Original Article

Ultrasound-guided percutaneous intracystic deroofing is effective in the treatment of simple renal cysts

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Received April 3, 2023; Accepted August 10, 2023; Epub August 15, 2023; Published August 30, 2023

Abstract: Objective: To investigate the efficacy and safety of ultrasound-guided percutaneous intracystic deroofing for the treatment of simple renal cysts. Methods: A retrospective study was conducted to analyze the clinical data of 46 patients with dorsal exophytic simple renal cysts treated at the First Affiliated Hospital of Nanchang University between February 2017 and June 2022. The patients were divided into two groups according to the surgical method, with 20 cases undergoing ultrasound-guided percutaneous intracystic deroofing being assigned to the observation group and 26 cases treated by retroperitoneal laparoscopic renal cyst removal included in the control group. The operation time, blood loss, postoperative catheterization time, postoperative drainage tube indwelling time, postoperative hospital stay, and complications were compared. Results: None of the 46 patients converted to open surgery. The observation group showed significantly less blood loss, shorter operation time, drainage tube drainage time, postoperative hospital stay, and complications were compared. Results: None of the 46 patients converted to open surgery. The observation group showed significantly less blood loss, shorter operation time, drainage tube drainage time, postoperative hospital stay, and complicated catheterization time than the control group (all P<0.05). The two procedures had a success rate of 100%. There were no statistical significances in K⁺, Na⁺, or serum creatinine between the two groups (all P>0.05). All patients were followed up (3 to 6 months) after surgery, and no cyst recurrence was found by imaging examination. Conclusions: Ultrasound-guided percutaneous intracystic deroofing of renal cysts is worthy of clinical application in the treatment of simple renal cysts due to its significant advantages such as short operation time, less trauma, quick recovery, safety, effectiveness, and low cost.

Keywords: Percutaneous nephroscopy, renal cyst, intracapsular deroofing, laser

Introduction

Simple renal cyst is a common benign renal disease [1, 2]. With increasing awareness of physical examination and advances in diagnostic equipment and techniques, the detection rate of renal cysts is getting higher [3]. Surgery is currently the main method to treat renal cysts, mainly including open surgery, retroperitoneal laparoscopic resection, percutaneous renal cyst aspiration plus sclerotherapy injection, and flexible ureteroscopic incision and internal drainage [4-7], among which retroperitoneal laparoscopic renal cyst decortication of the lower renal cysts, by virtue of less trauma, quick recovery, and good curative effects, is currently the preferred method for the treatment of simple renal cysts [8-10]. However, this method has limitations such as reduced operation field of the retroperitoneal approach and high requirements for the operator’s anatomic familiarity [11]. As medical technology constantly develops, percutaneous intracystic deroofing of renal cysts has been used in clinical practice and achieved significant curative effects [5]. This study retrospectively analyzed the clinical data of 20 cases of percutaneous renal cyst deroofing and 26 cases of laparoscopic renal cyst deroofing during the same time period to compare the efficacy of the two methods. The innovation of this study lies in the following points: the two surgical methods are confirmed to be equivalent in terms of clinical efficacy and postoperative safety; second, from the point of view of surgery-related recovery indicators, it was validated that ultrasound-guided percutaneous intracystic deroofing contributes to less operation time, intraoperative blood loss, postoperative drainage indwelling time, catheter retention time, and postopera-
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tive hospital stays, as well as fewer channels
dilated intraoperatively and better surgical
effect. Finally, it was confirmed from the per-
spective of electrolyte indicators that the two
surgical modalities did not cause electrolyte
disturbance. From the above points of view, we
can see that ultrasound-guided percutaneous
intracystic deroofing has advantages in surgical
effects.

Materials and methods

Clinical data

The clinical data of 46 patients with renal cysts
who were treated at the First Affiliated Hospital of
Nanchang University between February 2017 and June 2022 were collected retrospec-
tively. Among them, there were 20 cases under-
going ultrasound-guided percutaneous intra-
cystic deroofing (observation group), including
12 males and 8 females, aged 32 to 98, with
an average age of 52 years; the renal cysts
were 4.1 to 9.7 cm in diameter, with an average
of 5.7 cm. There were 26 cases treated by ret-
roperitoneal laparoscopic renal cyst removal
(control group), including 15 males and 11
females, aged 35 to 81, with an average age of
54 years; the diameter of renal cysts was 4.0 to
8.7 cm, with a mean of 5.5 cm.

