Safety and efficacy of *en bloc* renal hilum control during laparoscopic nephrectomy and nephroureterectomy: A single-center experience in Saudi Arabia

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**Abstract**

**Objective:** The objective of the study is to evaluate the safety, efficacy, and long-term outcome of *en bloc* renal pedicle control during laparoscopic nephrectomy and nephroureterectomy.

**Patients and Methods:** A total of 126 nephrectomies and nephroureterectomies that underwent *en bloc* renal pedicle control using the endovascular stapler (45 or 60 mm vascular reload) were retrospectively analyzed. Perioperative outcomes, including the risk of arteriovenous fistula (AVF), hospital stay, and estimated blood loss, were recorded. Complications were reported using Clavien classification.

**Results:** *En bloc* pedicle control was employed in 126 laparoscopic nephrectomies and nephroureterectomies on 126 patients with a mean age of 55.7 years (range: 18–94) and a mean body mass index of 29.2 kg/m² (range: 17–42). All laparoscopic nephrectomies were performed or supervised by one of three minimally invasive surgeons using identical surgical techniques, even in cases of multiple hilar vessels. During follow-up with a mean 23.3 months (range: 12–48), no patients presented with radiological or clinical signs of AVF (91 patients where followed up with either Doppler ultrasound, computed tomography with contrast, or magnetic resonance imaging for different indications). The mean operative time was 91.8 min (range: 45–215). Intraoperative blood transfusion was required in two cases. Diaphragmatic injury occurred in one case but was repaired laparoscopically. Open conversion occurred in two cases with severe colonic adhesions and injury, with one requiring primary repair, and the other managed with a colostomy. One patient developed fever; two patients developed paralytic ileus. Hospital stay mode was 5 days, ranging from 3 to 10 days.

**Conclusion:** *En bloc* renal pedicle control during laparoscopic nephrectomies is safe with reasonable operative time, and there were no indications of AVF with this technique over the long term.

**Keywords:** Arteriovenous fistula, laparoscopy, nephrectomy, nephroureterectomy

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INTRODUCTION

Laparoscopic nephrectomies have been increasing in popularity in the field of urology since their introduction in the 1990s, becoming one of the most popularly employed urological surgeries.[1] Over time, laparoscopic techniques have become the gold standard and preferred to open surgery in treating renal tumor disease and upper-urethelial tract cancer due to its multiple advantages such as shorter hospital stay, faster recovery, and less postsurgical analgesia. Renal hilum control during these procedures is a critical step, of which there are two approaches to the renal artery and vein ligation: Separate ligation or en bloc ligation with an endovascular stapling device. It was believed that en bloc ligation carried a risk of arteriovenous fistula (AVF), which could manifest as hypertension, congestive heart failure, or abdominal murmur due to the close relationship between the artery and vein after the en bloc ligation.[11] However, recent studies showed that en bloc ligation is safer than it has been thought to be in the past.[12]

At our institution, en bloc ligation has been the preferred approach since 2016, as we considered it to be efficient, safe, and easier to learn than the alternative of hilar dissection. In this study, we present long-term patient outcomes of the en bloc technique during renal pedicle control.

PATIENTS AND METHODS

After institutional ethical committee clearance was taken for the project. We retrospectively reviewed all en bloc renal pedicle control-associated laparoscopic nephrectomies and nephroureterectomies that were performed between January 2016 and January 2019. All surgeries adopted the same surgical technique and endovascular stapler (45 or 60 mm vascular reload) for control of the renal pedicle. Excluded patients were those whose surgery included selective renal pedicle control, and those lost to follow-up patients.

Data regarding patient demographics, nephrectomy indication, nephrometry scores were calculated and verified using R.E.N.A.L.-Nephrometry scoring system (www.nephrometry.com).[13] Total operative time, laparoscopic time, use of intraoperative hemostatic agents, intra- and postoperative complications, and histopathological were collected for analyses. During follow-up, we reviewed blood pressure, the presence or absence of hyperdynamic circulation signs, as well as any evidence of AVF in a Doppler ultrasound, contrast computed tomography (CT), or magnetic resonance imaging (MRI) for different indications, avoiding CT for those with impaired renal function. Seventy-one patients underwent these procedures for oncological purpose. Thirty patients were followed up by MRI the remaining were followed by CT due to normal renal function. We aimed to investigate the incidence of AVF after en bloc ligation, and then further evaluate the technique’s effects on operative duration, approximate blood loss, and occurrence of perioperative complications. Data analyses were done using the Statistical Package for the Social Sciences version 20 (SPSS Inc., IBM Corp., Armonk, NY, USA).

