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## The outcome of hilar clamping in comparison with non-clamping in partial nephrectomy procedure

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### Abstract

**Background:** Partial Nephrectomy (PN) or Nephron Sparing Surgery (NSS) is a major improvement in renal cell carcinoma (RCC) therapy, especially for bilateral or single kidney cancer patients. Originally, radical nephrectomy - complete kidney removal - was the usual treatment for RCC. However, with improved surgical skills and kidney cancer biology, PN has become a feasible, less invasive option, especially for certain patient populations. Aims of the study is to compare perioperative and short term data of hilar clamping and non-clamping partial nephrectomy for renal masses.

**Method:** A prospective study was conducted on 26 patients undergoing partial nephrectomy for renal masses at Rizgari Teaching Hospital and Zheen International Hospital from December 2018 to September 2019. The patients were divided into two groups: non-clamping (n = 16) and clamping (n = 10). The study involved documenting patient demographics, perioperative parameters, postoperative outcomes, and classifying patients based on nephrometry scores.

**Results:** In a study of partial nephrectomy patients, 65% were male with no significant gender difference between non-clamping and clamping groups. Non-clamp patients had higher estimated blood loss (484 vs 260 mL) and transfusion rates (43%), but no significant difference in postoperative hemoglobin. There was no significant difference in tumor size or short-term serum creatinine changes between the two groups, with more complex renal masses often undergoing clamping nephrectomy.

**Conclusion:** Non-clamp partial nephrectomy is used in most patients regardless of tumour size, however it causes greater blood loss and transfusions. Hilar clamping with correct ischemia time can be done (if needed) with minimum creatinine impact in a short postoperative period.

**Keywords:** Outcome, hilar, clamping, non-clamping, partial nephrectomy

### Introduction

Partial Nephrectomy (PN) or Nephron Sparing Surgery (NSS) represents a significant advancement in the treatment of renal cell carcinoma (RCC), particularly for patients with bilateral or solitary kidney cancer. Originally, radical nephrectomy was the standard approach for managing RCC, involving the complete removal of the affected kidney. However, with the evolution of surgical techniques and a better understanding of renal cancer biology, PN has emerged as a viable, less invasive alternative, especially for specific patient groups [1]. The increasing acceptance of PN is attributed to its ability to conserve renal function while effectively treating the cancer. This is particularly important in patients with a solitary kidney or bilateral RCC, where preserving as much healthy kidney tissue as possible is crucial. The American Urological Association and the European Association of Urology now recommend PN as the first-line treatment for T1a renal tumors ( $\leq 4$  cm) in the presence of a normal contralateral kidney [1]. This recommendation extends to larger T1b tumors (4-7 cm) in experienced centers and carefully selected patients [2]. The key advantage of PN over radical nephrectomy is its ability to preserve more of the patient's renal function. This is not only important for the immediate postoperative period but also has long-term benefits. Studies have shown that patients who undergo PN have a lower incidence of chronic kidney disease, which in turn reduces the risk of cardiovascular events and improves overall survival [3]. However, PN is not without its limitations and risks. In cases where achieving negative surgical margins is challenging, such as with extensive renal mass or renal vein extension, PN may not be advisable [4]. Furthermore, despite the precision of the surgery, there's a risk of recurrence in the ipsilateral kidney. The rate of local recurrence for elective NSS in low-stage lesions under 4 cm is estimated to be between 0 and 10% [5].

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Interestingly, recurrence is often more associated with multifocal tumors than with incomplete tumor resection leading to positive operative margins [6]. PN can be performed through various approaches, including transperitoneal (subcostal incision) or retroperitoneal flank incision. The latter is more commonly used due to its direct access to the kidney and minimal disturbance of other abdominal organs [7]. The surgical techniques employed in PN have also diversified, including tissue enucleation, segmental polar nephrectomy, wedge resection, and extracorporeal partial nephrectomy followed by renal auto-transplantation [7]. These techniques are selected based on tumor characteristics and surgeon preference and expertise. An important aspect of PN is the management of warm ischemia (WI). WI occurs when the renal blood supply is temporarily cut off to facilitate tumor removal and is a known risk factor for postoperative renal impairment. Recent studies suggest that the maximum safe duration of WI is around 25 minutes [8]. To mitigate the risks associated with WI, off-clamp partial nephrectomies (OFF-PN) have been developed, offering a feasible alternative in both open and minimally invasive surgeries [9]. Another innovative approach is the selective clamping technique, which aims to minimize ischemic damage to healthy kidney parenchyma. This technique is particularly useful in minimally invasive PN and has been adapted in open procedures by some surgeons [10]. The selective clamping of tumor-specific arterial branches further refines this approach, with the aid of advanced imaging techniques like Color Doppler sonography and robotic vascular fluorescence imaging for precise intraoperative arterial control [11]. Despite these advancements, PN is not without complications. Surgical challenges include bleeding, urinary fistula formation, acute renal failure, and other less common issues like pneumothorax and small bowel obstruction [12]. In the context of RCC staging and grading, the tumor, nodes, and metastasis (TNM) system by the Union International Centre le Cancer (UICC) and the American Joint Committee on Cancer (AJCC) provide a structured approach to classifying RCC based on tumor size, nodal involvement, and metastasis [13]. Fuhrman's grading system, which focuses on nuclear characteristics, has been widely adopted and is recognized as a key prognostic factor in RCC [14]. Aims of the study is to compare perioperative and short term data of hilar clamping and non-clamping partial nephrectomy for renal masses.

