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*Original Article*

# Efficacy of holmium laser lithotripsy under electron flexible cystoscope versus extracorporeal shockwave lithotripsy in treating patients with renal calculi

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**Abstract:** Objective: To investigate the efficacy of holmium laser lithotripsy under an electron flexible cystoscope compared to extracorporeal shockwave lithotripsy in treating patients with renal calculi. Methods: Two hundred and seven patients with renal calculi were retrospectively analyzed. One hundred and fourteen patients, who were treated by holmium laser lithotripsy under an electron flexible cystoscope, were included in the holmium laser lithotripsy group. Ninety-three patients, who were treated by extracorporeal shockwave lithotripsy, were included in the shockwave lithotripsy group. The clinical data, operation time, clinical efficacy, complications (the calculi dropped to the renal pelvis and hyperpyrexia), and the level of serum β2-MG were recorded and compared. Results: The operation time of the patients in the holmium laser lithotripsy group was significantly shorter than that of the patients in the shockwave lithotripsy group. The difference was statistically significant ($P < 0.001$). The number of the patients whose renal calculi was smashed in the holmium laser lithotripsy group was significantly higher than that in the shockwave lithotripsy group. The difference was statistically significant ($P < 0.01$). The number of the patients whose renal calculi was excreted in the holmium laser lithotripsy group was significantly higher than that in the shockwave lithotripsy group. The difference was statistically significant ($P < 0.01$). The complication of the patients in the holmium laser lithotripsy group was significantly less than that in the shockwave lithotripsy group. The difference was statistically significant ($P < 0.01$). The level of serum β2-MG at T1 was significantly higher than the level of serum β2-MG at T0 and T2. The difference was statistically significant (both $P < 0.05$). The difference between the level of serum β2-MG at T0 and T2 was not statistically significant between the two groups ($P > 0.05$). The level of serum β2-MG of the patients in the holmium laser lithotripsy group at T1 was significantly lower than that in the shockwave lithotripsy group. The difference was statistically significant ($P < 0.05$). Conclusion: The application of holmium laser lithotripsy under an electron flexible cystoscope for patients with renal calculi not only has a good control effect on complications and a high safety coefficient, but also has a better clinical effect than that of extracorporeal shockwave lithotripsy. It can obviously improve the calculi-free rate and is worthy of being popularized in clinic.

**Keywords:** Renal calculi, holmium laser lithotripsy under electron flexible cystoscope, extracorporeal shockwave lithotripsy, clinical efficacy

## Introduction

Renal calculi are a common disorder of the urinary system, which can lead to poor urine drainage, urinary tract obstruction and urinary tract infections. The overall morbidity of renal calculi worldwide is between 3% and 13% [1-3]. If renal calculi are not treated timely, the calculi will continue to grow, making the patient's condition more serious and causing renal empyema, uremia and renal pelvic cancer, thus the patient's basic physiological activities and health will be greatly affected [4-6]. With the development of social economy and people's poor life habits, the number of patients with renal calculi is increasing year by year, showing a trend of youthful onset [7].

When it comes to the treatment of renal calculi, in addition to the conventional medical treatment, the lithotripsy commonly used in clinic includes conventional percutaneous nephrolithotomy and extracorporeal shockwave lithotripsy, etc. [8, 9]. However, when these traditional lithotripsies are used to treat patients, some calculi still remain in the kidney and can

not be excreted after they are smashed, which greatly injures the surrounding tissues of the kidney, thus the safety of traditional lithotripsy still needs to be improved [10]. Moreover, shortening the operation time has become a focus in the development of ureteroscopy in recent years [11].

With the rapid development of lithotripsy, as a minimally invasive treatment, holmium laser lithotripsy under an electron flexible cystoscope has been applied in treating ureteral calculi. Compared with traditional lithotripsy, holmium laser lithotripsy under an electron flexible cystoscope is an endoscopic minimally invasive surgery that can smash and take out renal calculi through the urinary tract, without perforating the patient's waist, which greatly reduces the risk of surgical infections [12, 13]. At present, there are few studies about the application of holmium laser lithotripsy under an electron flexible cystoscope in treating patients with renal calculi. In this study, the success rates of holmium laser lithotripsy under an electron flexible cystoscope versus extracorporeal shockwave lithotripsy were compared in ability to smash the renal calculi in the patients (whether the size of the renal calculi was less than 1 cm after it was smashed), as well as, the calculi-free rates, complications, operation times, and some serum factors of the patients were compared, to investigate the clinical efficacy and value of holmium laser lithotripsy under an electron flexible cystoscope versus extracorporeal shockwave lithotripsy in treating patients with renal calculi.

