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EXTRACORPOREAL SHOCK WAVE LITHOTRIPSY VERSUS LASERTRIPSY FOR THE TREATMENT OF UPPER URETERIC CALCULI

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Objectives: To compare the efficacy, cost effectiveness and safety of both extracorporeal shock-wave lithotripsy (ESWL) and Holmium:YAG laser lithotripsy for the management of upper ureteric stones.

Patients and Methods: One hundred and eight patients of various age groups and of both sexes who had primary or recurrent unilateral or bilateral upper ureteric stones underwent 108 primary procedures and 19 ancillary procedures (total: 127) including in-situ ESWL (60 patients) using the Dornier MPL 9000 machine and ureterorenoscopy (URS) combined with Holmium:YAG laser lithotripsy (46 patients).

Results: The overall stone-free rate was 93.75% for the patients subjected to URS in combination with laser lithotripsy and 91.7% for the patients subjected to ESWL. For stones < 1 cm, the success rate was 100% in the laser and 95.65% in the ESWL group. For stones > 1 cm, the success rate was 90% in the laser and 78.6% in the ESWL group. For impacted stones, the success rate was 92.85% in the laser and 72.7% in the ESWL group. The efficiency quotient (EQ) for the laser and ESWL groups was 0.86 and 0.73, respectively. The complication rate was 12.53% in the laser and 11.7% in the ESWL group. The average cost (in Egyptian pounds) was 1618.1 £E for Holmium: YAG laser treatment and 1069.1 £E for ESWL treatment.

Conclusion: Apart from the treatment of impacted stones and stones larger than 1 cm, ESWL is the first choice as treatment modality for upper ureteric stones. However ESWL and URS combined with holmium: YAG laser lithotripsy may be complementary to each other in treating upper ureteric stones.

Key Words: ESWL, Holmium, laser, ureter, stone

INTRODUCTION

The management of upper ureteric stones has undergone a series of dramatic changes over the past 10 to 15 years. While for stones 4-5 mm in size spontaneous passage may occur in 80% to 90% of cases[1,2,3], larger stones usually require treatment. Once the decision of intervention is taken, the next step is to decide the appropriate line of therapy. At present, the different modalities available for the treatment of upper ureteric calculi include ESWL, rigid and flexible retrograde ureterorenoscopy (URS), antegrade URS, laparoscopy and open surgery. ESWL and URS are the procedures of choice for the treatment of upper ureteric stones[4,5,6] leaving a minor role for laparoscopy and open surgery[7,8]

The aim of this study was to compare the indications, effectiveness, complications and costs of URS combined with holmium laser lithotripsy and ESWL in the management of upper ureteric calculi.

PATIENTS AND METHODS

This prospective study which was carried out between May 2001 and May 2002 included 108 patients of both sexes and of different age groups who presented with symptomatic upper ureteric stones of variable sizes, unilateral or bilateral, primary or recurrent, to the urologic outpatient clinic of Assiut University Hospital, Assiut, Egypt. The patients underwent either URS combined with Holmium: YAG laser

Table 1: Results of ESWL Treatment Relative to Stone Size

	Stone Size	
	< 1 cm	> 1 cm
No. of cases (%)	46 (76.7%)	14 (23.4%)
Average no. of sessions per patient	1.04	1.40
Average no. of shock waves per patient	1695	2845
Average operative time (minutes)	36.7	46.5
Average KV	20	20
Stone-free rate; No. (%)	44 (95.7%)	11 (78.6%)
Complications; No. (%)	1 (1.7%)	6 (10.0%)

Table 2: Results of Laser Treatment Relative to Stone Size

	Stone Size	
	< 1 cm	> 1 cm
No. of cases (%)	18 (37.5%)	30 (62.5%)
Average laser energy (J/pulse)	1.6	2.4
Average laser pulse frequency (Hz)	10	15
Average operative time (minutes)	37	63
Stone-free rate; No. (%)	18 (100%)	27 (90%)
Complications; No. (%)	6 (12.5%)	4 (8.3%)

lithotripsy or in-situ ESWL. The choice of the treatment modality for each patient was primarily based on the patient's choice after explanation of the available treatment options and the drawbacks, complications and advantages associated with each one. A written consent for the acceptance of the surgical procedure and its possible complications was obtained.

