Urinary and Renal Research (2023) Volume 4 Issue 1, *pp.*1–11.
doi:10.54517/urr.v3i1.2060

Efficacy and safety of minimally invasive percutaneous nephrolithotomy(MPCNL) and standard channel percutaneous nephrolithotomy(SPCNL) in the treatment of kidney stones:A meta analysis

ZHANG Ke [1], CHENG Jianjun [2] , WANG Jingyu [3], REN Ruimin [3], ZHANG Yangang [3], ZHANG Cheng [1]

1.Shanxi Medical University, Taiyuan 030001, china

2.The second people's hospital of Shanxi Province department of urology, Taiyuan 030001, china

3.Shanxi Academy of Medical Science, Shanxi Dayi Hospital, Taiyuan 030032, china

Abstract Objective: To evaluate the efficacy and safety of minimally invasive percutaneous nephrolithotomy(MPCNL) standard channel percutaneous nephrolithotomy(SPCNL) in the treatment of kidney stones. Methods: We searched pubmed, Cochrane Liabrary, CNKI, VIP , Wangfang database from January 1, 1992 to April 1, 2015. Screening of the two methods of treatment of kidney stones randomized controlled trials (RCT) and quality assessment, using revman5.2 software for statistical analysis. Results: A total of nine RCT, 1017 patients, 508 cases in MPCNL group, 509 cases in SPCNL group. The results show: the stones clearance , MPCNL group was lower than SPCNL group [*OR*=0.62, 95%CI(0.43, 0.91), *P*=0.01]; in terms of operative time, MPCNL group was longer than SPCNL group [MD = 14.23 , 95% CI (6.30, 22.16), P = 0.0004]; hospitalization time, blood loss, total complications, were no significant difference between the two group, the results are [MD = 0.88, 95% CI (-0.69 , 2.44), P = 0.27], [MD =-19.87, 95% CI (-64.36, 24.61), P = 0.38], [*OR*=1.28, 95%CI(0.90, 1.84), *P*=0.17]. Conclusion: the stone clearance rate:MPCNL group was lower than SPCNL group, the operative time of MPCNL group was longer which may affect postoperative recovery, the complications, hospital stay, blood loss, the two groups had no significant difference. So , we tend to standard channel percutaneous nephrolithotomy in the treatment of common type of kidney stones.

Keywords: Minimally invasive percutaneous nephrolithotomy; Standard channel percutaneous nephrolithotomy; Kidney stones; Meta analysis

CLC classification No.: R692.4 Document identification code: A

Urolithiasis is a common disease in urology, among which kidney stones are the most common. Percutaneous nephrolithotomy (PCNL) is one of the main methods to treat renal calculi. It has the advantages of small trauma, high stone clearance rate, fast postoperative recovery, etc. The treatment effect is equivalent to or even better than that of open surgery. It may gradually replace open surgery as the main surgical method for the treatment of kidney stones [1-2]. The channel of traditional PCNL is 26~34 F. A larger channel is conducive to stone removal, but it is easy to cause kidney damage and massive bleeding. With the improvement of clinicians' technology and the progress of technology in related fields, most of the channels currently used are standard percutaneous nephrolithotomy (spcnl), and the working channel is 20~26 F. However, Chinese scholars have proposed minimally invasive percutaneous nephrolithotomy (MPCNL). Its working channel is 14~16 F, and f 8.0/ 9.8 ureteroscope is used instead of nephroscope, with a stone clearance rate of 90%, There were no serious complications [3]. However, the clinical efficacy of the two channels in the treatment of common kidney stones (excluding stones with a diameter greater than 3 cm, cast stones, multiple stones, infectious stones, horseshoe kidney stones, solitary kidney stones, calyceal diverticulum stones, etc.) Is still controversial, and meta-analysis is used for objective evaluation.

1 Data and methods

1.1 Literature search

The computer searches pubmed, sciencedirect, Ovid, Springer, Wiley online library, the Cochrane Library, CNKI, CBM, VIP, Wanfang and other relevant databases. The retrieval period is from 1992 to 2015. The Chinese keyword is "minimally invasive percutaneous nephrolithotomy/microchannel percutaneous nephrolithotomy, standard channel percutaneous nephrolithotomy, kidney stones, treatment", and the English keyword is "mini percutaneous nephrolithotomy, standrad percutaneous nephrolithotomy, children stones, renal calculus, treatment". In order to ensure completeness, supplementary records can be made from the references included in the literature.

