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Research Article

# Lymphatic Complications in Renal Transplant: Electrosurgical Unit Versus Ultrasonic Cutting and Coagulation Device

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## ABSTRACT

Background: Lymphatic complications, particularly lymphocele, are common after renal transplantation and can adversely affect graft function. Electrosurgical units (ESU) and ultrasonic cutting and coagulation devices (UCCD) are widely used, but their comparative effectiveness in preventing lymphatic leakage remains unclear. Methods: A prospective observational comparative study was conducted over two years at Atal Bihari Vajpayee Institute of Medical Sciences and Dr. Ram Manohar Lohia (ABVIMS & Dr. RML) Hospital, New Delhi. Statistical analysis was performed using appropriate tests including the Wilcoxon-Mann-Whitney U test, Fisher's exact test, and Chi-square test; a p-value <0.05 was considered significant. Twenty donor-recipient pairs were included and alternately assigned to either the ESU group (n=10) or the UCCD group (n=10). Outcomes assessed included intraoperative blood loss, postoperative lymphatic complications, urine output, serum creatinine levels, and the need for additional interventions. Results: The incidence of lymphocele was higher in the ESU group (3/10, 30%) compared to the UCCD group (1/10, 10%), though the difference was not statistically significant (p=0.582). Patients in the ESU group required more postoperative imaging (3/10, 30% vs. 1/10, 10%) and interventions (2/10, 20% vs. 0/10, 0%) for lymphatic complications. No significant differences were observed in renal graft function, as measured by serum creatinine reduction and urine output trends. Conclusions: Both surgical techniques resulted in comparable renal function outcomes; however, the UCCD was associated with a lower incidence of lymphatic complications and fewer postoperative interventions. Larger studies are warranted to validate these findings.

***Keywords****: Surgical Outcomes, Ultrasonic Cutting Device, Electrosurgical Unit, Lymphatic Complications, Lymphocele, Renal Transplant.*

## INTRODUCTION

Chronic kidney disease (CKD) is a major public health concern due to its strong association with cardiovascular disease, increased mortality, and progression to end-stage renal disease (ESRD) [1-3]. Once kidney function declines to approximately 12-15%, survival depends on renal replacement therapies such as peritoneal dialysis, extended daily dialysis, sustained low-efficiency dialysis, intermittent hemodialysis, continuous renal replacement therapy, and kidney transplantation. Among these options, renal transplantation (RT) is considered the most effective for improving both quality of life and survival [4,5].

Complications after RT are broadly classified as early, including acute rejection, delayed graft function, lymphatic complications, and thrombosis, or late, including graft pyelonephritis and renal artery stenosis [6]. Lymphatic complications are among the most frequent early issues, resulting from surgical disruption of lymphatic vessels. This can lead to lymphocele formation, immune cell loss, and impaired graft function [7,8]. Clinical presentation depends on the size and location of the collection and may include abdominal pain, incision tenderness, deep vein thrombosis, or fever [9]. Diagnosis relies on ultrasonography (USG), computed tomography (CT), and aspiration of fluid with serum-matched creatinine analysis [10,11].

Although many lymphoceles resolve spontaneously, some require intervention, with reported incidences ranging from 0.04% to 14.6%. Treatment options include aspiration, drain placement, sclerotherapy, or surgical intervention. Laparoscopic fenestration is preferred because of its lower recurrence rate [12]. Preventive strategies include meticulous dissection, careful vessel ligation, and the creation of an extraperitoneal drainage pathway [13].

Two surgical tools commonly used for dissection and hemostasis in renal transplantation are electrosurgical units (ESU) and ultrasonic cutting and coagulation devices (UCCD). ESU cut and coagulate tissue using high-frequency electrical current, while UCCD simultaneously cut and coagulate by converting ultrasonic energy into mechanical vibration, producing heat at the active blade for effective hemostasis. Advantages of UCCD include precise dissection, reduced lateral thermal injury, and reliable sealing of vessels through protein denaturation [14,15].

The present study was designed to compare the incidence of lymphatic complications in renal transplant recipients undergoing surgery with an ESU versus a UCCD.

## MATERIALS AND METHODS

This prospective observational comparative study was conducted in the Department of General Surgery at Atal Bihari Vajpayee Institute of Medical Sciences and Dr. Ram Manohar Lohia (ABVIMS & Dr. RML) Hospital, New Delhi, over a period of two years. Approval was obtained from the Institutional Ethics Committee, and written informed consent was secured from all participants. The study included 20 donor-recipient pairs. Patients with metallic implants or those unwilling to provide consent were excluded.

