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The clinical efficacy of monolayer suture combined with hem-o-lok clip in partial nephrectomy among patient with renal cell carcinoma: a quasi-experimental study

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Abstract

Objective To explore the clinical efficacy of monolayer suture combined with a hem-o-lok clip during partial nephrectomy among patients with renal cell carcinoma (RCC).

Methods Eighty patients with RCC underwent laparoscopic partial nephrectomy from January to October 2021. They were assigned into a control group and an intervention group, each with 40 cases using random number table. The control group received double-layer sutures on the wound, while the intervention group had single-layer sutures with a hem-o-lok clip for hemostasis. The study compared operative indexes and postoperative recovery of the two groups.

Results Intraoperative bleeding and warm ischemia time in the intervention group were significantly shorter than that in the control group. There were no significant differences in operation time, drainage volume on the first day after operation, and hospital stay between the two groups. Before operation, there were no significant differences in serum creatinine and blood urea nitrogen between the two groups. However, 24 h post-operation, both groups experienced a significant increase in these levels, with the intervention group showing lower levels than the control group. Changes in glomerular filtration rate were significantly lower in the intervention group than the control group. Complication rates were similar, with 7.5% in the research group and 10.0% in the control group.

Conclusion Monolayer suture combined with a hem-o-lok clip can shorten the time of warm ischemia, reduce intraoperative bleeding and the loss of normal renal parenchyma in patients undergoing laparoscopic partial nephrectomy. More studies with larger sample size are needed to confirm the results.

Keywords Double suture, Monolayer suture, Hemlock clamp, Partial nephrectomy

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Introduction

Based on recent data, kidney cancer is among the most common urological malignancies globally. In 2019, approximately 371,000 new cases of kidney cancer were reported worldwide, representing a significant increase of 154.78% since 1990. This growth is part of a broader trend of rising incidence in genitourinary cancers, with prostate cancer showing the highest increase (169%). Bladder cancer cases also rose by 123.34%. The mortality rate for kidney cancer, however, has stabilized since 2010, following an initial rise [1]. Kidney tumors (including renal cell carcinoma) constitute 2–3% of all adult malignancies [1, 2]. In the United States, about 81,610 new cases of kidney cancer are expected in 2024, accounting for around 4–5% of all cancers. The disease remains more common in men than women [3]. The annual incidence of RCC ranges from 4.4 to 11.1 per 100,000 people, with a mortality rate of about 1.47/100,000. RCC accounts for 80-90% of renal malignant tumors and is the most deadly among urinary malignant tumors [4]. In recent years, with the improvement of imaging technology and physical examinations, the incidence of renal tumors is also increasing, with localized renal tumors accounting for 63.8% of cases [5]. With advancements in medical imaging, more renal tumors can be diagnosed and treated. To better protect renal function and reduce the risk of chronic kidney disease, laparoscopic partial nephrectomy has become the recommended standard treatment by the European Urology Association for T1 renal tumors [6, 7].

Laparoscopic partial nephrectomy takes longer than open nephrectomy. The renal artery occlusion and suturing the renal parenchyma during surgery can lead to renal ischemia-reperfusion injury and partial loss of renal function. Prolonged warm ischemia time can also lead to irreversible damage of residual renal function [8]. Current surgical approaches for localized renal tumors focus on protecting renal function while treating the cancer. The monolayer suture technique, involving suturing only the central base of the wound tightly or using electrocoagulation to stop bleeding without suturing, is widely used and believed to reduce renal parenchyma loss and warm ischemia time. This technique aims to minimize nephron loss by avoiding excessive suturing of normal kidney tissue [9–11]. However, monolayer suture may lead to a significant increase in blood loss in complex tumors [12]. This study aimed to explore the clinical efficacy of combining monolayer suture with hem-o-lok clip during partial nephrectomy in patients with renal cell carcinoma.

Methods

Study design, setting, and ethics

This quasi-experimental study was conducted at Xingtai First Hospital in Hebei Province, China, involving 80 patients with RCC who underwent laparoscopic partial nephrectomy from January to October 2021, consecutively. The random number table method was used to allocate the patients into control and intervention groups, with 40 cases in each group. In the control group, double-layer suturing (basal and cortical wound) was performed, while the intervention group received monolayer suture (basal wound only) combined with a hem-o-lok clip for hemostasis during partial nephrectomy. The Ethics committee of Xingtai First Hospital approved the study, and all patients signed the informed consent form.

