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STENTING OR NOT PRIOR TO SHOCK WAVE LITHOTRIPSY FOR UPPER AND MIDDLE POLE RENAL STONE OF 10-20MM

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Abstract

Objective: To evaluate the impact of routine ureteral stenting before SWL treatment for upper and middle pole stone of 10-20mm in size, on the prevention of post-SWL complications and to confirm whether this procedure affects the improvement of the success rate.

Methods: Our study was retrospective study, carried out in GH "8th of September" - Skopje in the period from March 2022 to November 2022 with an analysis of the medical data of 41 patients treated with extracorporeal shock wave lithotripsy (SWL) for stones in the upper and the middle pol of 10 to 20mm in size. The first group included 13 patients treated with SWL, with a ureteral JJ stent placed before treatment, and the second group included 28 patients without a ureteral JJ stent. Patients were treated with an extracorporeal lithotripter of the third generation of electromagnetic lithotripters (Lithoskop®, Siemens Medical Systems, Erlangen, Germany). Both groups were compared in stone size, stone clearance pain, steinstrasse, UTI, lower urinary tract symptoms (LUTS), hematuria and number of SWL sessions.

Results: The mean size of the stone in the group of patients with ureteral JJ stent was statistically significantly greater compared to the non-stented group (p=0.000012). The average number of sessions and re-treatment rate was significantly higher in patients with a ureteral JJ stent (p=0.006). There was a statistically significant difference in the energy used for stone disintegration in both groups (p=0.0028). Stone clearance occurred in 76.92% patients in stented group and 85.71% in non-stented group. In stented group lower urinary tract symptoms were found in 33.7 versus 0% in a non-stented group. "Steinstrasse" developed in 7.69% of the patients with JJ stent and in 7.14% patients without JJ stent. Regarding pain, lower urinary tract infections and hematuria, there was no statistically significant correlation between the two groups (p=0.84 p=0.14 p=0.17).

Conclusion: Routine stenting for upper and middle pole stone of 10-20mm in size before SWL should not be recommended because it does not prevent the formation of a "stainstrasse", does not improve the success rate and causes irritative symptoms of the lower urinary tract.
Key Words: pre-stenting, stainstrasse, SWL, ureteral JJ stent.

Introduction

The development of minimally invasive surgical techniques in the last three decades has significantly changed the approach of modern medicine in the treatment of kidney stones. These changes redefined modern kidney stone treatment techniques, including SWL, RIRS and PCNL, which became much less invasive and easily performed methods with few complications and almost completely have replaced the open surgical approach. In the European Urological Association (EAU) guideline, percutaneous nephrolithotomy (PCNL) is recommended as the method of choice for the treatment of the kidney stones larger than 20 mm, while extracorporeal shock wave lithotripsy (SWL) is recommended for kidney stones smaller than 10mm, while SWL, RIRS and PCNL are recommended as the methods of choice in the treatment of kidney stones between 10 and 20mm (1). The main argument in favor of endourological techniques was the fact that the stone can be removed in one session with little consequences, in contrast

to SWL, which has a retreatment rate of 20 to 30%, and problems related to the elimination of stones (2). But, still SWL is widely used in the treatment of stones smaller than 20mm, primarily due to its higher efficiency in selected cases and the low morbidity rate, which are some of the most important advantages of this method, which today makes it the first choice for treatment in many cases, despite other available treatment alternatives (3). However, there are factors that limit the use of SWL and influence its success such as: the type of lithotripter, stone-related factors such as size, structure, number and location, renal anatomy and patient-specific structural features (4,5).

With SWL, the stone is not removed completely, but it is broken into smaller fragments of different sizes, which must be spontaneously eliminated from the urinary tract. The duration of fragment elimination is highly variable, and fragments can obstruct the ureter, leading to post-SWL complications such as renal colic, hydronephrosis and renal failure (6). This especially applies to the SWL treatment of larger stones, when large number of fragments are created, which can be impacted in the ureter and form a stone road or "steinstrasse". To prevent the formation of "steinstrasse" and other post-SWL complications, some studies highlight the benefit of stenting the ureter with a ureteral JJ stent before the intervention (7). On the other hand, there are studies that indicate that the use of ureteral JJ stents can reduce post-SWL complications such as obstruction and renal colic but does not prevent the formation of "steinstrasse", does not reduce the rate of infectious complications and does not increase success rates (8, 9). The use of ureteral JJ stent is associated to stent-related symptoms (SRSs) such as patient discomfort, bladder pain and lower urinary tract symptoms (LUTS) such as: frequency, urgency, dysuria, hematuria, and lumbar pain that reduce the patient's quality of life. Therefore, the routine use of a ureteral JJ stent before SWL is a controversial issue, especially in the treatment of stones up to 20mm in size.

