Available online at www.sciencedirect.com

ScienceDirect

Journal of the Chinese Medical Association 80 (2017) 551−557

www.jcma-online.com

Original Article

Clinical analysis of 48-h emergency department visit post outpatient extracorporeal shock wave lithotripsy for urolithiasis

Chin-Heng Lu [a], Junne-Yih Kuo [a,b,c,*], Tzu-Ping Lin [a,b,c], Yi-Hsiu Huang [a,b,c], Hsiao-Jen Chung [a,b,c], William J.S. Huang [a,b,c], Howard H.H. Wu [a,b,c], Yen-Hwa Chang [a,b,c], Alex T.L. Lin [a,b,c], Kuang-Kuo Chen [a,b,c]

[a] *Department of Urology, Taipei Veterans General Hospital, Taipei, Taiwan, ROC*
[b] *Department of Urology, School of Medicine, National Yang-Ming University, Taipei, Taiwan, ROC*
[c] *Shu-Tien Urological Institute, National Yang-Ming University, Taipei, Taiwan, ROC*

Received March 14, 2016; accepted November 7, 2016

Abstract

Background: Patients suffering from renal or ureteral stones can undergo significant discomfort, even when timely diagnosed and treated. The aim of this study was to assess the risk factors and safety of outpatient Extracorporeal Shock Wave Lithotripsy (ESWL) in the management of patients with renal or ureteral stones.

Methods: In this study, our cohort consisted of 844 outpatients who underwent outpatient ESWL treated between February 2012 and November 2014 at Taipei Veterans General Hospital. Patients who visited the emergency room (ER) within 48 h after Outpatient ESWL were included in this article. This article analyzes the stone size, stone shape (long to short axis ratio), stone location, previous medical management, urinalysis data, complications and treatment received in the emergency department.

Results: Among the 844 initial consecutive patients who underwent outpatient ESWL a total of 1095 times, there were 22 (2%) patients who sought help at our emergency room within 48 h after the outpatient ESWL. Of those 22 patients, the mean age was 54.3 ± 12.6 years, and the BMI was 25.9 ± 3.2. The most common complication complaint was flank pain (55.2%). Other complications included hematuria (13.8%), fever (17.2%), nausea with vomiting (6.9%), acute urinary retention (3.4%) and chest tightness with cold sweating (3.4%). In 22 patients who went back to the ER, 7 patients were admitted to the ward and 1 patient again returned to the ER. All patients received medical treatment without ESWL or surgical management. The meaningful risk factor of ER-visiting rate following outpatient ESWL within 48 h was stone location, and the renal stones showed statistic significant ($p = 0.047$) when compared to ureteral stones.

Conclusion: Our study indicated that renal stone contributed to a significantly higher risk of ER-visiting rate to patients than did ureteral stone, following outpatient ESWL within 48 h. This study confirmed that Outpatient ESWL is a safe treatment for renal or ureteral stones, while inpatient ESWL is not absolutely necessary.

Keywords: Complication; Extracorporeal shock wave lithotripsy; Outpatient

1. Introduction

Extracorporeal shock wave lithotripsy (ESWL) was first introduced into medical standard practice for renal or ureteral stone in the 1980s. Since then, ESWL has become one of the main treatment options for patients with urolithiasis. However, with the progress and increased safety and success

Conflicts of interest: The authors declare that they have no conflicts of interest related to the subject matter or materials discussed in this article.

* Corresponding author. Dr. Junne-Yih Kuo, Department of Urology, Taipei Veterans General Hospital, 201, Section 2, Shi-Pai Road, Taipei 112, Taiwan, ROC.

E-mail address: jykuotpe@gmail.com (J.-Y. Kuo).

http://dx.doi.org/10.1016/j.jcma.2016.11.010

rates of endourology and minimally invasive surgeries, the applicability of ESWL was gradually reduced. Therefore, it has become necessary to search for the relative risks and careful selection of candidates for ESWL in order to optimize the results of this procedure, and prevent complications.[1,2]

Previously, patients used to receive ESWL treatment after admission into our hospital, and they required hospitalization for more than 48 h after treatment. As the skills and experience of surgeons have advanced, we changed the treatment policy from 2-day admission to outpatient ESWL beginning in February 2012. The large majority of current articles have discussed those complications within 1 week or longer after ESWL. Our study focused on the complications and risk factors within 48 h after ESWL. This study design can be attributed to the fact that most patients admitted for ESWL were hospitalized 48 h after the ESWL treatment. We aimed to analyze whether administration was needed for ESWL under the indication of renal−ureteral urolithiasis.

