



REVIEW ARTICLE

Is extracorporeal shock wave lithotripsy a current treatment for urolithiasis? A systematic review[☆]



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Abstract

Introduction: Technological advances have prompted a change in the management of urolithiasis. Endourological techniques are gaining importance because they are highly effective treatments. The aim of this study was to answer the question of whether extracorporeal shock wave lithotripsy (ESWL) is still a competitive alternative compared with other therapeutic modalities.

Acquisition of evidence: We conducted a literature search of articles published in the past 5 years. We identified 12 randomized and comparative studies and assessed the methodology and results of the study variables. We performed a narrative synthesis of the included studies. To summarize the variables, we used the mean and standard deviation for continuous variables and absolute numbers and percentages for the qualitative variables.

Analysis of the evidence: Of the studies reviewed, 7 evaluated the various treatments for nephrolithiasis and 5 evaluated the treatments for ureteral lithiasis. At the renal level, a stone-free rate of 33.33–91.5% at 3 months was reached with ESWL, while a rate of 90.4–100% was achieved with the other endourological techniques, without finding statistically significant differences in the studies. At the ureteral level, a stone-free rate of 73.5–82.2% at 3 months was reached with ESWL, while a rate of 79–94.1% was achieved with the other endourological techniques, without finding statistically significant differences in the studies.

Conclusion: There is a lack of homogeneity among the published studies. ESWL is a minimally invasive treatment that with an appropriate technique and patient selection achieves high effectiveness, thus maintaining an important role at this time.

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PALABRAS CLAVE

Litiasis;
Litotricia
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Tratamiento

¿Es la litotricia extracorpórea por ondas de choque en la actualidad un tratamiento vigente para el tratamiento de la litiasis urinaria? Revisión sistemática

Resumen

Introducción: Los avances tecnológicos han motivado un cambio en el manejo de la urolitiasis. Las técnicas endourológicas están cobrando mayor importancia, ya que son tratamientos altamente eficaces. El objetivo de este trabajo es responder a la cuestión de si la LEOCH sigue siendo una alternativa competitiva frente a otras modalidades terapéuticas.

Adquisición de la evidencia: Se realizó una búsqueda bibliográfica de artículos publicados en los últimos 5 años. Fueron identificados 12 estudios aleatorizados y comparativos. Se evaluó la metodología y el resultado de las variables estudiadas. Se ha realizado una síntesis narrativa de los estudios incluidos. Para resumir las variables se ha utilizado la media y la desviación estándar en variables continuas, y para variables cualitativas el número absoluto y el porcentaje.

Análisis de la evidencia: De los estudios revisados, 7 trabajos evaluaban los distintos tratamientos para litiasis renales y 5 para litiasis ureterales. A nivel renal, con LEOCH se alcanza una TLL a los 3 meses entre 91,5-33,33%, mientras que con otras técnicas endourológicas entre 100-90,4%, sin encontrar diferencias estadísticamente significativas en todos los estudios. A nivel ureteral con LEOCH se alcanza una TLL a los 3 meses entre 82,2-73,5%, mientras que con otras técnicas endourológicas entre 94,1-79%, sin encontrar diferencias estadísticamente significativas todos los estudios.

Conclusión: Existe una falta de homogeneidad entre los estudios publicados. La LEOCH es un tratamiento mínimamente invasivo, que con una adecuada técnica y selección del paciente alcanza una elevada efectividad, manteniendo un papel importante en la actualidad.

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Introduction

With the development of extracorporeal shock wave lithotripsy (ESWL) in the 1980s as a treatment for urinary lithiasis, there was a significant change in the management of this condition. Open surgery, which until now had been the standard treatment, was displaced by a technique that was minimally invasive, effective and with a low complication rate.

Subsequently, contraindications to the use of ESWL in certain patients, as well as their complications, led to the onset of endourology. Due to the development and technological advances achieved in medicine, we are witnessing a new change in the management of urolithiasis. Ureteroscopy (URS), retrograde intrarenal surgery (RIRS) or percutaneous nephrolithotomy (PCNL) are becoming more important among clinical urological practice, as they are highly effective treatments that allow a stone-free rate (SFR) to be achieved in a single surgical intervention.

