ANALYSIS OF RELATED FACTORS OF EXTRACORPOREAL SHOCK WAVE LITHOTRIPSY IN THE TREATMENT OF URINARY CALCULUS

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ABSTRACT

Objective: *To study the influencing factors of extracorporeal shock lithotripsy wave (ESWL) in the treatment of urinary calculus and provide reference for the clinical practice of treating urinary calculus.*

Method: *In the The No. 3 Affilated Hospital of Qiqihaer Medical University, 800 patients who had had urinary stones from January 2017 to February 2018 were randomly selected for follow-up investigation. Disease information and preoperative preparation information for each patient are collated. Images of the patient's physical condition are recorded and saved. The postoperative follow-up, data, and clinical symptoms or complications were analyzed. All patients were followed up 1 week after surgery and the follow-up was generally continued for 3 months. Successful treatment: calculus is completely discharged or residual stone≤3mm, and hydronephrosis is light. Failure treatment: calculus is not discharged or residual stone>3mm, hydronephrosis is not alleviated or aggravated. Statistical factors were used to analyze the factors affecting the effect of extracorporeal shock wave lithotripsy on urinary calculus.*

Result: *All patients who underwent treatment were followed up for 3 months and the data were summarized. Based on the therapeutic effect, the patients were divided into a failure group and a success group. The complete discharge of calculus or residual calculus≤3mm belongs to the successful group. The calculus texture is hard, so the broken calculus or the small calculus after the crush is still large, and it is not discharged smoothly. However, in general, a partial calculus diameter > 3 mm is called a treatment failure. The X2 test was used to compare the data of the two groups of patients.*

Conclusion: *The type of lithotripter, the age of the patient, the location of the calculus, BMI, the degree of hydronephrosis, the approach of the source of the shock, the frequency of the shock wave, and the energy during the lithotripsy are all factors that influence the therapeutic effect of the extracorporeal shock wave.*

Keywords: *Extracorporeal shock wave, urinary calculus, influencing factors, clinical medical.*

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Introduction

Shockwave lithotripsy does not touch the affected area of the patient's body. Outside the patient's body, the concentrated high-energy shock wave is used to shatter the calculus in the body, which is a minimally invasive surgery(1). The world's first shock wave crusher was produced by Dornier in Germany. However, initially, the shock wave was only for military issues. However, in the late 1970s, a large amount of experimental data proved that the isolated calculus in water can be crushed by shock waves and is not affected by the passing organism or tissue(2). Later, scientists used this theory to study a lithotripter test article. After the evolution, a specimen of crushing calculus in vitro using extracorporeal shock wave lithotripsy (ESWL) technology was made, and a test machine was manufactured using the specimen(3-5).

The urinary system calculus is a common and frequently-occurring disease in urology, but it does affect people's normal life seriously. The causes of the disease are often related to the nutritional situation. The backward countries eat plant protein, so the excretion of urine phosphate is less, which can easily produce bladder calculus(6-8). Children are more likely to have this disease. Kidney calculus is common in developed countries. There are many types of theoretical theories about urinary stones: nuclear theory, matrix theory, and crystallization inhibitor theory, but there is no theory that fully reveals the causes of urinary stones(9). Obstruction of the urinary system, foreign body sensation or infection may produce urinary stones. Conversely, urinary stones may also cause urinary tract infections and obstruction. Metabolic diseases such as hyperthyroidism, gout, oxalic acid, and cystine may also cause urolith formation due to abnormal metabolism. In the urinary system calculus, the proportion of renal calculus accounts for more than half(10-13). The large or non-moving calculus in the kidney calculus sometimes has no obvious manifestations, or the waist side is sore and discomfort but most of them are ignored(14). Therefore, many patients have already suffered from impaired renal function or loss of function when they seek medical treatment.

Logistic regression analysis was used to analyze the factors affecting the therapeutic effect of urinary calculus, and several factors that have a great influence on the therapeutic effect were obtained, and the actual data and theoretical theory were discussed.

