



Role of Preoperative Computed Tomography Findings in Predicting Surgical Difficulty During Laparoscopic Simple Nephrectomy: A Retrospective Observational Study

Dr. Varun Chauhan, Dr. Virendra Soni, Dr. Syed Jamal Rizvi

Department of Urology and Transplantation Surgery, Institute of Kidney Diseases and Research Center and Dr. H.L. Trivedi Institute of Transplantation Sciences (IKDRC-ITS), Ahmedabad, India

***Corresponding Author:**

Dr. Varun Chauhan

Assistant Professor, Department of Urology and Transplantation Surgery, Institute of Kidney Diseases and Research Center and Dr. H.L. Trivedi Institute of Transplantation Sciences (IKDRC-ITS), Ahmedabad, India

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Abstract

Laparoscopic simple nephrectomy (LSN) is the standard treatment for benign non-functioning kidneys. Dense perinephric inflammation, prior interventions, and distorted hilar anatomy may increase operative difficulty. Preoperative computed tomography (CT) may help identify patients at risk for challenging surgery.

Objectives:

To evaluate the role of preoperative CT findings in predicting surgical difficulty during laparoscopic simple nephrectomy.

Materials and Methods:

A retrospective study was conducted at a tertiary care center from November 2024 to May 2026. A total of 120 patients undergoing laparoscopic simple nephrectomy for benign non-functioning kidneys were included. Sixty patients underwent transperitoneal nephrectomy and sixty underwent retroperitoneal nephrectomy. Surgical difficulty was defined by the presence of dense adhesions requiring extensive adhesiolysis, operative time exceeding 180 minutes, blood loss >300 ml, or conversion to open surgery. Preoperative CT parameters including perinephric fat stranding, pyonephrosis, hilar lymphadenopathy, renal calculi, renal size, and previous urinary tract intervention were evaluated.

Results:

Among 120 patients, 45 (37.5%) were classified as difficult surgeries. Perinephric fat stranding was significantly associated with difficult surgery (73.3% vs 24.0%, $p < 0.001$). Hilar lymphadenopathy was more common in difficult cases (42.2% vs 10.7%, $p < 0.001$). Pyonephrosis showed significant association with surgical difficulty (35.6% vs 12.0%, $p = 0.003$). Prior urinary tract intervention was observed in 60.0% of difficult cases compared to 30.7% of non-difficult cases ($p = 0.002$). Mean operative time and blood loss were significantly higher in difficult cases.

Conclusion:

Preoperative CT findings, particularly perinephric fat stranding, hilar lymphadenopathy, and pyonephrosis, are valuable predictors of surgical difficulty during laparoscopic simple nephrectomy. Incorporation of these findings into preoperative assessment may facilitate operative planning and patient counseling.

Keywords: Laparoscopic nephrectomy, Computed tomography, Surgical difficulty, Perinephric fat stranding, Pyonephrosis, Predictors

Introduction

Laparoscopic simple nephrectomy has become the preferred treatment for benign non-functioning kidneys due to reduced postoperative pain, shorter hospital stay, and improved cosmetic outcomes compared with open surgery.¹ However, chronic inflammatory renal conditions frequently lead to dense perinephric adhesions and hilar fibrosis, making laparoscopic dissection challenging.²

Predicting operative difficulty before surgery is important for surgical planning, counseling, operating room scheduling, and anticipation of conversion to open surgery.³ Contrast-enhanced CT is routinely performed before nephrectomy and provides detailed information regarding renal anatomy and surrounding inflammatory changes.⁴

Several radiological features including perinephric fat stranding, renal calculi, pyonephrosis, hydronephrosis, enlarged hilar lymph nodes, and previous interventions have been suggested as indicators of difficult nephrectomy.⁵ However, evidence remains limited, especially in Indian populations.

The present study evaluates the utility of preoperative CT findings in predicting surgical difficulty during laparoscopic simple nephrectomy.

Aims And Objectives

Primary Objective:

To assess the association between preoperative CT findings and surgical difficulty during laparoscopic simple nephrectomy.

Secondary Objectives:

1. To identify independent predictors of difficult nephrectomy.
2. To evaluate conversion rates.
3. To compare perioperative outcomes between difficult and non-difficult cases.

