**Total**	**P-value**
Fail fragmentation	1	3	4	0.615
Complete fragmentation	41	39	80	
Total	**42**	**42**	**84**	

p < 0.05 Fisher exact test

Table 4 Underlying diseases

Underlying disease	n (%)	
	Laser Lithotripsy (n = 42)	Pneumatic Lithotripsy (n = 42)
Diabetes mellitus	4 (9.52)	3 (7.14)
Essential hypertension	12 (28.57)	14 (33.33)
Dyslipidemia	9 (21.43)	8 (19.05)
Chronic obstructive pulmonary disease	3 (7.14)	3 (7.14)
Bones and joints disorder	1 (2.38)	0 (0)

Table 5 Data of average stone size and time of fragmentation

Data analysis	Laser Lithotripsy (n = 42)		Pneumatic Lithotripsy (n = 42)		t	P
	Mean	SD	Mean	SD		
Average stone size (centimeter)	0.755	0.167	0.664	0.188	2.328	0.110
Time of fragmentation (minute)	13.039	5.630	7.943	5.143	4.331	0.00002

$p < 0.05$ independent paired t-test

Their difference failed to show statistic significant (Table 3).

The average size of stone in Laser Lithotripsy group were insignificantly larger than that of Pneumatic Lithotripsy group yet times spent to fragment stone in Laser Lithotripsy were significantly longer than in Pneumatic Lithotripsy (Table 5). Overall efficacy of stone fragmentation by both techniques were not significant specifically different by statistic $p < 0.05$ insignificantly (Table 3).

Discussion

Seong Soo Jeon et al revealed that Laser Lithotripsy was better in terms of stone free rate as well as minimal complication rates than Pneumatic Lithotripsy compatible with this study.[12] According to previous study of Peh OH et al reported that Holmium: Yag Laser Lithotripsy is significant in both effective and safety procedure.[13] The development of Swiss Pneumatic Lithoclast was created in Switzerland in 1989 and clinical research result was published in the early 1990s for urinary calculi.[14] The disadvantage of Pneumatic Lithotripsy was stone retropulsion that was found incidentally. In this study it likewise needed to retain double J ureteric stent for internal urinary diversion.[15] Serious complication of urosepsis occurred in situation of fragmented stone piece obstruction or abnormal host defense mechanism of patients. The disadvantage of Laser Lithotripsy is considered relating to costly device and strict eye protection . The means of surgical time was longer for Laser Lithotripsy than Pneumatic Lithotripsy because of techniques and mechanisms of procedures but surgical results from previous studies were favourable to Laser Lithotripsy because of photothermal mechanism to vaporization of ureteric calculi regardless of stone composition; these data were compatible with other studies.[16] Besides these data, the study was shown that stone fragmented pieces from Laser Lithotripsy were smaller than those from Pneumatic Lithotripsy

resulting in easier passing than that of fragmented stones Pneumatic Lithotripsy. Based on time of fragmented stones disappearance in the follow up by plain KUB films at the second and fourth week after operation performed, stone free rates were 95.24 percent at the end of the second week for Laser Lithotripsy and 71.42 percent for Pneumatic Lithotripsy and only 2.38 percent sustained for Laser Lithotripsy compare to 21.43 percent sustained in Pneumatic Lithotripsy but surgical times of Laser Lithotripsy was also longer than that of Pneumatic Lithotripsy in order to make small particles of stone fragmentation in due process. It is worth noted that no further operation was needed because no stone fragmentation particles left after 3 months follow up by plain KUB films.

Otherwise, although the effective results of the study for stone fragmentation were not significant statistic ally which led to precise decision making how to use any kind of lithotripter, yet if considered operative complications, surgical operation with Laser Lithotripsy would be superior. All results of this evaluation of lithotripter sources has been shown that Laser Lithotripsy seems to be superior comparing with Pneumatic Lithotripsy but statistically evaluated data showed that it is yet to be confirmed. Otherwise, the number of population in the study should be further evaluated to establish its power of analysis.

Conclusion

Laser Lithotripsy is a superior modalities more than Pneumatic Lithotripsy for stone fragmentation and less complication than Pneumatic Lithotripsy.

Potential conflicts of interest

None.

