A meta analysis on the treatment of renal calculus by percutaneous nephroscope set and retrograde intra renal surgery

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Abstract: This meta analysis was focused on the comparison using percutaneous nephroscope set and retrograde intra renal surgery to treat renal calculus. The data were obtained from PubMed and Web of Science databases. The published time of literature were from March, 2014, the language included Chinese and English. The literature selection strategies were based on the evaluation and meta analysis on the preferred reporting items. The subgroup analysis comparison criteria were percutaneous nephrolithotomy (PCNL) minimally invasive percutaneous procedures (MIPPs), which included the comparison among mini-PCNL, micro-PCNL and RIRS. The research objects were selected from adult population. The searching words included: percutaneous nephrolithotomy, retrograde intrarenal surgery, percutaneous lithotripsy, RIRS, miniPCNL, micropercutaneous nephrolithotomy, flexible ureteroscopy. The efficiency of calculus removal, complication rate and hemoglobin decline rate after treatment were compared. PCNL had higher efficiency of calculus removal, but also had relatively higher complication rate, hemorrhage and longer hospitalization time. The standard efficiency of calculus removal for PCNL was higher than that of RIRS, while RIRS was better than MIPPs. Considering the complication and low efficacy, if the calculus was less than 2 cm, we should consider the use of RIRS standard treatment.

Keywords: Percutaneous nephroscope set, retrograde intra renal surgery, renal calculus, meta analysis

Introduction

Recently, minimally invasive surgery replaced the open operation to treat renal calculi gradually [1-3]. We used percutaneous nephrolithotomy (PCNL) to treat renal calculus which the diameter was larger than 2 cm [4]. While with the increasing complete clearance rate of renal calculi, the complication rate of the treatment also increased. To solve this problem, two kinds of minimally invasive percutaneous procedures (MIPPs) including mini-PCNL and micro-PCNL were used [4, 5]. Another kind of percutaneous treatment of renal calculus surgery was retrograde intra renal stone removal (RIRS), which was recommended by European Association for the urinary tract in 2013. If the anatomic structure was not suitable for using laser lithotripsy, then applied PCNL and RIRS would be the best choices for treating lower urinary calculi [6-8]. The aim of this study is to compare the advantages and disadvantages of using RIRS and MIPP to treat renal calculus.

Material and methods

The selection of the included literature

The data were obtained from PubMed and Web of Science databases. The published time of literature were from March, 2014, the language included Chinese and English. The literature selection strategies were based on the evaluation and meta analysis on the preferred reporting items. The subgroup analysis comparison criteria were PCNL minimally invasive percutaneous surgery (MIPPS), which included the comparison among mini-PCNL, micro-PCNL and RIRS. The research objects were selected from adult population. Keywords included: percutaneous nephrolithotomy, retrograde intrarenal surgery, percutaneous lithotripsy, RIRS, miniPCNL, micropercutaneous nephrolithotomy, flexible ureteroscopy.

Literature retrieval strategies were based on Preferred Reporting Items for Systematic Re-
views and Meta-analysis criteria (Figure 1). Only the study on the analysis and comparison between PCNL and RIRS would be included [9, 10]. We also retrieved the references which were included in this study. The abstract of the study was not included in this study, because it did not describe the research method in detail. There were two authors retrieving independently, who discussed and reached agreement on the differences in the study.

**Statistics**

Meta analysis was performed to assess the overall evaluation of PCNL and RIRS procedures. The subgroup analyzed and compared standard PCNL (the size of sheath was more than 24F) plus RIRS method and MIPPS plus RIRS method. The extracted data included the length of operation, the amount of bleeding during operation, hospitalization time, help program and the complication rate after operation.

Odds ratio (RO) was adopted to compare binary variables, and the average deviation and standardized mean difference was used to describe continuous parameters. For some studies, if we chose to use average value and valid data range to describe the data, then we would apply the method described by Hozo for calculating the standard deviations [11]. If the heterogeneity detection showed no obvious difference, then we would use fixed effect model (Mantel-Haenszel method) [12, 13] to calculate total estimated value or used random effect model (DerSimonian-Laird method) [13, 14]. The merge effect was assessed by z examination. If P < 0.05, the differences had significant statistical difference. Cochran chisquare test and the differences (I²) were used to estimate the heterogeneity among the researches. The data analysis was processed by Review Manager software (RevMan v.5.1, Cochrane Collaboration, Oxford, UK) software.