Materials and methods

Case collection

A total of 800 patients with urinary calculus who underwent ESWL treatment at the calculus center of A Hospital from January 2017 to February 2018 were collected. All subjects in this study had signed informed consent and have been approved by the ethics committee of The No.3 Affiliated Hospital of Qiqihaer Medical University.

800 cases of ureteral calculus were selected as the main follow-up subjects. All patients had a B-scan ultrasonography or a plain radiograph. All data before, during, and after surgery are complete.

Exclusion criteria for extracorporeal shock wave lithotripsy: From the theory of uroliths, in addition to unchangeable hemorrhagic disease and vascular obstruction in the distant calculus, in vitro calculus is a condition that is absolutely prohibited by ESWL. Several exclusion criteria are proposed:

In general, pregnant women cannot perform calculus surgery. Because the fetus is to avoid the adverse effects caused by the shock wave, it is recommended that the pregnant woman undergo calculus surgery after delivery.

If the condition of a diabetic patient is not well controlled, blind treatment with a lithotripsy can cause infection and is beyond control.

Patients with severe infection or acute calculus should be excluded prior to the operation of the lithotripsy. If such patients are treated with lithotripsy, infection may be aggravated, leading to complications such as bacteremia and toxemia. Therefore, after the infection is effectively controlled, the infected patient can perform the lithotripsy operation.

High-risk patients with organ dysfunction should be excluded, such as heart failure, renal insufficiency, and so on.

Obese patients will affect the specific positioning of the calculus by the machine because the fat is too thick.

Severe deformation of the bones and joints of the knees can affect the position in the ESWL, which may result in inaccurate calculus. In addition, for calculus larger than 5mm, the doctor recommends using a pedicle to perform lithotripsy, ureteroscopic lithotripsy or open surgery. For calculus less than 3mm, conservative treatment is generally chosen. The rest of the situation is considered an indication.

Experimental methods

Collection of preoperative elements of ESWL

The patient data elements that need to be collected before surgery mainly include:

The general condition of the patient: age, sex, body mass index, duration of the disease, etc.

Medical history: hypertension, diabetes, orthopedic diseases, history of calculus, and corresponding treatment history (open surgery, endoluminal surgery, extracorporeal shock wave lithotripsy).

The calculus situation (based on the pre-operative B-ultrasound, radiograph): The number of calculus, the length of calculus, the width of calculus, the side of calculus, the position of calculus (divided into upper/middle/lower ureter), the degree of hydronephrosis (divided into no\light\medium\severe water) and other factors.

According to the conventional method of observation and measurement of B ultrasound images, the degree of hydronephrosis is:

No hydronephrosis: normal renal collection system separation ≤ 1.5cm.

Mild hydronephrosis: The size and state of the kidneys are normal, the thickness and echo of the renal parenchyma are normal, and the renal collecting system is separated by 2-3 cm.

Moderate hydronephrosis: The degree of renal enlargement is not large, the shape is full, the thickness of the kidney is slightly reduced, the renal column is unclear in the angiography, the renal pelvis and renal pelvis are significantly increased, and the renal collecting system is separated by 3-4 cm.

Severe hydronephrosis: the kidneys are enlarged, the morphology is abnormal, and the parenchyma is significantly thinner. The entire kidney area is visualized as a dark area. In the meantime, there is an echo of the renal column under pressure. It is radially arranged. The dark areas are connected to each other. The separation of renal collection system was greater than 4cm.

According to the position, the ureter calculus can be divided into upper, middle and lower segments, which can also be called the abdominal segment, the basin segment and the bladder segment. The upper segment is located at the junction of the ureter and ureter to the iliac artery. The middle section is from the radial artery to the bladder wall. The lower segment is from the bladder wall to the bladder mucosa and ureteral opening.

Clinical manifestations: pain, hematuria, and others.