All patients were subjected to history taking, clinical examination and investigations (urine analysis, blood urea, serum creatinine, coagulation parameters, KUB [kidneys, ureter, bladder] film, abdominal ultrasonography and intravenous urography [IVU] when indicated).

Sixty patients (Group I) were treated on an outpatient basis by in-situ ESWL using the Dornier MPL 9000 lithotriptor. The average age of the patients was 37 years. The overall average stone size was 6.7 mm. In 46 patients the stone size was <1 cm and in the remaining 14 patients >1 cm. Impacted stones were found in 11 patients. After termination of the procedure, intravenous fluids, antispasmodics, antibiotics, diuretics and anti-emetics were given when required.

Forty-eight patients (Group II) underwent URS (using a small fiberoptic rigid ureteroscope, 8.5 Fr.) combined with Holmium: YAG laser lithotripsy under spinal or general anaesthesia. The average age of the patients was 41.5 years. The overall average stone size was 10.6 mm. In 30 patients the stone size was >1 cm and in 18 <1 cm. Impacted stones were found in 14 cases. After urethrocystoscopy and ureteral dilatation, the

Table 3: Results of ESWL Treatment Relative to Stone Impaction

	Stone Impaction	
	Impacted	Not Impacted
No. of cases (%)	11 (18.3%)	49 (81.7%)
Average no. of sessions per patient	1.7	1.0
Average no. of shock waves per patient	3136	1700
Average operative time (minutes)	63.6	33.47
Average KV	22.7	19.4
Stone-free rate; No. (%)	8 (72.7%)	47 (96.0%)
Complications; No. (%)	3 (5%)	4 (6.7%)

Table 4: Results of Laser Treatment Relative to Stone Impaction

	Stone Impaction	
	Impacted	Not Impacted
No. of cases (%)	14 (29.2%)	34 (70.8%)
Average laser energy (J/pulse)	2.34	2.0
Average laser pulse frequency (Hz)	15	12.35
Average operative time (minutes)	78.14	43
Stone-free rate; No. (%)	13 (92.9)	32 (94.1)
Complications; No. (%)	7 (14.6%)	3 (6.2%)

ureteroscope was advanced up to the stone. The minimum laser energy setting that achieved fragmentation was used. After complete fragmentation of the stone, the treated area was ureteroscopically checked again (under fluoroscopic guidance) to rule out any residual stone fragments or ureteral injuries. Then the ureter was drained with an open ended ureteral catheter, or – at times – we used a double pigtail stent. All patients of this group were hospitalized for an average period of 3 days. The external stents were removed 2 to 5 days postoperatively.

A KUB film was done on the second postoperative day in patients treated by ureteroscopy and after 15 days in those treated by ESWL to assess the state of disintegration. All patients were followed up one month, three months and six months postoperatively. Follow-up included clinical examination, urine analysis, abdominal ultrasonography, plain KUB film and IVU when indicated.

RESULTS

Fifty-five (91.7%) patients of Group I (ESWL) became stone free, while failure of disintegration and complete clearance was encountered in five. In Group II (endoscopy), 45 (97.8%) patients became stone free, while laser disintegration failed in three cases. This was due to migration of the stones in two cases and perforation in one case that necessitated open surgery.

In Group I, no intraoperative complications were encountered. Postoperative complica-

Table 5: The Efficiency Quotient Relative to Stone Size

Stone Size	Group	No. of Procedures			No. Stone-Free Patients	EQ
		Initial	Additional	Total		
< 1 cm	Laser	18	1	19	18	0.95
	ESWL	46	6	52	44	0.85
≥ 1 cm	Laser	30	3	33	27	0.81
	ESWL	14	9	23	11	0.48

Table 6: The Efficiency Quotient Relative to Stone Impaction

Stone Impaction	Group	No. of Procedures			No. Stone-Free Patients	EQ
		Initial	Additional	Total		
Impacted	Laser	14	2	16	13	0.81
	ESWL	11	10	21	8	0.38
Not impacted	Laser	34	3	37	32	0.86
	ESWL	49	5	54	47	0.9

tions occurred in seven patients; four of them developed high-grade fever which was treated conservatively, and steinstrasse was reported in three cases two of which were treated conservatively and the remaining one by ureteroscopy. In Group II, intraoperative complications in the form of ureteric perforation and urine extravasation were encountered in three cases. Two of them were managed by double-J stent, and open surgery had to be resorted to in the remaining case.