The aim of this study was to evaluate the impact of routine ureteral stenting with a JJ stent before SWL treatment for upper and middle stone of 10-20mm in size, on the prevention of post-SWL complications and to confirm whether this procedure affects the improvement of the success rate.

Materials and Methods

This study is a retrospective study, carried out in GH "8th of September" - Skopje in the period from March 2022 to November 2022 with an analysis of the medical data of 41 patients treated with extracorporeal shock wave lithotripsy (SWL) for stones in the upper and the middle pole of 10 to 20mm in size. The first group included 13 patients treated with SWL, with a ureteral JJ stent placed before treatment, and the second group included 28 patients treated with SWL, without a ureteral JJ stent. The study included: patients aged 18 to 70 years with an isolated solitary stones with a size of 10 to 20mm in the middle or upper pole, body mass index (BMI) <30kg/m^2, without anatomical abnormalities, with normal renal function. Patients with staghorn stones, multiple stones, stones smaller than 10mm and stones larger than 20mm, untreated urinary tract infection, congenital anomalies of the kidneys, solitary kidney, presence of uncorrected coagulopathies, patients with radiolucent stones and pregnant women were excluded. For each of the subjects included in the study, laboratory tests, urine culture, coagulation tests, EKG, ultrasonographic examination of the urinary tract and computerized tomographic urography (KT-urography) were carried out preoperatively. The stones' width and length were calculated based on the widest perpendicular diameters of the native CT-urography series. The surface of the stone was determined according to the formula of Tiselius and Anderson: The surface of the stone = length x width x 3.14 x 0.25.

All patients were treated with an extracorporeal lithotripter of the third generation of electromagnetic lithotripters (Lithoskop®, Siemens Medical Systems, Erlangen, Germany). Preoperatively, patients from both groups were given a single dose of antibiotic prophylaxis with a third-generation cephalosporin. Immediately before the intervention, each patient was given intravenous sedoanalgesia with amp. fentanyl i.v. (1mg/kg) and amp. midazolam i.v. (0.05-0.1mg/kg).

Postoperatively, the patients were monitored according to the following protocol: on the first postoperative day, complete blood analysis, ultrasonography of the urinary tract and KUB imaging were performed, after 3 months, ultrasonography of the urinary tract and non-contrast CT imaging were performed.

The efficiency of the method in both groups was assessed by determining the absence of residual fragments of the concretion or the presence of clinically insignificant fragments <4mm on control radiological examinations after the 90th postoperative day. The safety of the method in both groups was determined in terms of the frequency and severity of intra- and postoperative complications.

Results

In our analysis, no statistically significant difference was detected in terms of age, gender and stone location in both groups. Out of total 41 patients, 65.8% (27/41) were men and 34.1% (14/41) were women. In 31.7% (13/41) of patients, a ureteral JJ stent was placed before SWL while in 68.2% (28/41) a ureteral JJ stent was not placed. The mean age of patients treated with a ureteral JJ stent was 53.5 ± 7.0 years, and of patients treated without a ureteral JJ stent was 50.9 ± 10.4 years (p=0.41). Patients from both groups were homogeneous in terms of gender structure (p=0.69). In both groups, the majority were male versus female, namely 8/13 (61.54%) versus 5/13 (38.46%) in the stented group and 19/28 (67.86%) versus 9/28 (32.14%) in the non-stented group. The male-to-female ratio in the stented and non-stented groups was 1.6:1 and 2.1:1, respectively. Stones in both groups were equally present in the left and the right kidney (p=0.84). There was no significant difference in the topographical distribution of the stones (p=0.68). In the group of patients with a ureteral JJ stent, 7/13 (53.85%) of the stones were located in the upper calyces and 6/13 (46.15%) in the middle calyces, while in the group of patients without a ureteral JJ stent 17/28 (60.71%) of the stones were located in the upper calyces and 11/28 (39.29%) in the middle calyces. The comparison of the two groups regarding the dimensions of the stones showed that stones with a significantly different surface area were treated in both groups (p=0.000012). The mean size of the stone in the group of patients with ureteral JJ stent was statistically significantly greater compared to the non-stented group and was 245.40 ± 22.99mm3 versus 156.18 ±47.0mm3 respectively (Table 1).