1.2 Inclusion and exclusion criteria

1.2.1 Inclusion criteria

Type of literature research: randomized controlled trial.

Study subjects: Patients with renal calculi confirmed by imaging examination had no obvious surgical contraindications, and their sex, age and stone diameter were less than 3cm; Single stone.

Research Indicators: stone clearance rate, operation time, hospitalization time, hospitalization expenses, intraoperative bleeding, total postoperative complications, postoperative fever or infection, and whether blood transfusion. Stone clearance rate, operation time, and hospitalization time were the main indicators.

1.2.2 Exclusion criteria

Repeated studies;

Study subjects: Patients with severe renal function impairment, renal calculi complicated with infection, pyonephrosis, complex renal calculi (multiple calculi, calyceal diverticulum calculi, cast calculi, infectious calculi, horseshoe kidney calculi, solitary kidney calculi, etc.), including children (< 13 years old) and elderly (>

65 years old) with renal calculi;

Semi randomized controlled trials, non randomized controlled trials, observational studies, critical studies, retrospective studies; Relevant research indicators (especially main research indicators) are not mentioned in the literature, and relevant values are not extracted in the literature (standard deviation is not mentioned); those with different outcome index units and outcome events unrelated to this study.

Table 1 Basic characteristics of included literature

Included literature	Type of study	Number of cases (m/s)	Stone size and age distribution	Channel size (m/s)	Outcome indicators
Heyufa 2015	RCT	82/82	Be similar	-/24	a.b.c.d.e.j
Zhoujinbo 2014	RCT	35/36	Be similar	18/24	a.b.c.d.e.j
Hejingwei 2014	RCT	33/34	Be similar	18/24	a.b.c.d.
Ouxiaocong 2014	RCT	40/40	Be similar	-/16	a.b.d.e.f.g.h.
Huang Chao 2014	RCT	60/60	Be similar	16/24	a.b.c.d.e.f.g.h.
Chen Wei 2014	RCT	104/105	Be similar	16/21	a.b.c.
Zhang Xu 2013	RCT	50/50	Be similar	14-18/22-24	a.b.c.d.e.f.i.j
Chenzehua 2013	RCT	41/41	Be similar	16/24	a.b.c.d.e.f.g.h.
Chen Zhao 2012	RCT	63/61	Be similar	18/22	a.b.c.e.f.i.

Note: a. Stone removal rate; b. Operation time; c. Length of stay; d. Intraoperative blood loss; e. Total complications; f. Fever; g. Septic shock; h. Blood bacterial culture was positive; i. Postoperative bleeding; j. Hospitalization expenses m:mpcnl group s:spcnl group

Table 2 Quality evaluation of included literature

Included literature	Random method blind method		Intentionality analysis	Baseline comparison	Follow-up	Quality grade/Jadad score
Heyufa 2015	Use	Not used	Nothing	Be similar	Full and complete	A/3 points
Zhoujinbo 2014	Use	Not used	Nothing	Be similar	Full and complete	A/3 points
Hejingwei 2014	Use	Not used	Nothing	Be similar	Full and complete	A/3 points
Ouxiaocong 2014	Use	Not used	Nothing	Be similar	Full and complete	A/3 points
Huang Chao 2014	Use	Not used	Nothing	Be similar	Full and complete	A/3 points
Chen Wei 2014	Use	Not used	Nothing	Be similar	Full and complete	A/3 points
Zhang Xu 2013	Use	Not used	Nothing	Be similar	Full and complete	A/3 points
Chenzehua 2013	Use	Not used	Nothing	Be similar	Full and	A/3 points

Chen Zhao 2012	Use	Not used	Nothing	Be similar	complete Full and complete	A/3 points

1.3 Included literature

Search the literature, select the literature by two evaluators according to the inclusion and exclusion criteria, and extract the data after checking. In case of any disagreement, it shall be resolved through discussion, and the opinions of a third party shall be sought if necessary.

