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Original Article

Clinical superiority of 3D-assisted percutaneous nephrolithotomy in treating complex upper urinary tract calculi: a single-center study

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Abstract: Objective: To investigate the clinical efficacy of three-dimensional (3D) visualization technology assisted percutaneous nephrolithotomy (PCNL) in the treatment of complex upper urinary tract calculi. Methods: This study retrospectively analyzed clinical data from 127 patients with complex upper urinary tract stones admitted to Yongchuan Hospital, Chongqing Medical University from January 2020 to January 2023. According to the treatment methods, the patients were divided into an observation group (3D visualization technology assisted PCNL, n = 69) and a control group (conventional PCNL, n = 58). The operation time, blood loss, postoperative ambulation time, hospitalization duration, surgical puncture (puncture needle number), stone clearance rate, postoperative complications, and levels of urea nitrogen (BUN), creatinine (Cr), and cysteine protease inhibitor C (Cys C) were compared between the two groups before operation (T0) and on the 1st (T1) and 7th (T2) day after operation. The levels of C-reactive protein (CPR), interleukin-6 (IL-6), tumor necrosis factor-α (TNF-α), prostaglandin E2 (PGE2) and prostaglandin F2α (PGF2α) were measured by ELISA before and after the operation. The clinical efficacy and quality of life of the two groups were observed. Results: The intraoperative blood loss, operation time, postoperative ambulation time and hospitalization duration in the observation group were significantly less than those in the control group (all $P < 0.05$). The levels of CRP, TNF-α, IL-6, PGE2 and PGF2α at T1 and T2 in the two groups were significantly higher than those at T0, and the levels of CRP, TNF-α, IL-6, PGE2 and PGF2α at T1 and T2 in the observation group were significantly lower than those in the control group ($P < 0.05$). The levels of BUN, Cr and Cys C in the two groups at T1 and T2 were significantly higher than those at T0 ($P < 0.05$), and the above indexes at T2 were significantly lower than those at T1 ($P < 0.05$). At T1 and T2, the levels of serum BUN, Cr and Cys C in the observation group were significantly lower than those in the control group ($P < 0.05$). The observation group required fewer punctures and had a higher stone clearance rate, as well as a lower complication rate (all $P < 0.05$). The total clinical treatment effective rate in the observation group was higher than that in the control group ($P < 0.05$). At T3, quality of life scores on the WHOQOL-BREF scale were higher in both groups compared to T0, with the observation group scoring higher than the control group ($P < 0.05$). Conclusion: PCNL assisted by 3D visualization technology offers significant clinical advantages in treating complex upper urinary tract calculi. It reduces intraoperative bleeding, shortens operation and hospitalization time, minimizes postoperative inflammation and renal function damage, improves stone clearance, reduces complications and improves patients' quality of life. Therefore it is worthy of clinical promotion.

Keywords: 3D visualization technology, percutaneous nephrolithotomy lithotripsy, complex upper urinary tract calculi, clinical effect, operation time, intraoperative blood loss

Introduction

Urinary calculi are common and frequently occurrence, with upper urinary tract calculi being the most prevalent. Its clinical etiology is complex, often accompanied by pain, frequent urination, hematuria and other clinical symptoms. If not treated in time, it may lead to irreversible damage to the ureter or kidney [1, 2]. Complex upper urinary calculi are typically large in size, often presenting as massive renal casts or multiple stones. Patients may also have additional conditions such as stenosis of the ureteropelvic junction (UPJ), solitary kidney, or chronic obstructive nephropathy, making clinical management challenging. In the past, open

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surgery was the primary treatment approach [3]. With advancements in medical technology, percutaneous nephrolithotomy (PCNL) has replaced open surgery as one of the most used and effective operations for the treatment of complex renal stones and upper urinary tract stones. For large or multiple stones, PCNL has become the standard clinical treatment [4]. Despite its effectiveness, PCNL carries risks, including potential damage to the spine, pleura and surrounding organs, as well as a high risk of bleeding and infection [5, 6]. Therefore, how to accurately establish the puncture channel, reduce the risk of surgery, and improve the stone clearance rate are the difficulties and focuses of PCNL.

