SUNTEXT REVIEWS

SunText Review of Renal Sciences

Open Access
Research Article
Volume 1:1

Effect of Potassium Sodium Hydrogen Citrate Granule on the Wall Stone Shell of Preset Ureteral Stent before Ureteroscopy

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Received date: 22 October 2021; **Accepted date:** 31 October 2021; **Published date:** 07 November 2021

Citation: Li W, ShubinW, Min Z, Yong W, Jingchao C, Xiaoyu S, et al. (2021) Effect of Potassium Sodium Hydrogen Citrate Granule on the Wall Stone Shell of Preset Ureteral Stent before Ureteroscopy. SunText Rev Renal Sci 1(1): 102.

Abstract

Objective: To observe the effect of potassium sodium hydrogen citrate Granule on the wall stone shell of preset ureteral stent before ureteroscopy.

Methods: A 263 cases of renal calculi treated in our hospital from January 2019 to June 2021 who needed ureteroscopy and successfully preset ureteral stent were investigated retrospectively. 129 cases of patients who took oral potassium sodium citrate granules 10g a day from preset ureteral stent and maintained pH between 7.6 ~ 8.0 until before ureteroscopy were classified into the experimental group, 134 patients without oral administration of any drugs were classified as the control group. The patients in the experimental group took Potassium Sodium Citrate Granules orally. The daily dose was 4 standard spoons, 1 spoonful in the morning, 1 spoonful at noon and 2 spoonfuls in the evening. Both groups of patients returned to the hospital for ureteroscopic lithotripsy after 3 weeks according to the doctor's advice. After pulling out the ureteral stent tube during the operation, the two doctors observed whether there was wall attached stone shell on the surface of the ureteral stent tube and the thickness of the stone shell, and recorded it in a special notebook after unified opinions. Finally, weigh the weight of ureteral stent and completely scrape off the stone shell to obtain the weight of stone shell.

Results: In the experimental group, 129 ureteral stents were pulled out, of which 7 showed thin stone shells and 4 showed thicker stone shells (the thickest part ≥ 1mm). The stone shell formation rate was 8.53%, and the average stone shell weight was 0.8521 ± 0.1952 G. In the control group, 134 ureteral stents were pulled out, including 21 thin stone shells and 9 thick stone shells. The stone shell formation rate was 22.39%, and the average stone shell weight was 1.7823 ± 0.1802 G. The ureteral stent was pulled out at one time in both groups. After oral administration of youlaite, there were significant differences in stone shell formation rate, stone shell thickness and stone shell weight between the two groups ($P < 0.05$).

Conclusion: Potassium sodium hydrogen citrate granules can be used as an economic, effective and safe drug to reduce the formation of stone shell attached to ureteral stent and slow down the progress of stone shell thickness, which is worthy of clinical promotion.

Keywords: Potassium sodium hydrogen citrate; Ureteral stent; Formation of wall attached stone shell; Ureteroscopy; Renal calculus

Introduction

Kidney stone is one of the most common diseases in urology. About 9% of people suffer from kidney stone, and about half of them will relapse [1]. Kidney stones are often accompanied by symptoms such as renal colic, nausea, vomiting and hematuria, and the treatment is mainly to relieve obstruction and reduce the loss of renal function. There are many treatment methods for kidney stones, such as extracorporeal shock wave lithotripsy (ESWL), percutaneous nephroscopy (PCNL) and ureteroscopy (RIRS). As the most minimally invasive and effective method, RIRS has obvious advantages and is often the first choice for clinicians [2]. The average diameter of ureter is 3 ~ 6mm, and F12 ~ 14 flexible ureteroscopy guide sheath is often placed during operation [3], so as to prolong the use time of flexible ureteroscopy, reduce the intraoperative renal pelvis pressure,

increase the lithotripsy efficiency, facilitate the movement of ureteroscopy, and improve the safety of operation [4,5]. However, the guide sheath leads to the failure of phase I operation in some patients, which requires phase II surgical lithotripsy [6]. Therefore, ureteral stents need to be preset 3 weeks before operation to passively expand the ureter, facilitate the placement of ureteroscopic sheath and increase the success rate of one-time operation [7,8]. However, the ureteral stent tube retained for more than 3 weeks often has the formation of stone shell attached to the wall of the ureteral stent tube [9]. The light one is the crystallization of thin stone shell on the surface, while the heavy one is combined with the formation of thicker stone shell, resulting in the inability or difficulty of removing the ureteral stent tube, which not only increases the difficulty of operation, but also brings great psychological pressure and economic burden to patients [10]. Oral administration of potassium sodium hydrogen citrate granules can change the urine microenvironment by adjusting the pH value of urine, so as to reduce the formation of stone shell of ureteral stent and even dissolve the stone shell. The utility model has the advantages of convenient and safe use, definite curative effect and less and slight adverse reactions.