Inclusion criteria: all patients were diagnosed
with simple renal cysts by preoperative routine
urinary B-ultrasound, intravenous urography
(IVU), and enhanced bilateral renal Computed
Tomography (CT) scan [12]; renal cyst diameter
was >4 cm; cysts were not associated with the
renal collection system; treatment-naive renal
cyst patients; Bosniak grade was grade I with
dorsal exophytic renal cysts. Exclusion criteria:
patients with serious heart, liver, lung and brain
diseases; surgical contraindications such as
coagulation disorders; renal cystic renal cell
carcinoma; renal cyst infection; or immune sys-
tem disorders.

The study was approved by the ethics commit-
tee of the First Affiliated Hospital of Nanchang
University.

Surgical methods

Percutaneous renal cyst deroofing (observation group): After general intravenous anesthe-
sia with the patient placed in a prone position
and catheter indwelling, skin preparation and
draping were routinely performed, and a surgi-
cal membrane was affixed. Under the guidance
of a color Doppler ultrasound instrument
(Shanghai Hanfei Medical Instrument Co., Ltd.,
E8), the renal cyst was punctured at the center
of the renal cyst, the needle core was pulled
out, and the cyst fluid discharged. The renal
puncture guide wire was then inserted along
the needle sheath, after which the needle
sheath was withdrawn. The skin was cut at the
puncture point with a sharp knife about 0.6~0.8
cm. Guided by a wire, the F8 fascia dilator was
used to dilate the fascia, after which a Cook
F20 tear sheath was directly inserted. After
that, an ureteroscope was inserted into the
sheath to check for tumors or hemorrhage in
the cyst and to distinguish the boundary
between the renal parenchyma and the cyst
wall. Next, the outer sheath was withdrawn to
the lateral side of the renal cyst, and the outer
sheath and the endoscope were used to disso-
ciate along the surface of the renal cyst to
the junction of the cyst and the renal parenchyma
and then re-entered the cyst using a 550 µm
laser fiber (2.5 J/30 Hz) every 1 cm. The bound-
ary between the renal parenchyma and the cyst
wall was marked, and the cyst wall was com-
pletely excised along the marked point with an
optical fiber and removed using a peeling
sheath (Figure 1A-D). When there was no obvi-
ous active bleeding in the visual field, the F12
nephrostomy tube was indwelled and properly
fixed, and was removed 1 to 2 days later.

Retroperitoneal laparoscopic renal cyst remov-
al (control group): After general intravenous
anesthesia, the patient was placed in a jack-
knife position on the contralateral side.
Catheterization was performed with the cathe-
ter being, 10 mm, 5 mm, and 5 mm at the iliac
crest 2 cm above the midline of the contralat-
eral subaxilla (10 mm catheter), below the cos-
tal margin on the anterior axillary line (5 mm
catheter), and below the twelfth costal margin
of the posterior axillary line (5 mm catheter),
respectively. Pneumoperitoneum was then
established with Trocar and the pressure was
set at 10-14 mmHg. After that, a laparoscopic
operating instrument was placed to separate
the perirenal fascia and adipose tissue to
reveal the renal cyst. After complete dissocia-
tion, the cyst wall was excised circularly at a
distance of about 5 mm from the renal paren-
chyma using an ultrasonic knife.
Outcome measures and efficacy evaluation

The operation process, operation time, blood loss, urinary catheter retention time, postoperative drainage tube indwelling time, postoperative hospital stay, number of channels dilated intraoperatively, perioperative complications, perioperative serum electrolyte changes and prognosis were recorded and compared between the two groups. Treatment efficacy was evaluated as follows: Cured: The cyst disappeared or the diameter was less than 1 cm three months after ultrasound or CT review, with no recurrence or growth during the follow-up; Effective: The cyst diameter was reduced by more than 50% of the original diameter; Ineffective: The cyst did not shrink or grow.

In addition, except for perioperative serum electrolyte change, which was a secondary outcome measurement, the other indexes were the primary ones in this study.

Statistical methods

Data were processed using SPSS17.0 statistical software. Measured data were expressed by mean ± standard deviation (x ± s), and t-test was used for comparison between groups. Counted data, represented by the number of cases (n), were compared by the chi-square test. P<0.05 was considered significant.