## Materials and methods

### *General data*

Two hundred and seven patients complicated with renal calculi, who were treated in The Second Hospital of Anhui Medical University from March 2016 to November 2017, were retrospectively analyzed. One hundred and fourteen patients, who were treated by holmium laser lithotripsy under an electron flexible cystoscope, were included in the holmium laser lithotripsy group. Ninety-three patients, who were treated by extracorporeal shockwave lithotripsy, were included in the shockwave lithotripsy group. Among those patients who were treated by holmium laser lithotripsy under an electron flexible cystoscope, there were 54 males and 60 females aged 45-73 years old, with an average age of 49.0±2.0 years old and an average disease course of 2.50±0.34 months. Among those patients who were treated by extracorporeal shockwave lithotripsy, there were 35 males and 58 females aged 45-72 years old, with an average age of 49.3±1.9 years old and an average disease course of 3.01±0.16 months.

Inclusion criteria: All patients were diagnosed with renal calculi by medical history, physical examination, X-ray examination and assay in The Second Hospital of Anhui Medical University [12]. Exclusion criteria: Patients whose clinical symptoms were inconsistent with the diagnostic criteria of renal calculi; patients with severe mental function disorder or cognitive function disorder; patients with severe renal failure; patients with severe cardiovascular and cerebrovascular diseases; patients who did not cooperate with the treatment. The patients and their family members were informed in advance before the study was carried out, and they signed an informed consent form after they agreed to participate. This study was approved by the Ethics Committee of The Second Hospital of Anhui Medical University.

### *Treatments*

The patients in the holmium laser lithotripsy group were treated by holmium laser lithotripsy under an electron flexible cystoscope. After the patients were anesthetized and the site of calculi in the bladder was found, the calculi were ascertained. The ureter and renal pelvis were detected by 8 F electronic ureteroscopy and 9 F electronic ureteroscopy. When the electron flexible cystoscope reached the junction of the ureter and the renal pelvis, some zebra guidewire was placed here, and then a holmium laser device with 500 μm diameter holmium laser fiber, 0.8 J output energy, and 10 Hz pulse frequency was placed. During the operation, the increase of output energy differed in different conditions of the patients; the stone basket net was taken out after the calculi was smashed.

The patients in the shockwave lithotripsy group were treated by extracorporeal shockwave lithotripsy. After the patients were anesthetized, they were placed in a supine position. HK.ESWL-109 extracorporeal shockwave lithotripter (Shenzhen Huikang Medical Instrument Co., Ltd.) was used to smash the calculi. Surgeons kept the voltage of the lithotripter between 16-18 KV, and the shock number between 1,500-2,000 times. The supplement of the shock time differed in different condi-

tions of the patients; it stopped when the calculi were successfully smashed.

*Outcome measures*

Some of the indicators of the patients in the holmium laser lithotripsy group and the shockwave lithotripsy group were recorded and compared, including clinical data, operation time (the duration that the patients stayed in the operating room), clinical efficacy including the success rate of the lithotripsy (abdominal plain film and B-scan ultrasonography were used to examine the patients, if there was no calculi imaging in the examination result, then the calculi was successfully smashed), calculi-free rate (the patients were reexamined by CT a week after the operation, if the result showed that the calculi was completely excreted and there was no residual calculi, then the calculi were successfully excreted), complications (the calculi drops to renal pelvis, hyperpyrexia). The venous blood from the patients in the holmium laser lithotripsy group and shockwave lithotripsy group was collected when they fasted before 9 am on the day of the operation (T0), one day after the operation (T1), and one month after the operation (T2); blood was and centrifuged, and the level of serum β2-MG was detected by an automatic chemiluminescence apparatus (Wuhan Easydiagnosis Biomedicine Co., Ltd., product model: SMART 300).