Surgical technique

The patient was placed in the lateral position at an angle of 35°–45°. Next, 3–4 trans-peritoneal ports were established. Mobilization of the colon was carried through line of told then the colon was mobilized medially, ensuring the dissection was outside and lateral to Gerota’s fascia, preventing the kidney from falling medially; if this were to happen, it would obscure the medial compartment of the hilum structures. On the right side, the triangular and hepatorenal ligaments were then incised. Splenocolic and splenorenal were incised on the left side. Next, a lower window at the lower pole of the kidney was formed [Figure 1a]. After identification of the ureter in the retroperitoneum, the psoas was exposed. With the ureter to the left in the nondominant hand, tension was applied to the renal hilum to aid in the identification of the renal vein and artery. At this point, we made sure to identify the vena cava. Over the psoas muscle, the dissection was executed in the superior direction until the kidney was completely free on the inferior and posterior sides. The next step was to identify the medial aspect of the renal vein. The upper window was created superior to the renal vein, creating a window between the upper pole of the kidney and the adrenal gland (if adrenalectomy not indicated) making sure not to injure the adrenal vein on the left side [Figure 1b and c]. The stapling device was used to control the renal hilum, as we always use the lower quadrant port site to introduce the stapling device. The tip of the lower jaw of the device should be visible from the upper window to ensure the renal vein and posterior hilum structures (including the renal artery) are in line with the stapler [Figure 2]. On the right side, the duodenum was retracted medially. After controlling the hilum, the remaining attachment of the kidney in its upper and lateral aspects was released, and the kidney was placed in a laparoscopic bag.

RESULTS

En bloc pedicle control was used in 126 laparoscopic nephrectomies and nephroureterectomies on 122 patients with a mean age of 55.7 (range: 18–94) years and a mean
body mass index of 29.2 (range: 17–42) kg/m² [Table 1]. All laparoscopic nephrectomies were done or supervised by one of three minimally invasive surgeons through the same surgical technique. Intraoperative blood transfusion was required in two cases with low preoperative hemoglobin levels. Diaphragmatic injury occurred in one case, but it was repaired laparoscopically, and the patient had an uneventful postoperative course. Open conversion was done in two cases with severe colonic adhesions where there was colonic injury: One case needed primary repair, and the other had a colostomy. Clavien classification Grade II postoperative complications in one patient presented as a fever and chest infection, while two patients developed paralytic ileus (Clavien Grade II). Hospital stay mode was 5 days and ranged from 3 to 10 days. The mean operative time was 91.8 min (range: 45–215). At a mean follow-up of 23.3 months (range: 12–48), none of our patients showed radiological evidence nor clinical signs of AVF [Tables 2 and 3].

**DISCUSSION**

Standard renal hilum control during nephrectomy and nephroureterectomy is the ligation of the renal artery and vein separately. Since its introduction in the 1990s, multiple pieces of literature reviewed the efficacy and safety of *en bloc* renal artery and vein stapling in terms of perioperative results and the formation of AVF.

Previously, it was generally understood that mass ligation of the renal hilum could cause AVF because of the close relation of the vessels and the possibility of ischemia-induced damage to the vessel wall.[4] On the other hand, even with separate ligation of the artery and vein, AVF could be a result of inflammation and adhesion.[5] The most extensive series of AVF research was conducted by Lacombe, where he reported 62 cases of AVF following nephrectomy. However, this mode of ligation was available only for 14 of the 62 patients, 12 of whom successfully underwent en bloc. In addition, a significant number of cases in this series were associated with an infection. As a result, *en bloc* ligation was assumed to be the reason for AVF, even though 48 patients in the cohort did not undergo this mode of ligation.[1,2,4‑6] In our series 91 out of 126 patients were followed up either by CT with contrast or MRI depending on renal function tests. 71 patients for

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**Table 1: Patient demographics and preoperative findings**

| Parameter                                      | Mean (% or range) |
|------------------------------------------------|-------------------|
| Age (years)                                    | 55.7 (18-94)      |
| BMI (kg/m²)                                    | 29.2 (17-42)      |
| Male (n)                                       | 74 (58.7%)        |
| Female (n)                                     | 52 (41.3)         |
| Side (n)                                       |                   |
| Left                                           | 79 (62.7%)        |
| Right                                          | 47 (37.3%)        |
| Indication of nephrectomy (n)                  |                   |
| Nonfunctioning kidney                          | 55 (43.7%)        |
| Renal tumors                                   | 66 (52.3%)        |
| Low score 4-6                                  | 2 (3%)            |
| Moderate score 7-9                             | 33 (50%)          |
| High score 10-12                               | 31 (46.9%, almost 47%) |
| Ureteric or renal-pelvic tumors                 | 5 (3.97%)         |
| Multiple arteries                              | 6 (4.8%)          |
| Multiple veins                                 | 6 (4.8%)          |

BMI: Body mass index

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**Figure 1:** (a) A lower window creation. The ureter is lifted with the nondominant hand, and the psoas muscle is clearly visible after clearing the inferior border of the kidney. (b) Upper window creation; the adrenal gland is spared if there is to be adrenalectomy (blue mark). (c) After completion, the psoas muscle should be visible before any attempt at applying an endovascular stapler device.