Results

Baseline data

As shown in Table 1, the observation group (n=20) and the control group (n=26) were not statistically different in baseline data such as age, sex, renal cyst diameter, smoking history, alcoholism history, or marital status (all P>0.05).
Ultrasound-guided renal cyst deroofing

**Table 1. Comparison of baseline data between the two groups**

<table>
<thead>
<tr>
<th></th>
<th>Observation group (n=20)</th>
<th>Control group (n=26)</th>
<th>χ²/t value</th>
<th>P</th>
</tr>
</thead>
<tbody>
<tr>
<td>Age (years)</td>
<td>52.70±9.81</td>
<td>54.58±12.61</td>
<td>0.550</td>
<td>0.585</td>
</tr>
<tr>
<td>Sex (male/female)</td>
<td>12/8</td>
<td>15/11</td>
<td>0.025</td>
<td>0.875</td>
</tr>
<tr>
<td>Renal cyst diameter (cm)</td>
<td>5.71±1.13</td>
<td>5.50±1.26</td>
<td>0.586</td>
<td>0.561</td>
</tr>
<tr>
<td>Smoking history (yes/no)</td>
<td>6/14</td>
<td>9/17</td>
<td>0.110</td>
<td>0.741</td>
</tr>
<tr>
<td>History of alcoholism (yes/no)</td>
<td>5/15</td>
<td>6/20</td>
<td>0.023</td>
<td>0.880</td>
</tr>
<tr>
<td>Marital status (married/single)</td>
<td>14/6</td>
<td>20/6</td>
<td>0.281</td>
<td>0.596</td>
</tr>
</tbody>
</table>

**Table 2. Comparison of overall clinical efficacy between the two groups**

<table>
<thead>
<tr>
<th>Group</th>
<th>No.</th>
<th>Cured</th>
<th>Efficient</th>
<th>Invalid</th>
<th>Total effective rate (%)</th>
</tr>
</thead>
<tbody>
<tr>
<td>Observation group</td>
<td>20</td>
<td>18</td>
<td>2</td>
<td>0</td>
<td>100</td>
</tr>
<tr>
<td>Control group</td>
<td>26</td>
<td>23</td>
<td>3</td>
<td>0</td>
<td>100</td>
</tr>
</tbody>
</table>

Note: Compared to the control group, P>0.05.

**Table 3. Comparison of intraoperative and postoperative indicators between the two groups (X±s)**

<table>
<thead>
<tr>
<th>Group</th>
<th>No.</th>
<th>Operation time (min)</th>
<th>Blood loss volume (ml)</th>
<th>Drain tube time (d)</th>
<th>Catheter retention time (d)</th>
<th>Postoperative hospital stay (d)</th>
<th>Number of channels dilated intraoperatively (n)</th>
</tr>
</thead>
<tbody>
<tr>
<td>Observation group</td>
<td>20</td>
<td>26.5±12.7</td>
<td>2.8±2.1</td>
<td>1.0±0.5</td>
<td>1.3±0.7</td>
<td>2.1±1.6</td>
<td>1</td>
</tr>
<tr>
<td>Control group</td>
<td>26</td>
<td>56.3±13.8</td>
<td>10.9±3.5</td>
<td>2.6±1.8</td>
<td>2.3±1.4</td>
<td>3.4±1.7</td>
<td>3</td>
</tr>
<tr>
<td>χ²/t value</td>
<td></td>
<td>7.513</td>
<td>9.147</td>
<td>3.853</td>
<td>0.006</td>
<td>0.012</td>
<td>0.609</td>
</tr>
<tr>
<td>P</td>
<td></td>
<td>&lt;0.001</td>
<td>&lt;0.001</td>
<td>&lt;0.001</td>
<td>2.921</td>
<td>2.637</td>
<td>0.435</td>
</tr>
</tbody>
</table>

Note: Compared to the control group, *P<0.05.

**Comparison of intraoperative and postoperative indicators**

In the observation group treated by percutaneous renal cyst deroofing, the operation time was (26.5±12.7) min, the intraoperative blood loss was (2.8±2.1) ml, the postoperative drainage tube indwelling time was (1.0±0.5) d, the urinary catheter retention time was (1.3±0.7) d, the postoperative hospital stay was (2.1±1.6) d, and the number of channels dilated intraoperatively was 1. In the control group treated by retroperitoneal laparoscopic renal cyst removal, the operation time was (56.3±13.8) min, the intraoperative blood loss was (10.9±3.5) ml, the postoperative drainage tube indwelling time was (2.6±1.8) d, the urinary catheter retention time was (2.3±1.4) d, the postoperative hospital stay was (3.4±1.7) d, and the number of channels dilated intraoperatively was 3. Statistical differences were observed in operation time, intraoperative blood loss, postoperative hospital stay, postoperative drainage tube indwelling time and postoperative catheterization time between the two groups (all P<0.05). Patients underwent B-ultrasound and double-renal CT plain scan re-examination 3 months after the operation. The results showed an effective rate of 100% in surgery of both groups, with significantly improved or even disappeared symptoms of low back pain. All patients were followed up for 3-24 months, and no case of recurrence of renal cyst was found, as shown in Table 3 and Figures 1E, 1F, and 2.