Three-dimensional (3D) visualization technology is a novel advancement in recent years. Using computer-assisted 3D reconstruction of CT and/or MRI images, it provides a clear and intuitive view of renal anatomy, location, shape, and relationship of stones with surrounding tissues. To a certain extent, it can reduce the damage to renal blood vessels during renal puncture, thereby improving the accuracy of puncture location [7, 8]. Unlike conventional imaging, 3D visualization technology does not rely on the clinical experience or spatial imagination of surgeons for 3D stereoscopic evaluation, making the results more stable [9, 10]. Although 3D visualization technology has shown its advantages in many medical fields, its application in assisting PCNL for complex upper urinary tract calculi remains in its early stages. At present, there are relatively few reports on the application of 3D visualization technology to assist PCNL, and its clinical effectiveness and safety require further investigation. This study aims to explore the clinical effect of 3D visualization-assisted PCNL in the treatment of complex upper urinary tract calculi, to provide a more scientific foundation and practical guidance for the application of this technology in the treatment of urinary calculi.

Subjects and methods

Case selection

A retrospective analysis was conducted on clinical data from 127 patients with complex upper urinary tract calculi admitted to Yongchuan Hospital, Chongqing Medical University from January 2020 to January 2023. This study was approved by the Ethics Committee of Yongchuan Hospital, Chongqing Medical University.

Inclusion criteria: ① Diagnosis of upper urinary tract stones confirmed by relevant clinical criteria; ② Confirmation by biochemical examination and ultrasound examination; ③ Eligibility for PCNL; ④ Presence of low back pain accompanied by recurrent chills, fever, and other symptoms, along with obvious urinary tract irritation; ⑤ Positive renal percussion pain (+); ⑥ Laboratory examination showing obvious symptoms of infection; ⑦ No recent history of stone surgery; ⑧ Complete clinical data available for analysis. Exclusion criteria: ① Presence of infectious diseases or immune system diseases; ② Abnormal anatomical structure of urinary system; ③ Diagnosis of malignant tumors or organ dysfunction; ④ Audio-visual disorders, or mental disorders; ⑤ Ureteropelvic junction stricture or ureteral stricture; ⑥ Pregnant and lactating women; ⑦ Coagulation dysfunction or congenital insufficiency.

Intervention methods

Control group: Preoperative examination: routine blood and urine tests, liver and kidney function, coagulation function, electrocardiogram (Shanghai Digital Medical Technology Co., Ltd., Shanghai Food and Drug Administration approval No. 2210992), chest X-ray (Digital medical X-ray photography system, Siemens Medical Co., Ltd., China, Machinery Injection 20152301269, Model: Ysio Max), and urinary tract CT scan with contrast (PHILIPS BRILLIANCE 64-slice spiral CT scanner, detector combination 0.625 mm × 64, PHILIPS, Netherlands; Ultravist containing iodine 370 g/L, produced by Schering company, German). These examinations aimed to assess the location, size, number of stones, shape of the renal pelvis and calices, and degree of hydronephrosis. Bowel preparation, including oral laxatives or enema, was performed the day before surgery to minimize intestinal gas interference during the surgical procedure. Preoperative fasting and water deprivation were routinely performed, and prophylactic antibiotics were given. Surgical procedure: After general anesthesia, the patient was positioned in the prone position. Intravenous injection of 40 mg furosemide (National drug approval No. H42023005; Wuhan Fuxing Biopharmaceutical Co., Ltd., 2 ml: 20 mg) was administered 15 min before PCNL.

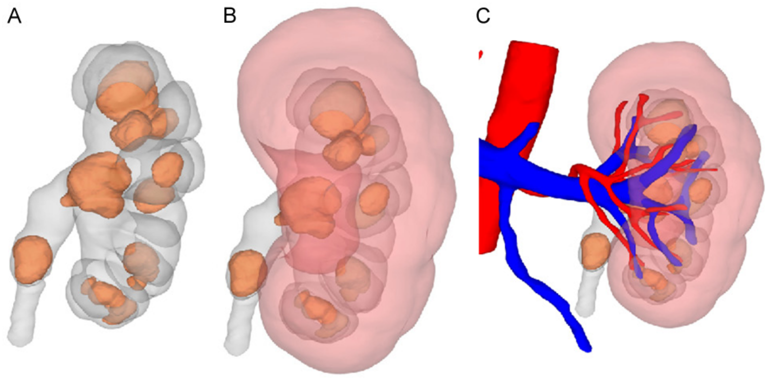

Figure 1. Three-dimensional reconstruction image. Note: (A) Three-dimensional reconstruction showed renal calculi and renal pelvis and calyx; (B) Three-dimensional reconstruction showed kidney stones and kidney conditions; (C) Three-dimensional reconstruction showed renal stones and renal blood vessels.