**The features of the included researches**

Finally 10 researches were included in the statistical analysis, including 697 PCNL operations and 545 RIRS operations. The patients' age of PCNL group and RIRS group was 44.8 and 45.07 years old, the body mass index was 24 kg/m² and 24.1 kg/m² respectively. And there was no statistical difference. Four studies compared RIRS and standard PCNL operation [15-18], four studies compared RIRS and miniperc [13, 19-21], one study compared RIRS and microperc operation [22], six studies were retrospective case control study [12, 13, 15, 16, 18, 20], two of them were prospective case control study [19, 21]. The operations of the PCNL and RIRS were not same, the differences in the operation pointer of the multiple renal calculi was that megaloo-ureter, the usage of sheathe and stent intervention which was in one of the MIPP research [18] and one PCNL
research [15]. Normal stent intervention was mentioned in three studies [15, 17, 21], most stent intervention stayed 1-2 weeks in the body (Tables 1-3)

Results

Overall analysis

For the evaluation of PCNL and RIRS treatment, there was no obvious difference in the duration of operation, weighted mean difference (WMD: -4.81 min; 95% CI: -14.05 to 4.43; P = 0.31). The stone-free rate of PCNL operation was higher (OR: 2.19; 95% CI: 1.53-3.13; P < 0.001), but at the same time, there were more complications (OR: 1.61; 95% CI: 1.11-2.35; P < 0.001), and hemoglobin decreased greatly (WMD: 0.87 g/dl; 95% CI: 0.51-1.22; P < 0.001, Figure 2A-E). The hospitalization time after RIRS operation was shorter (WMD: 1.28 d; 95% CI: 0.79-1.77; P < 0.001).

Subgroup analysis

Standard percutaneous nephrolithotomy: The stone elimination rate of standard PCNL was relatively higher (OR: 4.32; 95% CI: 1.99-9.37; P = 0.0002). But the length of the operation had no obvious difference (WMD: -9.21 min; 95% CI: -28.80~10.38; P = 0.36). There was also no obvious difference in the complication after operation (OR: 1.59; 95% CI: 0.84-3.02; P = 0.16, Figure 3A-D). While the hospitalization time was longer and RIRS was shorter (WMD: 1.84 d; 95% CI: 0.64-3.04; P = 0.003).

Minimally invasive percutaneous procedures (MIPPs): Compared with RIRS, the length of MIPPs was shorter (WMD -6.75 min; 95% CI,
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Table 3. Summary of the operation methods: the usage of percutaneous nephroscope set and Retrograde renal surgery

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<td>Laser setting, W</td>
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-12.97 to -0.52; P = 0.03), but the clearance rate of RIRS was better (OR: 1.70; 95% CI, 1.07-2.70; P = 0.03, Figure 4A-D). And the hospitalization time of RIRS after the operation was also shorter (WMD: 1.11 d; 95% CI, 0.39-1.83; P = 0.003). There was no obvious difference in the complication between RIRS and MIPPs (OR: 1.46; 95% CI, 0.87-2.45; P = 0.15).

Discussion and conclusion

In this study, a meta analysis processed the comparison between three kinds of PCNL skills (standard, small-sized and minitype) and RIRS by the first overall analysis. Then the analysis of two subgroup was processed, one of the standard was only PCNL, another was MIPPs (mini-perc and microperc).

There was no obvious difference in operation duration between PCNL and RIRS. Five studies showed that the operation duration of PCNL was short, while another two studies showed that RIRS was faster [22, 23]. If only compared with MIPPs, statistical result of subgroup analysis showed that PCNL had obvious advantages, including (WMD: 6.75 min; 95% CI, 12.97 to 0.52; p value = 0.03). Percutaneous urinary calculi removal showed the differences in the changes of image, dilation technique, size of sheath, stone-crusher, type/possition of the stone, ureteral stent implantation, road seal and etc among the illness case were very great during the operation.

