Comparison of the curative effect and serum indexes of ultrasonic pneumatic and holmium laser technology for percutaneous nephrolithotomy treatment of complex renal calculus

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Objective: To study the differences in the curative effect and serum indexes of ultrasonic pneumatic and holmium laser technology for percutaneous nephrolithotomy treatment of complex renal calculus. Methods: A total of 78 patients with complex renal calculus who accepted surgical treatment in our hospital between May 2011 and January 2016 were collected, the operation methods and test results were reviewed, and then they were divided into the observation group (n=34) who accepted ultrasonic pneumatic treatment and the control group (n=44) who accepted holmium laser treatment. I stage stone clearance rate of two groups of patients were recorded; serum was collected, sarcosine oxidase method was used to detect serum renal function indexes, and ELISA method was used to detect the levels of inflammatory factors and stress hormones. Results: The mean lithotomy time of observation group was shorter than that of control group; differences in I stage stone clearance rate were not statistically significant between two groups of patients. 3 d after operation, serum renal function indexes Scr, BUN and CysC levels of observation group were lower than those of control group; serum inflammatory factors PCT, IL-1β, IL-22 and IL-13 levels of observation group were lower than those of control group while IL-4 level was higher than that of control group; serum stress hormones Ang I, Ang II, Adr and NE levels of observation group were lower than those of control group. Conclusion: Both ultrasonic pneumatic and holmium laser technology can effectively remove complex renal calculus and ultrasonic pneumatic technology has the advantages of quicker operation and less injury.

1. Introduction

Complex renal calculus is with high clinical incidence, sometimes it can block the urinary tract and cause pain and hydronephrosis, and serious cases may even cause uremia and kidney neoplasms[1,2]. Conservative treatment has little effect on complex renal calculus, and percutaneous nephrolithotomy is the most reliable. Percutaneous nephrolithotomy mainly includes ultrasonic pneumatic lithotripsy and holmium laser lithotripsy, and there is no unified conclusion about the curative effect comparison between the two[3,4]. In the study, the differences in the curative effect and serum indexes of ultrasonic pneumatic and holmium laser technology for percutaneous nephrolithotomy treatment of complex renal calculus were analyzed.

2. Information and methods

2.1 General information

A total of 78 patients with complex renal calculus who accepted surgical treatment in our hospital between May 2011 and January 2016 were selected, and the patients themselves signed the informed consent. The operation methods and test results were...
approved by the hospital ethics committee. Laser fiber gently reach the stones through ureteroscope and break the holmium laser lithotriptor energy frequency was set to make the stones were searched and positioned under nephroscope, and establish kidney tract was the same as that of observation group, holmium laser treatment, specifically as follows: the method to F22 standard channel was used. Control group of patients accepted nephrolithotomy (EMS Company in Switzerland) was adopted, and immediately into the renal pelvis. Percutaneous ultrasonic pneumatic was indwelled at last, and after removal, ureteroscope was inserted for expansion step by step, the expander with sheath (F16) was expanded and established, the guide wire and fascia dilator were pulled out indicated successful puncture. Percutaneous renal channel with stones to the pelvis, and urine outflow after the needle was substernal line, the needle was punctured from the kidney calyces from the area between 11th intercostal posterior auxiliary line and raised and arched, B-ultrasoound was indwelled for retrograde injection. Patients were put in prone position with the waist raised and arched, B-ultrasound was used to position the stones, a rational puncture point was selected from the area between 11th intercostal posterior auxiliary line and subcapular line, the needle was punctured from the kidney calyces with stones to the pelvis, and urine outflow after the needle was pulled out indicated successful puncture. Percutaneous renal channel was expanded and established, the guide wire and fascia dilator were inserted for expansion step by step, the expander with sheath (F16) was indwelled at last, and after removal, ureteroscope was inserted immediately into the renal pelvis. Percutaneous ultrasonic pneumatic nephrolithotomy (EMS Company in Switzerland) was adopted, and F22 standard channel was used. Control group of patients accepted holmium laser treatment, specifically as follows: the method to establish kidney tract was the same as that of observation group, the stones were searched and positioned under nephroscope, and the holmium laser lithotriptor energy frequency was set to make the laser fiber gently reach the stones through ureteroscope and break the stones from the edge. High-pressure water was used to flush the crushed stone out of body, alligator forceps were used to remove the larger stones, and F6 double J tube was indwelled after operation. The mean lithotomy time of two groups of patients were recorded during operation; 3 d after operation, two groups of patients accepted B ultrasound again to clarify stage stone clearance rate.

2.4 Serum index detection methods

3 d after operation, 2 mL of fasting venous blood was collected from two groups of patients, anti-coagulated, let stand at room temperature over night, and centrifuged at low speed to get supernatant, and the following indicators were detected: (1) renal function indexes: sarcosine oxidase method was used to determine serum creatinine (Scr), blood urea nitrogen (BUN) and cystatin C (CysC) levels; (2) inflammatory factors: enzyme-linked immunosorbent assay (ELISA) was used to determine serum inflammatory factors procalcitonin (PCT), interleukin-4 (IL-4), interleukin-1 β (IL-1 β ), interleukin-22 (IL-22) and interleukin-13 (IL-13) levels; (3) stress hormones: ELISA method was used to detect serum levels of stress hormones angiotensin I (Ang I ), angiotensin II (Ang II), adrenaline (Adr) and norepinephrine (NE).

