Success rate and trauma degree of three minimally invasive operating methods URL, MPCNL and RLU for upper ureteral calculi

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ABSTRACT

Objective: To analyze the success rate and trauma extent of three minimally invasive operating methods URL, MPCNL and RLU for upper ureteral calculi. Methods: According to different operating methods, 138 patients with upper ureteral calculi were divided into transurethral ureteroscopic lithotripsy (URL) group (n=48), minimally invasive percutaneous nephrolithotomy (MPCNL) group (n=50) and retroperitoneal laparoscopic ureterolithotomy (RLU) group (n=40). Differences in one-time calculus removal success rate, postoperative trauma degree and so on were compared among the three groups after treatment. Results: One-time stone-free rate of MPCNL group and RLU group were significantly higher than that of URL group. Inflammatory factors TNF-α, PCT, IL-1β and IL-8 content in serum of RLU group and URL group were lower than those of MPCNL group; immunoglobulin and complement IgG, IgM, IgA, C3 and C4 content in serum were significantly higher than those of MPCNL group; endocrine hormones NE, ACTH and Cor content in serum were lower than those of MPCNL group; pain mediators β-EP, NGF, CGRP, 5-HT, SP and PGE2 content in serum were lower than those of MPCNL group. Conclusions: RLU has the advantages of both high efficiency in calculus removal and small trauma, and it is the ideal operating method for clinical treatment of upper ureteral calculi.

1. Introduction

Upper ureteral calculi are the most common type of urinary tract calculi, and the calculus removal by minimally invasive surgery is an ideal treatment for patients who fail after changing dietary habit and taking drugs to remove calculus[1]. Transurethral ureteroscopic lithotripsy (URL), minimally invasive percutaneous nephrolithotomy (MPCNL) and retroperitoneal laparoscopic ureterolithotomy (RLU) are ureteroscopic lithotripsy with extensive clinical development, the calculus removal effect and the trauma caused to patients are different, and it remains controversial which method should be preferred in clinical application[2]. In the study, patients with upper ureteral calculi in our hospital were selected as the research subjects, the above three operating methods were applied to them, and the differences in the calculus removal effect and the trauma caused to patients of the three operating methods were mainly elaborated.

2. Materials and methods

2.1. General information

A total of 138 patients with upper ureteral calculi treated in our hospital between April 2014 and April 2016 all received minimally invasive lithotomy, and the inclusion criteria were: (1) diagnosed with upper ureteral calculi by B ultrasound and with pain and other typical clinical criteria; (2) whose constitution could tolerate surgical trauma; (3) did not receive other surgical treatment 3 months before operation; (4) who signed informed consent. Exclusion criteria were: (1) with congenital ureteral anatomic abnormalities; (2) with systemic or local renal and ureteral acute infectious diseases;
were comparable.

difference in the distribution of gender and age (P>0.05) and they were comparable.

2.2. Treatment methods

For transurethral ureteroscopic lithotripsy (URL) group, the specific operating method was as follows: patients took lithotomy position after epidural anesthesia, ureteroscope was inserted in the affected side of ureter through urethra and moved upward until reaching the place with calculi, the stone form and size were observed and then pneumatic lithotripsy was adopted (under low-pressure perfusion). The larger stones were taken out, and smaller fragments were washed with water. For patients combined with ureteral polyps, clamps were used to remove the polyps. Double J tube (5F) was routinely indwelled after operation, B ultrasonic review was conducted 1 week after operation and the calculus removal success rate was recorded. For minimally invasive percutaneous nephrolithotomy (MPCNL) group, the specific operating method was as follows: patients took lithotomy position after epidural anesthesia, retrograde ureteral catheterization was conducted, patients were changed to prone position, the needle was inserted from the 11th rib between linea scapularis and posterior axillary line, and then guided by B ultrasound to puncture in middle renal calyx, percutaneous renal channel was expanded along the guide wire, and 16-18 F Peel-away sheath was indwelled. Ureteroscope was inserted in the channel to find the renal pelvis and enter into the ureter. The location of calculi was found, then expanding sheath was used to press against the calculi and pneumatic lithotripsy was conducted. Subsequent processing method was the same as that of URL group. B ultrasonic review was conducted 1 week after operation and the calculus removal success rate was recorded.