### Preoperative Evaluation

All donors and recipients underwent standardized preoperative assessment, including detailed medical history and physical examination. Laboratory investigations consisted of blood grouping, viral marker testing [hepatitis B surface antigen (HBsAg), hepatitis C antibody (Anti-HCV), human immunodeficiency virus type I/II (HIV I/II), and cytomegalovirus immunoglobulin G and M (CMV IgG, IgM)], human leukocyte antigen (HLA) typing, and pre-transplant cross-matching using the complement-dependent cytotoxicity (CDC) technique. Additional assessments included urine analysis, coagulation profile, kidney, ureter, bladder (KUB) X-ray, two-dimensional echocardiography (2D echo), and Doppler evaluation of the recipient's arterial system.

### Surgical Technique

Renal transplantation was performed using standard surgical techniques. Donor nephrectomy was carried out either laparoscopically or via open approach, depending on anatomical and clinical factors. The graft kidney was placed extraperitoneally, typically on the right side, and anastomosed end-to-side to the recipient's external iliac artery and vein using 6-0 polytetrafluoroethylene (PTFE) sutures. Warm ischemia time was recorded. Ureteroneocystostomy was performed over a double-J (D-J) stent. Hemostasis was ensured, blood loss quantified, and a drain placed adjacent to the graft before layered wound closure.

Postoperatively, patients were monitored in the intensive care unit (ICU) with close observation of urine output and hemodynamic parameters.

Study Groups- Participants were alternately assigned to one of two groups:
Electrosurgical unit (ESU) group (n=10): Dissection performed with an electrosurgical unit.
Ultrasonic cutting and coagulation device (UCCD) group (n=10): Dissection performed with an ultrasonic cutting and coagulation device.

### Outcome Measures

Primary outcomes included intraoperative blood loss and postoperative lymphatic complications such as lymphocele. Secondary outcomes were urine leakage, urinary obstruction, infection, surgical site complications, drain output, time to diuresis, serum creatinine levels, and vascular complications (renal artery stenosis, arteriovenous fistula, and pseudoaneurysm) assessed by Doppler ultrasound.

Statistical Analysis: Statistical analysis was performed using SPSS version 26.0 (IBM Corp., Armonk, NY, USA). Continuous variables were presented as mean ± standard deviation (SD) or median with interquartile range (IQR), and categorical variables were expressed as frequencies and percentages (n, %). The Wilcoxon-Mann- Whitney U test was used for intergroup comparisons of continuous variables. Comparisons for categorical variables were performed using Fisher's exact test due to the small sample size; a p-value of less than 0.05 was considered statistically significant.

## RESULTS

A total of 20 donor-recipient pairs (n=20) were included in the study. All donors were live donors; cadaveric transplantation was not performed. The mean age of the recipients was 30.45 years, while the mean donor age was 43.40 years. The majority of recipients were male (17/20, 85%), whereas most donors were female (16/20, 80%). Nearly all

recipients (19/20, 95%) and all donors (20/20, 100%) had a body mass index (BMI) below 24 kg/m², indicating that obesity was not a confounding factor in this cohort (Table 1).

**TABLE 1: Demographic Characteristics of Recipients and Donors**

| Demographic Parameter | Recipients (n = 20) | Donors (n = 20) |
|---|---|---|
| Age (years) | | |
| Mean ± SD | 30.45 ± 7.50 | 43.40 ± 13.87 |
| Median (IQR) | 30.0 (25.75–34.25) | 45.0 (31.25–56.0) |
| Range | 18–44 | 22–72 |
| Gender | | |
| Male | 17 (85.0%) | 4 (20.0%) |
| Female | 3 (15.0%) | 16 (80.0%) |
| Body mass index (BMI) | | |
| <24 kg/m² | 19 (95.0%) | 20 (100.0%) |
| ≥24 kg/m² | 1 (5.0%) | 0 (0.0%) |

SD: standard deviation; IQR: interquartile range; BMI: body mass index

Baseline Characteristics

Recipients were divided into two groups according to the surgical dissection method: the ultrasonic cutting and coagulation device (UCCD) group (Harmonic Scalpel, n=10) and the electrosurgical unit (ESU) group (Bipolar Cautery, n=10). There were no statistically significant differences between the groups in terms of recipient age, gender, or BMI. Donor characteristics, including age, gender, and BMI, were also comparable. Comorbidities such as diabetes mellitus (DM) and hypertension (HTN) were evenly distributed. An accessory renal artery was present in 10% (1/10) of grafts in both groups. None of the recipients experienced acute rejection, and all patients received high-dose steroids postoperatively (Table 2).

