



Original article - Lithiasis

A prospective trial comparing laparoscopic and open surgery for the treatment of impacted ureteral stones

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Introduction and objectives: To investigate two practical approaches in ureterolithotomy for the treatment of large impacted stones, we carried out the assessment and monitoring of perioperative features of consecutive patients undergoing ureterolithotomy after unfavourable results from endourological treatment.

Methods: Of the 110 patients included in the study, 34 underwent laparoscopic ureterolithotomy. Patients were divided into three ureterolithotomy subgroups: group A, 76 open operations; group B, 16 transperitoneoscopies, and group C, 19 retroperitoneoscopies. All procedures were conducted in a specialised urology programme for resident physicians.

Results: The patients' age, sex, ASA classification and stone characteristics showed no significant differences between the groups. Overall, the complication rate and operation times recorded were similar. One patient had bilateral stones and both sides were treated in a single transperitoneoscopic procedure. Three retroperitoneoscopies ended up in open surgery due to technical difficulties. A prolonged urinary leakage occurred in 3/35 cases (8.5%), and 2 of these patients were treated by insertion of a ureteral catheter. Both laparoscopic groups had significantly lower analgesia requirements and shorter hospitalisation periods ($p < 0.001$ and $p = 0.003$, respectively). No patient had stones in the follow-up visit the following month.

Conclusions: To our knowledge, this is the first prospective comparison of laparoscopic and open ureterolithotomy in a laparoscopic training environment. Although these interventions were conducted by urologists with limited laparoscopic experience, laparoscopy offered significant advantages over traditional open ureterolithotomy, resulting in improved analgesia and shorter hospital stays, but with similar complication rates.

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Estudio prospectivo que compara laparoscopia y cirugía abierta para el tratamiento de cálculos ureterales impactados

R E S U M E N

Palabras clave:

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Obstrucción ureteral

Introducción y objetivos: Con objeto de investigar dos enfoques en la práctica de ureterolitotomías para el tratamiento de cálculos impactados de grandes dimensiones, hemos llevado a cabo la evaluación y el seguimiento de las características perioperatorias de pacientes consecutivos sometidos a una ureterolitotomía tras obtener resultados desfavorables al aplicar un tratamiento endourológico.

Métodos: De los 110 pacientes incluidos en el estudio, 34 se sometieron a una ureterolitotomía laparoscópica. Se dividió a los pacientes en tres subgrupos de ureterolitotomías: grupo A, 76 intervenciones abiertas; grupo B, 16 transperitoneoscopias, y grupo C, 19 retroperitoneoscopias. Todos los procedimientos se llevaron a cabo durante un programa de especialización en urología para médicos residentes.

Resultados: La edad y el sexo de los pacientes, la clasificación ASA y las características de los cálculos no mostraron diferencias significativas entre los grupos. En general, la tasa de complicaciones y la duración de las intervenciones registradas fueron similares. Uno de los pacientes presentaba cálculos bilaterales y ambos lados se trataron en un único procedimiento de transperitoneoscopia. Tres retroperitoneoscopias finalizaron en cirugía abierta debido a dificultades técnicas. En 3 de los 35 casos (8,5%) se produjo fuga urinaria prolongada y 2 de estos pacientes recibieron tratamiento mediante la inserción de un catéter ureteral. Ambos grupos laparoscópicos tuvieron necesidades analgésicas significativamente menores y una hospitalización de menor duración ($p < 0,001$ y $p = 0,003$, respectivamente). Ningún paciente presentaba cálculos en la visita de seguimiento realizada al mes siguiente.

Conclusiones: Según la información de que disponemos, ésta es la primera comparación prospectiva entre laparoscopia y ureterolitotomía abierta que se realiza en un entorno de formación en laparoscopia. A pesar de que estas intervenciones las realizaron residentes con limitada experiencia laparoscópica, la laparoscopia aportó ventajas significativas sobre la ureterolitotomía abierta tradicional, que dio como resultado una mejor analgesia y una estancia en el hospital menos prolongada, con similares tasas de complicaciones.