For retroperitoneal laparoscopic ureterolithotomy (RLU) group, the specific operating method was as follows: after tracheal intubation under general anesthesia, retroperitoneum was established and cannulas were placed. The laparoscope was inserted from above iliac spine, air was inflated to maintain abdominal pressure between 12-15 mmHg, the laparoscope was moved on the dorsal part of inferior pole of kidney and along the psoas major surface to find the ureter, and those with hard matter feeling after clamping local distention could immediately be identified as calculi. The proximal calculi were clamped to prevent them from moving up, ureteral wall was longitudinally incised, and the stones were dissociated, loosened and then removed completely. During operation, low-energy electrocautery was used to stanch the hemorrhagic spots, epidural catheter was used for support, double J tubes (F6) were inserted from the distal ureteral incision to the bladder, the epidural catheter was pulled out and the double J tubes were moved up and inserted to the renal pelvis. Absorbable suture was used to seam the ureteral incision, retroperitoneal drainage tube was indwelled and abdominal incision was seamed. B ultrasonic review was conducted 1 week after operation and the calculus removal success rate was recorded.

2.3. Peripheral blood indexes

24 h after surgery, 3 mL of cubital venous blood was collected from three groups of patients, and 1ml was directly used to detect the levels of immunoglobulin and complement, including IgG, IgM, IgA, C3 and C4. The remaining 2 mL was let stand at room temperature for 1h and centrifuged at low speed (1 500 r/min) for 10 min, and then the following indexes were detected: (1) inflammatory factors: using ELISA was used to detect tumor necrosis factor-α (TNF-α), procalcitonin (PCT), interleukin-1β (IL-1β) and interleukin-8 (IL-8) content; (2) endocrine hormones: radioimmunoassay was used to detect norepinephrine (NE), adrenocorticotropic hormone (ACTH) and cortisol (Cor) content; (3) pain mediators: 5-hydroxytryptamine (5-HT), substance P (SP) and prostaglandin E2 (PGE2) content.

2.4. Statistical methods

Data in the study was input in software SPSS23.0, measurement data analysis between two groups was performed by t test and P<0.05 indicated statistical significant differences.

3. Results

3.1. Calculus removal success rate

One-time stone-free rate of RLU group was 92.50% (37/40), one-time stone-free rate of URL group was 68.75% (33/48) and one-time stone-free rate of MPCNL group was 92.0% (46/50). One-time stone-free rate of MPCNL group and RLU group were significantly higher than that of URL group, and differences were statistically significant (P<0.05).

3.2. Inflammatory factors

Differences in TNF-α, PCT, IL-1β and IL-8 content in serum

(3) associated with autoimmune deficiencies; (4) with malignant tumor diseases; (5) pregnant or breastfeeding women. According to different operating methods they received, the included patients were divided into URL group (n=48), MPCNL group (n=50) and RLU group (n=40). URL group included 26 male cases and 22 female cases that were 27-61 years old and (40.18±8.95) years old in average; MPCNL group included 27 male cases and 23 female cases that were 25-59 years old and (42.71±9.82) years old in average; RLU group included 23 male cases and 17 female cases that were 28-61 years old and (41.05±8.74) years old in average. The three groups of research subjects showed no statistically significant difference in the distribution of gender and age (P>0.05) and they were comparable.
were statistically significant among three groups (P<0.05), TNF-α, PCT, IL-1β and IL-8 content in serum of RLU group and URL group were significantly lower than those of MPCNL group and differences were statistically significant (P<0.05), and differences in TNF-α, PCT, IL-1β and IL-8 content in serum were not statistically significant between RLU group and URL group (P>0.05), shown in Table 1.