Physiological and biochemical data indicators: blood routine, urine routine, liver and kidney function electrolytes, acid-base balance.

Other preparation

Control of infection: The results of pre-operative urine routine tests showed that the patient had a certain degree of infection. Therefore, patients should undergo calculus surgery after controlling the infection.

Relieve the patient's mood: Before the operation, the doctor should fully communicate with the patient to ease the patient's mood and let them actively cooperate with the treatment. If circumstances permit, patients who have recovered will communicate with patients who are about to undergo surgery to ease tension.

Intestinal preparation: especially in patients with middle and lower calculus, to achieve the best results of surgery, the intestines can be cleaned the day before treatment. This facilitates accurate positioning during surgery and reduces the loss of shock waves as they pass through the intestinal tract.

Skin preparation: Patients with calculus in the lower ureter should undergo skin preparation in the prone position.

Pain relief: In general, most patients do not need anesthesia to relieve pain. However, a small percentage of patients are very sensitive to pain. After the operation, the vomit can be used for spasmodic drugs. During the operation, pethidine hydrochloride can achieve better results.

Follow-up: After surgery, patients were followed up once a week for 3 months. The complications were collected. Depending on the circumstances, ESWL or other treatments are decided. By the third month, the data was evaluated.

Inspection and treatment

When using the Siemens MODULARIS Variostar dual positioning extracorporeal shock wave lithotripter, the positioning method was determined according to calculus and X-ray. Negative calculus chose ultrasound localization, and positive calculus chose X-ray localization. The position is supine or prone. The shock wave probe is adjusted based on the position of the calculus and the patient's condition. Before the treatment, the coupling agent is evenly applied and the couplant and the surface of the skin are sufficiently in contact. In this way, the air between the couplant and the skin can be avoided as much as possible, and the energy loss can be reduced. Therapeutic energy: The voltage of the liquid-electric lithotripter is 5-20KV, and the energy of the electromagnetic lithotripsy is 10-300%. The total number of impacts in a treatment will not exceed 3500 times. During the treatment, the video camera monitors in real time to confirm the effect of the calculus and to make dynamic positioning adjustments at any time. Accurate positioning can be ensured during the treatment, and the calculus pulverization can be observed to determine the number of impacts. Patients with complex calculus need to be given oral medications for assisted drainage. When necessary, medication to relieve nerve pain is given (Figure 1-2).

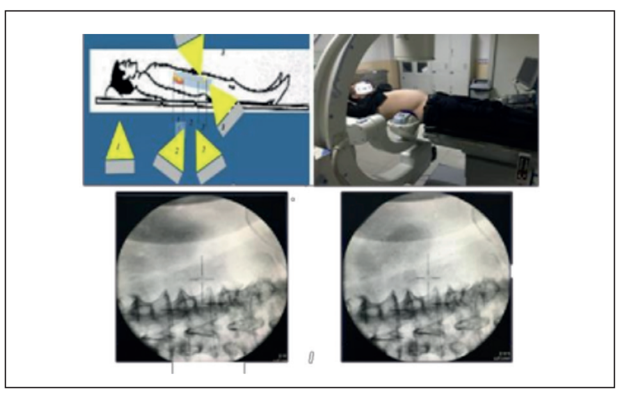

Fig 1: Contrast image of the calculus when lying on the back.

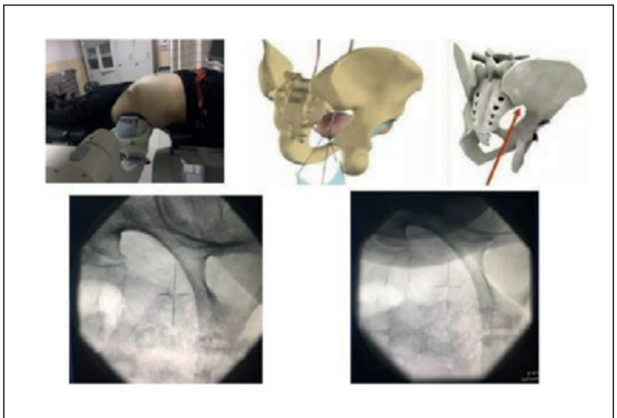

Fig 2: Contrast image of the calculus when lying down.

