

A Novel Semi-rigid Nephroscope Percutaneous Nephrolithotomy: The Best Therapy for Renal Staghorn Calculi

Bo Xiao, Song Chen, Xin Zhang, Wei-Guo Hu, Yu-Bao Liu, Yu-Zhe Tang, Jian-Xing Li

Department of Urology, Beijing Tsinghua Changgung Hospital, Medical Center, Tsinghua University, Beijing 102218, China

Key words: Kidney; Percutaneous Nephrolithotomy; Semi-rigid; Staghorn

Percutaneous nephrolithotomy (PCNL) has been the first-line treatment for renal staghorn calculi for many years. Several techniques have been described for percutaneous access and stone removal, but a multi-access approach is the mainstay of treatment. The main concern about PCNL is the resultant morbidity: Complications such as bleeding, parenchymal damage, and organ injury hindered the adoption of PCNL in primary hospitals in China. Multiple access points significantly increase the risk of bleeding, as well as the risks of other major complications. Although single access and flexible nephroscopy has been recommended as the most effective means of curing full staghorn stones, it is less popular as it is labor-intensive and time-consuming. In our opinion, the optimal strategy should be highly efficient and carry low risk, which requires new instruments. We have developed a semi-rigid nephroscope that integrates the function of rigid and flexible nephroscopes, and is manufactured in China by YouCare Technology Co., Ltd. It can be deployed with an ultrasonic or pneumatic lithotripsy system in rigid mode and a holmium laser in flexible mode, switching between the two is straightforward. We hope this nephroscope can achieve the goal of treating complete staghorn calculi efficiently and relatively noninvasively through a single access port. Herein, we report our experience of semi-rigid nephroscopic PCNL in the 1st year of its use.

Informed consents were signed by patients and the study was approved by ethics committee of our hospital. Between August 2013 and August 2014, 60 patients with staghorn calculi were treated in our institution. Thirty were randomized to be treated using the semi-rigid nephroscope and the remaining patients were treated according to a standard technique with a rigid scope. The main body of the semi-rigid nephroscope device comprises four parts: An outer tube, an inner tube, a steering handle, and

a tube connector [Figure 1]. The scope can be switched easily between rigid and flexible modes using the steering handle.

Ultrasonography was used to locate the stones and identify the correct target calyx in both groups. A 24-Fr tract was created under ultrasound guidance. Briefly, a 17.5-G coaxial needle was introduced into the fornix of the target calyx under ultrasound guidance (3.5-MHz LOGIQ e, GE Healthcare, USA). The correct position was confirmed by aspiration of urine. A tract was dilated serially over the guide wire using 8–16 Fr fascia dilators (UroVision, Bad Aibling, Germany). A 16-Fr peel-away sheath was placed to facilitate observation by ureteroscope. The working channel was dilated by an 18–24-Fr metal dilator to create the 24-Fr access port. In the rigid nephroscope group, stones were fragmented and cleared by pneumatic lithotripsy and an ultrasonic system (EMS Electro Medical System, Nyon, Switzerland). An ultrasound check for residual stones was undertaken to define whether additional tracts were necessary. In the semi-rigid nephroscope group, pneumatic and ultrasonic lithotripsy was initially used to remove stones under rigid mode. A holmium laser was used in flexible mode to fragment invisible stones. A nephrostomy tube and ureteric stent were placed for urine drainage. The stone-free rate (SFR) was evaluated by kidney-ureter-bladder X-ray or computed tomography scan,

Address for correspondence: Dr. Wei-Guo Hu,
Department of Urology, Beijing Tsinghua Changgung Hospital,
Medical Center, Tsinghua University, Beijing 102218, China
E-Mail: lijianxing2015@163.com

This is an open access article distributed under the terms of the Creative Commons Attribution-NonCommercial-ShareAlike 3.0 License, which allows others to remix, tweak, and build upon the work non-commercially, as long as the author is credited and the new creations are licensed under the identical terms.