**Figure 2:** (a) The view of an upper and lower window (indicated by blue and green, respectively) before applying the endovascular stapler device. (b) The endovascular device is introduced through the lower quadrant port going from the lower window to the upper window. It is essential to ensure that the lower jaw of the device is seen through the upper pole of the kidney prior to any attempt at using the instrument.
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Table 2: Intra and postoperative findings

| Parameter                          | Mean (% or range) |
|------------------------------------|-------------------|
| Estimated blood loss (ml)           | 75 (20-200)       |
| Intraoperative transfusion rates (n)| 2 (1.5%)          |
| Conversion to open surgery (n)      | 2 (1.6%)          |
| Hemostatic agent used               | 66 (52.4%)        |
| Intraoperative complications (n)    | 3 (2.4%)          |
| Operative time (min)                | 91.8 (45-215)     |
| Postoperative complications (n)     | 3 (2.4%)          |
| Hospital stay (days)                | 5 (3-10)          |

Table 3: Follow-up findings

| Parameter                          | Mean (% or range) |
|------------------------------------|-------------------|
| Mean duration of follow-up (months)| 23.3 (12-48)      |
| Imaging used for follow-up         |                   |
| Ultrasound Doppler                 | 35 (27.8%)        |
| CT with contrast                   | 61 (48.4%)        |
| MRI                                | 30 (23.8%)        |
| Symptoms or signs of AVF (n)       | 0                 |
| Imaging finding suggest AVF (n)    | 0                 |

AVF: Arteriovenous fistula, CT: Computed tomography, MRI: Magnetic resonance imaging

oncological purpose, 20 patients with benign causes where followed up for different indication such as evaluation of renal bed and contralateral kidney.

Infection and its associated inflammation increase a patient’s risk of AVF as an independent factor, whether separate ligation or en bloc pedicle control. In a retrospective review by Sherer et al., 69 patients out of 433 underwent en bloc pedicle control for inflammatory renal disease with a mean follow-up of 51 months, of which none of the patients were followed up by imaging showing evidence of AVF. Another review by Conradie et al., which included some patients with active infections during the procedure with EBSH, none of them developed AVF. Similar to our series of 33 cases of chronic pyelonephritis, none of our patients showed symptoms of AVF in follow-up imaging or physical examinations.

White et al. published a prospective radiographic follow-up for 40 patients who underwent en bloc renal pedicle control and were followed up by CT with a mean follow-up time of 35 months, and none of them showed clinical or radiological evidence of AVF. Schatloff et al. conducted a retrospective review of 125 laparoscopic nephrectomies and nephroureterectomies where 65 patients underwent en bloc renal pedicle control with a median follow-up time of 30 months. None of the patients in this study developed AVF. A meta-analysis by Lai and Rais-Bahrami that reviewed 595 patients, none of whom showed evidence of AVF (mean follow-up: 26 months). As such, Lai and Rais-Bahrami concluded that en bloc control resulted in significant improvements in surgery duration. Recently, Huang et al. reported 90 patients who underwent either a nephrectomy or nephroureterectomy. Of these patients, none developed AVF as identified by radiological imaging nor clinical examination. However, three patients were diagnosed with heart failure, one was lost to follow-up, while the remaining patients showed no evidence of AVF.

To the best of our knowledge, no AVF has been mentioned in literature after laparoscopic nephrectomy. Our results agree with previous studies; that there is no association between laparoscopic en bloc renal hilum control and AVF.

En bloc stabling of the renal hilum is an appropriate alternative to the classic separate ligation of renal vessels, and device malfunction has been reported in <0.5% of cases. Resorlu et al. reported no device malfunction in 27 patients that partook in their series, while Chan et al. conducted a study of 565 patients where staple malfunction presented in 10 patients (1.7%). In the present study, we faced no device malfunction using the 60 mm endovascular stapling device. We believe that renal hilum control should be as lateral as possible (with respect to the kidney of interest), and there should be a minimal dissection of the hilum to decrease the bulk of tissue to prevent stapler failure ultimately. It is critical that there are no clips nor bulky tissue in the path of the stapling device, as this can decrease the functionality of the device. Proximal control with clips and hemlock to be used, should the device malfunction.