Initial search: 36 (Chinese database) +3 (foreign database), 39 articles in total; 22 articles (Chinese database) +3 articles (foreign database) after reading the title to exclude complex calculi and kidney stones with infection; then read the full text again, excluding semi randomized controlled trials, non randomized controlled trials, retrospective analysis and those who mentioned complex kidney stones in the full text. Finally, 9 articles were included in the study, all of which were in Chinese.

1.4 Document quality evaluation

Jadad scale was used to evaluate the quality of literature [scoring method: 1-5 points (1-2 points for low-quality research, 3-5 points for high-quality research)][4-5]. The classification is carried out according to the method of Cochrane collaborative network system evaluator manual [6], see Table 1 and Table 2.

1.5 Meta analysis

Revman5.2 provided by Cochrane Collaboration Network was used for meta-analysis. If the research variable is a dichotomous variable, or value is used as the combined effect quantity; for continuous variables, the weighted mean difference (WMD) is used as the combined effect quantity, and the test level is $\alpha = 0.05$. Heterogeneity included in the study was analyzed by Revman software $\chi 2$ inspection. The inspection level is $\alpha = 0.05$, when $p > 0.05$, the heterogeneity of each study was not obvious, and the fixed effect model was used for analysis; When $p \leq 0.05$, there is statistical heterogeneity in each study, so the random effect model analysis can be used to make descriptive analysis on the studies with heterogeneity. If the heterogeneity is too large, no analytical meta-analysis can be done.

2 Results

The 9 literatures included in this meta-analysis are randomized controlled trials. There is no significant difference in the general conditions of patients in the trials, and they are all high-quality literatures.

2.1 Stone clearance

Nine literatures [7-15] mentioned the stone clearance rate, of which one literature study [9] only mentioned that there was no statistical difference in the stone clearance rate between the two, and no specific data were given. One literature [7] mentioned the evaluation of stone removal (kub or ultrasound were reexamined 3-5 days after operation, and there were no symptoms or the stone fragment diameter was less than 3 mm); the evaluation of stone removal was not mentioned in other literatures. The stone load of each study was similar, and the results of each study were homogeneous ($P=0.09 > 0.05$). Therefore, the fixed effect model meta-analysis results showed that there was a statistically significant difference in the stone clearance rate between the two surgical methods [$OR=0.62$, 95%CI (0.43, 0.91), $P=0.01$], $P < 0.05$. The stone clearance rate of MPCNL group

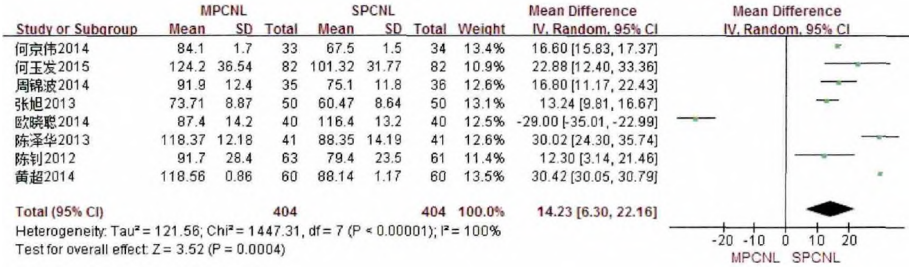
was lower than that of spcnl group (see Figure 1).

2.2 Operation time

Nine studies [7-15] described the operation time, but in one study of literature [12], the operation time did not report the standard deviation, which was excluded; there was statistical heterogeneity among the results of the other 8 Literature Studies ($P < 0.00001$). The random effect model meta-analysis should be used. The results showed that there was a statistically significant difference in the operation time between the two groups [md=14.23, 95%ci (6.30, 22.16), P=0.0004], $P < 0.05$. The operation time in MPCNL group was longer than that in spcnl group (see Figure 2).