**TABLE 2: Comparison of Recipient and Donor Parameters by Surgical Technique**

| Parameter | Harmonic Scalpel (n = 10) | Bipolar Cautery (n = 10) | p-value | Test Statistic | Effect Size (OR, 95% CI) |
|---|---|---|---|---|---|
| Recipient age (years) | 29.10 ± 7.53 | 31.80 ± 7.61 | 0.325 | U=39.5 | — |
| Recipient gender | | | 0.211 | FET | OR: 0.00 (0.00 - 1.84) |
| Male | 7 (70.0%) | 10 (100.0%) | | | |
| Female | 3 (30.0%) | 0 (0.0%) | | | |
| Recipient BMI | | | 1 | FET | OR: 0.00 (0.00 - 9.81) |
| <24 kg/m² | 10 (100.0%) | 9 (90.0%) | | | |
| ≥24 kg/m² | 0 (0.0%) | 1 (10.0%) | | | |
| Donor age (years) | 41.10 ± 12.46 | 45.70 ± 15.47 | 0.569 | U=42.0 | — |
| Donor gender | | | 1 | FET | OR: 1.00 (0.11 - 9.26) |
| Male | 2 (20.0%) | 2 (20.0%) | | | |
| Female | 8 (80.0%) | 8 (80.0%) | | | |
| Donor BMI (<24 kg/m²) | 10 (100.0%) | 10 (100.0%) | 1 | FET | N/A |
| Diabetes mellitus (DM) | 0 (0.0%) | 0 (0.0%) | 1 | FET | N/A |
| Hypertension (HTN) | 10 (100.0%) | 9 (90.0%) | 1 | FET | OR: 0.00 (0.00 - 9.81) |
| Accessory artery in graft | 1 (10.0%) | 1 (10.0%) | 1 | FET | OR: 1.00 (0.05 - 18.59) |
| Acute rejection | 0 (0.0%) | 0 (0.0%) | 1 | FET | N/A |
| High-dose steroid | 10 (100.0%) | 10 (100.0%) | 1 | FET | N/A |
| Warm ischemia time (min) | 52.10 ± 3.25 | 53.90 ± 7.62 | 0.789 | U=45.0 | — |
| Cold ischemia time (min) | 29.10 ± 3.90 | 33.60 ± 8.30 | 0.15 | U=29.0 | — |
| Lymphocele (present) | 1 (10.0%) | 3 (30.0%) | 0.582 | FET | OR: 0.26 (0.02 - 2.82) |
| Side of harvest | | | 1 | FET | OR: 1.00 (0.05 - 18.59) |
| Right | 1 (10.0%) | 1 (10.0%) | | | |

| | | | | | |
|---|---|---|---|---|---|
| Left | 9 (90.0%) | 9 (90.0%) | | | |
| Investigation required | | | 0.582 | FET | OR: 0.26 (0.02 - 2.82) |
| None | 9 (90.0%) | 7 (70.0%) | | | |
| USG | 1 (10.0%) | 3 (30.0%) | | | |
| Intervention required | | | 0.474 | FET | OR: 0.00 (0.00 - 2.31) |
| None | 10 (100.0%) | 8 (80.0%) | | | |
| Laparoscopic deroofing | 0 (0.0%) | 2 (20.0%) | | | |

*BMI: body mass index; DM: diabetes mellitus; HTN: hypertension; USG: ultrasonography; SD: standard deviation; FET: Fisher's Exact Test; U: Mann-Whitney U statistic; OR: Odds Ratio; CI: Confidence Interval; N/A: Not Applicable. Statistical significance at $p < 0.05$.*

Ischemia Time- Warm ischemia time was slightly shorter in the UCCD group (52.10 minutes) compared to the ESU group (53.90 minutes), though the difference was not statistically significant (U=45.0, p=0.789). Cold ischemia times were comparable between the two groups (U=29.0, p=0.150).