Materials And Methods

Study Design:

Retrospective observational study.

Study Period:

November 2024 to May 2026 at a tertiary care centre.

Sample Size:

120 patients.

Inclusion Criteria:

1. Age >18 years
2. Benign non-functioning kidney
3. Laparoscopic simple nephrectomy performed
4. Complete CT imaging available

Exclusion Criteria:

1. Malignancy
2. Incomplete imaging records
3. Pediatric patients

Surgical Approach:

Transperitoneal nephrectomy: 60 patients

Retroperitoneal nephrectomy: 60 patients

Definition of difficult surgery is presence of one or more of the following:

1. Dense adhesions requiring extensive dissection
2. Operative time >180 minutes
3. Blood loss >300 ml
4. Conversion to open surgery

Data Collected:

Demographic variables:

Age, sex, side.

Clinical variables:

Prior intervention (DJ stent, PCN, URS, PCNL), pyonephrosis.

Radiological variables:

Perinephric fat stranding, hilar lymphadenopathy, renal calculi.

Perioperative outcomes:

Operative time, blood loss, conversion.

Statistical Analysis:

Data analyzed using SPSS version XX.

Continuous variables expressed as mean $\pm$ SD.

Categorical variables expressed as frequencies and percentages.

Chi-square test used for categorical variables.

Independent t-test used for continuous variables.

P value <0.05 considered statistically significant.

A total of 120 patients who underwent laparoscopic simple nephrectomy for benign non-functioning kidneys between November 2024 and May 2026 were included in the study. The mean age of the study population was 46.8 ± 12.5 years. There were 72 males (60.0%) and 48 females (40.0%). The left kidney was involved in 68 patients (56.7%), while the right kidney was involved in 52 patients (43.3%).

Preoperative computed tomography revealed renal calculi in 78 patients (65.0%), perinephric fat stranding in 50 patients (41.7%), prior ipsilateral renal intervention in 50 patients (41.7%), hilar lymphadenopathy in 27 patients (22.5%), and pyonephrosis in 25 patients (20.8%).

Based on the predefined criteria, 45 cases (37.5%) were classified as difficult surgeries, whereas 75 cases (62.5%) were categorized as non-difficult.

Table 1. Baseline Characteristics of Study Population (n=120)

Variable	Value
Age (years), mean $\hat{A} \pm$ SD	46.8 $\pm$ 12.5
Male sex	72 (60.0%)
Female sex	48 (40.0%)
Right-sided kidney	52 (43.3%)
Left-sided kidney	68 (56.7%)
Prior renal intervention	50 (41.7%)
Pyonephrosis	25 (20.8%)
Perinephric fat stranding	50 (41.7%)
Hilar lymphadenopathy	27 (22.5%)
Renal calculi	78 (65.0%)
Difficult surgery	45 (37.5%)
Non-difficult surgery	75 (62.5%)

Association Between CT Findings and Surgical Difficulty:

Perinephric fat stranding was significantly more common among difficult cases than non-difficult cases (73.3% vs. 24.0%, $p < 0.001$). Similarly, hilar lymphadenopathy was observed more frequently in difficult surgeries (42.2% vs. 10.7%, $p < 0.001$).

Pyonephrosis was present in 35.6% of difficult cases compared to 12.0% of non-difficult cases ($p=0.003$). A history of prior renal intervention was also significantly associated with difficult surgery (60.0% vs. 30.7%, $p=0.002$).

Although renal calculi were more frequently observed in difficult surgeries (75.6% vs. 58.7%), the association did not reach statistical significance ($p=0.067$).

Table 2. Comparison Between Difficult and Non-Difficult Surgeries

Variable	Difficult (n=45)	Non-difficult (n=75)	p-value
Perinephric fat stranding	33 (73.3%)	18 (24.0%)	<0.001
Hilar lymphadenopathy	19 (42.2%)	8 (10.7%)	<0.001
Pyonephrosis	16 (35.6%)	9 (12.0%)	0.003
Prior intervention	27 (60.0%)	23 (30.7%)	0.002
Renal calculi	34 (75.6%)	44 (58.7%)	0.067

Operative Outcomes:

Difficult surgeries were associated with significantly longer operative times and greater intraoperative blood loss. The mean operative time was 198 ± 32 minutes in the difficult group compared with 132 ± 25 minutes in the non-difficult group ($p<0.001$).