Using the bladder lithotomy position, the ureteral catheter (Jinan Zhongkangshun Medical Device Co., Ltd., Model: F4) was inserted into the affected ureter through the urethra and retained. Then, the patient was repositioned to the prone position with a soft pad under the abdomen to support the renal area. Under ultrasound guidance (Ultrasonic imaging system purchased from Shanghai Yuyan Scientific Instrument Co., Ltd.), an 18 G puncture needle was inserted through the 11th intercostal or 12th rib margin of the posterior axillary line of the affected side. After entering the target renal calices, the needle core was pulled out, and a zebra guidewire was inserted upon observing the urine outflow. The puncture needle was then withdrawn. The subcutaneous tissues were incised in turn, and the percutaneous renal channel was expanded to F18-F20. A rigid ureteroscope was inserted into the renal pelvis, and stones were identified. A Wolf pneumatic lithotripsy machine (Germany) was used for lithotripsy, followed by rinsing with a perfusion pump to remove the stone fragments. Double-J tubes, nephrostomy tubes, and urinary catheters were placed for drainage (all purchased from Lekai, Germany).

Observation group: 3D visualization technology was used to assist PCNL. The preoperative operation was the same as that of the control group, including comprehensive preoperative evaluation and intestinal preparation. A CT scan was performed in the prone position, and the image data were extracted in DICOM format. After threshold selection and applying regional growth, multi-layer editing, and modification techniques using Mimics 17.0 software, 3D reconstruction images of different parts of the kidney were obtained. This process created a complete 3D model of the kidney, including the 11th and 12th ribs, to ensure smooth, fine details for post-processing. The resulting model was saved as an STL file, which was then used to plan the puncture point, puncture path, depth, and trajectory. Using the reconstructed 3D model, preoperative planning was conducted, including the assessment of the PCNL channel, target renal calyx, and puncture angle, to predict residual stones, puncture depth, and lithotripsy process. The model can visually display the size, shape, location and spatial relationship between stones and surrounding tissues, and provide accurate basis for surgical path planning and puncture point selection (as shown in **Figure 1**).

The patient positioning and anesthesia were the same as those in the control group. With the help of 3D visualization technology, the operation process was simulated by a computer before operation. The puncture path, working channel locations, and number of channels were accurately planned to reduce the damage to the renal parenchyma and improve the stone clearance rate. During the operation, the preoperative plan was followed, and the puncture and working channels were established under the guidance of the 3D visualization software operating system (Touch Viewer V3.2.4.1 Xudong digital medical image). The system provided real-time display of the position and depth of the puncture needle, ensuring accurate puncture placement. Lithotripsy was performed using a nephroscope and lithotripsy equipment in the 3D visual field. After stone removal, a nephrostomy tube and catheter were retained, and the procedures were concluded. All PCNL procedures in both groups were completed by the same urologist, who had performed more than 100 PCNLs.

Both groups were given routine postoperative care, including anti-infection, hemostasis, rehydration and other supportive treatments. Vital signs and potential complications were closely observed. Patients were encouraged to mobilize early to promote recovery. Regular follow-up examinations, including urinary tract plain film or CT, were performed to evaluate the stone clearance and improvement of hydronephrosis.

Data collection and observation indicators

Primary observation indexes: (1) Surgical-related Indicators, including operation time, amount of bleeding, time to ambulate after surgery, and length of hospitalization were compared between the two groups. (2) The fasting peripheral venous blood of the two groups of patients was collected in the morning before operation (T0) and on the 1st (T1) and 7th day after operation (T2). After centrifugation, inflammatory markers, including the levels of C-reactive protein (CRP), tumor necrosis factor-α (TNF-α), interleukin-6 (IL-6), prostaglandin E2 (PGE2) and prostaglandin F2α (PGF2α) were detected by enzyme-linked immunosorbent assay. (3) Renal function markers, including blood urea nitrogen (BUN), creatinine (Cr) and cystatin C (Cys C), were measured at T0-T2 for both groups using ELISA kit (Shanghai Kehua Bioengineering Co., Ltd.).