Lymphatic Complications- Lymphocele formation occurred in 10% (1/10) of patients in the UCCD group compared to 30% (3/10) in the ESU group (FET, p=0.582; OR: 0.26, 95% CI: 0.02 - 2.82). Although this difference did not reach statistical significance, patients in the ESU group required more postoperative imaging, with 30% (3/10) undergoing ultrasonography (USG) compared to 10% (1/10) in the UCCD group (FET, p=0.582; OR: 0.26, 95% CI: 0.02 - 2.82). Two patients (2/10, 20%) in the ESU group required surgical intervention (laparoscopic deroofing) for lymphocele, whereas no patients (0/10, 0%) in the UCCD group required further procedures (FET, p=0.474; OR: 0.00, 95% CI: 0.00 - 2.31).

Other Categorical Outcomes- The comparison of other categorical variables, including recipient gender (FET, p=0.211), recipient BMI (FET, p=1.000), donor gender (FET, p=1.000), presence of hypertension (FET, p=1.000), presence of an accessory artery (FET, p=1.000), and side of graft harvest (FET, p=1.000), showed no statistically significant differences between the two groups. The relevant odds ratios and confidence intervals for these comparisons are detailed in Table 2.
Renal Function Outcomes- Serum creatinine levels and urine output were recorded postoperatively to assess graft function. No statistically significant differences in creatinine reduction or urine output were observed between the two groups at any time point (Table 3).

**TABLE 3: Postoperative Trends in Serum Creatinine and Urine Output**

| Postoperative Day | Serum Creatinine (mg/dL) – Mean ± SD | Urine Output (mL) – Mean ± SD | p-value (Creatinine) | p-value (Urine Output) |
|---|---|---|---|---|
| POD 1 | 5.23 ± 1.18 | 11755 ± 1919.83 | 0.545 | 0.518 |
| POD 3 | 3.38 ± 1.01 | 9935 ± 2165.10 | 0.649 | 0.198 |
| POD 7 | 2.21 ± 0.86 | 6615 ± 1361.99 | 0.596 | 0.496 |
| POD 14 | 1.69 ± 0.80 | 3615 ± 641.77 | 0.622 | 0.128 |
| POD 21 | 1.37 ± 0.81 | 2559.38 ± 489.29 | 0.108 | 0.317 |

*POD: postoperative day; SD: standard deviation. P-values from Mann-Whitney U test*

Summary of Findings
Overall, the use of the UCCD was associated with a lower incidence of lymphocele (10% vs. 30%) and fewer secondary interventions (0% vs. 20%) compared to the ESU, while renal function recovery was similar across both groups.

**DISCUSSION**

Renal transplantation, like other surgical procedures, is associated with complications that may or may not affect graft function. The most common causes of graft dysfunction are typically related to graft quality, recipient factors, or rejection. Historically, surgeons ligated lymphatic channels with silk sutures (3-0 or 4-0) to minimize lymphatic leakage. More recently, energy-based devices such as ultrasonic cutting and coagulation devices (UCCD) and electrosurgical units (ESU) have largely replaced ligatures, primarily due to operative efficiency. However, their use may contribute to complications such as lymphocele and lymphorrhea.

In this study, half of the participants (n=10/20) underwent renal transplantation with a UCCD (Harmonic Scalpel), while the other half (n=10/20) underwent dissection with an ESU (Bipolar Cautery). Lymphocele formation was observed in 30% (3/10) of patients in the ESU group compared to 10% (1/10) in the UCCD group (FET, p=0.582). Of the four patients who developed lymphocele, two resolved spontaneously, while the others required surgical intervention.

**Risk Factors and Independent Variables**

Potential risk factors for lymphocele formation, including recipient age, gender, body mass index (BMI), donor age, donor gender, donor BMI, ischemia times, side of graft harvest, and presence of an accessory renal artery, were analyzed. Pearson correlation showed no significant collinearity, suggesting that these variables acted independently. Lymphocele development was not significantly associated with graft side, accessory arteries, or BMI. Instead, it appeared to result primarily from inadequate lymphatic sealing around graft vessels.

Comparison with Literature

The mean recipient and donor ages (30.45 and 43.40 years, respectively) were consistent with previous studies, which reported similar age distributions [16,17]. Ozkul et al. reported improved outcomes in younger recipients, supporting the findings of the present study [17]. The predominance of male recipients (17/20, 85%) and female donors (16/20, 80%) also aligns with prior research [16-19].

Most recipients in this study had a BMI <24 kg/m² (19/20, 95%), which has been associated with a reduced risk of postoperative complications in other studies, as obesity (BMI ≥30 kg/m²) is an independent predictor of adverse outcomes following renal transplantation [20,21]. Warm ischemia time (WIT) and cold ischemia time (CIT) were similar between the groups and remained below the thresholds associated with acute rejection or delayed graft function, consistent with published literature [22,23].