Time and content of follow-up

After 2 to 4 weeks of treatment, a review of radiograph or B-ultrasound should be performed. Recent complications such as hematuria, pain or fever after treatment were investigated. Thereafter, the longest follow-up was 3 months. A review or B-ultrasound was used to assess the effect of the treatment. According to the results of ESWL treatment, patients were divided into two groups: after a single ESWL treatment, calculus was completely discharged or the residual calculus was ≤ 3 mm. The patient does not need to be in clinical treatment. This is the ESWL treatment successful group. After ESWL repeat treatment, at 3 months of follow-up, residual calculus was >3 mm or other types of treatment were performed, such as ureteroscopic lithotripsy, percutaneous nephrolithotomy, retroperitoneal calculi or open surgery, etc. This is the ESWL treatment failure group. The patient's basic information, the influence factor of the calculus effect, and the complications were collected and recorded:

• General conditions of the patient: age, sex, body mass index.

• Medical history: hypertension, diabetes, calculus onset or confirmation time.

• Clinical manifestations: pain, hematuria, degree of hydronephrosis, etc.

• The case of calculus: the location of the calculus, the location of the calculus, the long diameter and the wide diameter.

• Recent complications after treatment: hematuria, pain, fever, formation of steinstrasse.

The standard of success of crushed calculus and the collection of prognosis

One week after the operation, the patients were followed up for 3 months, and the recent complications were collected. According to the specific situation, it was decided whether ESWL should be re-treated or other treatment should be changed. Three months after ESWL is an evaluation period. Patients were divided into two groups according to the effect of ESWL treatment: Successful group: calculus discharge (it means that the calculus is completely discharged or the residual calculus diameter is <3mm). Failure group: calculus was not expelled, residual calculus diameter was ≥ 3 mm or the patient accepted other treatment. All patients were followed up for one week after surgery and the follow-up period was 3 months. The details of the patient are included in Table 1.

Item	Value	Failure group		Successful group	
Gender	Male	79	19.22%	332	80.78%
	Female	29	14.11%	178	85.99%
Course of disease	<3 days	9	4.52%	190	95.48%
	3-7 days	15	8.77%	156	91.23%
	7-14 days	25	24%	79	75.96%
	>30 days	58	40.85%	84	59.15%
Location of calculus	Upper ureter	15	8.33%	165	91.67%
	Midsection of ureter	22	16.30%	113	83.70%
	Lower ureter	34	20.00%	136	80.00%
Hematuria	No	98	18.96%	419	81.04%
	Yes	17	17.00%	83	83.00%
Pain	No	18	18.00%	82	82.00%
	Yes	97	18.76%	420	81.24%
Degree of hydronephrosis	Mild hydronephrosis	17	9.94%	154	90.06%
	Moderate hydronephrosis	43	21.83%	154	78.17%
	Severe hydronephrosis	9	21.95%	32	78.05%
	No hydronephrosis	3	7.89%	35	92.11%
BMI	>30	1	33.33%	2	66.67%
	≤30	106	17.26%	508	82.73%

Table. 1: General condition of the patient (double positioning model) (counting data).

Statistical method

SPSS20.0 software is applied. The X2 test was used to perform a univariate analysis of patient information such as gender, duration of disease, hematuria, calculus position, and hydronephrosis to identify factors affecting calculus clearance. These factors were used to perform multivariate logistic regression analysis and the results were obtained.