Heyufa 2015
Zhoujinbo 2014
Zhang Xu 2013
Ouxiaocong 2014
Chen Wei 2014
Chenzehua 2013
Chen Zhao 2012
Huang Chao 2014

Figure 1 Comparison forest chart of stone clearance rate between MPCNL group and spcnl group



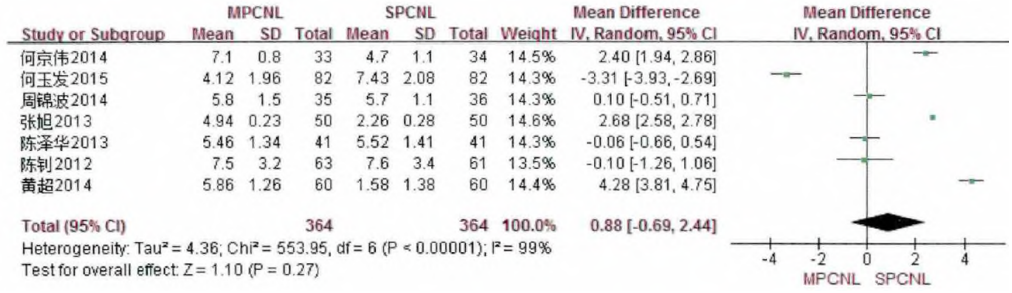
Hejingwei 2014
Heyufa 2015
Zhoujinbo 2014
Zhang Xu 2013
Ouxiaocong 2014
Chenzehua 2013
Chen Zhao 2012

Huang Chao 2014

Figure 2 Comparison forest chart of operation time between MPCNL group and spcnl group

2.3 Length of stay

Eight literature studies [7-9, 11-15] reported the length of stay, of which one literature study [10] did not report the standard deviation and was excluded; the results of the other seven literature studies were heterogeneous (P < 0.0001), and the random effect model meta-analysis should be used. The results showed that there was no significant difference in hospital stay between the two surgical methods [md=0.88, 95%ci (-0.69, 2.44), *P*=0.27], P > 0.05. There was no significant difference in hospital stay between MPCNL group and spcnl group (see Figure 3).

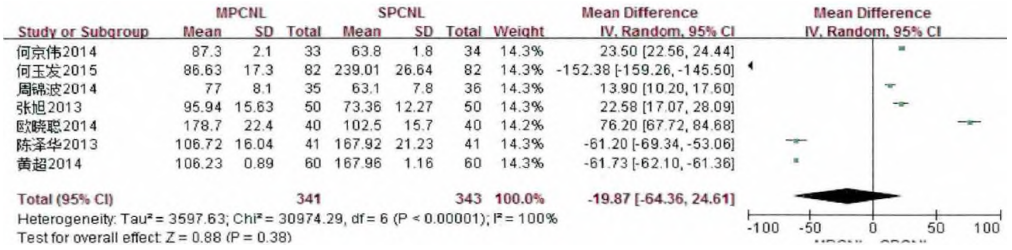


Hejingwei 2014
Heyufa 2015
Zhoujinbo 2014
Zhang Xu 2013
Chenzehua 2013
Chen Zhao 2012
Huang Chao 2014

Figure 3 Comparison forest chart of hospitalization time between MPCNL group and spcnl group

2.4 Intraoperative blood loss

Seven literature studies [7-11, 13-14] reported the amount of intraoperative bleeding. The results were heterogeneous (P < 0.00001). The random effect model should be used for analysis. The results showed that there was no significant difference in the amount of intraoperative bleeding between the two surgical methods [md=-19.87, 95%ci (-64.36, 24.61), P =0.38], p> 0.05. There was no significant difference in the amount of intraoperative bleeding between the two groups (see Figure 4).



Heyufa 2015
Zhoujinbo 2014

Zhang Xu 2013

Ouxiaocong 2014

Chenzehua 2013

Huang Chao 2014

Figure 4 Comparison forest chart of intraoperative blood loss between MPCNL group and spcnl group

Heyufa 2015

Zhoujinbo 2014

Zhang Xu 2013

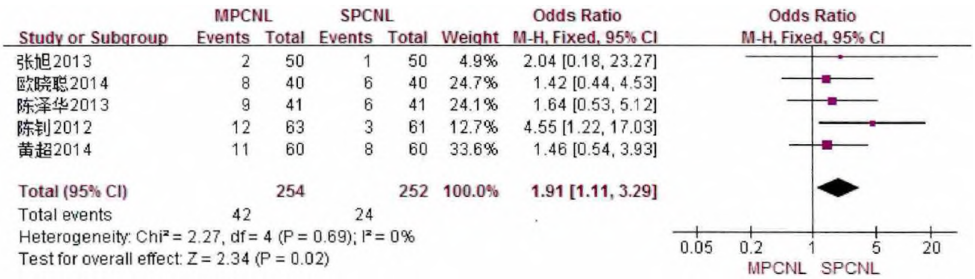
Ouxiaocong 2014

Chenzehua 2013

Chen Zhao 2012

Huang Chao 2014

Figure 5 Comparison forest chart of total complications between MPCNL group and spcnl group