*Statistical methods*

SPSS 22.0 software was used to analyze the data. The count data was expressed as the number of cases/percent (n, %). Fisher's exact test was used to compare the incidence of complications between groups. The measurement data were expressed as mean ± standard deviation ($\bar{x} \pm sd$). Independent t-test was used for comparison between two groups, paired t-test was used for comparison within groups before and after the patients were treated. When $P < 0.05$, the difference was considered statistically significant.

## Results

*The comparison of clinical data of the patients in the holmium laser lithotripsy group and the shockwave lithotripsy group*

The differences in age, gender, and disease course of the patients in the holmium laser lithotripsy group and the shockwave lithotripsy group were not statistically significant ($P > 0.05$). Two groups were comparable. See **Table 1**.

*The operation time of the patients in the holmium laser lithotripsy group and the shockwave lithotripsy group*

The operation time of the patients in the holmium laser lithotripsy group and the shockwave lithotripsy group was 59.03±13.53 minutes and 73.68±12.43 minutes, respectively. The operation time of the patients in the holmium laser lithotripsy group was significantly less than that of the patients in the shockwave lithotripsy group. The difference was statistically significant ($P < 0.001$). See **Table 2**.

*The clinical efficacy of the patients in the holmium laser lithotripsy group and the shockwave lithotripsy group*

*The success rate of the lithotripsy in the holmium laser lithotripsy group and the shockwave lithotripsy group:* There were 110 patients whose operations were successful in the holmium laser lithotripsy group and 78 patients whose operations were successful in the shockwave lithotripsy group. The number of the patients whose operations were successful in the holmium laser lithotripsy group was significantly higher than that of the shockwave lithotripsy group. The difference was statistically significant ($P < 0.01$). See **Table 3** and **Figure 1A**.

*The calculi-free rate of the patients in the holmium laser lithotripsy group and the shockwave lithotripsy group:* There were 101 patients whose calculi were successfully excreted in the holmium laser lithotripsy group and 69 patients whose calculi were successfully excreted in the shockwave lithotripsy group. The number of the patients whose calculi was successfully excreted in the holmium laser lithotripsy group was significantly higher than that of the shockwave lithotripsy group. The difference was statistically significant ($P < 0.01$). See **Table 4** and **Figure 1A**, **1B**.

*The complications of the patients in the holmium laser lithotripsy group and the shockwave lithotripsy group*

In the holmium laser lithotripsy group, no patients had complications with hyperpyrexia and calculi dropping into the renal pelvis, while

**Table 1.** Comparison of clinical data in the holmium laser lithotripsy group and the shockwave lithotripsy group

| Group | Holmium laser lithotripsy group (n=114) | Shockwave lithotripsy group (n=114) | $t/\chi^2$ | P |
|---|---|---|---|---|
| Age (year) | 49.0±2.0 | 49.3±1.9 | 0.934 | 0.351 |
| Gender (n, %) | | | 1.980 | 0.159 |
| Male | 54 (47.37) | 35 (37.63) | | |
| Female | 60 (52.63) | 58 (62.37) | | |
| Course of disease (month) | 3.02±0.34 | 3.01±0.16 | 0.261 | 0.794 |
| Stone diameter | | | | |
| < 1 cm | 60 (52.63) | 58 (62.37) | 0.446 | 0.504 |
| ≥ 1 cm | 54 (47.37) | 35 (37.63) | | |
| Classification (n, %) | | | | |
| Pelvis calculi | 20 (17.54) | 15 (16.13) | 0.793 | 0.373 |
| Calyceal calculi | 34 (29.82) | 20 (21.51) | 0.006 | 0.937 |
| Renal parenchymal calculus | 60 (52.63) | 58 (62.37) | 1.980 | 0.159 |
| Family history of renal calculi (n, %) | | | | |
| Yes | 34 (29.82) | 20 (21.51) | 1.838 | 0.175 |
| No | 80 (70.18) | 73 (78.49) | | |
| Past medication (n, %) | | | 0.820 | 0.365 |
| Yes | 113 (99.12) | 93 (100.00) | | |
| No | 1 (0.88) | 0 (0.00) | | |
| Magnesium deficiency diet (n, %) | | | 0.516 | 0.473 |
| Yes | 94 (82.46) | 73 (78.49) | | |
| No | 20 (17.54) | 20 (21.51) | | |
| Vitamin B6 deficiency (n, %) | | | 0.516 | 0.473 |
| Yes | 94 (82.46) | 73 (78.49) | | |
| No | 20 (17.54) | 20 (21.51) | | |