For reprints contact: reprints@medknow.com

© 2015 Chinese Medical Journal | Produced by Wolters Kluwer - Medknow

Received: 23-08-2015 **Edited by:** Li-Min Chen

How to cite this article: Xiao B, Chen S, Zhang X, Hu WG, Liu YB, Tang YZ, Li JX. A Novel Semi-rigid Nephroscope Percutaneous Nephrolithotomy: The Best Therapy for Renal Staghorn Calculi. Chin Med J 2015;128:3109-11.

Access this article online

Quick Response Code:



Website:
www.cmj.org

DOI:
10.4103/0366-6999.169109

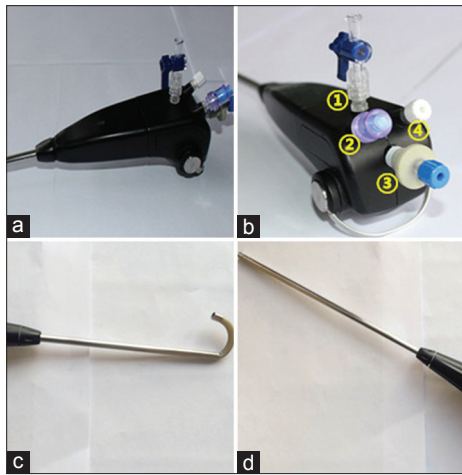


Figure 1: The appearance (a) and flexible (c) rigid (d) mode of semi-rigid nephroscope (b) operating package of the scope: (1) Flushing interface (2) vice performing channel (3) main performing channel (4) light source interface.

1 month later. Stones ≤ 4 mm were considered to be clinically insignificant residual fragments.

The differences among pre- and post-operative blood hemoglobin concentrations, number of tracts required, length of postoperative hospital stay, operative duration, SFR, and postoperative complications were recorded.

Statistical analysis was performed using SPSS for Windows version 16.0. The Chi-squared test and two-sample independent *t*-tests were used. Data are presented as the mean \pm standard deviation (SD) unless otherwise stated. A $P < 0.05$ was considered statistically significant.

The mean age of the patients was 46 years (range: 21–65 years); there were no significant differences among the groups in terms of the proportion of men and women, the type of stone, stone diameter, or the proportion of left- and right-sided stones. Treatment was successful in all the 60 patients. In the semi-rigid group, treatment was completed in one session in all the cases, but six patients (20.0%) in the rigid group required a second procedure to address residual stones. Significantly, fewer access tracts were needed in the semi-rigid group (mean 1.5, compared with 2.2 in the rigid group, $P = 0.01$). Although there was significantly less blood loss in the semi-rigid scope group (the perioperative hemoglobin loss in the semi-rigid group was 12.8 ± 5.2 g/L compared with 22.0 ± 9.1 g/L in the rigid scope group, $P = 0.01$), none of the patients required a blood transfusion. The duration of surgery was significantly longer in the semi-rigid scope group than the rigid scope group (76.0 ± 32.5 min compared with 56.0 ± 25.5 min, respectively, $P = 0.001$). Postoperative hospital stay was significantly shorter in the semi-rigid scope group (4.3 ± 1.4 days compared with 5.2 ± 2.1 days in the rigid scope group, $P = 0.02$). There was no significant difference in the proportions developing postoperative pyrexia ($\geq 38.5^\circ\text{C}$), and there were no incidences of major complications such as adjacent organ injury, embolization, septic shock, or kidney loss in either group. Stone composition analysis was

performed in 42 patients, the majority of stones were found to be calcium oxalate calculi. One month after the surgery, SFR was broadly comparable between the groups ($P = 0.45$).

The goal of staghorn calculi therapy is complete stone clearance with minimal morbidity, but it can be difficult to achieve stone-free status with a traditional rigid nephroscope, as multiple tracts may be needed to access the already fragile and diseased kidney.^[1] Although safe methods of creating percutaneous renal tracts are well established, none is completely free of the potential for complications during or after the procedure. The risk of hemorrhagic complications requiring blood transfusion is associated with multiple punctures and dilations. The most common source of bleeding is the nephrostomy tract itself, but parenchymal lacerations can also occur during tract dilation and during stone removal.