2.5 Statistical methods

SPSS 18.0 software was used for statistical processing, measurement data was in terms of mean ± standard deviation (Mean ± SD) and comparison between two groups was by group t test; count data was in terms of rate and comparison between two groups was by χ² test. P<0.05 indicated statistical significance in differences.

3. Results

3.1 Mean lithotomy time and stage stone clearance rate

The mean lithotomy time of observation group was (59.23±8.11) min and the mean lithotomy time of control group was (81.57±10.74) min; stage stone clearance rate of observation group was 82.35%(28/34) and stage stone clearance rate of control group was 81.82%(36/44). The mean lithotomy time of observation group was shorter than that of control group, and differences between groups were statistically significant (P<0.05); differences in stage stone clearance rate were not statistically significant between two groups of patients (P>0.05).
3.2 Renal function indexes

3 d after operation, comparison of serum renal function indexes Scr (μmol/L), BUN (mmol/L) and Cys C (mg/L) between two groups of patients was as follows: serum renal function indexes Scr, BUN and CysC levels of observation group were significantly lower than those of control group. Differences in serum renal function indexes Scr, BUN and CysC levels were statistically significant between two groups of patients 3d after operation ($P < 0.05$), shown in Table 1.

### Table 1.
Comparison of serum renal function index levels after operation.

<table>
<thead>
<tr>
<th>Groups</th>
<th>n</th>
<th>Scr</th>
<th>BUN</th>
<th>CysC</th>
</tr>
</thead>
<tbody>
<tr>
<td>Observation</td>
<td>34</td>
<td>76.38±8.29</td>
<td>6.11±0.75</td>
<td>0.85±0.09</td>
</tr>
<tr>
<td>Control</td>
<td>44</td>
<td>92.47±10.05</td>
<td>9.57±0.98</td>
<td>1.31±0.24</td>
</tr>
<tr>
<td>T value</td>
<td></td>
<td>8.293</td>
<td>6.274</td>
<td>5.973</td>
</tr>
<tr>
<td>P value</td>
<td></td>
<td>&lt;0.05</td>
<td>&lt;0.05</td>
<td>&lt;0.05</td>
</tr>
</tbody>
</table>

3.3 Inflammatory factors

3 d after operation, comparison of serum inflammatory factors PCT (ng/mL), IL-4 (pg/mL), IL-1 $\beta$ (pg/mL), IL-22 (μg/mL) and IL-13 (pg/mL) levels between two groups of patients was as follows: serum inflammatory factors PCT, IL-1 $\beta$, IL-22 and IL-13 levels of observation group were significantly lower than those of control group while IL-4 level was higher than that of control group. Differences in serum inflammatory factors PCT, IL-4, IL-1 $\beta$, IL-22 and IL-13 levels were statistically significant between two groups of patients 3d after operation ($P < 0.05$), shown in Table 2.

### Table 2.
Comparison of serum inflammatory factor levels after operation.

<table>
<thead>
<tr>
<th>Groups</th>
<th>n</th>
<th>PCT</th>
<th>IL-4</th>
<th>IL-1 $\beta$</th>
<th>IL-22</th>
<th>IL-13</th>
</tr>
</thead>
<tbody>
<tr>
<td>Observation</td>
<td>34</td>
<td>0.67±0.08</td>
<td>32.48±4.12</td>
<td>45.62±5.59</td>
<td>4.24±0.56</td>
<td>34.21±4.52</td>
</tr>
<tr>
<td>Control</td>
<td>44</td>
<td>2.12±0.26</td>
<td>19.74±2.75</td>
<td>61.28±6.48</td>
<td>7.13±0.88</td>
<td>49.05±5.18</td>
</tr>
<tr>
<td>P value</td>
<td></td>
<td>&lt;0.05</td>
<td>&lt;0.05</td>
<td>&lt;0.05</td>
<td>&lt;0.05</td>
<td>&lt;0.05</td>
</tr>
</tbody>
</table>

3.4 Stress hormones

3 d after operation, comparison of serum stress hormones Ang I, Ang II, Adr and NE levels between two groups of patients was as follows: serum stress hormones Ang I, Ang II, Adr and NE levels of observation group were significantly lower than those of control group. Differences in serum stress hormones Ang I, Ang II, Adr and NE levels were statistically significant between two groups of patients 3d after operation ($P < 0.05$), shown in Table 3.