### Comparison of pain mediator content in serum among three groups

#### Table 3

<table>
<thead>
<tr>
<th>Groups</th>
<th>Case No.</th>
<th>NE</th>
<th>ACTH</th>
<th>Cor</th>
</tr>
</thead>
<tbody>
<tr>
<td>RLU</td>
<td>40</td>
<td>92.74±9.15</td>
<td>54.38±6.11</td>
<td>34.27±4.05</td>
</tr>
<tr>
<td>MPCNL</td>
<td>50</td>
<td>132.74±15.94</td>
<td>103.27±11.85</td>
<td>101.83±14.71</td>
</tr>
<tr>
<td>URL</td>
<td>48</td>
<td>91.38±9.74</td>
<td>58.94±6.74</td>
<td>36.95±4.52</td>
</tr>
</tbody>
</table>

Note: *vs. MPCNL group, P<0.05.

### 3.5. Pain mediators

Differences in β-EP, NGF, CGRP, 5-HT, SP and PGE_2 content in serum were statistically significant among three groups (P<0.05), β-EP, NGF, CGRP, 5-HT, SP and PGE_2 content in serum of RLU group and URL group were significantly lower than those of MPCNL group and differences were statistically significant (P<0.05), and differences in β-EP, NGF, CGRP, 5-HT, SP and PGE_2 content in serum were not statistically significant between RLU group and URL group (P>0.05), shown in Table 4.

### 4. Discussion

Some of the upper ureteral calculi belong to impacted stones, such stones require complex calculus removal process, are with low probability of complete calculus removal and cause bigger intraoperative trauma, and the most reasonable way of minimally invasive surgery needs to be chosen to ensure operation effect and patients’ treatment safety. Transurethral URL, MPCNL and RLU are the mainstream ways for treatment of upper ureteral calculi, the calculus removal of above three surgical treatments were recorded in the study at first, and it was found that one-time stone-free rate of MPCNL group and RLU group were higher, showing that the URL still has defects in the calculus removal effect. URL is operated through the natural urethra-ureter channel, and when it is used to handle upper ureteral calculi that are high in position (especially associated with ureter polyps, stenosis and other complex situations), difficulty in inserting ureteroscope causes that the ureteroscope cannot reach the targeted location, or it is easily pushed into the renal pelvis after reaching the calculus and leads to failure of operation, which are also the main reasons for the lower calculus removal success rate of the operating method in above study[3].

#### Table 2

Comparison of immunoglobulin and complement content among three groups (g/L).

<table>
<thead>
<tr>
<th>Groups</th>
<th>Case No.</th>
<th>IgG</th>
<th>IgM</th>
<th>IgA</th>
<th>C3</th>
<th>C4</th>
</tr>
</thead>
<tbody>
<tr>
<td>RLU</td>
<td>40</td>
<td>9.23±0.91</td>
<td>1.32±0.15</td>
<td>2.01±0.25</td>
<td>1.09±0.14</td>
<td>0.31±0.04</td>
</tr>
<tr>
<td>MPCNL</td>
<td>50</td>
<td>6.12±0.71</td>
<td>0.73±0.08</td>
<td>0.79±0.08</td>
<td>0.57±0.06</td>
<td>0.18±0.02</td>
</tr>
<tr>
<td>URL</td>
<td>48</td>
<td>9.45±0.98</td>
<td>1.29±0.14</td>
<td>1.95±0.24</td>
<td>1.01±0.12</td>
<td>0.29±0.03</td>
</tr>
</tbody>
</table>

Note: *vs. MPCNL group, P<0.05.

#### Table 4

Comparison of pain mediator content in serum among three groups.