2. Methods

2.1. Data collection

We retrospectively reviewed patients who received outpatient ESWL at Taipei Veterans General Hospital between February 2012 and November 2014. Ultimately, 844 patients were enrolled and were treated with the Dornier compact Delta II lithotripter; the number of shocks administered was 3000−3200 shockwaves per session. We evaluated the images of plain abdominal films of the kidney, ureter, and bladder (KUB), intravenous urogram (IVU), ultrasonography or non-contrast (unenhanced) CT. Since outpatient ESWL was a case-payment procedure, all patients had the lab data, examination data and image reports that we needed. If the patient had taken any anti-coagulation, antiplatelet or thrombolytic agent such as aspirin or Warfarin, the medication was discontinued for 7 days prior to ESWL. We did not prescribe antibiotic before or after the ESWL. Contraindications for ESWL included pregnancy, untreated urinary tract infection or urosepsis, uncontrolled arrhythmia, decompensated coagulopathy, and abdominal aortic aneurysm > 4.0 cm,[3] as referenced by the American Urological Association Stone Guidelines Panel. Of course those customary other suitable treatment methods should routinely be proposed in the event any of these conditions were presented.

Informed consent was obtained from all patients before starting the ESWL treatment. All ESWL treatments were carried out under intravenous general anesthesia (IVGA) of Pethidine (duration 120−150 min), Dormicum (duration 1−6 h) or Propofol (duration 5−10 min) prior to procedure. The treating anesthesiologist decided the appropriate anesthetic regimen according to the condition of each individual patient, and all patients were treated on an outpatient basis. Among these patients, those who visited the ER within 48 h after the Outpatient ESWL were included. The study protocol was approved by the institution review board of TPEVGH (VGHIRB No.: 2016-02-010CCF).

2.2. Study population

A patient group comprising subjects who did not seek help at the ER was selected for comparison with patients who visited the ER within 48 h after the outpatient ESWL. There were 108 patients randomly selected and matched by age, BMI and gender with a confidence level of 95% and a confidence interval of 9.4%.

Parameters of age, sex, body mass index (BMI), stone side, ureteral and renal stone number, stone height, stone width, stone shape (height and width ratio), stone management, serum creatinine (Cr), pre-ESWL hydronephrosis, diabetes mellitus (DM), hypertension (HTN), cardiovascular disease (CAD), Pre-ESWL serum creatinine level (Cr), urine analysis data including urine PH value, urine white blood cell counts (WBC), urine red blood cell counts (RBC), urine pus cell counts, and urine protein before ESWL were investigated. Subsequently, the chief complaint, complications and ER treatments were assessed and recorded.

2.3. Statistical analysis

Statistical analysis was performed using the IBM SPSS ver. 20.0 (IBM Co., Armonk, NY, USA); the Chi-square test, Fisher's exact test and two-sample *T*-test were used. Additionally, univariate analysis was performed. The difference was considered statistically significant when the p value was less than 0.05.

3. Results

There were 844 patients with complete laboratory and image data who were treated with outpatient ESWL at Taipei Veterans General Hospital between February 2012 and November 2014. Of these 844 patients, a total of 1095 outpatient ESWL procedures (times) were performed. We used "times" rather than patient number to describe the ratio of ER visiting rate within 48 h post outpatient ESWL. There were 22 patients who visited the ER within 48 h after the outpatient ESWL, for a rate of 2%. In these patients, 19 patients received ESWL for renal stone and 3 patients for ureteral stone. The mean renal stone size was 12.2 ± 5.9 mm, and the mean ureteral stone size was 6.1 ± 0.2 mm. The demographic data are described in Table 1. In patients who returned to the ER, the mean age was 54.3 ± 12.6 years, BMI was 25.9 ± 3.2, pre-ESWL Cr was 0.89 ± 2.54 mg/ml, post-ESWL Cr was 1.04 ± 0.23 mg/ml, and stone height/width ratio was 1.80 ± 0.57. In total, 451 patients had right side stone, and 14 (14/465 = 3.0%) patients had left side stone. There were 2 patients who returned to the ER with DJ insertion before ESWL. In the control group, 5 patients had DJ insertion before ESWL.