These changes are also reflected in the number of scientific publications. Currently, there is a tendency to decrease the work on ESWL and increase studies on endourological technique.¹

The treatment of lithiasis is gaining importance because it allows for its elimination in a single procedure compared to a less invasive treatment, although with a higher rate of retreatment. In this situation, we ask ourselves if we are facing the onset of the disappearance of ESWL, just as it did decades ago with open surgery.

The aim of this study is to try to answer the question of whether ESWL is still a competitive alternative compared to other therapeutic modalities.

Evidence acquisition**Search strategy**

A literature search was conducted in PubMed of articles published in the last five years. We used as search criteria the terms: Ureteroscopy/retrograde intrarenal surgery/Flexible ureteroscopy/RIRS or percutaneous nephrolithotomy/percutaneous lithotripsy/PCNL or extracorporeal shock wave lithotripsy/ESWL.

Inclusion criteria

The inclusion criteria for the selection and revision of the articles obtained were:

- Studies published in the last five years.
- Written in English or Spanish.
- Randomized and comparative studies of the use of ESWL for the treatment of urinary lithiasis (renal or ureteral) versus other endourological techniques (URS, RIRS, PCNL).
- Studies in adult population.
- Studies that include at least among the variables studied the SFR and the complications associated with the applied treatment.

Systematic review process

Studies that met the inclusion criteria described above were evaluated for the analysis of evidence. The methodology and results of the variables studied in each of them were

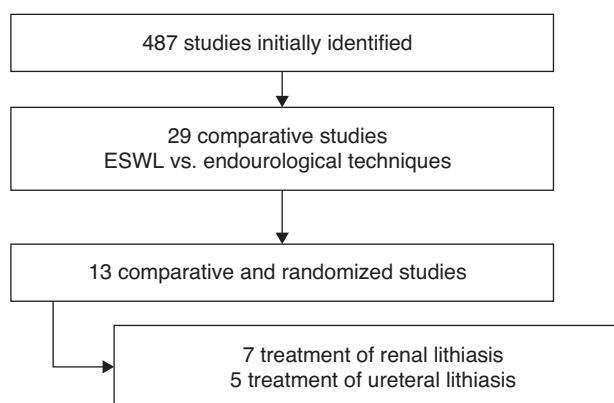


Figure 1 Review process performed.

assessed: SFR, efficiency coefficient (EC), complication rate, retreatment index, mean number of procedures, as well as mean operative time.

Of the 487 articles included in the initial search that responded to the terms used, a total of 29 studies compared the effectiveness of lithotripsy versus other techniques. After an initial screening of titles and abstracts, it was observed that 10 were review papers, 6 corresponded to retrospective or non-randomized studies and 13 were articles on comparative and randomized studies of the results of the application of ESWL versus other endourological techniques such as treatment of urolithiasis. Of these, one was dismissed due to multiple errors of published results and only 12 papers were selected. Seven studies evaluated the results of the application of the different techniques at the renal level and 5 of them at the ureteral level (Fig. 1).

Data acquisition

The data were extracted by PB and reviewed by a second author (AB) to avoid possible errors in obtaining and summarizing them.

Data analysis

A narrative synthesis of the included studies was conducted. To summarize the variables, the mean and standard deviation (SD) was used for continuous variables, and absolute number and percentage for qualitative variables. The main variables analyzed were SFR and EC. Secondary variables were the complication rate, the operative time, the retraction index and the average number of procedures.

Evidence analysis

Tables 1 and 2 summarize the basic characteristics of the included studies in which the treatment outcome was evaluated and compared using different renal and ureteral lithiasis techniques, respectively.

All groups underwent ESWL on an outpatient basis, and all other techniques required hospitalization. Except for Deem et al.⁸ and Lopes Neto et al.,¹⁰ ESWL was performed under general anesthesia. Other studies applied lithotripsy session under intravenous sedation. The RIRS, URS, miniPerc, PCNL

and laparoscopic techniques were performed under general anesthesia.