**Comparison of electrolyte indicators**

There was no significant difference in electrolyte indicators serum potassium (K⁺), serum sodium (Na⁺) and serum creatinine (Scr) between the observation group and the control group (all P>0.05) as shown in Table 4 and Figure 3.

**Discussion**

Simple renal cysts are a common benign renal disease [13]. Surgery can alleviate clinical symptoms and prevent the occurrence of complications, such as pain, bleeding, high blood pressure, infection and cyst compression of the renal parenchyma and collecting system [14-16]. How to achieve optimal therapeutic out-
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comes with minimal trauma is the focus of clinical research. There are many treatment methods for simple renal cysts [17], each with its own advantages and disadvantages. For example, traditional translumbar open roof decompression surgery has been gradually replaced by other minimally invasive procedures due to large trauma, slow postoperative recovery, and long hospital stays. Laparoscopic deroofing of renal cysts, by virtue of less trauma, quick recovery, and good curative effects, is currently the preferred method for the treatment of simple renal cysts, with a success rate of 96.3% [18]. However, this technique requires general anesthesia, long surgical preparation time, establishment of multiple channels, wide surgical anatomy, and skilled endoscopic operation techniques of the operator, which carries the risk of complications such as hypercapnia, subcutaneous emphysema, and postoperative adhesive intestinal obstruction during the operation [19-21]. The recurrence rate after simple percutaneous aspiration and drainage under B-ultrasound guidance is as high as 20% to 80% [22]. Percutaneous renal cyst puncture and sclerotherapy combined with injection sclerotherapy significantly improves the success rate of simple puncture and drainage and has the advantages of less trauma and fast recovery, which

![Figure 2. Comparison of intraoperative and postoperative indicators between the two groups. A. Comparison of operation time between groups. B. Comparison of blood loss volume between groups. C. Comparison of drain tube time between groups. D. Comparison of catheter retention time between groups. E. Comparison of postoperative hospital stay between groups. F. Comparison of number of channels dilitated intraoperatively between groups. Note: Compared to the control group, *P<0.05.](image)

![Table 4. Comparison of electrolyte indicators between the two groups (X ± s)](image)

<table>
<thead>
<tr>
<th>Group</th>
<th>No.</th>
<th>K⁺</th>
<th>Na⁺</th>
<th>Scr</th>
</tr>
</thead>
<tbody>
<tr>
<td>Observation group</td>
<td>20</td>
<td>3.60±0.39</td>
<td>142.07±18.28</td>
<td>71.10±5.76</td>
</tr>
<tr>
<td>Control group</td>
<td>26</td>
<td>3.80±0.29</td>
<td>136.47±17.25</td>
<td>67.05±8.74</td>
</tr>
<tr>
<td>t value</td>
<td></td>
<td>1.996</td>
<td>1.064</td>
<td>1.792</td>
</tr>
<tr>
<td>P</td>
<td></td>
<td>0.052</td>
<td>0.293</td>
<td>0.080</td>
</tr>
</tbody>
</table>

Note: K⁺ is serum potassium, Na⁺ is serum sodium, Scr is serum creatinine.
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contributes to better treatment of small peripheral cysts; however, for endophytic, pararenal and larger cysts, it may result in many complications and a high possibility of recurrence [23].