Results

A total of 800 patients were treated. The follow-up time was 3 months, and calculus was completely discharged in 689 cases, with a total success rate of 86.125%. Extracorporeal shock wave lithotripsy failures include the following: calculus is hard, which is not crushed and excreted. After the calculus was crushed, there were more remnants, with a total of 111 cases. The failure rate of stones was 12.875%. Of the 111 failed cases, 93 patients had calculus that was hard and could not be shattered. The ratio is 83.78%. The calculus fragmentation was larger, resulting in 16.22% of calculus not excreted. Patients with failed ESWL treatment underwent ureteroscopic lithotripsy or open surgery. Statistical analysis of the relevant variables of the data included: patient gender, type of extracorporeal shock wave lithotripter, duration of calculus formation, location of calculus, degree of hematuria, degree of pain relief, degree of water accumulation due to calculus, number of lithotripsy, body mass index

Univariate analysis of gender, calculus side, calculus position, urinary tract irritation, hematuria or renal colic was performed by X2 test. Gender ($P = 0.382$) and location of calculus ($P < 0.05$) were analyzed. As shown in Table 2, hematuria was excluded according to the predictive variable screening criteria ($P=0.091$). In summary, the urinary calculus was the most effective in removing the lithotripsy, and the calculus removal efficiency was reduced after repeated lithotripsy ($P<0.05$). The body mass index of patients accepting electromagnetic extracorporeal shock wave lithotripsy was summarized and analyzed. It was found that patients with lower body mass index had the highest clearance efficiency of urinary calculus. As the patient's body mass index increased, the clearance efficiency of calculus decreased ($P<0.05$). The detailed results are shown in Table 2.

Item	Value	Failure group		Successful group		P value
Gender	Male	79	19.22%	332	80.78%	0.382
	Female	29	14.11%	178	85.99%	
Course of disease	<3 days	9	4.52%	190	95.48%	0.013
	3-7 days	15	8.77%	156	91.23%	
	7-14 days	25	24%	79	75.96%	
	>30 days	58	40.85%	84	59.15%	
Location of calculus	Upper ureter	15	8.33%	165	91.67%	0.029
	Midsection of ureter	22	16.30%	113	83.70%	
	Lower ureter	34	20.00%	136	80.00%	
Hematuria	No	98	18.96%	419	81.04%	0.091
	Yes	17	17.00%	83	83.00%	
Pain	No	18	18.00%	82	82.00%	0.078
	Yes	97	18.76%	420	81.24%	
Degree of hydronephrosis	Mild hydronephrosis	17	9.94%	154	90.06%	0.065
	Moderate hydronephrosis	43	21.83%	154	78.17%	
	Severe hydronephrosis	9	21.95%	32	78.05%	
	No hydronephrosis	3	7.89%	35	92.11%	
BMI	>30	1	33.33%	2	66.67%	0.027
	≤30	106	17.26%	508	82.73%	

Table. 2: P-value of the patient's general condition (double positioning model).

	Minimum value	Maximum value	Mean	Standard deviation	P value
Age	12	84	39.9	12.416	0.382
BMI	13.78	37.46	23.37	3.390	0.027
Course of disease	1	360	16.03	29.489	0.013
Size of calculus	0.08	3.75	0.687	0.416	0.000

Table. 3: Candidate variable value table affecting calculus treatment effect.

	B	AOR	Maximum value	Minimum value	P value
Pain (X^1)	0.411	1.508	0.999	2,277	0.051
Location of calculus Upper (X^2) Middle (X^3)	-0.429 -0.984	0.651 0.374	0.391 0.191	1.086 0.731	0.027 0.100 0.004
Size of calculus (X^4)	-1.404	0.246	0.152	0.396	0.013
Constant term	2.857	17.416			0.000

Table. 4: Predictive model for the treatment of ureteral calculus after stepwise regression.