Participants

Inclusion criteria

(1) Compliance with the guidelines of RCC operation in the Chinese urology disease diagnosis and treatment guidelines (the 2014 edition); (2) Procedures performed by retroperitoneal laparoscopic approach by the same experienced physician; (3) The diameter of renal tumor less than 3 cm; (4) R.E.N.A.L score ≤ 6.

Exclusion criteria

(1) Abnormal preoperative serum creatinine and urea nitrogen levels (serum creatinine: male > 104.0umol/L, female > 84umol hammer L; urea nitrogen: adult > 6.4mmol/L, over 60 years old > 7.5mmol/L); (2) Previous urological surgeries; (3) Endogenic tumor; (4) Tumor proximity to renal collecting system or renal sinus ≤ 4 mm.

Intervention methods

Before the operation, a thorough examination was conducted, including blood, urine, stool routine, liver and kidney function tests, electrolyte levels, blood glucose, coagulation function, blood type, and liver HIV virological examination. Imaging tests included urinary CT scans, abdominal color ultrasound, chest CT, ECG, heart color ultrasound. Patients fasted and underwent an enema the night before operation, and received antibiotics prophylactically on the day of operation. In the control group, during partial nephrectomy, the wound was sutured in double layers; the approach was chosen based on tumor location, and the surrounding tissues were meticulously treated to expose the tumor surface. The renal artery was isolated and blocked before tumor resection, followed by complete removal of the tumor and a thin layer of normal renal tissue. If the collecting system is damaged, perform a full-layer continuous suture with 3/0 absorbable suture. Then, suture the basal and cortical parts of the wound with a continuous 2/0 absorbable thread, maintaining a distance of about 1 cm and a depth not exceeding 5 mm. After suturing, release and block the artery, then apply biological protein glue to the wound. In the research group, during partial nephrectomy, use a

Table 1 The comparison of general data between two groups

Group	*N*	Gender (male / female)	Age (years)	Body weight(kg)	Tumor location	
					Left side	Right side
Intervention group	40	25/15	57.35 ± 8.43	71.42 ± 8.46	27	13
Control group	40	26/14	59.03 ± 9.24	72.28 ± 8.71	25	14
χ2/t		0.054	0.849	0.447	0.101	
P		0.816	0.398	0.655	0.750	

Table 2 Comparison of surgical observation indexes [(n) %]

Group	*N*	The length of operation(min)	Intraoperative bleeding volume(ml)	Warm ischemic time(min)	Drainage volume on the first day after operation(ml)	Hospitalization time(d)
Control group	40	131.42 ± 25.31	134.43 ± 54.22	22.31 ± 4.21	104.24 ± 27.18	4.83 ± 1.25
Intervention group	40	126.53 ± 24.25	112.42 ± 41.42	14.02 ± 3.84	97.43 ± 25.38	4.32 ± 1.15
t		0.882	2.040	9.201	1.158	1.899
P		0.380	0.044	< 0.01	0.250	0.061

single-layer suture for the wound (only suturing the basal part) combined with a hem-o-lok clip to close any vessel injuries. If there is collecting system damage, implement a full-layer continuous suture with 3/0 absorbable thread. Suture the wound base with 2/0 absorbable thread, keeping a distance of about 1 cm and a depth of 5 mm. Release the artery blockage and reduce pneumoperitoneum pressure to 5mmHg [13]. Utilize the hem-o-lok clip to fix the suture during the operation and finish by applying biological protein glue to the wound.

Measures

Operative observation index

The operation time, intraoperative blood loss, warm ischemia time, drainage volume and hospitalization time were calculated on the first day after operation.

Renal function

Before and 24 h after operation, blood samples were treated with EDTA anticoagulation, centrifuged at 3000 rpm for 10 min, and the upper serum was frozen at -80 ℃ for testing. The serum creatinine and blood urea nitrogen levels were analyzed by an automatic biochemical analyzer. The glomerular filtration rate was measured before and three months after operation, and the change in glomerular filtration rate was calculated using the formula: Δ GFR= (pre-GFR-GFR reexamination)/GFR preoperation × 100%.