Table 1. Demographic characteristics of patient and stone

Patient and stone characteristic	Stent	No stent	p-value
No if patient	13	28	
Age **mean ± SD** **min – max**	53.5 ± 7.0 45 – 65	50.9 ± 10.4 28 – 70	t=0.8 p=0.41
Sex **Female** **Male**	5/13 (38.46%) 8/13 (61.54%)	9/28 (32.14%) 19/28 (67.86%)	X^2=0.16 p=0.69
Stone **left** **right**	7/13 (53.85%) 6/13 (46.15%)	16/28 (57.14%) 12/28 (42.86%)	X^2=0.04 p=0.84
Stone **upper pole** **middle pole**	7/13 (53.85%) 6/13 (46.15%)	17/28 (60.71%) 11/28 (39.29%)	X^2=0.17 p=0.68
stone volume(mm3) **mean ± SD** **median (IQR)**	245.40 ± 22.99 240.2(226.08–253.55)	156.18 ±47.0 142.08(122.46-200.96)	Z=4.38 ***p=0.000012

t (Student t-test),X^2(Pearson Chi-square test),Z (Mann-Whitney test)
**p<0.01, ***p<0.0001

No statistically significant difference was detected regarding the number of applied shock waves required for stone disintegration in both groups (p=0.082). On the other hand, there was a statistically significant difference in the energy used for stone disintegration in both groups (p=0.0028). In the group of patients with a ureteral JJ stent, the average energy used for stone disintegration was 241190.8 ± 123468 J versus 144119.9 ± 74288.5 J in the group of patients without a ureteral JJ stent. It was shown that the average number of sessions was significantly higher in patients with a ureteral JJ stent (p=0.006). A statistically higher number of patients in the stented group had re-treatment after the failed first treatment (p=0.0069). In fact, 9/13 of the stented patients (69.2%) and 7/28 of non-stented patients (25.0%) underwent an additional second or third treatment for stone disintegration. The success rate of SWL after 3 months, in the group of patients without a ureteral JJ stent was 85.71% (24/28) and was higher in relation to the success rate in patients with a ureteral JJ stent which was 76.92% (10/13). Despite the significant percentage difference between the two groups, no statistically significant difference was detected (p=0.66). In the stented group, the average time of the procedure was 49.15 ± 1.7 minutes, while in the non-stented group it was 46.14 ± 3.5 minutes. The difference of 3.01 minutes was statistically significant (p<0.0026) (Table 2).

Table 2. Treatment parameters and success rate

Treatment Parameters	Stent	No stent	p-value
No of SW **mean ± SD** **median (IQR)**	1302.85 ± 1871.5 105(103-4000)	2926.57 ± 1673.4 4000(1578.5-4000)	Z=1.7 p=0.082
Energy (J) **mean ± SD** **median (IQR)**	241190.8 ± 123468 326726(115932-342470)	144119.9 ± 74288.5 114669.5(106029-171445.5)	Z=2.98 **p=0.0028

No of session **1-session** **2-session** **3-session**	4/13 (30.77%) 3/13 (23.08%) 6/13 (46.15%)	21/28 (75%) 5/28 (17.86%) 2/28 (7.14%)	Fisher's exact **p=0.006
Re-Treatment **yes** **no**	9/13 (69.23%) 4/13 (30.77%)	7/28 (25%) 21/28 (75%)	X^2=7.3 **p=0.0069
Treatment duration(min) **mean ± SD** **median (IQR)**	49.15 ± 1.7 50 (48 – 50)	46.14 ± 3.5 46 (44.5 – 49)	Z=3.01 **=0.0026
Success rate **Unsuccessful**	10/13 (76.92%) 3/13 (23.08%)	24/28 (85.71%) 4/28 (14.29%)	Fisher's exact p=0.66

t(Student t-test),X^2(Pearson Chi-square test),Z (Mann-Whitney test)
**p<0.01, ***p<0.0001