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Introduction

Urolithiasis is a recurrent condition in routine urological practice and involves huge economic expense.¹ The treatment of urolithiasis has changed significantly over recent decades and can now be carried out by various methods with particular rates of complete stone elimination, additional operational requirements and complications. To summarise the existing literature, the authors of the International Guidelines propose extracorporeal shock wave lithotripsy (ESWL) and ureteroscopy (URS) as initial treatment for large proximal and medial ureteral stones.²

In fact, the use of open surgery for surgical removal of ureteric stones is now out of date due to the emergence of new minimally invasive techniques. Flexible ureteroscopy with laser lithotripsy has become the standard treatment, with lower rates of subsequent treatments and higher total removal rates when compared with the ESWL technique, although it has a higher morbidity.² Other topics to discuss are the high cost and duration of endoscopic equipment, as they have

limited the spread of this technology in emerging economies. However, there are other popular choices for these types of situations, such as retrograde operations, percutaneous surgery and small bore ureteroscopy. Although open surgery is virtually obsolete in the best endourological centres, sometimes urologists have to practise ureterolithotomies for a small group of patients where neither ESWL nor endourological techniques are recommended.³

The surgical evolution of laparoscopy regained interest in ureterolithotomy as a highly effective option in the treatment of complicated ureteral stones. Initially, Wickham⁴ described laparoscopic ureterolithotomy (UL) in 1979 and this has now proven to be a minimally invasive alternative to open surgery.^{5,6} However, there are recent reports which conclude that UL requires significant practice and experience for good results.^{7,8} In addition, other prestigious specialist centres in laparoscopy have used this technique for the treatment of ureteral stones larger than 10mm.^{9,10} Regardless of the current state of ESWL and URS, all urology departments throughout the world have to consider a number of circumstances when

choosing a technique, among which are the availability of adequate equipment, the characteristics of the patients and stones and the surgeon's skill. Moreover, prospective comparison between UL and open surgery has not yet taken place in an environment of resident urology physicians.

Patients and methods

Patients

A prospective evaluation of UL in our department began in January 2004, where data was collected from all patients who underwent ureterolithotomy until November 2007. The study population is represented by our experience with 110 consecutive patients treated by laparoscopic ureterolithotomy (35 operations: 19 retroperitoneal and 16 transperitoneal) and open ureterolithotomy (76 lumbotomy) for treating stones in the proximal and medial ureter.

No specific criteria were used in selecting patients for the open ureterolithotomy groups (AU) by transperitoneoscopies (ULT) or retroperitoneoscopies (ULR), except as preferred by the urology department (a laparoscopic surgeon or an open surgeon). Previous criteria such as lumbotomy or obesity were not considered either when placing patients into the ULR or ULT groups. Ureterolithotomies were advised once the retrograde handling of percutaneous lithotripsy or rigid ureterolithotripsy treatments had no effect. None of the patients had previously undergone ESWL, as this service was limited in our centre.

These interventions were conducted within a urology residency programme supervised by urologists familiar with lithiasis procedures (2 surgeons with vast experience of open surgery and 1 urologist skilled in laparoscopy).

All stones had a diameter greater than 10mm. Their presence was confirmed before surgery with a kidney-ureter-bladder radiograph combined with abdominal ultrasound. However, in some cases excretory urography and an abdominal CT scan were performed. The stones were located in the abdominal ureter, between the ureteropelvic junction and the iliac crest. Double J catheters were not systematically placed and ureteral stents were placed only in cases where there were signs of haematuria or excessive manipulation of a friable ureter.

Surgical technique

The patient was administered preoperative prophylactic antibiotics, and was placed in the lateral decubitus position for all techniques. A kidney support was only used in open surgery. A retroperitoneal space was created by blunt dissection with a 3cm subcostal incision up to the 12th rib. A blunt dissection was performed with a manual ball (using a Foley catheter and gloves) to create the workspace, then a 10mm trocar was inserted in the incision. In addition, two other trocars were placed in a V: one of 5mm on the midclavicular line and another of 10mm (for the optics) on the posterior axillary line. Occasionally, an optional fourth 5mm trocar was placed on the anterior axillary line just below

the rib margin. After dissection, the ureter was identified and the stone located from where it protruded or produced ureteral dilatation. To prevent dislocation in the upper part, a band was placed and an incision made in the ureter with a surgical scalpel. The stone was extracted with forceps, the ureter rinsed with saline and a double-J catheter inserted if necessary. Polyglactin 4-0 internal sutures were used to close the ureteral incision.

For the transperitoneal procedure, we used the technique previously described by Raboy et al¹¹ in 1992. Only 3 trocars were used and, after separation from the colon, the ureter was treated in the same way as in the retroperitoneal technique described above, leaving a laminar retroperitoneal drainage in all cases. In the follow-up visit 1 month later, a flat X-ray was performed to confirm complete removal of the stones.