We analyzed parameters between the two groups as Table 1. There was no statistically significant risk factor for age,

Table 1
Demographic data of ER and non-ER groups.

Characteristics			ER	Non-ER (control)	*p*
Total patients number			22	108	–
Sex (male/female)			12/10	74/34	0.224[b]
Age (yr)			54.3 ± 12.6[d]	56.5 ± 12	0.431[a]
BMI[c]			25.9 ± 3.2	27.0 ± 4.3	0.308[a]
Pre-ESWL Cr (mg/ml)			0.89 ± 2.5	0.99 ± 0.3	0.587[a]
Post-ESWL Cr (mg/ml)			1.04 ± 0.23	–	–
Previous stone management			12	54	0.698[b]
Pre-ESWL hydronephrosis			4	37	0.139[b]
Diabetes mellitus			2	16	0.479[b]
Hypertension			5	35	0.370[b]
Coronary artery disease			0	13	0.086[b]
Urine PH value			6.24 ± 0.56	6.18 ± 0.57	0.702[a]
Double J insertion			2	5	0.43[b]
Stone location	Side (right or left)	Right side stones	8	51	0.351[b]
		Left side stones	14	57	
	Renal or ureter	Renal stone	19	70	**0.047**[b,e]
		Ureteral stone	3	38	
Stone size and shape	Size	Stone height (mm)	1.11 ± 0.57	9.97 ± 4.90	<0.0001[a]
		Stone width (mm)	0.63 ± 0.28	6.66 ± 3.12	<0.0001[a]
	Shape	Height/width ratio	1.80 ± 0.57	1.57 ± 0.58	0.079[a]
Stone location and size		Renal stone height (mm)	1.19 ± 0.59	10.6 ± 5.5	<0.0001[a]
		Ureteral stone height (mm)	0.61 ± 0.02	8.8 ± 3.1	<0.0001[a]

[a] Two-sample *T* test.
[b] Fisher's exact test; others (chi square test).
[c] BMI = weight (kg)/height (m^2).
[d] Data were presented as mean ± standard deviation (range).
[e] The definition of statistical significance is a *p*-value less than 0.05.

sex, body mass index (BMI), stone side, stone shape (height and width ratio), stone management, serum Cr, pre-ESWL hydronephrosis, diabetes mellitus (DM), hypertension (HTN), CAD, Pre-ESWL serum creatinine level (Cr), urine PH value or DJ insertion before ESWL.

Parameters of renal or ureteral stone, renal stone height, ureteral stone height, stone height and stone width were statistically significant but not reasonable. The only meaningful statistically significant risk factor was the stone location with the renal stone as compared to the ureteral stone ($p = 0.047$). The parameter of stone height/width ratio ($p = 0.079$) was a tendency risk factor for ER re-visiting. Other statistically significant parameters included renal stone size, ureteral stone sizes, stone height and stone width. However, those statistical results showed that patients who went back to the ER within 48 h had smaller stone size, regardless of the stone's location. This was curious because, in general, the result had no reasonable explanation. Other parameters had no statistic significant difference (Table 1).

In these 22 patients, previous stone management including EWSL, percutaneous nephrolithotomy (PCNL) or ureteroscopic lithotripsy (URSL). The previous stone management also had no statistically significant difference between the two groups.

We also analyzed parameters of urine analysis data, including urine white blood cell counts (WBC), urine red blood cell counts (RBC), urine pus cell counts and urine protein, and found no statistically significant result. Therefore, the analysis details of these parameters were not mentioned.

The most common complication was flank pain (16 patients, 55.2%), which was experienced by 14 patients with renal stones and 2 patients with ureteral stones. Other complications included fever (5 patients, 17.2%), hematuria (4 patients, 13.8%), nausea and vomiting (2 patients, 6.9%), acute urinary retention (1 patient, 3.4%), and chest tightness with cold sweating (1 patient, 3.4%) (Table 2).

The characteristics of these 22 cases are summarized in Table 3. The table showed the association between the post ESWL stone location and the symptoms. All ureteral stones before ESWL were located in the upper third of the ureter. There were 15 patients who had renal stone before outpatient ESWL, as well as stone residual in the renal pelvis after the shock wave treatment. There were 7 renal stone patients who presented with ureteral stone after ESWL, and symptoms of stone street were noted in 4 patients. There were 4 patients who presented with hydronephrosis before ESWL. However,

Table 2
Chief complaints at ER.