## Method

The study was a prospective, randomized trial conducted between December 2018 and September 2019 at Rizgari Teaching Hospital and Zheen International Hospital in Erbil. It involved 29 patients with solid renal masses undergoing partial nephrectomy, with three excluded due to conversion to radical nephrectomy. Patients with a solitary kidney or renal failure were also excluded. Participants were divided into two groups based on the surgical technique used: those undergoing partial

nephrectomy without hilar clamping (non-clamping, n = 16) and those with hilar clamping (n = 10). The decision to use clamping was at the discretion of the surgeon, based on intraoperative conditions. Patients were selected based on presenting symptomatic or incidental solid renal masses. A thorough medical history was taken, emphasizing comorbidities affecting the cardiovascular system and kidneys, such as heavy smoking, hypertension, diabetes, and coronary artery disease. Diagnostic assessments included abdominal and pelvic ultrasound, CT or MRI for staging, complete blood count (CBC), liver function tests (LFT), and renal function tests (RFT). The R.E.N.A.L nephrometry scoring system was employed to classify the surgical complexity of the renal tumors. Based on the scoring, tumors were categorized into low (4-6 points), moderate (7-9 points), or high (10-12 points) complexity groups. Data collected included demographic information (age, sex), preoperative data (laboratory results, imaging findings, tumor characteristics, nephrometry scores), perioperative details (use of hilar clamping, ischemia time, duration of operation, estimated blood loss, blood transfusions), and postoperative outcomes (drain output, hemoglobin and creatinine levels, blood transfusions, hospital stay duration, and complications). The surgical procedure for both groups involved an extraperitoneal flank incision, with mobilization of the kidney and preservation of perinephric fat over the tumor. In the non-clamping group, vascular control was achieved using loosely placed clamps around the renal artery and vein, if necessary. Tumor resection involved electrocautery and blunt dissection with precise control of vessels. For the clamping group, the technique was similar, with the addition of renal pedicle occlusion using non-traumatic clamps and observation of ischemia time. Postoperatively, patient monitoring included drain management, early mobilization, renal function and CBC tests, and blood transfusions based on hemoglobin levels. Statistical analysis was performed using Student's t-test, with a significance threshold set at a p-value of less than 0.05.

## Results

A total of 29 patients who underwent partial nephrectomy (PN) for renal masses in Rizgari teaching hospital and zheen international hospital in Erbil, Iraq, between September 2018 and September 2019 were evaluated and collected. Three of these patients were excluded when they converted to radical nephrectomy. Patients were categorized into two groups:

1. **Group A:** (Non-clamping), 16 /26.
2. **Group B:** (Clamping) 10/26.

The number of male patient in group A was 10/16, in group B 7/10. The mean age in group A was 52.2 (61-44) years and in group B was 55 (64-45) years with no significant difference. The mean tumor size according to CT scan was 4 (2.6-5.3) cm for Group A which slightly smaller than mean size for group B 4.39 (3-6.2) cm with no significant difference. As shown in Table 1.

**Table 1:** Patients characteristics

Variables	Group A (non-clamping)	Group B (clamping)	P value
<b>Sex</b>			
Male 65.4%	10/16	7/10	0.04
Female 34.6%	6/16	3/10	
Mean age in years (range)	52.2 ±4.4 (61-44)	55 ±5.6 (64-45)	0.08
Mean tumor size in cm (range )	4±1.2 (2.6-5.3)	4.39±1.1 (3-6.2)	0.29

Tumor complexity by clamp type was analyzed using the R.E.N.A.L scoring system. The tumors were classified into low,

moderate, and high complexity based on the sum of R.E.N.A.L sub-scores. In all, 68.75% of non-clamping and 30% of

clamping procedures were related to tumors in the low complexity category. There was a greater proportion of moderate complexity tumors in the clamping group as compared

with the non-clamp group (50% vs 25%). Additionally, there were more high complexity score tumors in the clamping group (20% vs 6.25%),  $p < 0.001$ . As shown in table 2.

**Table 2:** Comparison of tumor complexity using the R.E.N.A.L. scoring system.

	Low Complexity Score 4-6 n (%)	Moderate Complexity Score 7-9 n (%)	High Complexity Score 10-12 n (%)	P value
Group A (Non-clamping, n=16)	11 (68.75)	4(25)	1(6.25)	<0.001
Group B (Clamping, n = 10)	3(30)	5(50)	2(20)	
Total of 26 patients	14 (53.8)	9(34.6)	3(11.5)	

Preoperatively, the mean ischemia time in group B was 17.5 (15-23) minutes. The mean estimated blood loss in group A was significantly higher than group B 484 (200-1500) cc versus 260 (100-1100) cc,  $p < 0.04$ , however this blood loss was not affected

on postoperative hemoglobin changes because patients were transfused blood preoperatively. The mean operation time for group A was 147 (90-210) min and in group B was 118 (100-180) min with P value of 0.01 (significant). As shown in table 3.