Statistical analysis

The analysis of categorical variables was performed using the Pearson χ^2 test. Variables with a normal distribution (age, stone size, drain time) were compared using analysis of variance (ANOVA). To compare the median operating time, hospital stay and blood loss, the Kruskal-Wallis test was used. The results were considered statistically significant when $p < 0.05$. Data were analysed using SPSS 13.0 (SPSS 13 for Windows, Rel 13.0 2004 SPSS Inc.).

Results

The resident urology physicians performed all ureterolithotomies. Table 1 summarises the values for the baseline characteristics of patients and stones. It can be seen that the demographic characteristics, ASA classification, stone size and side of the ureter were similar in all three groups. Proximal ureteral stones were more frequent in the ULR group. In addition, one patient had bilateral stones and both sides were treated with ULT in a single operation.

Table 2 presents data on the operations and postoperative morbidity. There were no significant differences in the median duration of the operation, the need to insert a ureteral catheter or blood loss. No blood transfusions were required.

In the ULR group, three interventions resulted in open surgery and another was changed to a transperitoneal one because of technical difficulties.

During the postoperative period, the laparoscopy group required a much smaller amount of opiates and shorter hospitalisation times ($p < 0.001$ and $p = 0.003$, respectively). The average Penrose drain was similar for all groups.

There were no differences in complication rates between groups and no major complications during or after the operation in any of the 3 groups, except for 2 patients (10%). These were in the retroperitoneoscopic group and had persistent urine leakage, which required the insertion of a double J catheter on days 5 and 6 after the operation. Of these 2 patients, one had an urinoma and the other an infected haematoma and fever. Similarly, 1 patient (6.2%) in the ULT group had a persistent urine leak, as did 2 other patients

Table 1 – Baseline characteristics

Characteristics	Groups			Total	p
	Open surgery	Transperitoneal	Retroperitoneal		
Patients, n	76	15	19	110	
Age (years)	46.5 ± 14.5	43.2 ± 16.7	43.8 ± 15.7	44.3 ± 14.6	0.784
Male/female, n	45/31	8/7	12/7	66/44	0.915
ASA classification, mean ± SD	1.5 ± 0.7	1.5 ± 0.6	1.4 ± 0.6	1.5 ± 0.6	0.813
Size of stone (mm), mean ± SD	13.9 ± 5.6	12.5 ± 2.6	13.6 ± 3.8	13.6 ± 4.7	0.808
Mean (range)	11.5 (10-30)	12.5 (10-17)	14 (10-20)	12 (10-30)	
Ureter, n (%)					0.026
Proximal	11 (14.5)	3 (18.8)	8 (42.1)	22 (19.8)	
Medial	65 (85.5)	13 (81.3)	11 (57.9)	89 (80.2)	
Side, n (%)					0.367
Right	56 (73.6)	10 (62.5)	8 (44.4)	74 (67.2)	
Left	20 (26.3)	6 (37.5)	10 (55.6)	36 (32.7)	

Table 2 – Operative and postoperative data

	Groups			Total	p
	Open surgery	Transperitoneal	Retroperitoneal		
Interventions, n	76	16	19		
Operating time minimum (min), median (P25-75)	80 (60-120)	100 (70-180)	105 (90-120)	90 (70-120)	0.143
Blood loss (mL), median (range)	0 (0-250)	50 (0-100)	50 (0-100)	50 (0-250)	0.247
Conversions (%)	–	–	4	4	
Ureteral stents, n (%)	6 (7.9)	2 (12.5)	1 (5.3)	9 (8.1)	0.732
Penrose drain days, mean ± SD	2.6 ± 1.1	2 ± 0.8	2.6 ± 1.8	2.4 ± 1.4	0.554
Opioids used, n (%)	63 (82.8)	7 (43.7)	8 (42.1)	78 (70.2)	< 0.001
Complications, n	11	2	5	18	0.415
Days of hospital stay, median (P25-75)	5.3 (3-6.5)	3 (2-3)	2 (2-3)		0.003

(2.6%) in the open surgery group, which was resolved by conservation treatment. In the ULT group, 1 patient (6.2%) had fever immediately after the intervention, which was treated with IV antibiotics. In the open surgery group, 11 patients (14.4%) suffered minor complications treated without surgery; 4 patients (5.2%) had fever; 3 (3.9%), urinoma; 2 (2.6%), loss of urine; and 2 patients (2.6%) experienced a transient decrease in renal function.