Some studies evaluated and compared the average operative time. The average time for performing a lithotripsy session was between 12.2 ± 5.16 and 49.2 ± 1.7 min,^{2,3,5,12} the average surgical time of the URS was 39.1 ± 1.5 min,¹² the mean operative time for RIRS was between 44 ± 7.4 and 78.7 ± 20.03 min²⁻⁶ and the mean operative time for minipercutaneous surgery was 61.1 ± 1.3 min.² Vilches et al.⁵ and Javanmard et al.⁶ found statistically significant differences between the surgical times used to perform ESWL and RIRS.

The SFR results are shown in Table 3 according to the follow-up times in which it was evaluated. Except two studies^{2,8} that did not indicate the maximum size of the residual lithiasis with which the patient was considered free of renal lithiasis, the rest of the groups considered the resolution of the renal lithiasis when in the imaging tests no renal calculi remains were observed, or these were smaller than 3 mm. Most studies^{2,4-8} use noncontrast computed tomography (ncCT) for outcome assessment. Singh et al.³ evaluated the resolution of renal lithiasis using urinary tract radiography and ultrasound.

Vilches et al.⁵ conducted a stratified analysis of SFR according to calculi size and observed that for calculi sized between 1 and 1.5 cm the SFR was 41.2% for ESWL and 75% for RIRS. Those differences were statistically significant ($p = 0.006$). Sener et al.⁴ analyzed and compared EC between the different techniques. An EC of 0.85, 0.79 and 0.09 was observed for RIRS, ESWL and the control group respectively, without evaluating the statistical significance of the results.

For the evaluation and comparison of complications, most studies used modified Clavien–Dindo classification.^{2,7} None of the studies showed statistically significant differences between the techniques evaluated. Table 4 shows the total percentage of complications in the different studies.

Some studies evaluated the percentage of retreatments for the resolution of renal lithiasis.^{2,3,6,8} For ESWL, it is between 36–67%; 2.1–9.5% for RIRS; 2.2% for minipercutaneous renal surgery and 0% for PCNL. Those differences are statistically significant in all studies. Sener et al.^{4,7} also studied the mean number of procedures for ESWL, ranging from 1.48 ± 0.65 to 2.7 ± 0.4 according to the different studies, and was significantly higher than for RIRS.⁴

Table 5 details SFR and EC of the treatment of renal lithiasis in proximal ureter. All the studies evaluated the outcome of the intervention using a simple radiography of the urinary tract and only the group of Lopes-Neto et al.¹⁰ used ncCT in the case of diagnostic doubt.

Islam et al.¹¹ evaluated and compared the treatment of distal ureteral calculi by URS or ESWL reaching a SFR at 3 months (size of residual fragment is not defined as non-significant) of 94.1% and 73.5%, respectively ($p = 0.001$) and an EC of 0.818 for URS and of 0.532 for ESWL.

For the evaluation and comparison of complications between the different techniques at the ureteral level, most studies 11–13 conducted a descriptive study of the same, while Lopes Neto et al.¹⁰ and Ozturk et al.⁹ classified them according to the modified Clavien–Dindo scale. Table 6 describes the total complication rate.

When analyzing those studies that share the same methodology in the performance of ESWL,^{2,4,7,9,11,12} it is

Table 1 Characteristics of the studies on renal lithiasis.

Study	Techniques	Number of patients	Size of the lithiasis	Location of the renal lithiasis	Other characteristics	Period
Kumar et al. ²	ESWL vs. RIRS vs. Miniperc	42/43/41	1–2 cm	Lower calyx	Radiolucent lithiasis Obese patients Asymptomatic patients	2012–2013
Singh et al. ³	ESWL vs. RIRS	35/35	1–2 cm	Lower calyx		2011–2013
Sener et al. ⁴	ESWL vs. RIRS	70/70	<1 cm	Lower calyx		2012
Vilches et al. ⁵	ESWL vs. RIRS	31/24	≤1.5 cm	Lower calyx		2009–2010
Javanmard et al. ⁶	ESWL vs. RIRS	25/21	1–2 cm	Renal pelvis		2010–2014
Sener et al. ⁷	ESWL vs. RIRS vs. control	50/50/50	<1 cm	Lower calyx		2011–2014
Deem et al. ⁸	ESWL vs. PNL	12/20	1–2 cm	Middle ad upper calyx		2008–2010

RIRS: retrograde intrarenal surgery; Miniperc: minipercutaneous; PNL: percutaneous nephrolithotomy; ESWL: extracorporeal shock wave lithotripsy.