Secondary observation indicators: (1) The number of punctures was recorded as the number of times the puncture needle entered and exited the skin. The number of punctures was counted as the number of times the needle passed from the skin to the kidney, from the start of the procedure to its completion. (2) Postoperative complications, including fever, hematuria and infection, were recorded for both groups. (3) The stone clearance rate at T2 was determined by KUB (kidney-ureter-bladder radiography) and urinary ultrasound. Postoperative residual stones greater than 5 mm or those between 3-5 mm with more than 3 stones were considered as residual stones. (4) Clinical efficacy at postoperative 1 month was assessed. Cured: no residual stones on imaging, and clinical symptoms disappeared; Markedly effective: no residual stones on imaging, and clinical symptoms significantly improved; Effective: a small number of residual stones present upon imaging, but clinical symptoms improved; Ineffective: Most stones remain upon imaging, and clinical symptoms did not significantly improve. Total effective rate = [(cured cases + markedly effective cases + effective cases)/total number of cases] × 100%. (5) Before operation (T0) and 3 months after operation (T3), the World Health Organization Quality of Life Scale-brief form questionnaire (WHOQOL-BREF) [11] was used to evaluate the quality of life. The scale includes four domains: physical, psychological, social relationships, and environment. The higher the score, the better the quality of life. The Cronbach's α coefficient of the scale was 0.852.

Statistical methods

SPSS 26.0 was used for statistical analysis of the collected data. Measurement data from a normal distribution were expressed as ($\bar{x}$ ± s), and analyzed by independent sample t test or one way or two way ANOVA followed by Tukey test. The enumeration data represented were presented as frequencies (n) and percentages (%), and tested by χ^2 test. $P < 0.05$ was considered statistically significant.

Results

Comparison of general information between the two groups

There were no significant differences in age, gender, BMI, stone distribution, STONTE score, ASA grade, diabetes mellitus, hypertension and other general data between the two groups (all $P > 0.05$, **Table 1**).

Comparison of various surgical indicators between the two groups

In the observation group, the operation time was (128.29±17.34) min, the time to ambulation after operation was (4.25±0.93) d, and the hospitalization duration was (6.94±0.81) d, which were all shorter than those in the control group (all $P < 0.05$). The intraoperative blood loss of the observation group was (75.09±10.27) mL, which was less than that of the control group ($P < 0.05$) (**Figure 2**).

Comparison of inflammatory factor levels between the two groups

The levels of CRP, TNF-α and IL-6 in both groups at T1 were significantly higher than those at T0

Table 1. Comparison of general data between the two groups of patients

Category		Control group (n = 58)	Observer group (n = 69)	t/χ^2	P
Age ($\bar{x}$ ± s, year)		36.42±1.26	35.98±2.06	1.398	0.165
Sexuality	Males	34 (58.62)	33 (47.83)	1.473	0.225
	Female	24 (41.38)	36 (52.17)		
BMI ($\bar{x}$ ± s, kg/m^2)		25.72±3.21	26.14±3.13	0.804	0.423
Distribution of stones	Left side	19 (32.76)	23 (33.33)	3.611	0.164
	Right-hand side	14 (24.14)	26 (37.68)		
	Bilateral	25 (43.10)	20 (28.99)		
STONTE score (points)		9.12±1.12	9.30±1.07	-1.054	0.294
ASA classification	I	6 (10.34)	9 (13.04)	0.403	0.817
	II	48 (82.76)	54 (78.26)		
	III	4 (6.90)	6 (8.70)		
Complicated with diabetes mellitus	Yes	22 (37.93)	21 (30.43)	0.791	0.374
	No	36 (62.07)	48 (69.57)		
Complicated with hypertension	Yes	33 (56.90)	37 (53.62)	0.136	0.712
	No	25 (43.10)	32 (46.38)		

($P < 0.05$), and those at T2 were significantly lower than those at T1 ($P < 0.05$). There was no significant difference between T2 and T0 in both groups ($P > 0.05$). At T1 and T2, the levels of CRP, TNF-α and IL-6 in the observation group were lower than those in the control group ($P < 0.05$), as shown in **Figure 3**.

Comparison of prostaglandin levels between the two groups

The levels of PGE2 and PGF2α in the two groups at T1 were significantly higher than those at T0 ($P < 0.05$), and those at T2 were significantly lower than those at T1 ($P < 0.05$). There were no significant differences in the levels of PGE2 and PGF2α between T2 and T0 in both groups ($P > 0.05$). The levels of PGE2 and PGF2α in the observation group were lower than those in the control group at T1 and T2 ($P < 0.05$), as shown in **Figure 4**.

Comparison of renal function indexes between the two groups

There was no significant difference in serum BUN, Cr and Cys C levels between the two groups at T0 ($P > 0.05$). The above indexes of the two groups at T2 were significantly lower than those at T1 ($P < 0.05$). There was no significant difference in BUN, Cr and Cys C levels between T2 and T0 in the observation group ($P > 0.05$). At T1 and T2, the levels of serum BUN, Cr and Cys C in the observation group were significantly lower than those in the control group ($P < 0.05$), **Figure 5**.