**Table 2.** Comparison of operation time in the holmium laser lithotripsy group and the shockwave lithotripsy group

| Group | N | Operation time |
|---|---|---|
| Holmium laser lithotripsy group | 114 | 59.03±13.53 |
| Shockwave lithotripsy group | 93 | 73.68±12.43 |
| T | | 8.035 |
| P | | < 0.001 |

**Table 3.** Comparison of success rate of the lithotripsy in the holmium laser lithotripsy group and the shockwave lithotripsy group

| Group | N | Success rate of lithotripsy (n, %) |
|---|---|---|
| Holmium laser lithotripsy group | 114 | 110 (96.49) |
| Shockwave lithotripsy group | 93 | 78 (83.87) |
| $\chi^2$ | | 9.786 |
| P | | 0.002 |

in the shockwave lithotripsy group, two patients had calculi drop into the renal pelvis and four patients had hyperpyrexia. The incidence of the patients' complications in the holmium laser lithotripsy group was significantly lower than that of the shockwave lithotripsy group. The difference was statistically significant (P < 0.01). See **Table 5**.

*The levels of serum β2-MG from the patients in the holmium laser lithotripsy group and shockwave lithotripsy group*

The levels of serum β2-MG from patients in the holmium laser lithotripsy group were 2.31±1.14 mg/L, 8.23±1.68 mg/L, and 2.29±1.13 mg/L at T0, T1, and T2, respectively. The levels of serum β2-MG from the patients in the shockwave lithotripsy group were 2.33±1.14 mg/L, 9.09±1.92 mg/L, and 2.35±1.13 mg/L at T0, T1, and T2, respectively. When the levels of

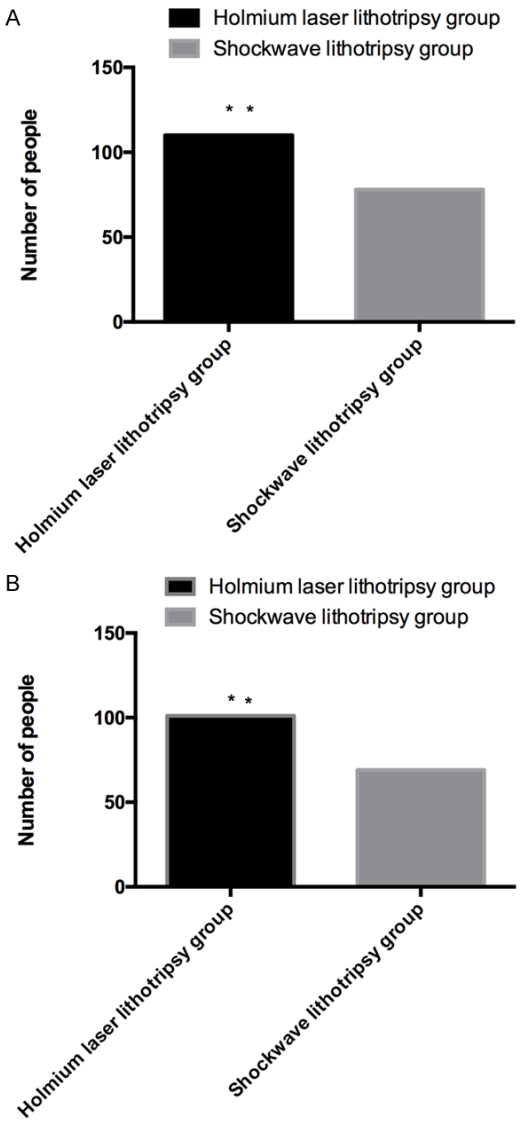


**Figure 1.** Comparison of the clinical efficacy in the holmium laser lithotripsy group and the shockwave lithotripsy group. A: Success rate of lithotripsy. B: Calculi-free rate. The success rate of lithotripsy and calculi-free rate of the patients in the holmium laser lithotripsy group was significantly higher than that in the shockwave lithotripsy group, $^{**}P < 0.01$.