Table 2 Characteristics of the studies on ureteral lithiasis.

Study	Techniques	Num. of patients	Stone size	Ureteral lithiasis location	Period
Ozturk et al. ⁹	ESWL vs. RIRS vs. Lap	52/48/51	1–2 cm	Proximal ureter	–
Lopes Neto et al. ¹⁰	ESWL vs. URS vs. Lap	14/16	>1 cm	Proximal ureter	2008–2010
Islam and Malik ¹¹	ESWL vs. URS	68/68	<2.5 cm	Distal ureter	2010–2011
Kumar et al. ¹²	ESWL vs. URS	37/41	<2 cm	Proximal ureter	2010–2011
Manzoor et al. ¹³	ESWL vs. URS	199/199	1–1.5 cm	Proximal ureter	2010–2011

RIRS: retrograde intrarenal surgery; Lap: laparoscopy; ESWL: extracorporeal shock wave lithotripsy; URS: ureteroscopy.

Table 3 Lithiasis-free rate (LFR) according to the time evaluated.

Study	Time	ESWL (% LFR)	RIRS (% LFR)	PNL (% LFR)	Miniperc (% LFR)	Control (%LFR)	p
Kumar et al. ²	3 months	73.8	86.1	–	95.1	–	0.01
Singh et al. ³	1 month	48.57	82.85	–	–	–	0.005
Sener et al. ⁴	3 months	92	92	–	–	2	0.001
Vilches et al. ⁵	2 months	48.3	70.8	–	–	–	0.109
Javanmard et al. ⁶	3 months	68	90.4	–	–	–	0.019
Deem et al. ⁸	1 week	16.67	–	95	–	–	<0.0001
	3 months	33.33	–	85	–	–	0.005
Sener et al. ⁷	1 week	48.6	52.3	–	–	–	0.176
	3 months	91.5	100	–	–	–	<0.05

RIRS: retrograde intrarenal surgery; ESWL: extracorporeal shock wave lithotripsy, Miniperc: minipercutaneous, PNL: percutaneous nephrolithotomy.

observed that for the treatment of renal calculi with ESWL, SFR at 3 months is reached up to 92%.⁴ At the ureteral level, SFR at 3 months is 84.9%. The percentage of complications with extracorporeal lithotripsy is between 5.7% and 7.4% (Table 7).

No study included in this study performs a cost analysis according to the different techniques used in the treatment of urolithiasis.

Discussion

ESWL, as well as endourological techniques, are highly effective treatments for the treatment of urinary lithiasis. Selecting the best therapeutic modality for each patient is a point of controversy for the urologist.

The results of prospective and randomized studies comparing these techniques help to draw conclusions in

Table 4 Percentage of total complications according to different studies.

Study	% complications				<i>p</i>
	ESWL	RIRS	PNL	Miniperc	
Kumar ²	7.1	9.3	–	24.3	0.10
Singh ³	17	11	–	–	0.22
Sener ⁴	5.7	2.8	–	–	>0.05
Vilches ⁵	16.1	37.5	–	–	>0.05
Javanmard ⁶	20	14.2	–	–	0.211
Sener ⁷	6	14	–	–	0.318
Deem ^{8,a}	–	–	–	–	–

RIRS: retrograde intrarenal surgery; ESWL: extracorporeal shock wave lithotripsy; Miniperc: minipercutaneous; PNL: percutaneous nephrolithotomy.

^a Does not specify total complication rate.

Table 5 Rate free of lithiasis in the treatment of lithiasis in proximal ureter according to different studies.