Complications

The postoperative complications were observed.

All patients were followed up for 3 months.

Statistical methods

SPSS version 24.0 was used for statistical analysis. Measurement data were expressed as mean ± standard deviation, while count data were expressed as frequency or rate. T-test was used for normally distributed measurement data. Chi-square test was used for count data. Repeated measurement data were analyzed by repeated measures analysis of variance. The results of main effect test were used when there was no interaction, and simple effect analysis was carried out when there was interaction. A $P<0.05$ indicated statistical significance.

Results

The age of the intervention group was between 23 and 78 years old, while the age of the control group was between 24 and 76 years old. There were no significant differences in sex, age, and other general data between the two groups ($P>0.05$) (Table 1).

Comparison of operative observation indexes

The intraoperative blood loss and warm ischemia time in the intervention group were significantly shorter than that in the control group ($P<0.05$). However, there were no significant differences in operation time, drainage volume on the first day after operation, and hospital stay ($P>0.05$) between the two groups (Table 2).

Renal function

Before operation, there were no significant differences in serum creatinine and blood urea nitrogen levels ($P>0.05$). However, 24 h after operation, both serum creatinine and blood urea nitrogen significantly increased, showing statistically significant differences between groups ($P<0.05$). The intervention group had lower levels of serum creatinine and blood urea nitrogen compared to the control group ($P<0.05$). After three months, the changes in glomerular filtration rate were significantly lower in the intervention group compared to the control group ($P<0.05$) (Fig. 1).

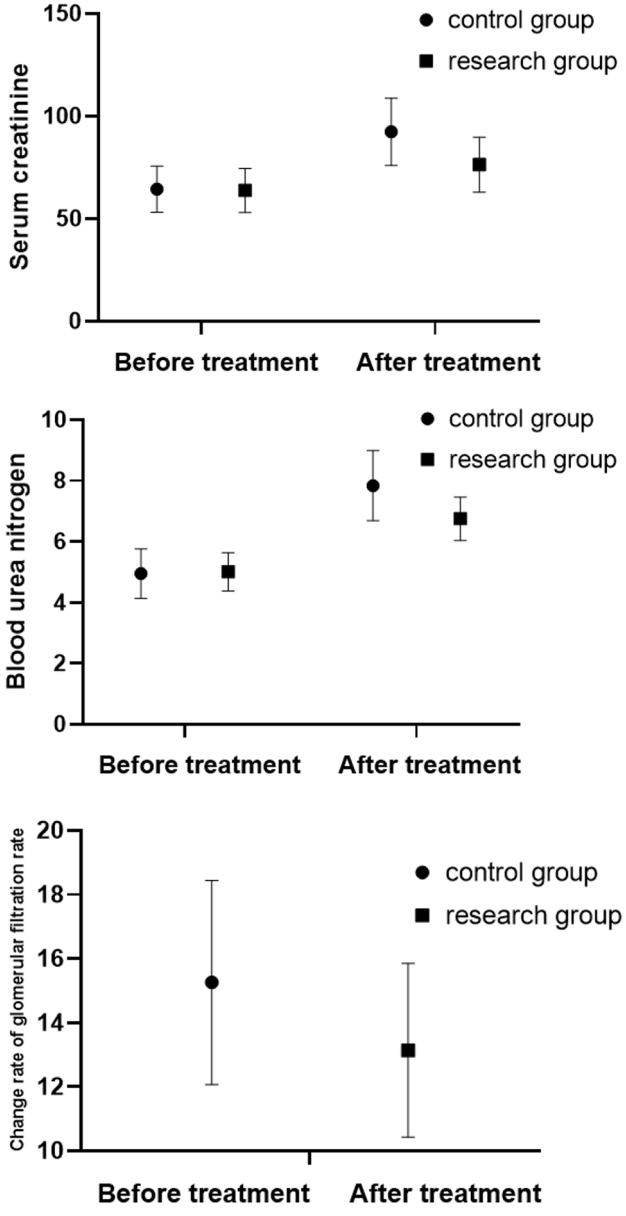

Fig. 1 Comparison of renal function indexes between the two groups

Complication

The incidence of complications in the intervention group (7.5%) was lower compared to the control group (10.0%) but it was not statistically significant ($\chi 2=0.156$, $P=0.692$) (Table 3).