It is possible to reduce the number of tracts and rate of complications, as well as achieve stone-free status using flexible instruments. Evidence has already that demonstrated the advantages of using rigid and flexible nephroscopes or ureteroscopes together to treat complex calculi, detect and remove residual stones; the need for fewer percutaneous access points reportedly results in reduced morbidity.^[2] These findings support the concept that the flexible nephroscope is the instrument of choice for dealing with staghorn stones.

Our novel instrument has some disposable components, such as the handle portion, which covers the stainless steel sheath and the flexible tube, and is manufactured from a polymer material. The flexible tube can extend smoothly and rotate axially. A fiber-optic source can be advanced into the channel freely when the tube is straight. The minimum bend radius of the flexible tube is up to 5 mm, with a turning angle $>180^\circ$ with the fiber-optic source *in situ*. The use of high-resolution optical fiber ensures optimal image quality, and a separate fluid inlet valve improves the speed of irrigation.

In our preliminary study, the patients who underwent treatment with the semi-rigid nephroscope required fewer access tracts and experienced less peri- and post-operative bleeding. Nevertheless, the duration of surgery was approximately 20 min longer; we believe this is due to the lower efficiency of holmium laser lithotripsy. There were no significant differences in complication rates between the two groups. We previously reported that the rate of major complications of PCNL in our unit is $<1\%$,^[3] so it seemed likely that our study was not adequately powered to detect statistically significant differences in the incidence of complications. Similarly, although the SFR in the semi-rigid scope group was lower than the rigid scope group, the difference was not statistically significant. The success of single-tract PCNL in complex renal lithiasis using a flexible ureteroscope or nephroscope depends on the anatomy of the collecting system. Our device requires further development and refinement, for example, its curvature and unidirectional bending limits its application in unfavorable calyces, which makes it technically difficult to clear stones in the

lower poles. Our future work will focus on improving the device's maneuverability, performance, and image quality. In our opinion, the semi-rigid nephroscope could replace the traditional rigid nephroscope in the future, potentially establishing a new means of treating renal staghorn calculi that we call "flexible and rigid percutaneous nephrolithotomy" (FRPCNL). This technique could become a standard therapy, resulting in substantial clinical, economic, and social benefits.

Our study had some limitations. The number of cases is comparatively small, some of our statistical analyses could be more robust. Further studies with larger cohorts are needed to examine the benefits of FRPCNL. Although patients were randomized, there may still have been inadvertent bias when selecting the patients suitable for study entry. The SFR could also have been affected by collecting system anatomy and stone texture;^[4] these factors were not among our original outcome measures and these data were not always available retrospectively. Furthermore, we did not evaluate long-term renal damage, postoperative pain scores, or the cost effectiveness of the semi-rigid scope technique.

In conclusion, our preliminary study shows that a novel semi-rigid nephroscope appears to have several advantages over a

traditional rigid scope technique for the treatment of staghorn renal calculi. Further studies will be needed, however, to establish its potential role in routine clinical practice.

Financial support and sponsorship

This study is supported by Beijing Tsinghua Changgung Hospital Fund (No. 12015C1010).

Conflicts of interest

There are no conflicts of interest.

REFERENCES

1. Desai M, Jain P, Ganpule A, Sabnis R, Patel S, Shrivastav P. Developments in technique and technology: The effect on the results of percutaneous nephrolithotomy for staghorn calculi. *BJU Int* 2009;104:542-8.
2. Marguet CG, Springhart WP, Tan YH, Patel A, Undre S, Albala DM, *et al.* Simultaneous combined use of flexible ureteroscopy and percutaneous nephrolithotomy to reduce the number of access tracts in the management of complex renal calculi. *BJU Int* 2005;96:1097-100.
3. Li J, Xiao B, Hu W, Yang B, Chen L, Hu H, *et al.* Complication and safety of ultrasound guided percutaneous nephrolithotomy in 8,025 cases in China. *Chin Med J* 2014;127:4184-9.
4. Anastasiadis A, Onal B, Modi P, Turna B, Duvdevani M, Timoney A, *et al.* Impact of stone density on outcomes in percutaneous nephrolithotomy (PCNL): An analysis of the clinical research office of the endourological society (CROES) pcnl global study database. *Scand J Urol* 2013;47:509-14.