Zhang Xu 2013

Ouxiaocong 2014

Chenzehua 2013

Chen Zhao 2012

Huang Chao 2014

Figure 6 Comparison forest diagram of MPCNL group and spcnl group in terms of fever

2.5 Complications

Seven literature studies [7-8, 10-11, 13-15] reported total complications, including fever, infection, postoperative bleeding, septic shock, positive blood bacterial culture, etc. In terms of total complications, the results of each study were homogeneous (P=0.06>0.05), so the fixed effect model meta-analysis should be used. The results showed that there was no significant difference in total complications between the two surgical methods [OR=1.28, 95%CI (0.90,

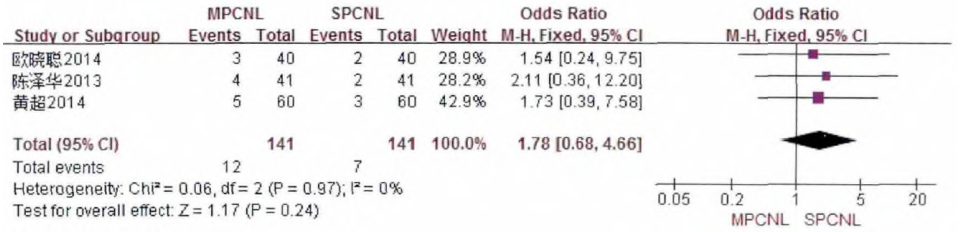
1.84), P=0.17], P > 0.05, and there was no significant difference in total complications between the two groups (see Figure 5). However, in terms of fever, five studies [10-11, 13-15] reported that there was no significant heterogeneity among the literatures (P=0.69 > 0.05). The fixed effect model analysis showed that the results were statistically significant [OR=1.28, 95%CI(0.90, 1.84), P=0.02], P < 0.05. The fever rate of MPCNL group was higher than that of spcnl (see Figure 6). There was no significant heterogeneity among the studies on septic shock [10, 11, 14] (P=0.97> 0.05), positive blood bacterial culture [10, 11, 14] (P=0.97 > 0.05), postoperative bleeding [13, 15] (P=0.55 > 0.05). The results were not statistically significant by using fixed model analysis [OR=1.79, 95%CI(0.51, 6.25), P=0.36], [OR=1.78, 95%CI(0.68, 4.66), P=0.02], [OR=1.38, 95%CI(0.27, 7.15), P=0.70], P is greater than 0.05, There was no significant difference between the two groups in terms of postoperative septic shock, positive blood bacterial culture and postoperative bleeding (see Figure 7, 8 and 9).

Ouxiaocong 2014

Chenzehua 2013

Huang Chao 2014

Figure 7 Comparison forest diagram of MPCNL group and spcnl group in septic shock

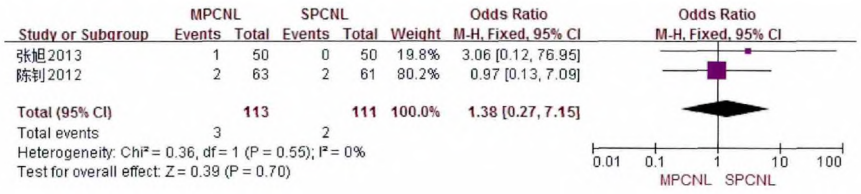


Ouxiaocong 2014

Chenzehua 2013

Huang Chao 2014

Figure 8 Comparison forest diagram of blood bacterial culture and Nutrition between MPCNL group and spcnl group



Zhang Xu 2013

Chen Zhao 2012

Figure 9 Comparison forest chart of postoperative bleeding between MPCNL group and spcnl group

2.6 Hospitalization expenses

Two literatures [7, 13] mentioned hospitalization expenses, but the expenses of the two studies were quite different and had no comparative value. It needs further clinical observation and practice.