Data and Methods

Clinical data

A retrospective study was conducted on 263 cases of unilateral renal calculi treated in our hospital from January 2019 to June 2021. One ureteral stent (usi-524, cook group, 750 Daniels way, Bloomington, Indiana 47402-0489, United States) was preset before operation. Among them, 10g sodium hydrogen citrate granules were orally taken from the preset ureteral stent every day, 129 patients whose pH remained between 7.6 and 8.0 until before ureteroscopy were classified as the experimental group, while 134 patients who did not take any drugs orally were classified as the control group. There were 59 male patients and 70 female patients in the experimental group, aged from 22 to 63 years, with an average of 42.16 ± 3.91 years; in the control group, there were 65 male patients and 69 female patients, aged from 24 to 65 years, with an average of 43.15 ± 4.26 years. There were no renal dysfunction and electrolyte disorder in both groups. There was no significant difference in gender and age between the two groups (P > 0.05), as shown in (Table 1).

Research methods

Both groups of patients had stones < 2cm above the ureteropelvic junction (UPJ). Finally, unilateral ureteral stent was preset for about 3 weeks before operation, and the position of ureteral stent was satisfactory after indwelling. There was no significant difference in tube time (t = 0.1120, P = 0.9109). Both groups of patients returned to the hospital on time for ureteroscopic lithotripsy according to the doctor's advice. After the ureteral stent was preset until the ureteral stent was removed, the patients in the experimental group took oral potassium sodium citrate granules (youlaite, planextrakt GmbH & Co. kg, Import Registration Certificate No.: h20181128, specification 91.7g / 100g) according to the doctor's advice, and the daily oral dose was 4 standard spoons (each standard spoons was 2.5G, a total of 10G per day), The patients were 1 standard spoon half an hour before meals in the morning, 1 standard spoon half an hour before meals at noon and 2 spoons half an hour before going to bed at night, and the self-test pH value of urine was maintained at 7.6 ~ 8.0.

Table 1: *General basic information.*

	Age	Male	Female
Experience Group(n=129)	42.16 ± 3.91	59	70
Control Group(n=134)	43.15 ± 4.26	65	69
t/χ^2	-1.2984	0.1066	
P	0.1953	0.7441	

The measurement method of urine pH is to use pH test paper to measure urine pH during each urination (colorimetric card method), and maintain the urine pH at 7.6 ~ 8.0. If the urine pH is less than 7.6, add 1 standard spoon at noon, and if the urine pH exceeds 8.0, reduce 1 standard spoon at night. The patients in the control group did not take any related drugs, including antispasmodic drugs, antihypertensive drugs, alkalized urine drugs, litholytic drugs, vitamin C, vitamin B6, antibiotics, etc. The two groups of patients returned to the hospital to recheck the abdominal plain film and found no obvious displacement of the ureteral stent. They signed the operation of transurethral ureteroscopic holmium laser lithotripsy under general anesthesia. After pulling out the ureteral stent through ureteroscopy during the operation, the two doctors observed whether there was wall attached stone shell on the surface of the ureteral stent and evaluated the thickness of the thickest stone shell (< 1mm is the thin stone shell, 1 ~ 2mm is the thicker stone shell, and > 2mm is the stone shell). Finally, the electronic scale weighs the weight of the ureteral stent with the wall attached stone shell and the weight of the ureteral stent after the stone shell is completely scraped off. The weight of the wall attached stone shell of each ureteral stent is obtained by subtracting the two. After the two doctors agree, the data are recorded in the special notebook for research and kept by a specially assigned person.

Statistical treatment

Use R 3.4.3 for all data (https://www.r-project.org)And R studio 1.1.385 (https://www.rstudio.com)Statistics and analysis of the data, in which the measurement data, such as age, stone shell weight, etc., are expressed by mean ± standard deviation ($\bar{x}\pm s$). Firstly, Shapiro Wilk test is used to conform to the normal distribution, and then two groups of independent sample t-test are used for statistical test, if it does not conform to the normal distribution, the Wilcoxon rank test is used. The comparison of counting data, such as stone shell formation rate, thickness, gender, etc., is expressed in percentage (%), using chi square (χ^2) Fisher's exact rate was used for those with single item < 4 cases. The test results showed that the difference was statistically significant (P < 0.05).