The equation for the prediction model is:

$$LogitP = 2.857 + 0.411*X_1 - 0.429*X_2 - 0.987*X_3 - 1.404*X$$

The equation for the prediction model is:

$$P = \frac{1}{1+\ell^{-(2.857 + 0.411*X_1 - 0.429*X_2 - 0.987*X_3 - 1.404*X)}}$$

In the formula, P is the predicted probability of the model, with a range between 0-1. ℓ is the natural logarithm ℓ 2.718). X_1, X_2, X_3 and X_4 represent the pain, the upper ureter, the middle ureter, and the size of calculus, respectively. To treat the independent factors affecting the efficacy of ureteral calculus, the AOR values were 1.508, 0.651, 0.374, and 0.246, respectively.

The logistic regression prediction model had an X^2 value of 54.460, P<0.001. There is no hypothesis. The regression equation is obvious, and the predictors included in the model are more convincing to the outcome of the treatment. The fit of the predictive model was tested by Hosmer-Lemeshow (X^2=8.406, df=8, p=0.395). It shows that the degree of fit of the model is good.

Discussion

The position of the upper ureteral stones is stable. In the imaging process of B-ultrasound and intravenous urography and X-ray examination, the positioning artifacts are small. The efficiency of the crushed stone was improved. The middle and lower calculi of the ureter are affected by the gas around the intestine, the positioning is not accurate, and the efficiency of crushing stone is reduced(12). Therefore, the success rate of the upper ureteral calculi is higher than that of the middle and lower calculi. Based on the data of the degree of hydronephrosis, the calculus rate of patients with urinary calculi accompanied by severe hydronephrosis was 78.05%. The stone-free rate with moderate hydronephrosis was 78.17%. The stone-free rate of water was 90.06%, and the stone-free rate without hydronephrosis was 92.11%. When the urinary calculi are struck by an extracorporeal shock wave, the efficiency gradually decreases as the degree of water accumulation in the kidney increases. The heavier the water, the worse the crushing efficiency. This may be related to the ability of the kidney to secrete urine. When patients with urolithiasis are accompanied by severe hydronephrosis, the function of the kidneys excreting urine becomes worse. Consequently, when patients receive extracorporeal shock wave lithotripsy, energy is depleted, renal function is damaged again, and urinary secretion is further deteriorated. It is difficult to excrete powdered or fragmented stones by means of the formed urine. The success rate of the surgery is reduced and the treatment effect is deteriorated. The influencing factor of BMI is derived from the theoretical knowledge of physics, because the energy of the shock wave is affected by the propagation of energy through different media(13). Although the degree of reduction of ultrasound in water is minimal, the degree of energy reduction during propagation in adipose tissue is enormous. Therefore, the therapeutic effect of ESWL in obese patients is much worse than that in normal body type patients, which can be a factor affecting the therapeutic effect.

However, compared to other studies, in the stone position, other studies have shown that the lower the position of the ureteral calculus, the closer to the opening of the ureter. The stone path is short, the urinary tract is larger than the urethra, and the success rate of the gravel is higher(14). Compared with the study data of this group, the stone-free rate of ureteral stones was 86.125% (689/800) after 3 months after operation of extracorporeal shock wave lithotripsy. The upper ureter was 91.67% (165/180), the middle ureter was 83.7% (113/135), and the lower ureter was 80% (136/170). The results showed that the upper ureteral stone cure rate should be the highest. In the degree of hydronephrosis, some studies have suggested that patients with urinary calculi with moderate to severe hydronephrosis can undergo ureteral intubation and contact with obstruction before extracorporeal shock wave lithotripsy. The pressure of kidney function is relieved and the ability of the kidney to secrete urine is restored. This helps to remove stones and improve the efficiency of gravel(15). On the BMI, the results of this group and other studies are not very different. In patients with obesity, after eating a large amount of food, the food in the intestine is accumulated or the gas is rich, which interferes with the propagation of ultrasonic waves, which makes positioning difficult or the ultrasonic energy is weakened. The efficiency is reduced(16). With the increase of BMI, the efficiency of extracorporeal shock wave lithotripsy is gradually reduced. In summary, the controversy over the factors affecting the location of the stone is obvious. In the degree of hydronephrosis and BMI, this group of studies coincides with the results of other studies.