Study	Time	% LFR			<i>p</i>	Coefficient of efficiency			<i>p</i>
		ESWL	URS	LAP		ESWL	URS	LAP	
Ozturk et al. ^{9,a}	3 months	81	79	96	<0.05	–	–	–	–
Lopes Neto ^{10,b}	2 months	35.7	62.5	93.3	0.005	0.192	0.554	0.932	–
Manzoor et al. ^{13,c}									
Total	1 week	49.2	57.8	–	0.088	–	–	–	–
≤12 mm		44.6	44.3		0.88				
>12 mm		52	55.7		0.019				
Kumar et al. ^{12,d}									
Total	3 months	82.2	86.6	–	0.34	0.673	0.852	–	–
<1 cm		84.9	87.7	–	0.32	0.691	0.892	–	0.32
1–2 cm		78.4	85.4		0.12	0.464	0.834	–	0.01

LAP: laparoscopy; ESWL: extracorporeal shock wave lithotripsy; URS: ureteroscopy; LFR: lithiasis-free rate.

^a LFR defined as the absence of residual stones or fragments <4 mm.

^b LFR defined as the absence of lithiasis or residual fragments ≤3 mm.

^c Does not define non-significant residual fragment size.

^d LFR defined as absence of lithiasis or residual fragments <3 mm.

Table 6 Percentage of total complications according to different studies.

Study	% complications			<i>p</i>
	ESWL	URS	LAP	
Ozturk et al. ⁹	7.06	4.11	7.86	<0.05
Lopes Neto et al. ¹⁰	21.43	18.7	0	0.127
Kumar et al. ¹²	6.6	11.1	–	>0.05
Isalam and Malik ¹¹	7.4	8.8	–	0.75
Manzoor et al. ¹³	–	–	–	–

Does not specify the total rate of complications.

LAP: laparoscopy; ESWL: extracorporeal shock wave lithotripsy; URS: ureteroscopy.

Table 7 Percentage of free rate of lithiasis and complications in the treatment of urinary lithiasis by extracorporeal lithotripsy at 3 months of intervention according to different studies.

Study	Location	% LFR	% complications
Kumar et al. ²	Lower calyx	73.8	7.1
Sener et al. ⁴	Lower calyx	92	5.7
Sener et al. ⁷	Lower calyx	91.5	6
Ozturk et al. ⁹	Proximal ureter	81	7.06
Kumar et al. ¹²	Proximal ureter	84.9	6.6
Isalam and Malik ¹¹	Distal ureter	73.5	7.4

LFR: lithiasis-free rate.

therapeutic decision making. When we do not have multicentric studies, it is important to observe if the mythology used in different studies, as well as the analyzed variables, are coincident. After the literature review, we observed a lack of homogeneity in the definition of the main variables studied. They use different times for the evaluation of SFR and consider different sizes for the non-significant residual fragment. Studies in the literature did not use the same scale to classify the complications of the different techniques used.

In our opinion, it is necessary to unify evaluation criteria. In order to evaluate the outcome of a technique, it would be necessary to define pure SFR, which would correspond to the absence of renal calculi after treatment, and residual SFR, which would include the persistence of non-significant residual fragments. Consequently, the patient would be identified with lithiasic fragments that could cause recurrence of the disease. The size of those fragments as well as the follow-up time is also a point of discrepancy among studies. The majority considered as a non-significant residual fragment when the size is smaller than 3 mm at 3 months of the intervention. However, recent studies¹⁴ have shown that fragments of 4 mm, which are considered clinically insignificant, caused 44% of related events after one-year follow-up, of which up to 29% were reoperations. In addition, it should be agreed upon the ideal follow-up moment to assess the result of the applied technique. Most studies considered the optimal time 3 months of follow-up, giving a margin for the expulsion of fragments, as demonstrated by studies comparing the variable at different times of treatment.^{6,7}

Another difference lies in what is the ideal method of valuing the outcome of the intervention. The image test should be standardized in order to make a proper comparison of the different studies. A sensitivity of up to 97% has been described with ncCT for the diagnosis of urolithiasis. It is the best complementary examination compared to others.¹⁵ However, if we consider the dose of radiation emitted and that many patients will present a chronic disease in need of retreatment, ncCT is not the ideal test for follow-up. The combination of plain radiography and ultrasound achieves a sensitivity of up to 89%, a specificity of 100%, a positive predictive value of 100% and a negative predictive value of 81%.¹⁶ Therefore, it should be considered a valid option for the control of renal lithiasis initially radiopaque.¹⁷