serum β2-MG were compared within the groups, the result showed that the levels of serum β2-MG of the patients in the two groups gradually increased from T0 to T1, then reached a peak at T1, and then decreased to the level at T0. The level of serum β2-MG at T1 was significantly higher than that at T0 and T2. The difference was statistically significant ($P < 0.05$). The difference between the level of serum β2-MG at T0 and T2 was not statistically significant in the two groups ($P > 0.05$). When the levels of serum β2-MG were compared between groups, the result showed that the difference between the level of serum β2-MG at T0 and T2 was not statistically significant between the two groups ($P > 0.05$), but the level of serum β2-MG of the patients in the holmium laser lithotripsy group at T1 was significantly lower than that of the patients in the shockwave lithotripsy group at T1. The difference was statistically significant ($P < 0.05$). See **Figure 2**.

**Table 4.** Comparison of the calculi excretion in the holmium laser lithotripsy group and the shockwave lithotripsy group

| Group | N | Calculi-free rate (n, %) |
|---|---|---|
| Holmium laser lithotripsy group | 114 | 101 (88.60) |
| Shockwave lithotripsy group | 93 | 69 (74.19) |
| $\chi^2$ | | 7.238 |
| P | | 0.007 |

## Discussion

Holmium laser lithotripsy under an electron flexible cystoscope uses an infrared laser to break up calculi. It is very safe and its penetrating power does not injure tissues, moreover, it can shorten the patient's treatment time and has little damage to the patient [14, 15]. In the past, the operations that were used to treat renal calculi had great damage to the patient, not only with the infection rate being high, but also the patient often came down with some adverse symptoms such as hyperpyrexia [16].

In this study, the operation time of the patients in the holmium laser lithotripsy group and shockwave lithotripsy group was compared. It was found that the operation time of the patients in the holmium laser lithotripsy group was significantly shorter than that of the shockwave lithotripsy group, the difference was statistically significant. Shortening operation times can not only reduce the probability of intraoperative infections caused by foreign matters, but also effectively reduce postoperative inflammatory responses of the patient's wound [17, 18]. Li et al. researched patients with renal calculi who were treated by holmium laser lithotripsy under an electron flexible cystoscope and extracorporeal shockwave lithotripsy, the results they found also demonstrated that the operation time of patients who were

**Table 5.** Comparison of the complications in the holmium laser lithotripsy group and the shockwave lithotripsy group

| Group | Calculi dropped to the renal pelvis (n, %) | Hyperpyrexia (n, %) | Total (n, %) |
|---|---|---|---|
| Holmium laser lithotripsy group (n=114) | 0 (0.00) | 0 (0.00) | 0 (0.00) |
| Shockwave lithotripsy group (n=93) | 2 (2.15) | 4 (4.30) | 6 (6.45) |
| $\chi^2$ | | 5.000 | 7.574 |
| P | 0.201 | 0.025 | 0.006 |

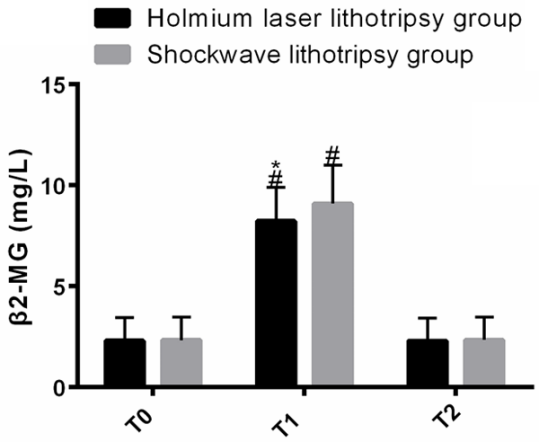


**Figure 2.** Comparison of the levels of serum β2-MG in the holmium laser lithotripsy group and the shockwave lithotripsy group. The serum level of β2-MG at this time point was significantly higher than that of other time points in the same group, $^{\#}P < 0.05$; the level of serum β2-MG in the holmium laser lithotripsy group at T1 was significantly lower than that in the shock wave lithotripsy group, $^{*}P < 0.05$.

treated by holmium laser lithotripsy under an electron flexible cystoscope was greatly shortened, which was significantly lower than that of patients who were treated by extracorporeal shockwave lithotripsy [19].