Various morbidities such as "stainstrasse", pain, lower urinary tract infection, hematuria and lower urinary tract symptoms (LUTS), were studied among stented and non-stented patients. Regarding pain, lower urinary tract infections and hematuria, there was no statistically significant correlation between the two groups (p=0.84 p=0.14 p=0.17). Regarding the post-SWL complications, a statistically significant difference was observed regarding the total number of complications, which in the group of patients with a ureteral JJ stent was 76.92% versus 28.57% in the non-stented group (p=0.0069). A statistically significant correlation between both groups was observed in the presence of a ureteral stent and the presence of lower urinary tract symptoms (LUTS) such as frequency, urgency and dysuria (P=0.002), which were more significant in the stented group as seen in Table 3. A total of 7.69% patients in the stented group and 7.14% patients in the non-stented group had "stainstrasse". There was no statistically significant difference in the formation of "stainstrasse" in both groups (p=0.95).

Table 3. Complication

Complication	Stent	No Stent	P value
Overall	10/13 (76.92%)	8/28 (28.57%)	X^2=7.3 **p=0.0069
LUTS	4/13 (30.77%)	0	**p=0.002
Hematuria	2/13 (15.38%)	1/28 (3.57%)	p=0.17
Pain	2/13 (15.38%)	5/28 (17.86%)	p=0.84
UT infection	1/13 (7.69%)	0	p=0.14
Stainstrasse	1/13 (7.69%)	2/28 (7.14%)	p=0.95

t (Student t-test),X^2(Pearson Chi-square test),Z (Mann-Whitney test)
* *p<0.01, ***p<0.0001

Discussion

Ureteral stents are commonly used to allow drainage of the kidney in the presence of obstruction between the kidney and the bladder, usually caused by a stone or stone fragments produced during the treatment of kidney stones with SWL. This condition is significantly related to the size of the stone. In our study, there was a significant difference in stone surface area between the two groups. In the group of patients with a ureteral JJ stent, the surface of the stone was significantly larger compared to the group of patients without a ureteral JJ stent (p=0.000012). This result corresponds to the research done by Hollowell at all in which it was determined that the most urologists use a ureteral JJ stent in the case of stones larger than $2cm^2$ (10). We believe that urologists desire to prevent obstruction and consequent hydronephrosis and pain during SWL treatment of larger stones that play a role in the preference for using a ureteral JJ stent as in our study. A survey of American urologists on the use of ureteral stents before SWL showed a rate of 28% for 10mm stones, 57% for 15mm stones, and 87% for 20mm stones (11). The use of a ureteral JJ stent before SWL treatment is a rather undefined process, and numerous studies have shown that it is unbeneficial. In the study by Musa at all. it was shown that the use of a ureteral JJ stent before SWL, does not improve the outcome of the treatment (12). The authors reported a three-months success rate of 88% in the group of patients with a ureteral JJ stent and 91% in the group without a ureteral JJ stent. Similar results were shown in the study by Argyropoulos at all., where the success rate in patients with a ureteral JJ stent was 78% compared to those without a ureteral JJ stent, where it was 93% (13). And in the study by Mohayuddin at all. the success rate in patients with a ureteral JJ stent and those without it was 77.5% versus 82.5% respectively(14). It was observed that placement of a ureteral JJ stent before SWL for renal stones of 2cm ± 2mm reduces the risk of renal colic and obstruction but does not reduce the formation of a "stainstrasse" or infectious complications. Our study is consistent with the findings of those studies. In our study, a worse outcome of SWL was also observed in patients with ureteral JJ stent. The overall success rate of the SWL method was higher in patients without a ureteral JJ stent compared to the patients in whom a ureteral JJ stent was placed preoperatively, and was 85.71% vs. 76.92%, respectively, but without confirmed statistical significance (p= 0.66). The lower success rate of SWL in patients with a ureteral JJ stent may be due to the effect of the JJ stent on ureteral peristalsis, leading to reduced elimination of fragments.