In recent years, extracorporeal shock wave lithotripsy and its indications have undergone major changes. As a separate non-invasive treatment of kidney stones, many studies have focused on improving stone-free rates and safety. Summary and analysis of various factors affecting the efficiency of extracorporeal shock wave lithotripsy can help improve the efficiency of lithotripsy and increase the rate of stone removal(17). The extracorporeal shock wave lithotripsy technology is one of the three new medical technologies in the world. Because of its high safety, simplicity, easy operation, small trauma, general anesthesia, and repeated treatments, it has become the first choice for the treatment of urinary calculi. However, the therapeutic effect of extracorporeal shock wave lithotripsy is limited by factors such as obesity, water retention or distal obstruction of stones(18). Therefore, there are still some patients who are not the cause of this disease can not completely solve the stone problem when performing extracorporeal shock wave lithotripsy of urinary calculi. The cure rate is still not improving.

However, technology is not stopping development, and the application field of extracorporeal shock wave lithotripsy is still expanding. Any of the following conditions is considered an absolute contraindication to extracorporeal shock wave lithotripsy. The distal end of the stone is accompanied by obstruction caused by inflammatory polyps. Blood diseases cause hemorrhagic diseases, brain diseases such as cerebral infarction and cerebral hemorrhage. Women have urinary calculi while pregnant. The weight is too fat. Congenital skeletal malformations in patients lead to limb malformation. The patient is accompanied by a severe heart disease to place a pacemaker. With the continuous improvement and improvement of extracorporeal shock wave lithotripsy technology, there are also many problems. In some subordinate hospitals where medical conditions are not sound enough and medical treatment principles are not clear enough, there are many problems in understanding the extracorporeal shock wave lithotripsy technology(19). Based on the above reasons, there are many complications in the application of extracorporeal shock wave lithotripsy. Moreover, many literatures have reports on the success rate and complications of extracorporeal shock wave lithotripsy. According to reports in the literature, if patients with urinary calculi who have not been strictly screened are blindly treated with extracorporeal shock wave lithotripsy, the success rate is often less than 50%. Extracorporeal shock wave lithotripsy does not completely treat all urinary stones(20). The success of extracorporeal shock wave lithotripsy treatment is affected by many factors. After analyzing the clinical data of patients with extracorporeal shock wave lithotripsy, the related proximal obstructive factors affecting the success rate of extracorporeal shock wave treatment were determined. The choice of indications for extracorporeal shock wave lithotripsy technology is improved. At the same time, the treatment method is optimized to further improve the surgical efficiency of extracorporeal shock wave lithotripsy.

Conclusion

The influencing factors and prognosis of extracorporeal shock wave lithotripsy were studied. After analyzing the follow-up data of patients who have undergone surgery, the following conclusions are drawn: BMI, the location of the stone, the course of the disease, and hydronephrosis are important factors. For the choice of calculus surgery, the doctor should prepare ESWL technology according to the stone and the patient's specific conditions and predict the treatment effect in advance. The probability of successful postoperative treatment is predicted based on the patient's preoperative data. This can help the clinician choose the best treatment plan and fully satisfy the patient's right to know.