Management of Lymphocele

Symptomatic lymphoceles (Figure 1) required laparoscopic fenestration (Figure 2). This intervention led to immediate improvement in lower limb edema and graft function, evidenced by increased urine output and decreased serum creatinine levels. Similar outcomes have been reported by Bzoma and Ulrich, who demonstrated that laparoscopic fenestration is safe, effective, and associated with low recurrence [24,25].

Efficacy of Energy-Based Devices

Our findings suggest that the ESU (bipolar cautery) is less effective in sealing lymphatics, with a 30% (3/10) incidence of lymphocele, compared to 10% (1/10) with the UCCD (Harmonic Scalpel) (FET, p=0.582). Prior studies also support the use of ultrasonic devices in reducing lymphatic complications after renal transplantation [26-28]. Nurettin et al. emphasized that while meticulous surgical technique is critical, the choice of sealing device significantly impacts outcomes [29]. Based on our results and the literature, the UCCD appears superior for minimizing postoperative lymphatic complications.

Study Limitations

This study has several limitations that should be considered when interpreting the results. First, the relatively small sample size (n=20) limited our statistical power to detect significant differences between groups, potentially increasing the risk of Type II error. The single-center design may affect the generalizability of our findings to other institutions with different surgical protocols or patient populations. Additionally, the non-randomized, alternating allocation method, while practical, could introduce selection bias compared to a randomized controlled trial design. Future multi-center studies with larger sample sizes are needed to validate these findings.

**FIGURE 1: Lymphocele Presenting as Abdominal Swelling in a Post-Transplant Patient**

*Clinical photograph showing a large lymphocele manifesting as a visible abdominal bulge on the contralateral side following renal transplantation*

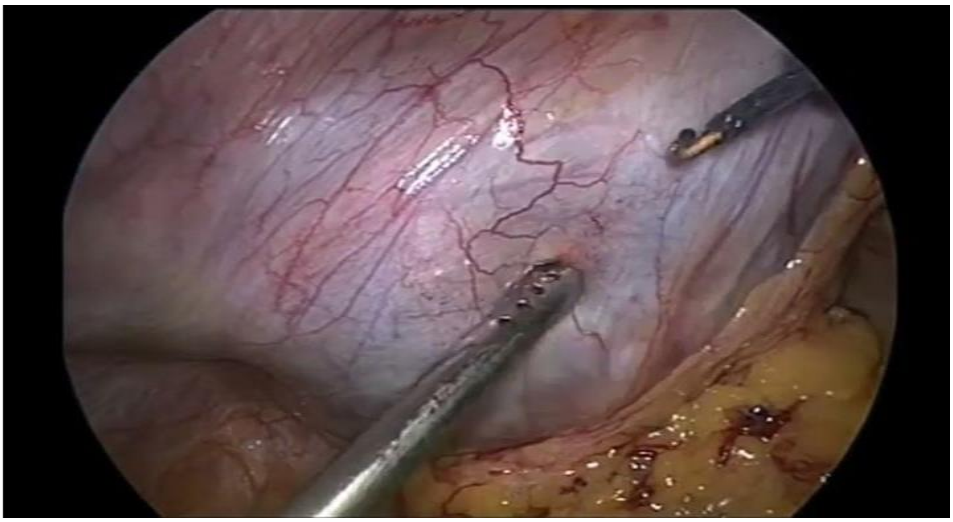

**FIGURE 2: Laparoscopic Deroofing of Post-Transplant Lymphocele**

*Intraoperative laparoscopic image demonstrating deroofing of a large post-transplant lymphocele. The harmonic scalpel is seen dissecting the lymphocele wall, allowing decompression and drainage.*

## CONCLUSION

Inadequate sealing of lymphatic vessels in both donors and recipients remains the principal cause of postoperative lymphatic complications. In this study, the use of an ultrasonic cutting and coagulation device (UCCD) was associated with a lower incidence of lymphatic complications compared with an electrosurgical unit (ESU); however, this difference did not reach statistical significance (FET, p=0.582). Renal graft function outcomes were comparable between the two techniques. The limited sample size constrains the definitive interpretation of these findings. Further studies with larger sample sizes are warranted to determine whether the observed trend reflects a true clinical benefit and to establish the superior device for preventing lymphatic complications in renal transplantation.

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