3. Discussion

Kidney stone is a common disease in clinic. If there is no timely treatment, it may cause damage to the kidney. In severe cases, it may cause pyonephrosis, renal atrophy, etc. The purpose of treatment is to remove the stone as much as possible and protect the renal function. With the improvement of people's living standards and the change of health concept, many smaller kidney stones have been found. At present, percutaneous nephrolithotomy is the main minimally invasive surgical treatment. The diameter of the traditional percutaneous nephrolithotomy channel is more than 24 F-34 F. It is highly traumatic and easy to damage the kidney, resulting in massive intraoperative and postoperative bleeding, slow recovery and long hospital stay, which limit its clinical application. At present, standard channels (18 F-2 4F) and microchannels (14 F-16 f) are mostly used for percutaneous nephroscopy.

MPCNL has small channel, slight damage to renal parenchyma, less bleeding and high safety factor, but its field of vision is small and the operation is complex, which on the one hand prolongs the operation time; On the other hand, in order to obtain a good visual field, continuous high-pressure perfusion of normal saline is required, which increases the pressure in the kidney and is prone to adverse reactions such as hyperthermia, bacteremia, electrolyte disorder and renal insufficiency. The passage of spcnl is relatively large, the visual field is good, the operation is completed under relatively low flushing pressure, the stones are easy to be removed, the operation time is shortened, and the incidence of postoperative complications is reduced [16, 19].

The 9 literatures included in this meta-analysis are all high-quality studies, and the stone load is common without complex stones (multiple stones, renal calyceal diverticulum stones, cast stones, infectious stones, horseshoe kidney stones, solitary kidney stones, etc.). The stone removal rate in MPCNL group was lower than that in spcnl group. There was heterogeneity in the operation time among the studies, which may be related to different surgeons and lithotripsy equipment. The results showed that the operation time of MPCNL was longer than that of spcnl; there is no significant difference between the two in terms of length of stay, intraoperative bleeding and total complications. On the one hand, it is related to the small number of included literatures, on the other hand, it may be related to specific surgical procedures. MPCNL has small trauma and long operation time, while spcnl has relatively large trauma and short operation time. In terms of postoperative fever, MPCNL group was higher than spcnl group, which may be related to the long operation time in MPCNL group. Studies have shown that MPCNL is equivalent to ureteroscopy in the treatment of kidney stones with a diameter less than 1.5 cm, and does not damage the ureter. The stone removal rate is higher than that of ureteroscopy [17]. Guohua z[18] and others found in the large-scale study of minimally invasive percutaneous nephrolithotomy that minimally invasive percutaneous nephrolithotomy is still an effective and safe choice for the treatment of

kidney stones. In recent years, some studies have shown that minimally invasive percutaneous nephrolithotomy is effective in the treatment of complex kidney stones, and some studies have shown that the effect of treating complex kidney stones is not as good as the standard channel, which is still controversial [20]. However, Chen Fuchang [21] and others' systematic evaluation of MPCNL and spcnl in the treatment of complex renal calculi showed that they have their own advantages in the treatment of different types of calculi. MPCNL is suitable for the treatment of multiple calyceal calculi and small renal pelvis calculi, and spcnl is suitable for the treatment of simple large renal pelvis calculi.

In conclusion, MPCNL group has lower stone removal rate and longer operation time than spcnl group in the treatment of common kidney stones, and there is no significant difference in other aspects. According to this analysis, the treatment of common kidney stones still tends to be standard channel (high stone removal rate and short operation time). There are few literatures included this time. We hope to have more high-quality literature studies, further evaluate the advantages and disadvantages of the two channels, and better guide clinical application.

References

[1] Luo Jianshi, Chen Guang Research progress of percutaneous nephrolithotripsy in the treatment of renal calculi [j] Medical review, 2013, 19 (24): 4538-4541

[2] Resorlu B, Kara C, Oguz U, et al. Percutaneous nephrolithotomy for complex caliceal and staghorn stones in patients with solitary kidney[J]. Urological research, 2011, 39(3): 171-176.