Chief complaints	*N* (%)
Flank pain	16 (55.2%)
Fever	5 (17.2%)
Hematuria	4 (13.8%)
Nausea, vomiting	2 (6.9%)
AUR	1 (3.4%)
Chest tightness & cold sweating	1 (3.4%)

The total patient number was more than 22 patients due to 1 patient presented more than 1 symptom.

Table 3
Details of 22 patients with post-ESWL ER visiting within 48 h.

No.	Age	Sex (M/F)	Stone size (cm)	Side (L/R)	Pre-ESWL stone position	Post-ESWL stone position	Chief complications
1	77	F	0.9	L	Renal stone Hydronephrosis	Renal stone	UTI, fever
2	57	M	1.8	L	Renal stone Hydronephrosis	Stone street at L4−5 level	Flank pain, hematuria
3	49	F	0.8	R	Renal stone	Renal stone U/3 to L/3 ureter stone street Hydronephrosis	Flank pain
4	52	F	0.6	L	Renal stone	U/3 ureter to UVJ stone street	LLQ Abdominal pain, nausea
5	36	F	0.88	L	Renal stone	Stone free	Flank soreness, hematuria
6	53	M	0.63	R	U/3 ureteral stone Hydronephrosis	L/3 ureteral stone	Flank pain
7	55	M	1.06	L	Renal stone	Renal stone U/3 ureter to UVJ stone street Hydronephrosis	Acute urinary retension
8	72	F	0.6	L	U/3 ureteral stone	U/3 ureteral stone	Flank Pain
9	37	F	0.4	L	Renal stone	Renal stone	Flank pain, hematuria, nausea
10	33	M	1.8	L	Renal stone	Renal stone L/3 ureter Stone street	Flank pain
11	58	M	0.85	R	Renal stone	Renal stone	Flank pain
12	35	F	1.97	R	Renal stone	U/3, L/3 ureteral stone	Fever, chills
13	64	M	1.1	L	Renal stone	Renal stone	Peri-umbilical abdominal pain
14	66	F	1.32	R	Renal stone	Renal stone	Flank pain
15	54	M	0.5	R	Renal stone	Renal stone	Flank pain
16	74	M	0.6	L	U/3 ureter Hydronephrosis	Ureteral stone	Chest tightness, cold sweating
17	42	F	2.6	L	Renal stone	Renal stone	Fever, hematuria
18	56	M	0.4	L	Renal stone	Renal stone	Flank pain
19	56	M	1.42	L	Renal stone	Renal stone L/3 ureteral stone	LLQ abdomen pain
20	45	M	1.68	R	Renal stone	Renal stone	Flank pain, hematuria
21	65	F	1	R	Renal stone	Renal stone	Fever
22	58	M	1.5	L	Renal stone	Renal stone L/3 ureteral stone Hydronephrosis	Flank pain

Sex (M/F): (male/female), side (L/R): side (left/right), L/3: lower third, LLQ: left lower quadrant, U/3: upper third, UTI: urinary tract infection, UVJ: ureterovesical junction.

there was no imaging evidence proving whether or not hydronephrosis was resolved after ESWL. There were 2 newly onset cases of hydronephrosis after outpatient ESWL. In these 2 cases, residual renal stones and stone fragments downward to the ureter were noted. There was only 1 patient who returned to the ER with a stone-free condition after ESWL with symptoms of flank soreness and hematuria. In 22 patients who went back to the ER, 7 (31.8%) patients were admitted to the ward after ER medical treatment, and 1 (4.5%) patient went back to the ER twice, continuously. All patients received medical treatment without ESWL or surgical management even after admission. There was no renal hematoma or other severe complication in these 22 patients. Because only 22 patients went back to ER arising from a total of 1095 procedures (times) of outpatient ESWL, multivariate analysis was not suitable for purposes of this study.

4. Discussion

4.1. The post outpatient ESWL 48 h ER visiting rate

In our study, the 48 h ER visiting rate post outpatient ESWL was 2%. We reviewed previous articles regarding post-ESWL complication rates. In fact, our study appears to be the first article that focused on the ER-visiting rate within 48 h post ESWL. In recent articles, there were 2 studies that mentioned the post ESWL ER visiting rate (Table 4).[4,5] Sun and Chang et al.[4] mentioned that according to the guideline,

Table 4
Post-ESWL unexpected ER visiting rate in recent studies.