The postoperative stay in hospital ranged from 2 to 6.5 days. The hospitalisation period was longer in the open surgery group compared with the ULR and ULT groups ($p < 0.003$, Table 2).

After 1 month, a kidney-ureter-bladder radiograph showed no residual stones in any of the cases.

Discussion

ESWL and URS have become, without doubt, the standard treatment for ureteral calculi and offer considerable advantages over conventional open ureterolithotomy.²

Despite constantly changing treatments in endourology, there are still many challenges to overcome to properly handle large impacted stones in the upper ureter. This is especially so in developing countries, with documented difficulties¹²⁻¹⁴ such as limited surgical resources and access to ESWL and laser technology techniques. In Latin America, availability of high range endourology, such as Holmium-YAG laser and flexible ureteroscopy is limited, and minimally invasive ureterolithotomy has become an alternative to open surgery.

A number of experts in endourology stress that it is sometimes important to change the planned urologic surgery into a more invasive operation. It is essential, therefore, that future urologists obtain training during their tenure as residents to perform ureterolithotomies. Historically, lumbotomy has been associated with several disadvantages, such as hernias, chronic pain, aesthetically unpleasant results and long periods of convalescence.¹⁵ Also, earlier studies demonstrate the safety and feasibility of laparoscopic ureterolithotomy when performed by laparoscopy experts.⁹

The aim of this prospective study is to compare laparoscopic ureterolithotomy with open ureterolithotomy in a training environment of limited laparoscopy experience. Overall, recorded complication rates and operation lengths were similar.

Perioperative complications occurred in 3 patients (15.7%) in the ULR group, in 2 ULT group patients (13.3%) and 11 (14.4%) open surgery group patients. Prolonged urine leaks (> 72 h) were confirmed in 3 laparoscopy group patients (8.5%; 2 in the ULR group and 1 in the ULT group), where 2 were treated by placing an ureteral catheter. Also, in the open surgery group, continuing urine loss was recorded in 2 patients (2.6%) who were given conservation treatment. This technical problem was similar to other problems included in the recent literature. Actual UL results have a urine loss rate of between 2 and 20%.^{3,5,10,13,14} In total, the documented urine loss rate in the group was 14.5%.^{3,10} The losses due to ureterotomy in our study could be a result of several factors, including the specific technique used, as a double J catheter is not routinely placed in the suture ureterotomy, and our inexperience. The decision of whether or not to suture the ureterotomy and place a stent in the ureter is controversial. Some authors choose not to close the ureterotomy and do not place a stent in the ureter.¹⁴ Recently, El-Moula et al¹⁴ documented a multicentre retrospective study of 64 UL retroperitoneal procedures which left the ureter open with a double-J, with only one patient suffering a prolonged loss of urine.

Due to technical problems, a retroperitoneoscopic intervention had to be changed into a transperitoneoscopy, as there was a scar from a previous lumbotomy. In addition, it was necessary to modify two other operations at the beginning of our experience with retroperitoneoscopies and another in an obese patient (BMI = 32) with only one kidney (3/35 procedures in total). Therefore, we documented a total stone removal rate of 91.4% (32/35) after laparoscopy. In other experiments, total stone removal rates after laparoscopic ureterolithotomy vary between 81 and 100%.^{7,16,17}

In our series, laparoscopies were better tolerated than open operations, with a significant decrease in postoperative analgesia ($p < 0.001$). Although our data are restricted to the first month of aftercare, we can guarantee that complications related to surgery and the convalescence period following completion of the UL were significantly reduced when compared with the open surgery group; an observation noted in several non-random, comparative studies.^{7,17} These results are consistent with those obtained by comparing laparoscopy with open surgery for all types of urological surgery.^{18,19}

Most of the UL studies to date have been retrospective and not comparative.^{9,10,20-23} Moreover, the number of patients included in the studies was relatively small, varying between 3 and 101.^{8,14} In English-language publications, only 2 comparative, non-random studies were found.^{7,17} Skrepetis compared 18 open operations with 18 ULT operations, and concluded that the operation time was significantly longer in the UL group. The study by Goel et al⁷ appears as the only non-random, prospective comparison investigating laparoscopy results in the treatment of upper ureteral stones. In addition, Basiri et al²⁴ recently compared UL with ureteroscopy and

percutaneous nephrolithectomy in a training programme. All the above studies repeated our results. A summary of recent publications can be found in Table 3.