Discussion

For patients with small renal tumors, nephron-sparing partial nephrectomy is preferred to radical nephrectomy. It offers similar treatment outcomes while preserving renal function, reducing the risk of renal failure, cardiovascular events, and improving the overall survival rate [14]. Laparoscopic partial nephrectomy is now a favored choice over open surgery, providing similar effectiveness in tumor treatment [15]. Preserving nephrons with renal function is a priority during tumor removal. Compared to radical nephrectomy, there are no significant difference in tumor-specific survival, local recurrence, and distant metastasis rates [16]. Occlusion of the renal artery to limit intraoperative bleeding can lead to renal ischemia-reperfusion injury [17]. Limiting warm ischemia time to 30 min is crucial to prevent renal damage. Some studies suggest limiting warm ischemia time to 20–25 min to protect renal function. If warm ischemia exceeds 20 min, a cold ischemia technique is recommended [18]. Minimizing renal warm ischemia damage and protecting the renal function is a key focus in urology. Postoperative protection of renal function, complete resection of tumor, and avoidance of surgical complications are essential in partial nephrectomy [19]. Postoperative renal function is affected by the time of warm ischemia, the amount of normal renal tissue removed, and the technique of renal reconstruction. Even with warm ischemia time under 25 min and limited normal tissue removal to 5 mm thickness, losing more than 12-20% of renal parenchyma can lead to 8–13% decline in renal function [20]. The reduction in normal renal parenchyma after operation is a better indicator of renal function damage than the time of warm ischemia, emphasizing the importance of preserving renal function. Strategies to minimize healthy renal tissue loss post-tumor resection and wound closure are crucial [21]. Monolayer suture, involving basal wound closure or hemostatic measures without extensive suturing, is believed to reduce renal parenchymal loss by shortening suture time and preserving renal tissue [22].

In this study, monolayer suture combined with a hem-o-lok clip could significantly reduce intraoperative bleeding and warm ischemia time compared to double-layer suture [23]. The hem-o-lok clip significantly reduced intraoperative bleeding by managing cortical bleeding points after suturing. Postoperative complications such as bleeding and urine leakage did not significantly differ, indicating the safety of monolayer suturing with

Table 3 Comparison of complication rates [(n) %]

Group	*N*	Infected	Leakage of urine	Continue to bleed	Incidence of complications
Control group	40	2	1	1	10.0%
Intervention group	40	2	0	1	7.5%
$\chi 2$					0.156
P					0.692

hem-o-lok clip during partial nephrectomy [24]. Double-layer suture conceals the basal wound under the cortex, potentially leading to challenges in managing bleeding at the basal vessel stump after operation. In contrast, monolayer suture exposes the basal wound for efficient treatment of residual bleeding points [25]. Applying biological hemostatic glue post-treatment, lowering pneumoperitoneum pressure, and observing for 5 min can avoid the risk of prolonged bleeding. Monolayer suture aids in protecting renal function by the time of warm ischemia, preserving the normal renal cortex, and reducing the loss of healthy renal parenchyma.

Double-layer suture involves suturing the basal and cortical layers, leading to longer renal perfusion blockage, increased warm ischemia time, and extended operation duration [26]. However, patients have a shorter hospital stay. This technique facilitates effective closure of renal wound arteriovenous connections, reducing postoperative bleeding, urine leakage, and arteriovenous fistula occurrence. Although considered a reliable suture method with potential complication reduction, some comparative studies show no statistical difference in complication rates. Double-layer suture may be necessary for shallow or larger wounds, where complete sealing is challenging, making it a convenient option for certain cases. However, it requires a higher level of surgical expertise and is best performed by experienced surgeons. Urologists are concerned about evaluating postoperative renal function. Researchers compared changes in renal function after double-layer and monolayer sutures. Their aim was to assess loss of renal volume and changes in glomerular filtration rate using CT scans. Patients with double-layer suture showed higher rates of renal volume loss and decreased glomerular filtration rate [26, 27].