The results for both groups relative to stone size and stone impaction are illustrated in Tables 1 – 4.

Since in this comparative study a statistical analysis would be of no value due to the small number of cases in the sub groups, we resorted to the use of the efficiency quotient (EQ) for comparing the results in the two groups. It is calculated by dividing the number of stone-free cases by the number of total procedures including primary and ancillary procedures.

In the laser group (Group II) there were 45 stone-free patients with a total number of 52 procedures including 48 primary and 4 ancillary procedures. The ancillary procedures included ESWL treatment (n=2), open ureterolithotomy and drainage of the collected fluid after perforation and extravasation (n=1) and endoscopic dilatation and application of a double-J stent for the treatment of a ureteric stricture that had developed at the site of laser lithotripsy (n=1). Therefore, the EQ in this group was 0.86.

In the ESWL group (Group I) there were 55 stone-free patients with a total number of 75 procedures including 60 primary and 15 ancillary procedures. The ancillary procedures consisted of stenting (n=9) and repeated ESWL sessions for failed cases (n=6). Therefore, the EQ in the ESWL group was 0.73. Tables 5 and 6 illustrate the EQ relative to stone size and stone impaction.

As for the use of stents in the ESWL group; nine patients were stented and eight had dou-

ble-J stents inserted before ESWL treatment (5 patients with solitary kidneys and 3 patients with bilateral obstructed kidneys). The remaining case had a ureteric catheter inserted for the control of persistent renal colic and fever following ESWL treatment. In the laser group; 49 cases were stented, 41 cases had ureteric catheters and three cases had double-J stents after ureterosopic manipulation. The remaining five cases were stented with double-J stents for other specific indications (two cases after extravasation had occurred during the procedure, two cases due to intra-operative migration of the stone into the kidney and one case after treatment of a ureteric stricture which had developed as a long-term post-operative complication.)

The average hospital stay was 0.31 days and 3 days for Group I and Group II, respectively. The average cost of the procedure was 1618.1 £E for the laser treatment and 1069.1 £E for ESWL.

DISCUSSION

The development and refinement of endourological and extracorporeal lithotripsy techniques in the past few decades has led to an increasing number of options for the management of upper ureteric calculi. Each of the methods available needs to be evaluated in terms of its clearance rate, potential morbidity and cost effectiveness[9]. ESWL has emerged as the treatment of choice for renal and proximal ureteral calculi when active intervention is indicated; this is due to its characteristics of being an easy, non-invasive, anaesthesia free procedure with minimal morbidity rates[10-12]. Recent technological advances have enabled endoscopes to become smaller, more flexible and easier to introduce. URS has become a less difficult procedure with a reduced incidence of complications. The introduction of holmium: YAG laser as an endoscopic lithotriptor has improved the endoscopic stone-free rates while at the same time decreasing the complication rates[13].

In this work, the overall stone-free rate achieved by the two treatment modalities is comparable (91.7% in the ESWL and 93.8% in the laser group). This is in agreement with the results obtained by other authors[13, 14, 18-26].

As we are dealing with two different procedures which are technically and physically totally different, the type of complications encountered is expected to be different. We reported an overall complication rate of 11.6% in the ESWL group which is consistent with the rates found in the literature[14,15]. In the laser group, the complication rate was found to be 12.5% which is similar to that reported in the study of Kelly et al.[16] and higher than that reported by Shroff et al.[17]. When comparing the complication rates in the two groups we found that the rate was approximately the same (11.6% and 12.5%). But in our study, the complications were minor in the ESWL group (high-grade fever in four and steinstrasse in three cases) and could be treated conservatively except for one case that was treated by ureteroscopy to relieve obstruction caused by steinstrasse. On the other hand, the complications encountered in the laser group were of the major type in the form of ureteric perforation and extravasation that necessitated insertion of a double-J stent in two cases and open surgery in one case. We also reported one case of ureteric stricture at the site of lithotripsy that needed balloon dilatation and internal ureteral stenting. These findings prove the greater safety of ESWL in comparison to URS combined with laser lithotripsy.