**Table 3:** Operative data

Variable	Group A (non-clamping)	Group B (clamping)	P value
Ischemic time (min), mean (range)	0	17.5 (15-23)	
Estimated blood loss, mean (range)	484 (200-1500)	260(100-1100)	0.04
Operation time (min) Mean (range)	147 (90-210)	118(100-180)	0.01

Postoperatively, there was no significant difference in mean days of hospital stay in group A and group B, 3.7 (3-8) days, 3.4 (3-6) days respectively. In the term of serum creatinine changes postoperatively, there was no significant changes in short term follow up, preoperative to postoperative difference for group A was 0.11 (0-0.3) mg/dl and for group B was 0.1 (0-0.4) mg/dl,  $p > 0.21$ . Blood transfusion was recorded intraoperatively or postoperatively, there was significant difference between two groups, 7/16(43%) of group A and 3/10 (30%) of group B

received one or more pints of blood,  $p < 0.01$ . Among these 26 patients, two patients developed complication related to operation (PN), first one was perirenal collection and fever belong to group A(non-clamping) which treated, after failure of conservative therapy, by re-exploration and evacuation of hematoma with controlling of all the bleeding vessels. The second one was urine leak (group B) which started at day 4 postoperatively, treated conservatively by DJ stent, Drain and Foley's catheter. As shown in table 4.

**Table 4:** Postoperative data

Variable	Group A (non-clamping)	Group B (clamping)	P value
<b>Mean mg./dl. serum hemoglobin (range)</b>			
Post op	11.75 (9-16)	11.16 (9.5-15)	0.19
Mean preop. To postop. Difference	1.68 (0-3)	1.82 (0.5-3.2)	
<b>Mean mg./dl. serum creatinine (range)</b>			
Postop	0.93 (0.6-1.5)	0.8 (0.7-1.3)	<0.21
Preop. To postop. Difference	0.11 (0-0.3)	0.1 (0-0.4)	
Hospital stay (days), mean (range)	3.75 (3-8)	3.4 (3-6)	<0.23
Blood transfusion rate	7/16 (43%)	3/10 (30%)	0.01
1 unit pRBCs	4/16	2/10	
2 unit pRBCs	2/16	1/10	
3 unit pRBCs	1/16		
Complications	1/16	1/10	
Perirenal collection	1	0	
Urine leak	0	1	

## Discussion

This study, conducted at Rizgari Teaching Hospital and Zheen International Hospital in Erbil, assessed the outcomes of partial nephrectomy (PN) in 26 patients with solid renal masses. The patients were divided into two groups: non-clamping (Group A, n = 16) and clamping (Group B, n = 10). The selection of the method was based on the surgeon's intraoperative decision. The study population predominantly consisted of male patients (65.4%), reflecting the higher male to female incidence ratio in renal cell carcinoma (RCC) [15]. There was no significant difference in mean tumor size between the groups, allowing for the application of the non-clamping method even for larger tumors. However, tumors with moderate to high complexity, as determined by the R.E.N.A.L nephrometry scoring system, were more likely to undergo clamping PN, a finding consistent with other studies [16]. In terms of intraoperative outcomes, Group A

experienced higher mean blood loss (484 mL) and a higher transfusion rate (44%) compared to Group B, and also higher than other clamped series reported in literature [17]. Despite this, there was no significant difference in preoperative and postoperative hemoglobin changes between the groups, possibly due to intraoperative blood transfusions. The mean ischemia time for the study was 17.5 minutes, aligning with recommendations to keep warm ischemia time below 20 minutes to minimize the risk of acute renal failure and chronic renal insufficiency [18]. The mechanisms of ischemic renal injury from hilar clamping, involving oxidative stress and inflammatory pathways, are complex and not fully understood [19]. Postoperative renal function, assessed by changes in serum creatinine, did not show significant differences in the short-term follow-up, aligning with other studies that found no early glomerular filtration rate (GFR) changes between clamping and

non-clamping groups [20]. However, a significant decrease in GFR was observed in the long-term in the hilar clamping group in other studies. Complications included urinary leakage in one patient who underwent clamping PN. The risk of persistent urinary leaks is higher in more complex PNs involving renal sinuses, with factors such as larger tumor size and endophytic tumor location contributing to this risk [21]. Another complication observed was delayed postoperative bleeding leading to perinephric hematoma in one patient from the non-clamping group, requiring re-exploration after conservative therapy failed. This necessitates careful postoperative monitoring and potential intervention, such as selective angiogram and coil embolization by interventional radiology to minimize damage to healthy kidney tissue [22].

### Conclusion

With sufficient surgical expertise, the non-clamp approach may be successfully used for most instances of partial nephrectomy, regardless of tumor size. However, it is important to note that this procedure may result in more blood loss and a higher likelihood of requiring a blood transfusion. Performing hilar clamping with appropriate ischemia time, if necessary, has negligible impact on creatinine levels during the immediate postoperative period.

### Conflict of Interest

Not available

### Financial Support

Not available

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