This may be because it blocks more segmental blood vessels or seals more renal calices, or it may be due to increased interstitial pressure caused by cortical compression [28–30]. Single-layer suture, compared to double-layer suture, is a simpler procedure, resulting in shorter warm ischemia time for the kidney and a shorter total operation time [31, 32]. However, the length of stay may be relatively long. In theory, monolayer suture only closes the basal layer and does not closely compress the wound, leading to a higher risk of postoperative complications such as bleeding and urine leakage, and a slightly increased arteriovenous fistula [33–35]. Interestingly, in a recently controlled study, suturing only the basal layer did not increase the risk of bleeding and urinary fistula but preserved the nephron better. Tumor volume and cortical suture were found to be correlated with future nephron retention. With monolayer suture, a larger portion of renal volume can be retained due to the renal cortex not being sutured, reducing the loss of glomerular filtration rate after operation [36–38].

In this study, the characteristics of double-layer suture involve closing the renal medulla with the first layer of suture, tightening it after continuous suturing, and fixing it on the kidney surface with hemlock. The second layer of continuous suture reaches the depth of the first layer, including the renal cortex and medulla, forming two vertically crossed layers to ensure accurate wound closure and release the renal artery clamp [39]. The double-layer vertical cross suture technique accurately matches larger and deeper wounds without leaving a dead space, significantly reducing postoperative bleeding, the formation of arteriovenous fistula, and pseudoaneurysm. The monolayer suture involves closing the wound base, the collecting system, and addressing bleeding. After releasing the artery occlusion, the pneumoperitoneum pressure was reduced to identify cortical bleeding points, which were then treated with electrocoagulation. The bleeding sites were sutured with absorbable sutures if needed. This single-layer suture only closes the collecting system and sutures the central wound base, addressing cortical bleeding with electrocoagulation and a shorter warm ischemia time compared to double-layer suture. The risk of a significant decrease in glomerular filtration rate over 10% was lower than that of double-layer suture. However, cortical stump bleeding may occur due to the artery being loosened and occluded before suturing the renal cortex, leading to higher intraoperative blood loss than with double-layer suture [40, 41] . This method is suitable for small-diameter, superficial, or protruding lesions. While our study focused on tumors smaller than 3 cm, the application of single-layer renorrhaphy for larger tumors remains an important consideration. Recent studies suggest that single-layer closure, while effective in preserving renal function and reducing ischemia time, may not be as suitable for larger renal masses due to the increased complexity of these cases. For tumors exceeding 3 cm, additional hemostatic measures, such as double-layer suturing, may be required to minimize the risk of bleeding and urinary leakage [42, 43].

There were some limitations in this study. The sample size was small and it was a single-center study, introducing inevitable bias. Future research should include large-sample, multi-center prospective studies to draw more valuable conclusions.

Conclusion

For patients undergoing laparoscopic partial nephrectomy, using single-layer suture combined with a hem-o-lok clip or hemostasis in the anastomotic wound can shorten the time of warm ischemia, reduce the amount of intraoperative bleeding, and reduce the loss of normal renal parenchyma. Due to our study's sample size, further validation is necessary through an expanded multi-center trial.

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Author contributions
G.Z., J.L., Q.Z., H.N., L.Z., and J.Z. contributed to writing the project and collecting the data. Q.Z., H.N., L.Z., and J.Z. wrote the first draft of the manuscript and G.Z. and J.L. critically revised the manuscript. All authors read and approved the final manuscript.

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Data availability
The datasets used and/or analyzed during the current study were available from the corresponding author on reasonable request.

Declarations

Ethics approval and consent to participate
The Ethics Committee of the Xingtai First Hospital approved the study. All participants were provided with a written informed consent form, clearly stating that their participation in the study was voluntary, and they had the right to withdraw at any time without facing any consequences. The participants were provided with detailed explanations about the confidentiality of their information. All methods were carried out in accordance with relevant guidelines and regulations.

Consent for publication
The subjects have given their consent for publication.

Competing interests
The authors declare no competing interests.

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