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บทคัดย่อ **การเปรียบเทียบผลของการรักษานิ่วในท่อไตส่วนปลายโดยใช้พลังงานเลเซอร์และพลังงานลมอัดกระแทก**

มานิตย์ บำรุงยา

แผนกศัลยศาสตร์ยูโรวิทยา กลุ่มงานศัลยกรรม โรงพยาบาลพุทธโสธร ฉะเชิงเทรา

วารสารวิชาการสาธารณสุข **2556; 22:758-764.**

ในปัจจุบันนิ่วในท่อไตส่วนปลายมีวิธีการรักษาได้หลากหลายวิธี แต่วิธีผ่าตัดนิ่วในท่อไตโดยใช้กล้องส่องท่อไตผ่าตัดร่วมกับการใช้ตัวกำเนิดการสลายนิ่วแบบพลังลมอัดกระแทกและพลังงานเลเซอร์นั้น เป็นวิธีการรักษาที่ค่อนข้างใหม่ในนวัตกรรมของระบบสาธารณสุขไทยแต่ผลของการรักษายังไม่เห็นผลอย่างชัดเจน จึงศึกษาเปรียบเทียบผลของการรักษาและภาวะแทรกซ้อนทางคลินิกในการรักษานิ่วในท่อไตส่วนปลายโดยใช้พลังงานเลเซอร์กับพลังงานลมอัดกระแทกเป็นการศึกษาทางคลินิกแบบสุ่มไปข้างหน้า โดยผู้ป่วยที่ได้เข้ารับการรักษาตัวในโรงพยาบาล ด้วยอาการของนิ่วในท่อไตอุดตันและได้รับการประเมินผ่าตัดเอานิ่วออก จะได้รับการพิจารณาใช้วิธีการรักษาโดยการส่องกล้องในท่อไต และสลายนิ่วโดยใช้พลังงานเลเซอร์หรือพลังงานลมอัดกระแทกจากวิธีการคัดเลือกแบบสุ่ม ผู้ป่วยจะได้รับการพิจารณาใช้ยาระงับความรู้สึกโดยวิธีดมยาสลบหรือใช้ยาชาเฉพาะที่ ประเมินประสิทธิผลของการรักษาและรวมถึงภาวะแทรกซ้อนของการรักษาโดยใช้หลักทางสถิติ ในช่วงระยะเวลาศึกษาตั้งแต่ 31 พฤษภาคม 2555 ถึง 7 มกราคม 2556 ผู้ป่วยจำนวน 84 ราย ได้เข้ารับการรักษาครั้งนี้ แบ่งเป็นผู้ป่วยที่ได้รับการรักษาโดยใช้พลังงานเลเซอร์ 42 ราย และใช้พลังงานลมอัดกระแทก 42 ราย ผลของการรักษาเมื่อเปรียบเทียบอัตราการแตกตัวของนิ่ว ซึ่งการใช้พลังงานเลเซอร์มีผลสัมฤทธิ์ ร้อยละ 97.62 ในขณะที่ผลการรักษาโดยใช้พลังงานลมอัดกระแทกมีผลสัมฤทธิ์ ร้อยละ 92.86 แต่ไม่พบว่ามีความแตกต่างกันอย่างมีนัยสำคัญทางสถิติ เมื่อพิจารณาถึงภาวะแทรกซ้อนที่เกิดขึ้นในการรักษาโดยใช้พลังงานลมอัดกระแทก พบว่ามีนิ่วย้ายตำแหน่งสูงขึ้นระหว่างผ่าตัด ร้อยละ 19.05 เกิดภาวะแทรกซ้อนบาดเจ็บต่อท่อไตที่จำเป็นต้องได้รับการใส่สายระบายท่อไต ร้อยละ 21.43 ติดเชื้อในกระแสเลือด ร้อยละ 2.38 และพบว่ามีภาวะปวดหลังผ่าตัดอย่างรุนแรงจนต้องใช้ยาแก้ปวด ร้อยละ 2.38 การรักษานิ่วในท่อไตส่วนปลายโดยใช้การสลายนิ่วด้วยพลังงานเลเซอร์และพลังงานลมอัดกระแทก ให้ประสิทธิผลการรักษาในการทำให้นิ่วแตกไม่แตกต่างกัน แต่ผลข้างเคียงและภาวะแทรกซ้อน ซึ่งเกิดจากการใช้พลังงานลมอัดกระแทกมีอัตราการเกิดสูงกว่า

คำสำคัญ: **ผ่าตัดนิ่วด้วยเลเซอร์, ผ่าตัดนิ่วด้วยพลังลม, นิ่วในท่อไตส่วนปลาย, การส่องกล้องผ่านทางท่อไป**