Author	Year	Inpatient/outpatient	Case number	Complication rate	Follow up period
Sun et al.[4]	2006	Outpatient	1026	ER visiting rate (13.6% and 29.8%)	1 week
White et al.[5]	2006	Outpatient	4621	ER visiting rate (0.85%)	90 days
Lu et al. (Our study)	2014	Outpatient	844	ER visiting rate (2%)	48 h

the post-ESWL ER visiting rate was about 10%. This was a study conducted in Taiwan, and the results showed that post-ESWL ER visiting rates within 1 week were 13.6% and 29.8% for training set and external validation set, respectively. White and Klein et al.[5] reported on a study in the United States with a post-ESWL ER visiting rate of 0.85%. In comparison to the study of Sun et al., the 2% 48 h post-ESWL ER visiting rate in our Taiwanese study was relatively low. In our study, all of the 2% ER visiting patients recovered after medication without surgical treatment. These results make its application more broadly comprehensive in that there was no need for inpatient ESWL for patients who presented in a generally good condition. Being the first article that focused on the ER-visiting rate within 48 h post-ESWL, our study still needs additional studies designed with similar inclusion criteria.

4.2. Complications of the post-outpatient ESWL 48 h ER-visiting group

We also assessed the safety of outpatient ESWL. Our complication rates were mentioned in Table 2. In 22 (2%) of those patients who visited ER within 48 h after outpatient ESWL, the most common complication was flank pain (55.2%). Other complications included fever (17.2%), hematuria (13.8%), nausea with vomiting (6.9%) and acute urinary retention (3.4%). We reviewed relevant articles that followed up the complications in the period from 1 week up to 6 months; these articles were presented in Table 5.[5–12] We described the published year, inpatient or outpatient, case number, complication rate and follow up period of these articles. All of the studies analyzed patients within the context of an outpatient institute. Our study result had similarities with the Albala et al.,[6] Mohammed et al.[7] and Salem et al.[8] that the most common complication was flank pain. The study of Salem et al.,[8] Joshi et al.[9] and Mohammed et al.[7] reported complications of gross hematuria which was also a common complication after ESWL.

There was no severe complication in our study such as renal hematoma, cardiovascular event or adjacent organ injury. The result was similar to most of the other studies. These other studies reported major complications, but the rates were low. Bhatia et al. reviewed 1350 patients and the major complication rate was 0.8%.[10] Salem et al. mentioned major complications of perirenal hematoma or subclinical subcapsular hematoma (4.6%) after monitoring for three months. These results implied that major complications can occur up to 6 months, and even after observation for 48 h. From the result, we can derive the conclusion that the major complication rate of outpatient ESWL is very low. It confirms the safety of outpatient ESWL for urolithiasis patients.

The 2015 EAU Guidelines on Urolithiasis and relative articles divided ESWL-related complications into 3 categories.[13] First, there were complications related to stone fragment including steinstrasse, regrowth of residual fragments, and renal colic. Second, infection-related complications including bacteriuria in non-infection stones, and sepsis. Third, tissue effect complications including hematoma, cardiovascular, gastrointestinal (blower perforation, liver, and spleen hematoma).[14] Microscopic hematuria occurs in virtually all cases. However, gross hematuria appears only in about one third of patients.[15]

The most common cause of flank pain after ESWL for renal stone is the disintegrated stones migrating to the ureter with obstruction. For patients who suffered from flank pain with a renal stone still in the kidney after ESWL, the possible mechanisms are as follows. First, the flank pain was due to tissue effect. The immediate tissue effect was due to direct impact of the shock wave on the kidney and adjacent soft tissue and organs. The degree of damage might not induce hematoma or perforation, but could still cause inflammation change such as swelling or pain. Second, after the stone was fragmented, the bacteria in the original stone could be exposed. The flank pain might be induced by infection from the bacteria of stone fragments after ESWL. Lastly, there

Table 5
Post-ESWL complication rates follow up results in recent studies.