Comparison of surgical puncture frequency and complications between the two groups

The proportion of patients with single-channel puncture in the observation group was higher than that in the control group, and the number of puncture needles was less than that in the control group (all $P < 0.05$). The stone clearance rate of the observation group (95.65%, 66/69) was significantly higher than that of the control group (77.59%, 45/58), and the total incidence of complications in the observation group (5.80%, 4/69) was significantly lower than that in the control group (27.59%, 13/58) (all $P < 0.05$), as shown in **Table 2**.

Comparison of clinical efficacy between the two groups

The total effective rate of clinical treatment in the observation group was higher than that in the control group ($\chi^2 = 4.913$, $P < 0.05$, **Table 3**).

Comparison of quality of life between the two groups

At T3, the scores of WHOQOL-BREF scale of the two groups were all higher than those at T0

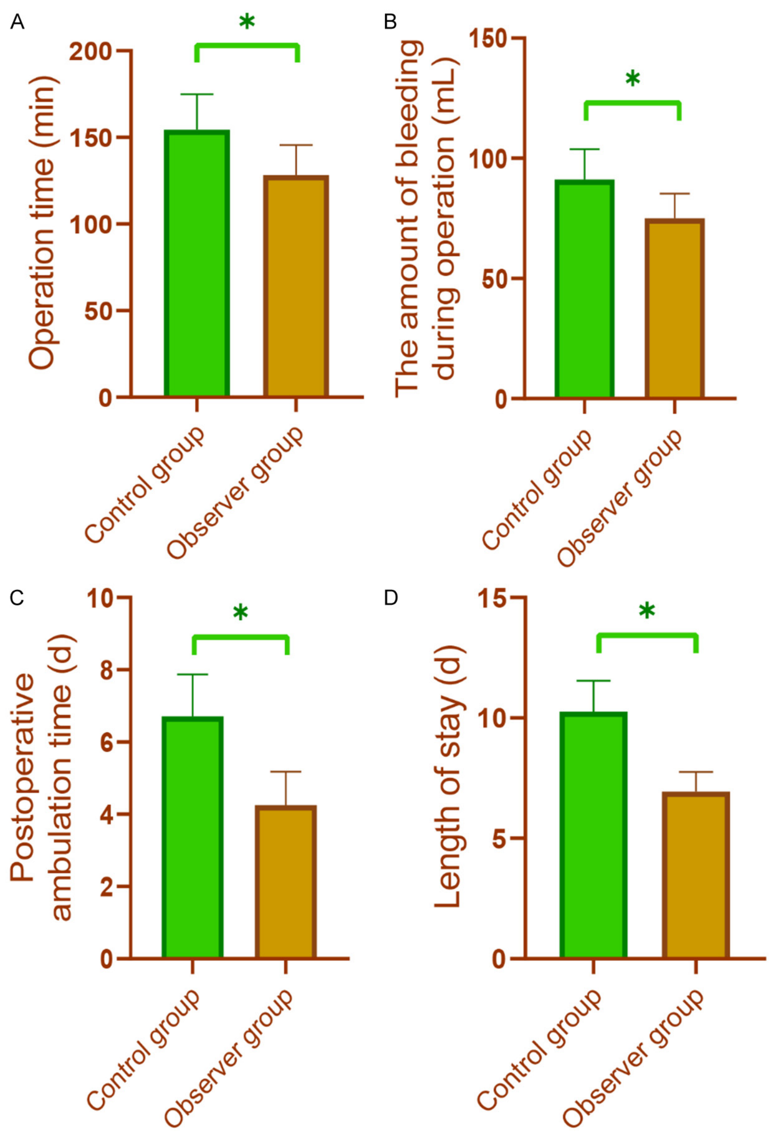

Figure 2. Comparison of various surgical indicators. A: Operation time; B: The amount of bleeding during operation; C: Postoperative ambulation time; D: Length of stay. *P < 0.05.

across each domain, and the observation group was higher than the control group (all $P < 0.05$), see **Table 4**.