The clinical efficacy of the patients in the holmium laser lithotripsy group and shockwave lithotripsy group was compared. The result showed that the number of patients whose operations were successful in the holmium laser lithotripsy group was significantly higher than that of the shockwave lithotripsy group. The difference was statistically significant. The number of the patients whose calculi were successfully excreted in the holmium laser lithotripsy group was significantly higher than that of the shockwave lithotripsy group. The difference was statistically significant. Smashing the calculi successfully is the premise of excreting the calculi. Lithotripsy can only smash large calculi, and renal calculi may recur after the patient is treated by lithotripsy, so renal calculi not only need to be smashed, but also need to be excreted [20, 21]. Holmium laser lithotripsy under an electron flexible cystoscope is a new-type of laser, its energy can smash calculi into powder, which is conducive to the excretion of the calculi [22]. The energy released by extracorporeal shockwave lithotripsy can only smash calculi into pieces; these pieces with large volumes are not conducive to be excreted [23]. A large number of clinical data show that for those patients who are treated by holmium laser lithotripsy under an electron flexible cystoscope, the breakdown and excretion rate of calculi are higher than those of patients who are treated by extracorporeal shockwave lithotripsy, moreover, the clinical efficacy of those patients is better [24, 25].

Next, the complications of the patients in two groups were observed; the result showed that in the holmium laser lithotripsy group, there were no patients with complications. In the shockwave lithotripsy group, two patients had calculi drop into the renal pelvis, and four patients had hyperpyrexia. The incidence of the patients' complications in the holmium laser lithotripsy group was significantly less than that of the patients' complications in the shockwave lithotripsy group. Some studies, which are about the lithotripsy used to treat patients with renal calculi, show that when holmium laser lithotripsy under an electron flexible cystoscope is used, the penetration depth of the holmium laser is not deep into tissues. The energy generated by the holmium laser can vaporize the water between the optical fiber and the calculi, the water vapor can absorb a large amount of energy and can greatly reduce the damage to the surrounding tissues, thus holmium laser lithotripsy under an electron flexible cystoscope is very safe [26]. It is believed that holmium

laser lithotripsy under an electron flexible cystoscope is effective in reducing the complications of patients with renal calculi.

Finally, the level of serum β2-MG of the patients in the holmium laser lithotripsy group and shockwave lithotripsy group was analyzed. The result showed that the level of serum β2-MG of the patients in the two groups peaked a day before and a day after the operation, and then gradually decreased, lastly to return to the preoperative level a month after the operation. The difference was not statistically significant, between the levels of serum β2-MG of the patients in the holmium laser lithotripsy group and the shockwave lithotripsy group before and after the operation. The level of serum β2-MG from the patients in the holmium laser lithotripsy group at T1 was significantly lower than that of the shockwave lithotripsy group. The difference was statistically significant. Serum β2-MG is filtered by the glomerulus and reabsorbed and decomposed by the renal tubules, and is used as an early monitoring indicator of impaired renal function, when there is acute or chronic injury in renal function, serum β2-MG will clearly increase [27]. Some researchers have also found that the level of serum β2-MG of patients with renal calculi who were treated by holmium laser lithotripsy under an electron flexible cystoscope was significantly lower than that of patients who were treated by conventional lithotripsy a day after their operation. This result is consistent with our findings and supports the conclusion of this paper [28].

In this study, there are some defects. For example, although the clinical efficacy of the patients in the two groups was compared, the life quality of the patients was not mentioned. Furthermore, the laser devices used in this study may not be advanced, which has a great impact on the results of this study. In order to remedy these defects, the study subjects will be followed up regularly in the future and other relevant study achievements will be focused upon.

In summary, when holmium laser lithotripsy under an electron flexible cystoscope is used to treat patients with renal calculi, it is not only good for controlling complications, but also very safe. Moreover, the clinical efficacy of holmium laser lithotripsy under an electron flexible cystoscope is better than that of extracorporeal shockwave lithotripsy, and it can obviously improve the calculi-free rate.

## Disclosure of conflict of interest

None.

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