<table>
<thead>
<tr>
<th>Groups</th>
<th>Case No.</th>
<th>β-EP(ng/L)</th>
<th>NGF(ng/L)</th>
<th>CGRP(ng/L)</th>
<th>5-HT(μg/L)</th>
<th>SP(ng/L)</th>
<th>PGE_2(ng/L)</th>
</tr>
</thead>
<tbody>
<tr>
<td>RLU</td>
<td>40</td>
<td>84.29±9.12</td>
<td>47.15±5.79</td>
<td>60.37±7.12</td>
<td>85.24±9.97</td>
<td>116.97±15.43</td>
<td>92.18±10.12</td>
</tr>
<tr>
<td>MPCNL</td>
<td>50</td>
<td>112.74±14.82</td>
<td>68.64±7.21</td>
<td>85.41±9.04</td>
<td>125.74±16.29</td>
<td>159.73±18.54</td>
<td>142.43±18.73</td>
</tr>
<tr>
<td>URL</td>
<td>48</td>
<td>89.35±9.67</td>
<td>48.86±5.31</td>
<td>62.48±7.88</td>
<td>83.68±9.72</td>
<td>112.42±17.89</td>
<td>94.76±10.53</td>
</tr>
</tbody>
</table>

Note: *vs. MPCNL group, P<0.05.
In order to further clarify the trauma caused by three kinds of operation methods to patients, it was specifically studied from four branches: inflammatory factors, immunoglobulin and complement, endocrine hormones, pain mediators. Surgical trauma is directly related to the acuteness degree of postoperative inflammatory reaction in the body, and many studies have shown that severe trauma can lead to early postoperative SIRS in patients. In the study, inflammatory factors TNF-α, PCT, IL-1β and IL-8 content in serum of three groups of patients were detected, and it was found the levels of above inflammatory factors of RLU group and URL group were lower 24 h after operation, indirectly showing that RLU and URL cause less trauma to the patients, but complete determination of this conclusion still needs the proof of further research. Another big reaction brought by the body trauma is the suppression of patients’ immune function, including cellular immunity and humoral immunity. Both immunoglobulin and complement are the important parts of the body’s humoral immune. In the study, early postoperative IgG, IgM, IgA, C3 and C4 content of RLU group and URL group were higher, showing that the humoral immune function of above two kinds of patients are less suppressed after operation, which is one of the specific manifestations of less surgical trauma.

Traumatic surgery will cause stress response in the body and abnormal levels of related endocrine hormones. NE, ACTH and Cor are the most commonly studied stress hormones at present, and it has been confirmed that the when patients are in stress state, NE, ACTH and Cor content rise sharply, and the rising degree is consistent with the degree of stress[9,10]. In the study, NE, ACTH and Cor content in serum of RLU group and URL group were lower, indicating that the stress state caused by surgical trauma is lighter, and MPCNL, on the contrary, can cause massive early postoperative secretion of stress hormones, and its minimal invasion is inferior to that of other two treatments. During the removal of ureteral calculi, retraction of the ureter or adjacent organs can all stimulate the secretion of central and peripheral pain mediators, they cause severe perception of pain, pain may directly lead to the severe stress reaction and inflammatory cascade reaction in patients, and it is one of the most concerned adverse reactions in patients with upper ureteral calculi[11,12]. In the study, pain mediators β-EP, NGF, CGRP, 5-HT, SP and PGE2 content in serum of three groups of patients were detected, and it was found that early postoperative β-EP, NGF, CGRP, 5-HT, SP and PGE2 content in serum of RLU group and URL group were lower, indicating that after RLU and URL, patients’ perception of pain is lighter, and the degree of secondary stimulation to inflammation and stress response also decreases. MPCNL requires the establishment of percutaneous renal channel and is with the risk of massive hemorrhage and urine-derived septicemia, and for the calculi far from renal pelvis, renal parenchyma tear and other severe complications can even occur during the operation, which is also the main reason for its unsatisfactory surgical traumatic indexes[13–15].

To sum up, the following conclusion can be reached: RLU is with higher calculus removal success rate and small surgical trauma, it is the ideal operating method for patients with upper ureteral calculi and it is worth popularization and application in clinical practice in the future.

References