Discussion

Upper urinary tract calculi are a common urinary system occurrence with a high prevalence and recurrence rate, which brings significant patient discomfort and complications [12]. According to statistics, the prevalence of urinary stones ranges from 2% to 20%, with a recurrence rate as high as 50% [13, 14]. With changes in lifestyle, diet, and environmental factors, the prevalence of urinary stones is also rising [15]. PCNL is currently the primary surgical method for treating upper urinary tract stones. It is minimally invasive, safe, and effective in removing larger stones. However, due to the relatively thick puncture channel, it may cause vascular injury particularly when the renal parenchyma is torn and dilated, leading to significant bleeding. Additionally, PCNL has a steep learning curve, especially for less experienced surgeons, which necessitates longer training periods [16]. Therefore, urologists have continuously worked on improving on all aspects of PCNL to enhance its safety and efficacy [17]. With the development of precision medicine and intelligent medicine, 3D visualization technology has been increasingly adopted in surgical practice. It offers several advantages, such as enhanced data visualization, improved surgical Intelligence, precise targeting, and simplified medical education. It can improve the communication mode between doctors and patients, reduce the incidence of surgical complications, improve the success rate of surgery, and shorten the learning cycle of young doctors [18, 19]. At the same time, the surgical plan is formulated by preoperative auxiliary science to reduce intraoperative injury, reduce intraoperative bleeding and serious postoperative complications, improve the safety of surgery and minimize the incidence of residual stones [20]. In this study, the stone clearance rate of the observation group was significantly higher than that of the control group, and the total treatment effective rate and quality of life scores in the observation group were all higher than those in the control group. These findings suggest that 3D visualization not only improves the success rate of

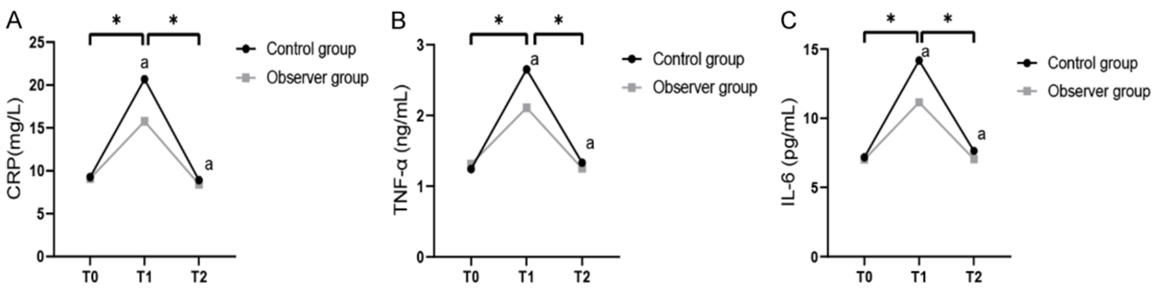

Figure 3. Changes in levels of inflammatory factors. A: CRP; B: TNF-α; C: IL-6. *P < 0.05; compared with the observer group: aP < 0.05. CRP: C-reactive protein; TNF-α: tumor necrosis factor-α; IL-6: interleukin-6.

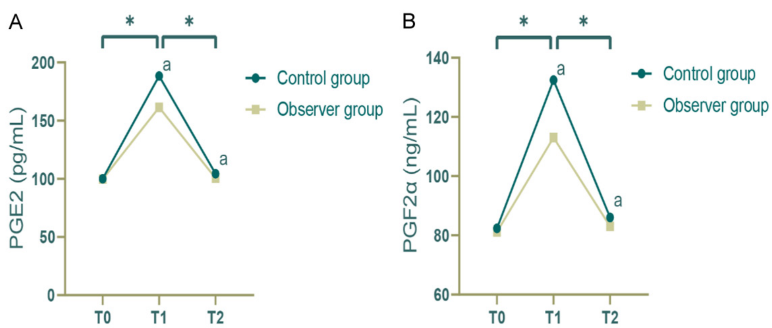

Figure 4. Comparison of prostaglandin levels. A: PGE2; B: PGF2α. *P < 0.05; compared with the observer group: aP < 0.05. PGE2: Prostaglandin E2; PGF2α: prostaglandin F2α.

lithotripsy, but also enhances the efficiency of stone removal, including the effective clearance of stone fragments. This contributes to a faster recovery and better overall outcomes for patients, as evidenced by the improved quality of life scores.