In this study we tried to evaluate the impact of stone size and stone impaction on the outcome of both procedures. We found that uretroscopy with laser lithotripsy was more effective than ESWL in the treatment of stones sized ≥1 cm, achieving a stone-free rate of 90% for laser versus 42.8% for ESWL, as well as in impacted stones, achieving a stone-free rate of 93% for laser versus 73% for ESWL. When using ESWL, the complication rate tends to be high when the stones are larger than 1 cm and/or impacted, reaching 42.8%. On the other hand, the complication rate increased to 35.7% when using laser for the treatment of impacted stones. These findings are confirmed by the work of other authors[13, 27-34].

The impression that ureteroscopy combined with laser is superior to ESWL in the treatment of stones ≥ 1 cm and impacted stones has been proved by calculating the EQ which is markedly higher for the laser group (0.81) than for the ESWL group (0.38-0.48). This finding is comparable to the results of other studies[13, 35, 36].

For non-impacted stones and stones < 1 cm, the situation is different. We have found that the two modalities of treatment have

nearly the same stone-free rate, complication rate and EQ.

In our study the need for hospital admission, the use of anaesthesia and the routine use of stents increased the average cost of ureteroscopy (16181 £E) in comparison to ESWL (1069.1 £E).

In conclusion, apart from the management of impacted stones and stones larger than 1 cm, ESWL is the first line of choice as a treatment modality for upper ureteric stones. However both ESWL and URS combined with holmium: YAG laser lithotripsy may be complementary to each other in treating upper ureteric stones.

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RESUME

Lithotripsie Extra Corporelle par Ondes de Choc Comparée au Laser dans le Traitement des Calculs du Haut Uretère.

Objectifs: Comparer l'efficacité, les coûts et la sécurité de la lithotripsie d'un côté par ondes de choc extracorporels et de l'autre par Laser au Holmium :YAG dans la prise en charge des lithiases du haut uretère. **Patients et Méthodes:** Cent huit patients de groupes d'âge variés, des deux sexes présentant une lithiase du haut uretère uni ou bilatérale primitive ou récurrente avaient bénéficié de 108 procédures primaires et 19 procédures accessoires (127 au total) incluant des ondes de choc extra corporelles in situ (60 patients) utilisant la machine de Dornier MPL 9000 et une uretéroscopie combinée à la lithotripsie par Laser au Holmium :YAG (46 patients). **Résultats :** Le taux de guérison était de 93,75% pour les cas ayant bénéficié d'une urétéroscopie combinée au Laser et de 91,7% pour les patients ayant bénéficié d'une lithotripsie extracorporelle par ondes de choc. Pour les calculs de taille <1cm, le taux de succès était de 100% pour le groupe soumis au Laser et de 95,65% dans le groupe soumis à la lithotripsie extra corporelle. Pour les calculs de plus de 1 cm de taille, le taux de réussite était de 90% dans le groupe du Laser et de 78.6% dans le groupe de lithotripsie extracorporelle. Pour les calculs impactés, le taux de réussite était de 92,85% dans le groupe du Laser et de 72,7% dans le groupe de lithotripsie extracorporelle. Le rapport Qualité – Efficacité était de 0,86 et de 0,73 respectivement pour le Laser et la lithotripsie extracorporelle. Le taux de complications était de 12,53% pour le Laser et de 11,7% pour la lithotripsie extracorporelle. Le coût moyen du traitement était d'environ de 1618,1 £E (Livre égyptien) pour le Laser et de 1069,1 £E pour la Lithotripsie extracorporelle. **Conclusion:** A part les calculs impactés et les calculs de taille > 1cm, la lithotripsie extracorporelle est la technique de choix dans la prise en charge des lithiases du haut uretère. Cependant aussi bien la lithotripsie extracorporelle que l'uretéroscopie combinée au Laser Holmium :YAG peuvent être complémentaires dans le traitement des calculs du haut uretère.

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