Stone-free rate was the most important parameter in the evaluation of urinary surgery. The overall analysis showed that the stone-free rate of PCNL was obviously higher than that of RIRS (OR: 2.19; 95% CI, 1.53-3.13; P < 0.00001), which was different from the result of subgroup analysis, the stone-free rate of standard PCNL was better than that of RIRS, while RIRS was better than MIPPs. Stone-free rate related to the feature of stone, one of them explained the removal condition of MIPPs and PCNL on Multiple calculus [24]. The stone size of most PCNL studies was more than 2 cm, while the
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stone size was relatively small for MIPPs operations. The position of the stone would also influence the removal efficiency. If the minimum of urethra was more than 1.5 cm, it would be more convenient to use percutaneous strategy, so it could reach the stone position directly. And the stone-free rate would be improved because the debris would be discharged with urine after operation.

The overall analysis showed that compared with RIRS, PCNL had higher complication rate (OR: 1.61; 95% CI, 1.11-2.35; P < 0.01). Fever (PCNL: 3-25%; RIRS: 2-28%), long-term use of antibiotics (PCNL: 2-8%; RIRS: 4-5%) and hematoxopenia (PCNL: 0.5-2%; RIRS: 3-5%). Haemorrhage problem made most complications of PCNL [26], which mentioned that hemoglobin value was decreased (WMD: 0.87 g/deciliter; 95% CI, 0.51-1.22; P < 0.00001). 5.5% patients with PCNL received transfusion. Distinctive PCNL extended urinary extravasation (N = 4), embolism (N = 1), injury of pleura (N = 1) and pelvic perforation (N = 2) and ureteral injury (N
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There was no obvious difference in the complication rate between MIPPs and standard PCNL, RIRS. Tyson and the colleagues reported that pulmonary disease (OR: 7.77), blood coagulation (OR: 6.16), anemia (OR: 3.82), paralysis (OR: 2.16) and other complications were the risk factor of increasing the expenses in the hospital [27].

Some parameters in this study had high heterogeneity. This kind of heterogeneity could be explained as the difference of surgery practice, follow-up method, follow-up frequency and results. The studies of MIPPs and RIRS should be compared by focusing on the operation of RIRS. Most of them used the ureter to enter sheath, semi rigid ureter mirror (dilated ureter), lower pole calculus shift and selective stent insertion. About percutaneous procedure, some studies [2, 21, 25] used intraoperative ultrasound imaging, follow up CT imaging and etc. The usage of these methods could also cause the bias in the results of the MIPPs study.

### Table A

<table>
<thead>
<tr>
<th>Study or Subgroup</th>
<th>mPCNL</th>
<th>RIRS</th>
<th>Mean Difference IV, Random, 95% CI</th>
<th>Mean Difference IV, Random, 95% CI</th>
</tr>
</thead>
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<td>Kirac 2013</td>
<td>57.3</td>
<td>66.4</td>
<td>25.1%</td>
<td>-1.0 (-1.66, -1.14)</td>
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<tr>
<td>Kruck 2013</td>
<td>62.4</td>
<td>73</td>
<td>21.4%</td>
<td>-0.2 (-1.14, 0.74)</td>
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<tr>
<td>Pan 2013</td>
<td>40.8</td>
<td>56</td>
<td>22.6%</td>
<td>-0.6 (-1.16, -0.06)</td>
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<tr>
<td>Sabnis 2012</td>
<td>11.6</td>
<td>17.7</td>
<td>25.1%</td>
<td>-0.2 (-0.84, 0.38)</td>
</tr>
<tr>
<td>Sabnis 2013</td>
<td>51.6</td>
<td>71.7</td>
<td>21.6%</td>
<td>-0.2 (-0.84, 0.38)</td>
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<tr>
<td>Total (95% CI)</td>
<td>163</td>
<td>159</td>
<td>100%</td>
<td>-0.5 (-1.29, 0.22)</td>
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</table>

### Figure 4

- A: Operation time, B: Stone removal rate, C: Finished rate, D: Hospitalization time.

= 2) needed to re-open (N = 1) specific RIRS.
The meta analysis showed that compared with RIRS, PCNL could provide higher stone-free rate, but its complication rate was also higher, hemorrhage and hospitalization time was longer, but there was no obvious difference in operation time. While compared with MIPPs, RIRS could provide higher stone-free rate. Considering MIPPs could increase the mortality rate and decrease the stone-free rate, which stone diameter was less than 2 cm, RIRS should be regarded as the first choice for treating this kind of stone, while MIPPs could be adopted under the situation of the surgical instruments and the experience of the operator was not enough.

Disclosure of conflict of interest

None.

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References

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