[3] Zhangsuibing, liuxiangbin Progress in minimally invasive treatment of kidney stones [j] Heilongjiang medical journal, 2009,33 (5): 349-351

[4] Jadad A R, Moore R A, Carroll D, et al. Assessing the quality of reports of randomized clinical trials: is blinding necessary? [J]. Controlled clinical trials, 1996, 17(1): 1-12.

[5] Jüni P, Altman D G, Egger M. Assessing the quality of controlled clinical trials[J]. Bmj, 2001, 323(7303): 42-46.

[6] HIgGins JPT, Green S(editors). Cochrane Handbook for systematicreviews of Interventions Version 5.1.0 [updated September 2011]. The Cochrane Collaboration, 2011, Available from.

[7] Heyufa Comparison of the therapeutic effects of micro channel percutaneous ureteroscopic holmium laser lithotripsy and standard channel percutaneous nephrolithotomy on renal calculi [j] Clinical medical engineering, 2015, 22 (1): 23-27

[8] Zhoujinbo Comparison of standard channel and microchannel percutaneous nephrolithotomy in the treatment of renal calculi [j] Grassroots medical forum, 2014, 18 (25): 3383-3384

[9] Hejingwei, tanjianqiu, fengnengzhuo, et al Comparison of standard and microchannel percutaneous nephroscopy in the treatment of renal calculi [j] China practical medicine, 2014, 9 (4): 66-67

[10] Ouxiaocong, liusonghua Comparative analysis of clinical efficacy of minimally invasive percutaneous nephrolithotomy and standard channel percutaneous nephrolithotomy in the treatment of renal calculi [j] Chinese medical guide, 2014, 12 (30): 176-177

[11] Huang Chao, Cheng Zemin, Zeng

Dongsheng, et al Clinical comparison of minimally invasive percutaneous nephrolithotomy and standard channel percutaneous nephrolithotomy in the treatment of renal calculi [j] Medical information, 2014, 27 (11): 265-266

[12] Chen Wei Comparison of the efficacy of micro channel percutaneous ureteroscopy and standard channel percutaneous nephrolithotomy with holmium laser lithotripsy in the treatment of renal calculi [j] Everyone health, 2014, 8 (3): 249

[13] Zhang Xu, Lei Guanghui, Xiang bin, et al Comparative study of standard channel and microchannel percutaneous nephrolithotomy in patients with renal calculi [j] China Medical Herald, 2013, 10 (21): 83-85

[14] Chenzehua Clinical comparison of minimally invasive percutaneous nephrolithotomy and standard channel percutaneous nephrolithotomy in the treatment of renal calculi [j] Chinese contemporary medicine, 2013, 20 (31): 42-43

[15] Chen Zhao Application of microchannel and standard channel in percutaneous nephrolithotomy [j] China medical frontier, 2012, 7 (19): 36-36

[16] Zhouguoming Clinical observation of percutaneous nephrolithotomy in the treatment of renal calculi China practical medicine, 2011, 6 (07): 68

[17] Sabnis R B, Ganesamoni R, Ganpule A P, et al. Current role of microperc in the management of small renal calculi[J]. Indian journal of urology: IJU: journal of the Urological Society of India, 2013, 29(3): 214.

[18] Zeng G, Mai Z, Zhao Z, et al. Treatment of upper urinary calculi with Chinese minimally invasive percutaneous nephrolithotomy: a single-center experience with 12,482 consecutive patients over 20 years[J]. Urolithiasis, 2013, 41(3): 225-229.

[19] Liaosongbai, Yu Yonggang, Wuyingjie, et al Effect of renal pelvis pressure on renal function during minimally invasive percutaneous nephrolithotomy [j] Journal of Clinical Urology, 2011, 26 (7): 501-503

[20] Dengchengen, Chen Yong, panwenbo, et al Comparison of standard channel and microchannel percutaneous nephrolithotomy in the treatment of renal calculi [j] Journal of Hainan Medical College, 2013, 19 (2): 219-223

[21] Chenfuchang, lijiqing, Liugang, et al Systematic evaluation of micro channel and standard channel percutaneous nephrolithotomy in the treatment of renal calculi [j] Chinese Journal of endoscopic Urology (Electronic Edition), 2014, 8 (5): 27-30