Results

In the experimental group, 129 ureteral stents were pulled out, of which 7 patients had thin stone shells (the thickness of the thickest part was < 1mm), and 4 patients had thicker stone shells (the thickness of the thickest part was 1 ~ 2mm). The overall stone shell formation rate was about 8.53%, and the average weight of the wall attached stone shell was 0.8521 ± 0.1952 G. In the control group, 134 ureteral stents were pulled out, including 21 patients with thin stone shells and 9 patients with thick stone shells. The overall stone shell formation rate was 22.39%, and the average weight of wall attached stone shells was 1.7823 ± 0.1802 G. Both groups of patients successfully pulled out the ureteral stent at one time, without thick stone shell, ureteral stent displacement, ureteral stent incarceration and so on. After oral administration of potassium sodium hydrogen citrate granules, the formation rate of stone shell attached to ureteral stent was lower in the two groups($\chi 2 = 8.5717$, P = 0.0034), and the formed wall stone shell is thinner($\chi 2 = 9.7144$, P = 0.0078) and the average weight of the wall attached stone shell is lighter (t = -40.143, P = 0.0000). The difference is statistically significant (P < 0.01). (Tables 2-4) for details.

Table 2: *Comparison of stone shell formation rate.*

	Stone shell	No stone shell
Experience Group(n=129)	11	118
Control Group(n=134)	30	104
χ^2	8.5717	
P	0.0034	

Therefore, it can be considered that oral administration of potassium sodium hydrogen citrate particles as required during the pre-setting of ureteral stent before ureteroscopic lithotripsy can effectively reduce the risk of the formation of mural stone shell of ureteral stent, reduce the weight and thickness of mural stone shell, and benefit patients who need to pre-set ureteral stent for 3 weeks or more.

Table 3: *Comparison of stone shell thickness.*

	Thicker stone shell	Thin stone shell	No stone shell
Experience Group (n=129)	4	7	118
Control Group (n=134)	9	21	104
χ^2	8.5717		9.7144
P	0.0034		0.0078*
*Fisher exact rate			

Table 4: *Comparison of stone shell weight.*

	Stone shell weight(g)
Experience Group(n=129)	0.8521 ± 0.1952
Control Group(n=134)	1.7823 ± 0.1802
t	-40.143
P	0.0000
Shapiro-Wilk, the weight of stone shell conforms to normal distribution (P>0.05)	

Discussion

At present, transurethral ureteroscopic holmium laser lithotripsy is one of the most important methods for the treatment of stones below 2cm in the upper segment of renal calyces, renal pelvis and ureter [10]. The wide clinical application of the new combined ureteral zebra flexible mirror solves many embarrassing situations such as high use cost, easy equipment damage, long maintenance cycle and high maintenance cost of the traditional ureteral flexible mirror [11]. With the application of ureteral guide sheath, it not only reduces the pressure in the renal pelvis during operation, but also facilitates the movement of the mirror body and the discharge of crushed stone debris, but also improves the efficiency of lithotripsy and the safety of operation, so that the ureteral guide sheath has been widely popularized and applied in the field of renal and ureteral stone lithotripsy [12,13]. However, because the ureter diameter is about 0.3-0.6cm, the success rate of phase I placement of F12 ~ 14 ureteral guide sheath still needs to be preset 2 ~ 3 weeks before operation. In a small number of patients, the ureteral stent was left in the body for about 3 weeks, and there may be the formation of mural stone shell [14]. Although most of the mural stone shells are small flake and mossy calcium salt deposits with soft texture, which can be easily removed by ureteroscopy, the texture of some ureteral stent mural

stone shells will gradually harden and increase in thickness from the second week, and may be embedded and unable to be pulled out more than 3 weeks [15,16]. Therefore, how to economically, effectively and safely reduce the risk of stone shell formation of ureteral stent and slow down the progress of stone shell thickness is an urgent problem to be solved in clinic.

Since the first discovery that citrate can be used to treat stones in Germany in 1917, various studies have found that citrate has good curative effect on oxalate stones, urate stones, cystine stones and other stone components [17].

The main mechanism is [18-20]:

- Citrate can directly inhibit the nucleation, growth and aggregation of calcium containing junction crystals.
- Citrate can directly chelate calcium ions to form citrate calcium chelates, so as to reduce the concentration of calcium ions in urine and indirectly reduce the risk of stone formation.
- Alkalize urine, so as to increase the solubility of uric acid and cystine.
- Citrate can be partially metabolized into bicarbonate in the body and increase the alkali load, so as to inhibit the reabsorption of citric acid by renal tubules and increase the concentration of citric acid in urine.

In addition, citric acid, as a physiological substance, theoretically will not produce adverse reactions under conventional doses. Clinically, only a small number of patients have mild gastrointestinal discomfort, and sodium hydrogen citrate preparation can release the same amount of potassium and sodium ions, which will not cause electrolyte turbulence in theory [21].

Conclusion

The results of this study show that potassium sodium hydrogen citrate particles can be used as an economic, effective and safe drug to reduce the formation of stone shell attached to ureteral stent and slow down the progress of stone shell thickness, which is worthy of clinical promotion.

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