Author	Year	Inpatient/outpatient	Case number	Complication rate	Follow up period
Bhatia et al.[10]	1994	Outpatient	1350	Major complication (0.8%)	6 months
Albala et al.[6]	2005	Outpatient	326	Overall complication (3.8%) Most symptom: pain (2.1%)	4–6 weeks
White et al.[5]	2006	Outpatient	4621	Total complication (6.54%)	90 days
Sio et al.[11]	2007	Outpatient	233	Minor complication (3.8%)	1 week
Wang et al.[12]	2010	Outpatient	831	No major complication	3 months
Salem et al.[8]	2010	Outpatient	3241	Colicky pain (40%)[a] Gross hematuria (32%) Urinary obstruction (30.9%) Perirenal or subcapsular hematomas (4.6%)	3 months
Mohammed et al.[7]	2013	Outpatient	225	Loin pain (37.9%)[a] Gross hematuria (7.1%)	3 months
Joshi et al.[9]	2014	Outpatient	430	Stainstrasse and minimal heamaturia (0.9%) No major complication	1–3 months
Lu et al. (Our study)	2016	Outpatient	844	Flank pain (55.2%)[a] ER visiting rate (2%)	48 h

[a] These complication rates are based on the sum of all complications instead of all patients who received ESWL.

might be some radiolucent stone compartment or small stone fragments that cannot be identified by KUB coated on the urothelium after ESWL. These stone fragments might cause post-ESWL flank pain.

4.3. Risk factors for the 48 h post outpatient ESWL ER-visiting group

In our study, risk factors with ER visiting rate after outpatient ESWL include stone location, stone size and stone shape (long to short axis ratio) were analyzed. The only meaningful statistic significant risk factor was renal stone compared to ureteral stone ($p = 0.047$). When these patients back to the parameter of stone height/width ratio ($p = 0.079$) was a tendency risk factor for ER re-visiting. There was no definite theory demonstrating how stone shape affected the complication and success rate of ESWL.

In our patients, all ureteral stones before ESWL were located in the upper third ureter before ESWL. The upper third ureteral stone may be the risk factor for ER-visiting 48-h post ESWL. We could generate a proof once the case numbers were sufficiently large. There were 15 patients who had renal stone before the outpatient ESWL and the stone residual in the renal pelvis after the shock wave treatment. There were 7 renal stone patients who presented with ureteral stone after ESWL and symptoms of stone street were noted in 4 patients. There were 4 patients who presented with hydronephrosis before ESWL. There was no image evidence to prove whether hydronephrosis was resolved or not after ESWL. There were 2 patients with newly onset hydronephrosis after outpatient ESWL. In these 2 cases, residual renal stones and stone fragments downward to the ureter were noted. There was only 1 patient who went back to the ER with stone-free condition after ESWL with symptoms of flank soreness and hematuria. A reasonable explanation is that most patient complications who returned to the ER within 48 h are induced by residual stone or stone fragments downward migration after ESWL. This condition tends to manifest in patients who have original renal or upper third ureteral stones.

The statistical results showed that patients visiting the ER within 48 h had smaller stone size no matter whether they were renal or ureteral stones, as noted in Table 1. The result suggested that large stone size was not a risk factor for ER visiting rate post outpatient ESWL. We cannot predict the ER visiting rate post outpatient ESWL by stone size. The reasonable mechanism for smaller stone size in patients returning to the ER within 48 h are as follows. First, the energy of shock wave is difficult to focus on the spot of the smaller stone. Accordingly, the adjacent tissue and organs are more easily exposed of the impact of shock wave; therefore, tissue damage is more likely to occur. Secondly, the smaller stone was hard to remedy and considerably easier to float during ESWL. Tissue damage might be induced when the stone bumped into the urothelium when impacted by shock wave.

Our result also showed the mean renal stone size was 12.2 ± 5.9 mm, and the mean ureteral stone size was 6.1 ± 0.2 mm. The result may be a factor for the finding that patients with renal stone have a higher ER-visiting rate post outpatient ESWL compared to patients with ureteral stone ($p = 0.047$).

In our study, there were 2 patients who returned to the ER with DJ insertion before ESWL. In the control group, 5 patients had DJ insertion before ESWL. The p value was 0.426. The result showed DJ insertion was not a risk factor for post-ESWL ER re-visiting rate within 48 h.

4.4. The contribution of our study

To the best of our knowledge, our study is the first article that focused on the ER-visiting rate within 48 h post-ESWL. According to the result of our study, we can inform patients with renal stone or height/width ratio that they may have relatively higher ER-visiting rate post outpatient ESWL. We should closely monitor these patients and educate them about possible complications. As mentioned above, most of the patients admitted for ESWL will be hospitalized 48 h after the treatment of ESWL, and our study has facilitated the planning of inpatient or outpatient ESWL for renal–ureteral urolithiasis.