This study demonstrates the significant benefits of utilizing 3D visualization technology in percutaneous nephrolithotomy (PCNL) for the treatment of upper urinary tract stones. Through 3D visualization reconstruction, the operation plan and intraoperative navigation can be carefully formulated, leading to improved surgical outcomes. It was confirmed that 3D visualization technology could improve the positioning accuracy, shorten the operation time, reduce the amount of bleeding, and facilitate the postoperative recovery of patients. By constructing a three-dimensional space and simulating various puncture schemes before surgery, 3D visualization allows for better planning and reduces the number of puncture channels required. This leads to fewer punctures and less trauma to the patient. The clear visualization of the surgical field ensures that the operation is carried out with greater accuracy, reducing the risk of injury to surrounding structures and minimizing intraoperative blood loss. As a result, the operation time is shortened, and the patient's recovery is expedited [21]. In this study, the observation group showed a higher number of single-channel puncture procedures, and a lower number of puncture needles used compared to the control group, further supporting the benefits of 3D guidance. Additionally, the stone clearance rate in the observation group was higher than that in the control group, underscoring the technology's contribution to the success of the procedure. By guiding the surgical approach with accurate positioning, 3D visualization improves the overall success rate of punctures and stone removal while minimizing collateral damage. 3D visualization technology makes up for the shortcomings of traditional imaging, which cannot fully display the anatomical structure. The kidney model is transparent, and the surgical path is adjusted according to the distribution of stones, hydronephrosis, and surrounding organs. Puncture and stone removal can be performed more accurately, thereby improving the efficiency and safety of surgery [22]. Meanwhile, the total incidence of complications in the observation group was lower than that in the control group. PCNL, as an invasive operation, can cause complications such as bleeding, renal tear and adjacent abdominal organ injury during the establishment of the operating channel and flushing out the stones. Most of the core parts of the stones contain bacteria, and the high

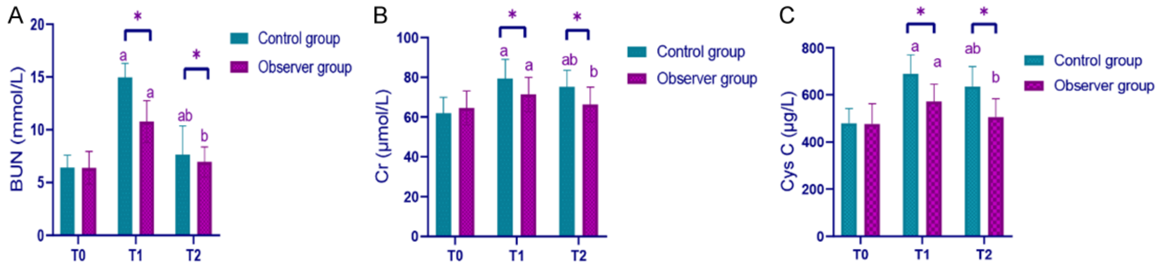

Figure 5. Comparison of renal function indexes. A: BUN; B: Cr; C: Cys C. *P < 0.05; compared with T0: aP < 0.05; compared with T1: bP < 0.05. BUN: blood urea nitrogen; Cr: creatinine; Cys C: cystatin C.

Table 2. Comparison of surgical puncture and complications between the two groups

Items		Control group (n = 58)	Observer group (n = 69)	χ^2/t	P
Number of puncture channels (example)	Single channel	39	61	8.432	0.004
	Multichannel	19	8		
Number of puncture needles (times)		5.12±1.10	4.22±0.83	4.805	< 0.001
stone free rate (n)		45	66	9.340	0.002
complications (n)	Fever	5	2		
	injury of the ureter	5	1		
	Postoperative hemorrhage	4	1		
	Total complications	13	4	7.505	0.006

Table 3. Comparison of clinical efficacy between the two groups of patients

Clinical efficacy	Control group (n = 58)	Observer group (n = 69)	χ^2	P
Recovery	15 (25.86)	22 (31.88)		
Effectual	20 (34.48)	27 (39.13)		
In force	19 (32.76)	20 (28.99)		
Null and void	4 (6.90)	0 (0.00)		
Total response	54 (93.10)	100	4.913	0.027

pressure of the renal pelvis caused by a large amount of isotonic fluid during the operation can lead to bacteremia [23]. The destruction of renal pelvis mucosa by PCNL and the need for a large amount of lavage fluid during operation are important factors leading to postoperative fever [24]. 3D visualization technology assisted PCNL puncture positioning can help doctors accurately find the location of stones and crush them, improve the success rate of puncture, and avoid serious damage to surrounding tissues, which can further improve the safety of surgery and avoid serious complications after surgery [25].