### Table 3.
Comparison of serum stress hormone levels after operation (pg/mL).

<table>
<thead>
<tr>
<th>Groups</th>
<th>n</th>
<th>Ang I</th>
<th>Ang II</th>
<th>Adr</th>
<th>NE</th>
</tr>
</thead>
<tbody>
<tr>
<td>Observation</td>
<td>34</td>
<td>5.09±0.62</td>
<td>9.38±0.87</td>
<td>13.28±1.76</td>
<td>37.29±3.02</td>
</tr>
<tr>
<td>Control</td>
<td>44</td>
<td>9.11±0.94</td>
<td>13.54±1.17</td>
<td>19.63±2.15</td>
<td>43.27±4.18</td>
</tr>
<tr>
<td>T value</td>
<td></td>
<td>8.293</td>
<td>7.187</td>
<td>8.192</td>
<td>12.142</td>
</tr>
<tr>
<td>P value</td>
<td></td>
<td>&lt;0.05</td>
<td>&lt;0.05</td>
<td>&lt;0.05</td>
<td>&lt;0.05</td>
</tr>
</tbody>
</table>

4. Discussion

Complex renal calculus treatment has been an urologist difficulty, traditional open surgery causes great trauma, it removes the stones and also causes great damage to normal renal tissue, and patients may develop renal dysfunction and even renal failure after operation[5]. Choosing efficient and safe surgical procedure is the key to the treatment of complex renal calculus, percutaneous nephroscope is the most widely applied clinical surgical procedure and includes nephroscopic ultrasonic pneumatic and holmium laser technologies, and there is no unified conclusion about their specific advantages and disadvantages[6]. Holmium laser is a new type of laser produced by activating ion holmium (HO), the technique is noninvasive or minimally invasive, and the patients are less painful. Ultrasonic pneumatic surgery breaks the stones through ultrasound and also belongs to noninvasive and highly efficient lithotomy[7,8]. In the study, the 1 stage stone clearance rate of two groups of patients were 82.35% and 81.82% respectively, and the stone clearance rate are both high and not significantly different. Percutaneous nephroscopic ultrasonic pneumatic technique includes pneumatic system and ultrasound system, both accomplish the stone-breaking effect by mechanical vibration of probe, the technology can save lithotomy time to a certain extent, and it was also found in the study that compared with control group, the observation group were with shorter mean lithotomy time, which is directly related to the stone-breaking mechanism by vibration of pneumatic ballistic lithotripsy.

The probe in the ultrasonic pneumatic system is a hollow tube, and after connected to the negative pressure device, it breaks the stones and also suck them out into receiving flask in time, which effectively reduces the intraoperative renal parenchyma perfusion pressure, decreases the residual stone movement and radically reduces and even avoids the residual renal calculus damage to the renal parenchyma[9,10]. Many cases reports have shown that patients with renal calculus develop acute renal injury after operation, which is speculated to be associated with intraoperative renal calculus residual, stone residue movement damage to renal parenchyma...
structure etc. Scr and BUN are the most common indexes to judge renal damage function, and their serum levels are positively correlated with renal damage degree; CysC is highly sensitive to renal damage, and serum CysC level may rise in the early damage[11]. In the study, the renal function indexes were compared between two groups of patients, and it was found that compared with control group, the observation group were with lower serum Scr, BUN and CysC levels, confirming that ultrasonic pneumatic surgery causes less damage to renal function of patients with complex renal calculi.

Surgery is an important causative factor for systemic stress reaction, and the bleeding and urinary infection caused by residual renal calculus and stone residue when they are discharged via urethra can further aggravate inflammatory stress reaction[12]. Holmium laser is also a common clinical minimally invasive lithotomy, but it needs to use alligator forceps to remove the larger stones after laser is also a common clinical minimally invasive lithotomy, but it was found in the study that compared with control group, the observation group were with lower serum Scr, BUN and CysC levels, confirming that ultrasonic pneumatic surgery causes less damage to renal function of patients with complex renal calculi.

In the study, serum inflammatory factor levels were compared between two groups of patients, and it was found that compared with control group, the observation group were with lower serum levels of pro-inflammatory factors PCT, IL-1β, IL-22 and IL-13, and higher levels of anti-inflammatory factor IL-4, confirming that the ultrasonic pneumatic operation can more effectively maintain the body’s inflammatory system balance and avoid the excessive production of pro-inflammatory factor, and it is more advantageous than holmium laser technology.

Systemic inflammation can stimulate the body’s hypothalamus-renin-angiotensin system and lead to the massive production of Ang I, Ang II, Adr, NE and other stress hormones[14]. Under stress state, the immunity is weakened and loses the control to the inflammatory response, and stress hormones accelerate the decomposition of proteins, which lead to difficult postoperative recovery of wound and the elevated incidence of postoperative infection events[15]. Serum levels of stress hormones can directly reflect the body’s stress state and indirectly reflect the surgical trauma, and it was found in the study that compared with control group, the observation group were with lower serum levels of stress hormones Ang I, Ang II, Adr and NE, confirming again that ultrasonic pneumatic operation can more effectively protect kidney tissues and reduce the systemic stress response and postoperative adverse reactions caused by surgical trauma.

To sum up, it is concluded that ultrasonic pneumatic treatment of patients with complex renal calculus is with positive curative effect, causes less operation wound, is a more reasonable surgical method and is worth popularization and application in clinical practice in the future.

References