Similarly, mean estimated blood loss was significantly higher in difficult cases (285 ± 110 mL) than in non-difficult cases (118 ± 55 mL) ($p<0.001$).

Conversion to open surgery occurred in seven patients (15.6%) in the difficult group, whereas no conversions were recorded in the non-difficult group ($p<0.001$).

Table 3. Operative Outcomes According to Surgical Difficulty

Variable	Difficult (n=45)	Non-difficult (n=75)	p-value
Operative time (min)	198 ± 32	132 ± 25	<0.001
Blood loss (mL)	285 ± 110	118 ± 55	<0.001
Conversion to open surgery	7 (15.6%)	0	<0.001

Multivariate Analysis:

Multivariate logistic regression analysis identified perinephric fat stranding as the strongest independent predictor of difficult laparoscopic nephrectomy (OR 4.8, 95% CI 2.0–11.2, $p < 0.001$).

Hilar lymphadenopathy was also independently associated with surgical difficulty (OR 3.6, 95% CI 1.4–9.0, $p = 0.007$). Prior renal intervention increased the likelihood of difficult surgery by approximately 2.5-fold (OR 2.5, 95% CI 1.1–5.8, $p = 0.028$).

Pyonephrosis remained a significant independent predictor, conferring a 2.2-fold increased risk of difficult surgery (OR 2.2, 95% CI 1.0–5.4, $p = 0.049$).

Table 4. Multivariate Logistic Regression Analysis for Predictors of Difficult Surgery

Variable	Odds Ratio	95% Confidence Interval	p-value
Perinephric fat stranding	4.8	2.0-11.2	<0.001
Hilar lymphadenopathy	3.6	1.4-9.0	0.007
Prior intervention	2.5	1.1-5.8	0.028
Pyonephrosis	2.2	1.0-5.4	0.049

Key Findings:

1. Difficult laparoscopic nephrectomy occurred in 37.5% of patients.
2. Perinephric fat stranding was the strongest predictor of surgical difficulty.
3. Hilar lymphadenopathy, prior renal intervention, and pyonephrosis were independent predictors of difficult surgery.
4. Difficult surgeries were associated with significantly longer operative time, increased blood loss, and higher conversion rates.
5. Presence of renal calculi alone was not an independent predictor of surgical difficulty.

Discussion

The present study demonstrates that preoperative CT findings can reliably predict surgical difficulty during laparoscopic simple nephrectomy.

Perinephric fat stranding emerged as the strongest predictor of difficult surgery. Chronic inflammation results in obliteration of tissue planes and dense adhesions, increasing operative complexity.

Hilar lymphadenopathy was another significant predictor. Enlarged nodes often indicate longstanding

infection and inflammation causing hilar fibrosis and difficult vascular dissection.

Patients with pyonephrosis experienced greater operative difficulty, likely due to chronic infective changes and surrounding tissue inflammation.

Previous urinary tract interventions were significantly associated with difficult nephrectomy. Repeated instrumentation may contribute to peri-renal fibrosis and adhesions.^{6,7}

Conversion to open surgery occurred in 7 patients (5.8%). Most conversions were related to dense hilar adhesions and inability to safely identify vascular structures.

Our findings are comparable to previous studies reporting perinephric inflammatory changes as important predictors of prolonged operative time and increased blood loss.^{8,9}

The study supports routine evaluation of CT findings before nephrectomy to identify high-risk patients and facilitate operative planning.

Limitations:

1. Retrospective design.

2. Single-center study.
3. Moderate sample size.
4. Subjective assessment of surgical difficulty.

Future prospective multicenter studies are warranted.

Conclusion

Preoperative CT findings are useful predictors of difficult laparoscopic simple nephrectomy. Perinephric fat stranding, hilar lymphadenopathy, pyonephrosis, and previous urinary tract intervention significantly increase the likelihood of operative difficulty. Incorporation of these radiological parameters into preoperative assessment may improve patient counseling, operating room planning, and surgical preparedness.

Ethics Statement

The study was conducted in accordance with institutional ethical standards. Patient confidentiality was maintained, and informed consent was waived due to the retrospective nature of the study.

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