4.5. Limitations

There were several limitations in our study. The major limitation was that it was conducted using a single institution database and retrospective recruitment. Second, a total of 22 patients who returned to the ER within 48 h after ESWL were included, which represents a relative small sample size. Owing to the above reasons, multi-center inclusion as well as longer follow-up periods are necessary for further investigation.

In conclusion, the 48-h Emergency Department Visiting rate was 2% in our hospital, with no case of severe morbidity or mortality. Renal stone is the risk factor ($p = 0.047$) for patients to return to the ER within 48 h post outpatient ESWL. The stone height/width ratio was a tendency ($p = 0.079$) parameter for patients back to ER within 48 h post outpatient ESWL. The patient with renal stone and high stone height/width ratio should be well-educated and monitored closely, particularly renal stone patients. After all, outpatient ESWL is a safe treatment for renal and ureteral stones, and inpatient ESWL is not absolutely necessary.

References

1. Torricelli FC, Danilovic A, Vicentini FC, Marchini GS, Srougi M, Mazzucchi E. Extracorporeal shock wave lithotripsy in the treatment of renal and ureteral stones. *Rev Assoc Med Bras* 2015;**61**:65–71.
2. Murota-Kawano A, Ohya K, Sekine H. Outpatient basis extracorporeal shock wave lithotripsy for ureter stones: efficacy of the third generation lithotripter as the first line treatment. *Int J Urol* 2008;**15**:210–5.
3. Streem SB. Contemporary clinical practice of shock wave lithotripsy: a reevaluation of contraindications. *J Urol* 1997;**157**:1197–203.
4. Sun CC, Chang P. Prediction of unexpected emergency room visit after extracorporeal shock wave lithotripsy for urolithiasis – an application of artificial neural network in hospital information system. *AMIA Annu Symp Proc* 2006:1113.

5. White W, Klein F. Five-year clinical experience with the Dornier Delta lithotriptor. *Urology* 2006;**68**:28−32.
6. Albala DM, Siddiqui KM, Fulmer B, Alioto J, Frankel J, Monga M. Extracorporeal shock wave lithotripsy with a transportable electrohydraulic lithotripter: experience with >300 patients. *BJU Int* 2005;**96**:603−7.
7. Al-Marhoon MS, Shareef O, Al-Habsi IS, Al Balushi AS, Mathew J, Venkiteswaran KP. Extracorporeal shock-wave lithotripsy success rate and complications: initial experience at Sultan Qaboos University Hospital. *Oman Med J* 2013;**28**:255−9.
8. Salem S, Mehrsai A, Zartab H, Shahdadi N, Pourmand G. Complications and outcomes following extracorporeal shock wave lithotripsy: a prospective study of 3,241 patients. *Urol Res* 2010;**38**:135−42.
9. Joshi HN, Karmacharya RM, Shrestha R, Shrestha B, de Jong IJ, Shrestha RKM. Outcomes of extra corporeal shock wave lithotripsy in renal and ureteral calculi. *Kathmandu Univ Med J* 2014;**12**:51−4.
10. Bhatia V, Biyani CS. Extracorporeal shock wave lithotripsy for urolithiasis. Experience with 3000 patients. *Int Surg* 1994;**79**:80−3.
11. De Sio M, Autorino R, Quarto G, Mordente S, Giugliano F, Di Giacomo F, et al. A new transportable shock-wave lithotripsy machine for managing urinary stones: a single-centre experience with a dual-focus lithotripter. *BJU Int* 2007;**100**:1137−41.
12. Wang M, Shi Q, Wang X, Yang K, Yang R. Prediction of outcome of extracorporeal shock wave lithotripsy in the management of ureteric calculi. *Urol Res* 2011;**39**:51−7.
13. D'Addessi A, Vittori M, Racioppi M, Pinto F, Sacco E, Bassi P. Complications of extracorporeal shock wave lithotripsy for urinary stones: to know and to manage them − a review. *Sci World J* 2012;**2012**:619820.
14. Newman RC, Bezirdjian L, Steinbock G, Finlayson B. Complications of extracorporeal shock wave lithotripsy: prevention and treatment. *Semin Urol* 1986;**4**:170−4.
15. Sofras F, Karayannis A, Kostakopoulos A, Delakas D, Kastriotis J, Dimopoulos C. Methodology, results and complications in 2000 extracorporeal shock wave lithotripsy procedures. *BJU Int* 1988;**61**:9−13.