Laparoscopic ureterolithotomy can be either retroperitoneal or transperitoneal. We chose the retroperitoneal route as this is farther from the transperitoneal structures and allows direct access to the ureter. Moreover, the difficulties in creating space and working in the retroperitoneum were minimised. However, in previous retroperitoneal operations, it was sometimes difficult to create space and dissect the ureter.²⁵ Some authors recommend the transperitoneal way,^{10,24} as it provides a superb working space. ULT's detractors argue that separation from the colon can create subsequent adhesions, intra-abdominal visceral injuries, and any urine loss would then not be confined to the retroperitoneal space.

We recognise the limitations of this study, among which may be the non-randomised design and the arbitrary criteria for deciding whether an intervention was performed openly or laparoscopically. However, the characteristics of both the patients and the stones were similar.

According to our experience in a single institution, we found that laparoscopic ureterolithotomy offers significant advantages over the traditional exposed side technique, and offers improved analgesia and reduced periods of hospital stay. However, this study was conducted during a residential training programme for surgeons with limited experience in laparoscopy, and postoperative UL showed similar complication rates to open surgery. Also, when performing UL, the amount of opiates used was reduced in comparison with the open surgery group. Therefore, this study confirms the results of other studies showing that patients undergoing UL require significantly lower post-operation hospital stays when compared with individuals who have undergone open ureterolithotomy.

Without doubt, open ureterolithotomy requires skills in performing laparoscopic procedures that take time to develop, including making internal stitches and working in a small area (retroperitoneoscopy). In our opinion, our inexperience may at least partially explain some of the complications observed, such as urine loss and the transformation of open interventions. In fact, we believe that UL is an excellent intermediate step in developing the necessary skills to perform laparoscopy in more complicated urological surgery.

Conclusions

We conclude that laparoscopic ureterolithotomy via the transperitoneal or retroperitoneal route is a highly efficient method for removing large or impacted calculi in the upper ureter, when compared with conventional open ureterolithotomy. Laparoscopy produces no more complications, has a similar operating time, lower analgesic requirements and shorter hospital stays. The main results from comparing laparoscopy with conventional lumbotomy for ureteral stones are promising, even in a urology training programme. We consider UL to be our first choice treatment in cases where URS and retrograde manipulation have not provided the expected results.

Table 3 – Summary of recent publications

Reference	Study design	Technique	UL or open interventions (n)	Average operating time (min)	Conversions to open surgery (%)	Perioperative morbidity (%)	Hospital stay (days)	Success (%)
Takeeley et al. ²² 1999	Case Series	ULT	14	105	0	3 (21%)	5.6	100
Feyaerts et al. ⁹ 2001	Case Series	ULT/UJLR	21/3	140/107	0	2 (8.3%)	3.8	95
Gaur et al. ¹⁰ 2002	Case Series	ULR	100	79	8 (8%)	30 (30%)	3.5	92
Demirci et al. ¹⁶ 2004	Case Series	ULR	21	105	4 (19%)	21 (100%)	6	81
Flasko et al. ⁵ 2005	Case Series	ULT/UJLR	6/69	45	1 (1.3%)	0	3	98
Kijviki et al. ²³ 2006	Case Series	ULR	30	121	0	3 (10%)	3.8	96
El-Feel et al. ¹³ 2007	Case Series	ULT	27	145	0	1 (3.7%)	4.1	100
El-Moula et al. ¹⁴ 2008	Case Series	ULT/UJLR	8/66	58	4 (5.4%)	15 (20.2)	6.4	94
Derouiche et al. ¹² 2008	Case Series	ULR	50	97	4 (8%)	10 (20%)	6.8	92
Comparative studies								
Skrepetis et al. ¹⁷ 2001	Retrospective	ULT vs UA	18 vs 18	130 vs 85	0	16.6 vs 22.2	3 vs 8	100 vs 100
Goel et al. ⁷ 2001	Prospective	ULR vs UA	55 vs 26	108 vs 98	10 (18%)	22 vs 42	3.3 vs 4.8	82 vs 100
Current study	Prospective	ULT/UJLR vs UA	35 (16/19) vs 76	100/105 vs 80	3 (8.5%)	13.3/15.7 vs 14.4	3 vs 5.3	91 vs 100

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