Stainstrasse is a radiological finding that occurs after SWL. Although there are suggestions that ureteral JJ stents have a contribution to the elimination of fragments after SWL and the prevention of "stainstrasse", as in the study of Shen et al., Bierkens et all. found no difference in the rate of occurrence of "stainstrasse" with or without a ureteral JJ stent (15,16). And in the study by Kato et al. no difference was found between patients with and without a ureteral JJ stent in terms of "stainstrasse" formation (17). The results in our study were correlated to these results. In our study, no statistically significant difference was observed between patients with and without ureteral JJ stent regarding the formation of "steinstrasse" (p=0.95). We believe that the edema created by the ureteral JJ stent on the mucosa of the ureter and the reduced lumen of the ureter are the most likely reasons for the appearance of "stainstrasse" despite the presence of the ureteral JJ stent.

Ureteral JJ stent use is also associated to lower urinary tract symptoms (LUTS) such as frequent and urgent urination with dysuria. In the study by Musa A. at all. as many as 85% of stented patients had LUTS (11). Joshi et all. reported that 60% of the patients with a JJ stent had symptoms of overactive bladder, such as increased frequency of urination and urge incontinence (18). A study by Ozkan B at all. showed a LUTS rate of 38% (19). The results in our study are consistent with the results of Ozkan B at all. (19). In our series, about 30.77% of the patients had frequent and urgent urination with dysuria. In our study, a statistically significant difference was observed between patients with and without placed ureteral JJ stent in terms of LUTS (p=0.002). These symptoms were generally controlled by symptomatic therapy, and there was no need to remove the ureteral stent because of these symptoms in any of the patients.

In our study, we did not find a statistically significant difference in the occurrence of pain, lower urinary tract infections and hematuria between the two groups (p=0.84 p=0.14 p=0.17). These results are consistent with the most of results published in the literature such as those in the study by Shen at all. (15). In the study of Mobasher Saeed at al. (20), also, there was no statistically significant difference in terms of the same parameters between the two groups (p=0.06, p=0.8, p=1) (20).

In this research, we did not find a significant difference regarding the number of Shock wave use for stone disintegration in both groups (p=0.082). This result is consistent with the most of results published in the literature including those published in the study by Musa at all. who showed an identical number of SW strokes in the group of patients with and without a ureteral JJ stent (11). On the other hand, in our study there was a significant difference regarding the energy used for stone disintegration in the group of patients with a ureteral JJ stent versus the group of patients without a ureteral JJ stent (p=0.0028). This finding was correlated with the study of Preminger at all which showed the use of significantly higher energy and a higher incidence of re-treatment in the group of patients with a ureteral JJ stent compared to those without a ureteral JJ stent (p<0.005) (21). Also, in the study of Wagar et all. significantly higher energy was used for the disintegration of stones in the patients with a ureteral JJ stent compared to those without a ureteral JJ stent (p<0.005) (22). Contrary to this, in the study of Ozkan et all. there was no significant difference in the energy used in patients with and without a JJ stent placed (p=0.627) (19). The reason for this difference is the different types of lithotripters during the intervention, as well as the difference in the experience of the physician. In our study, the mean number of sessions, as well as the retreatment rate were significantly higher in the group of patients with a ureteral JJ stent versus those without a ureteral JJ stent (p=0.006, p=0.006). These results were correlated with the results of Sfoungaristos at all. who reported that patients with a ureteral JJ stent needed more SWL sessions for stone disintegration compared to patients without a ureteral JJ stent (p=0.019) (23). Also, in the study of Ozkan et.all. the average number of sessions was significantly higher in the group of stented patients compared to non-stented patients (p=0.000) (19).

Conclusion

Routine stenting of renal stones of 10-20mm in size before SWL should not be recommended because it does not prevent the formation of a "stainstrasse", does not improve the success rate and causes irritative symptoms of the lower urinary tract. However, it can be used in cases of sepsis and in patients with worsening renal function due to obstruction or with unbearable pain.

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