At present, many scholars have carried out beneficial explorations on the minimally invasive treatment of renal cysts. Choi et al. [24] compared patient profiles, operation time, length of hospital stay, success rate of radiology, improvement of symptoms, treatment cost, and complication rate of the two groups through a controlled study of percutaneous aspirational sclerotherapy (PAS) and laparoscopic decapitation (LM). The results showed a significantly higher radiation success rate in LM group compared with PAS group at the 6-month follow-up (97.5% vs 60%; P<0.001); the symptom improvement rate was comparable (95% vs 90%; P=0.675), and no significant difference was identified in the treatment failure rate (5.0% vs 17.5%; P=0.154). The mean total cost for PAS and LM was $1256 and $2343, respectively (P=0.001). In a randomized study of percutaneous ureteroscopic plasma electrode removal (PCE) and laparoscopic deroofing for the treatment of simple renal cysts, Liu et al. [25] found that the mean operation time and average blood loss in the PCE group were significantly less than those of the laparoscopic group, while the average postoperative indwelling drainage tube time, average indwelling catheter time, and postoperative average hospital stay were comparable. Thus, PCE is a safe, minimally invasive and effective treatment for simple renal cysts. Busato et al. used percutaneous nephroscopic technique to treat 32 patients with Bosniak I and II renal cysts between 1995 and 2008, and the results showed that clinical success rate of symptom improvement was 100%, the mean hospital stay was (21.7±8.5) hours, and the mean operative time was (41.8±19.7) min, with no serious complications [26].

Through mastering percutaneous nephrolithotomy and learning from the successful experience of percutaneous nephroscopic technique in the treatment of simple renal cysts at home and abroad, we creatively proposed a new surgical method of percutaneous intracystic deroofing of renal cysts after careful research and repeated practice, a procedure with the following characteristics: 1. Within the cyst, it is easy to distinguish the boundary between the renal cyst and the renal parenchyma. The renal cyst is relatively transparent with pale yellow adipose tissue at the bottom, while the renal parenchyma is bright red and opaque with no adipose tissue at the bottom. 2. We retract the outer sheath to the outside of the cyst, and use the outer sheath and scope to dissociate along the surface of the renal cyst to the junction of the cyst and the renal parenchyma, so that the cyst is filled with water cushion and separated from other organs to increase the safety of the operation. 3. After removal from the outside of the cyst, the cyst wall is slightly shrunken. After re-entering the cyst, the cyst wall flutters slightly under the scouring of the water flow, making the boundary between the cyst and the renal parenchyma more clearly visible. 4. The boundary between the renal

Figure 3. Comparison of electrolyte indicators between the two groups. A. Comparison of K⁺ between groups. B. Comparison of Na⁺ between groups. C. Comparison of Scr between groups. Note: K⁺: serum potassium; Na⁺: serum sodium; Scr: serum creatinine.
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parenchyma and the cyst wall is marked with a laser beam at 1-cm intervals inside the cyst, and then a cut is made between the two marks. The cyst can be completely excised quickly and safely and removed through the outer sheath.

5. The use of laser cutting of the cyst wall avoids replacing perfusate, and the cutting effect is good. In addition, the isolation effect of the fat and water cushion on the outside of the cyst enables the cyst to be removed inside the cyst, with clear vision, good surgical safety, and comparable surgical effect to retroperitoneal laparoscopic deroofing.

Our results showed that compared to retroperitoneal laparoscopic renal cyst removal, percutaneous intracystic deroofing had significantly lower intraoperative blood loss, shorter operative time, postoperative drainage indwelling time, urinary catheter indwelling time and postoperative hospital stay, suggesting that percutaneous intracystic deroofing has lower surgical difficulty and postoperative risk, as well as faster postoperative recovery. This may be attributed to the above-mentioned characteristics, which can quickly and safely remove the cyst completely, improve visual field clarity, and effectively increase surgical safety [27]. Moreover, no significant differences were identified between groups in efficacy (total effective rate: both 100%), safety (no renal cyst recurrence), and postoperative electrolyte indicators (K⁺, Na⁺, Scr), suggesting that the efficacy, safety and influence on electrolytes of the two surgical methods are comparable.

In addition, the study has some limitations: first, due to the small number of cases studied in this project, it is necessary to increase the sample size to improve the accuracy of the research results; second, as a single-center study, there may be information collection bias, which can be addressed by conducting a multicenter study; third, it is limited by the sample size so research time, long-term effects, complications and related long-term prognosis need further observation and follow-up. The future research project will be supplemented and improved based on the above deficiencies.

To sum up, ultrasound-guided percutaneous intracystic deroofing has unique advantages in the treatment of simple renal cysts such as simple operation, high success rate, less trauma, fewer complications, and definite short-term efficacy.

Acknowledgements

The study was supported by the Science and Technology Plan of Jiangxi Provincial Health Commission (No. 202211637).

Disclosure of conflict of interest

None.

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References

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