Few studies^{4,10,12} include EC as variable study for the evaluation of the results of the applied technique. Clayman

et al.¹⁸ defined a concept that includes, besides the outcome of the technique used, the necessary auxiliary procedures and retreatments. This variable allows distinguishing among patients who are solved with a single technique or those who have needed other procedures. We consider that EC should be the main outcome variable, as SFR may be an isolated parameter of the effectiveness of a technique alone, the EC, however, allows a more accurate comparison between different therapeutic alternatives.

Regarding the evaluation of complications, most of the groups use the modified Clavien–Dindo scale for classification. We consider that Clavien–Dindo scale does not fully conform to the specific characteristics of ESWL. For this reason, our group is working on the development of a new classification that is more coherent and adapted to the technique, which also includes the concepts of the area of treatment complication and related isocosts. This classification will homogenize the classification criteria among the different centers and lithotriptors. This classification is under external validation.¹⁹

When we analyze the results of the reviewed studies, most of them evaluate the treatment of renal calculi in the lower pole, probably because of the anatomical difficulty involved in the treatment. At this level, with ESWL, SFR is reached between 48.3% and 92% and in RIRS the SFR is between 70.8 and 82.85%; not all studies reporting statistically significant differences. On the contrary, the difference in efficacy of ESWL versus PCNL is significant. Zhang et al.²⁰ and Srisubat et al.²¹ conducted study reviews and meta-analysis where treatment of ureteral lithiasis was compared by RIRS, PCNL and ESWL. They concluded that for both the lower calyx and the rest of renal locations, PNL is the technique that best SFR reaches, but at the expense of longer hospital stay. Regarding the treatment of ureteropelvic junction or located in the middle and upper calyx, we considered that other studies would be necessary to obtain conclusions. Javanmard et al.⁶ conducted a study of obese patients, representing a selection bias in favor of endourological techniques. Deem et al.⁸ evaluated the treatment of lithiasis located in the middle and upper calyceal stones, and they only reach a SFR at 3 months with ESWL 33% of patients. This result is lower than other studies that, despite trying renal lithiasis in the lower calyceal stones, they obtained better outcomes.^{2,7}

The SFR results are not consistent among studies. Studies comparing the treatment of lithiasis in the proximal ureter

with different procedures do not show similar outcomes. Lopes Neto et al.¹⁰ and Manzoor et al.¹³ obtained best SFR with ureteroscopy for cases of urolithiasis greater than 1 cm. According to these results, there are studies in the literature review on the treatment of proximal ureteral calculi greater than 1 cm and they report greater effectiveness for endourological treatment.²² In a study review and meta-analysis, Cui et al.²³ also found greater efficiency with ureteroscopy, but with a higher complication rate and hospital stay.

According to studies published in the last five years, there is not enough scientific evidence to believe that endourological techniques have displaced extracorporeal lithotripsy in the treatment of urolithiasis and we are at the beginning of the end of the ESWL era. ESWL continues to represent a valid therapeutic tool in clinical practice with its advantages and disadvantages and, therefore, with specific indications.

Nowadays, we have several options of minimally invasive treatment. The appropriate choice will depend on the characteristics of the lithiasis (size, radiological density and location), patient characteristics (BMI, skin-to-stone distance, skeletal deformities, hemorrhagic diathesis, pregnancy, urinary tract anatomy), available technology, the experience of the surgeon, the success rates of each technique in the hands of the operator, failure predictors of the technique and patient preference.