Research has found that the inflammatory response is an important factor causing kidney damage and inducing calculus [26]. As an early marker of inflammation, CRP has high sensitivity, high expression under the stimulation of tissue trauma, surgery and organ transplantation, and can be gradually reduced in the recovery period [27]. In addition, under surgical stimulation, the body's defense response is activated to release many inflammatory factors such as TNF-α and IL-6 to produce an inflammatory response, causing further damage to the body [28, 29]. The increase of inflammatory cytokines can further damage the vascular endothelium and promote the increase of CRP level, which can further activate the inflammatory response, promote the secretion of inflammatory mediators PGE2 and PGF2α, induce pain, fever and participate in the process of vasodilation, increased permeability and tissue edema. In this study, the levels of serum CRP, TNF-α and IL-6 in the two groups of patients after operation were increased, suggesting that the tissue trauma of complex upper urinary tract calculi surgery will cause the body's inflammatory response, resulting in the increase of serum inflammatory factor levels. The levels of serum CRP, TNF-α and IL-6 in the observation

Table 4. Improvement of quality of life in the two groups of patients

WHOQOL-BREF	Time	Control group (n = 58)	Observer group (n = 69)	T	P
Physiology	T0	69.53±4.59	70.21±4.03	0.972	0.333
	T3	80.23±3.31	82.27±3.45	3.353	0.001
t		13.985	18.649		
P		< 0.001	< 0.001		
Psychology	T0	66.31±4.36	67.52±4.81	1.532	0.128
	T3	71.15±3.03	72.90±3.12	3.031	0.003
t		7.643	7.501		
P		< 0.001	< 0.001		
Social relations	T0	72.32±5.13	73.01±4.19	0.845	0.400
	T3	74.11±3.04	75.54±3.36	2.463	0.015
t		2.183	3.858		
P		0.033	< 0.001		
Environment	T0	70.82±4.28	71.24±4.32	0.626	0.533
	T3	75.13±3.09	76.84±3.61	2.824	0.006
t		6.663	8.229		
P		< 0.001	< 0.001		

group decreased with the rehabilitation process at T2, and there was no significant difference compared with T0, which was consistent with the postoperative tissue injury. The levels of serum CRP, TNF-α and IL-6 in the observation group were lower than those in the control group at T1 and T2, which fully demonstrated that the observation group had less surgical trauma, less inflammatory stimulation to the body, and faster postoperative recovery, reflecting its minimally invasive advantages. 3D visualization technology assisted PCNL can accurately select the renal calyx that needs to be punctured, reduce the damage to the surrounding tissue, thereby reducing the release of inflammatory factors, and providing a guarantee for the stone removal effect.

At present, the research on upper urinary tract calculi surgery mostly focuses on clinical efficacy, and the change of body function caused by surgery is also an important index to evaluate the effect of surgery. BUN, Cr and Cys C are common renal function indicators, mainly metabolized by the kidney. Once renal dysfunction occurs, it will cause metabolic abnormalities of the above indicators [30, 31]. The results of this study showed that the levels of blood BUN, Cr and Cys C in the observation group were significantly increased at T1, and returned to the preoperative level at T2. The reason may be that the operation itself is an invasive operation, which may cause a certain degree of damage to the kidney and its surrounding tissues; at the same time, when using percutaneous nephrolithotomy during surgery, in order to maintain a clear vision, continuous perfusion of flushing fluid is required, which may lead to an increase in renal perfusion pressure, which may lead to temporary impairment of renal function, manifested as an increase in BUN, Cr, Cys C and other indicators. With the gradual recovery of the patient's body and the initiation of the renal compensatory mechanism, the damaged renal tissue is gradually repaired, and the renal function is gradually restored. In addition, the levels of serum BUN, Cr and Cys C In the observation group "were" lower than those in the control group at T1 and T2, suggesting that the effect of 3D visualization technology on PCNL on renal function was relatively small. The reason for this is that by constructing a 3D kidney model from the patient's CT or MRI data before surgery, the surgeon can Intuitively understand the precise location and shape of the stone, as well as its spatial relationship with the surrounding tissue. This helps to develop a more refined and personalized surgical plan to reduce blindness and uncertainty during the operation, thereby reducing the accidental damage to the kidney. PCNL assisted by 3D visualization technology does not require renal dissociation, and avoids damage to surrounding organs. In addition, the establishment of percutaneous renal channel Is optimized by 3D visualization technology. Although it will cause certain damage to the kidney, it has less mechanical damage than traditional PCNL surgery and is more conducive to the good recovery of postoperative renal function.

There are still some shortcomings in the design of this study. First, this study Is a retrospective study, and there is a certain selection bias in the included cases. Secondly, there is a lack of long-term follow-up after operation, and the long-term stone clearance rate of the two surgical methods cannot be analyzed. The sample size of our study is small, and the conclusions obtained cannot fully explain the advantages and disadvantages of the two surgical methods. Further analysis is needed to expand the sample. In summary, PCNL with 3D visualization guidance can improve the treatment effect of complex upper urinary tract calculi, reduce the amount of intraoperative blood loss, reduce renal dysfunction, reduce complications, and is it safe and effective.

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Disclosure of conflict of interest

None.

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