References

1) S Yamashita. Y Kohjimoto,Variation coefficient of stone density: a novel predictor of the outcome of extracorporeal shockwave lithotripsy[J]. Journal of Endourology, 2017, 31(4).
2) Jackman SV, Docimo SU,Cadcddu JA, ctal. The minipcrctcchniquc: aless incasive alternative to percutancous Ncnhrolithotomy[J]. Word jurol,2015,16(6):371-374.
3) Nussberger F. Roth B. Metzger T, et al. A low or high BMI is a risk factor for renal hematoma after extracorporeal shock wave lithotripsy for kidney stones[J]. Urolithiasis, 2017,45(3):1-5.
4) Wagenius M, Jakobsson J, Stranne J,et al. Complications in extracorporeal shockwave lithotripsy: a cohort study.[J]. Scandinavian Journal of Urology, 2017:1-7.
5) Cui H W,Devlies W,Ravenscroft S,et al. CT Texture Analysis of Ex Vivo Renal Stones Predicts Ease of Fragmentation with Shockwave Lithotripsy.[J].Journal of Endourology, 2017,31(7).
6) Hu LH, Ye B, Yang YG,et al. Extracorporeal Shock Wave Lithotripsy for Chinese Patients With Pancreatic Stones: A Prospective Study of 214 Cases.[J]. Pancreas, 2016, 45(2):298.
7) Torricelli FC, Danilovic A, Vicentini FC, MarchiniGS SrougiM MazzucchiE [J]. Circulation, 2015, 61(7): 65-71.
8) Zhang W, Zhou T,Wu T, et al. Retrograde Intrarenal Surgery Versus Percutaneous Nephrolithotomy Versus Extracorporeal Shockwave Lithotripsy for Treatment of Lower Pole Renal Stones: A Meta-Analysis and Systematic Review[J]. Journal of Endourology, 2014, 29(7): 745.
9) Cartledge J, Cross W, Lloyd S, et al. The efficacy of a range of contact media as coupling agents in extracorporeal shockwave lithotripsy.[J]. Bju International, 2015, 88(4): 321-324.
10) Yamashita S, Kohjimoto Y, Iguchi T, et al. Variation coefficient of stone density: a novel predictor of the outcome of extracorporeal shockwave lithotripsy[J]. Journal of Endourology, 2017, 31(4): 89-99.
11) Lenze F, Heinzow H S, Herrmann E, etal. Clearance of refractory bile duct stones with Extracorporeal Shockwave Lithotripsy: higher failure rate in obese patients[J]. Scandinavian Journal of Gastroenterology, 2014, 49(2): 209.
12) Guibin XU. XunL. Yongzhong H E, et al. Staged singletract minimally invasive percutancous nephrolithotomy and flexible ureteroscopy in the treatment of staghorn stone in patients with solitary kidney[J]. Urological Rescarch, 2014 40(6): 745-749.
13) Kramheck AE, Rule AD, Li X,et al.Shock wave lithotripsy is not predictive of hypertension among community stone formers at long-term followup[J]. J Urol, 2014, 7(185): 164-168.
14) Clark DL, Connors BA, Evan AP, et al. Effcct of shock wave number on renal oxidative stress and inflammation[J]. BJU int.2011, 9(107): 318-322.
15) Mira M A, Montoya Lirola M D, García Tabar P J, et al. Incidence of infectious complications after extracorporeal shock wave lithotripsy in patients without associated risk factors[J]. Journal of Urology, 2014, 192(5): 1446-1449.
16) Dcllabclla M, Milanese G, Muzzonnigro G. Efficacy of tamsulosin in the medical management of juxtrave sical ureteral stone[J]. JUro1, 2013 170(6): 2202-2205.
17) Cartledge J, Cross W, Lloyd S, et al. The efficacy of a range of contact media as coupling agents in extracorporeal shockwave lithotripsy.[J]. Bju International, 2015, 88(4): 321-324.
18) Lu P, Wang Z, Song R, et al. The clinical efficacy of extracorporeal shock wave lithotripsy in pediatric urolithiasis: a systematic review and meta-analysis[J]. Urolithiasis, 2015, 43(3): 199-206.
19) Hu LH, Ye B,Yang YG, et al. Extracorporeal Shock Wave Lithotripsy for Chinese Patients With Pancreatic Stones: A Prospective Study of 214 Cases.[J]. Pancreas, 2016, 45(2): 298.
20) Knudsen B E. Comparison Between Extracorporeal Shock Wave Lithotripsy and Ureteroscopic Lithotripsy for Treating Large Proximal Ureteral Stones: A Meta-analysis EDITORIAL COMMENT[J]. Urology, 2015, 85(4): 756-756.

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