There have been significant advances in the technology of lithotripters. ESWL is considered as a technique of choice for the treatment of ureteral stones smaller than 1 cm and a renal level up to 2 cm. The new devices generate waves with higher positive peak pressure, the focal areas are smaller and their application is better tolerated by patients. The main advantages of ESWL compared to other endourological techniques are the following: it is less invasive, the possibility of being performed under intravenous sedation with good tolerability and favorable safety profile. The key to optimizing the result is to make the appropriate selection of the patients who are candidate for this technique. Technological advances in image diagnosis facilitate the identification of renal lithiasis susceptible to treatment with ESWL. The low-dose ncCT is now available, and provides detailed information on the characteristics of renal lithiasis and urinary anatomy. It is possible to accurately measure the focal length, the density of the stone, and the size. Those three factors that Tran et al.²⁴ described as triple D score have an inverse correlation with the fragmentation of renal stones. If the skin-to-stone distance is significant (>10 cm) the effectiveness of ESWL decreases, therefore, in these cases endourological techniques may be the best choice. The size of the renal lithiasis is an important factor for the assessment of the therapeutic decision. The quantification of the renal lithiasis should be standardized to facilitate comparisons between studies. The location of the renal lithiasis, together with the anatomical characteristics of the urinary tract, are relevant factors in decision making. The presence of distal stenoses to the position of the renal lithiasis or non-favorable calyceal anatomical factors significantly limits the use of ESWL and occasionally RIRS. Radiological densities above 900 HU predict a decrease in the effectiveness of ESWL. Most of the studies included in this study do not specify these factors as inclusion/exclusion

criteria according to the treatment technique. In our opinion, they should be considered in order to optimize the effectiveness of the different techniques and to compare the results.

Another important factor in the success of ESWL is the careful performance of the procedure. Some authors demonstrated that ESWL can get comparable or even better results than other endourological techniques.^{4,9,12} In our experience, the technique must be performed by an expert urologist, as she or he achieves optimal control of the parameters that determine the success of the intervention. It is necessary an adequate management of energy application for fragmentation of renal stones, patient placement and constant monitoring of renal lithiasis location by radioscopy or ultrasound, as well as the correct administration of analgesic drugs to minimize patient movement. The increase of the energy applied in the renal lithiasis is an important factor in the effectiveness of the technique. In a retrospective study, Budía Alba et al.²⁵ did not find differences in the rate of complications in implementing more energy by increasing the number of waves per session. They observed a significant improvement of clinical effectiveness and reduced retreatment. A subsequent prospective study has confirmed the initial results of more effectivity (75% in the standard treatment vs 87.7% in the extended treatment) without an increase in observed complications.²⁶

We do not have randomized and comparative studies that evaluate the different treatments in terms of cost-effectiveness. Selecting the best treatment modality according to the economic cost represents a point of controversy in urology. At the same time, it is a challenge for the urologist due to the advantages and disadvantages of each method regardless of costs. We agree with Cone et al.²⁷ in that clinical decisions should not be based only in terms of costs, but we should analyze the total cost of each technique before deciding on a treatment option.

According to the literature reviewed, despite the heterogeneity and limited quality of cost-effectiveness assessments available, most studies have shown that the URS is more favorable than ESWL for ureteral lithiasis treatment.²⁸ However, there are significant differences between effectiveness and cost depending on countries and technologies. In the evaluations conducted in the USA, in a systematic review conducted by Matlaga et al.²⁸ described that the URS was associated with better SFR and lower cost than ESWL. But the authors acknowledge that it is difficult to assess the magnitude of the URS benefit over cost, given the wide variety of existing health systems. In Egypt, Salem et al.²⁹ found similar results in a prospective study of urolithiasis in proximal ureter. Yet, studies in Asia showed that the higher cost of lithotripsy was linked to the cost of acquiring and maintaining the lithotripter. Compared with European and American studies, the costs associated with ESWL were very low, as lithotripters are produced by themselves and the acquisition and maintenance costs are significantly reduced.³⁰ Our group has shown that in the Spanish health system the ESWL is more cost-effective in both renal and ureteral stones, with no difference in the complication rate between the two modes.^{31,32}

Conclusions

According to the literature reviewed in the last five years there is a lack of homogeneity among the different studies that evaluate and compare the treatment of urolithiasis by different techniques. ESWL plays an important role in the treatment of renal calculi in the urinary tract. It is a minimally invasive treatment that with an adequate technique and selection of the patient achieves high effectiveness.

Conflict of interest

The authors declare that they have no conflict of interest.

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