Infection and the associated inflammatory processes can lead to the adhesion of bulky tissue during hilum dissection during renal surgery. Ma et al. reviewed 33 patients who underwent nephrectomy for inflammatory renal disease with en bloc renal hilum control, where 3 cases were converted to laparoscopic hand-assisted surgeries due to hilar fibrosis and staple device failure. Conradie et al. compared conventional techniques to en bloc techniques in patients who underwent nephrectomy due to various causes, including infection. The author concludes that the en bloc technique was suitable, even in the presence of an infection, as there were likely to be fewer complications under this procedure. The study’s overall results were in favor of en bloc ligation as it associated with less operating time, blood loss, conversion to open surgery, and blood transfusion.

In a previous meta-analysis that evaluated 595 patients, en bloc showed a significant reduction in operating time compared to the traditional operative technique (78.7 min vs. 122 min, respectively). There were no significant
differences in the complication rates or approximate blood loss between the two arms.[5] Kouba et al. evaluated 161 patients, 90 of which underwent en bloc technique, and 71, which underwent the conventional technique, the blood loss, and open conversion were lower in patients with the en bloc technique compared to the conventional technique. [6] Chung et al. conducted a randomized controlled trial consisting of 70 patients total; 35 of them underwent en bloc renal hilum control that was performed with a 60 mm endovascular stapling device. The approximate blood loss and the operative team were less in en bloc when compared to an equivalent procedure that had separate ligations of the renal vessels.[7] In our series, two instances of laparoscopic surgery were converted to open surgery due to severe colonic adhesions; the mean approximate blood loss was low, despite the operative time being relatively higher compared to previously published studies. We attributed this difference to the nature of our center as a training grounds for prospective members of the Saudi Urology Board. Furthermore, most of the nephrectomies were completed by our center’s resident physicians under the supervision of laparoscopic urology consultants.

We found that renal hilum control using a stapler device was easy to learn and teach, safe, fast, and effective during laparoscopic nephrectomy and nephroureterectomy despite the limitations of our study’s retrospective design.

CONCLUSION

En bloc ligation of the renal pedicle appears to be safe, efficient and associated with a shorter operating when compared to the conventional technique. Historically, en bloc ligation was thought to be associated with AVF; however, to the best of our knowledge, there are no publications that indicate worrisome correlations or associations between the two. En bloc ligation is a suitable and safe alternative to the separate ligation of renal vessels.

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Conflicts of interest

There are no conflicts of interest.

REFERENCES

1. Kouba E, Smith AM, Derksen JE, Gunn K, Wallen E, Pruthi RS. Efficacy and safety of en bloc ligation of renal hilum during laparoscopic nephrectomy. Urology 2007;69:226-9.
2. Lai WS, Rais-Bahrami S. safety and efficacy of en bloc renal hilar vascular staple ligation: A meta-analysis. J Urol 2017;197:175-81.
3. Kutukov A, Uzzo RG. The R.E.N.A.L. nephrometry score: A comprehensive standardized system for quantitating renal tumor size, location and depth. J Urol 2009;182:844-53.
4. Resorhu B, Ozgur U, Polat F, Yesil S, Unsul A. Comparative analysis of pedicular vascular control techniques during laparoscopic nephrectomy: En bloc stapling or separate ligation? Urol Int 2015;94:79-82.
5. Atkin MS, Tunç İ, Batur AF, Kirac M, Bozkirli İ. The risk of arteriovenous fistula formation after en bloc stapling of the renal hilum during transperitoneal laparoscopic nephrectomies. Surg Laparosc Endosc Percutan Tech 2014;24:80-4.
6. Lacombe M. Renal arteriovenous fistula following nephrectomy. Urology 1985;25:13-6.
7. Chung JH, Lee SW, Lee KS, Cho WK, Kim TH. Safety of en bloc ligation of the renal hilum during laparoscopic radical nephrectomy for renal cell carcinoma: A randomized controlled trial. J Laparoendosc Adv Surg Tech A 2013;23:489-94.
8. Sherer BA, Chow AK, Newsome MJ, Coogan CL, Prasad SM, Latchamsetty KC. En bloc stapling of the renal hilum during laparoscopic nephrectomy: A double-institutional analysis of safety and efficacy. Urology 2010;75:69-75.
9. Conradie MC, Urry RJ, Naidoo D, Mahmood K, Jogiat Z, Alsharef M, et al. Advantages of en bloc hilar ligation during laparoscopic extirpative renal surgery. J Endourol 2009;23:1503-7.
10. White WM, Klein FA, Gash J, Waters WB. Prospective radiographic followup after en bloc ligation of the renal hilum. J Urol 2007;178:1888-91.
11. Schatloff O, Ramon J, Lindner U, Kirney N, Dostan Z, Nahomi-Shich O, et al. Is postoperative arteriovenous fistula still a concern after en bloc stapling of the renal hilum during laparoscopic nephrectomy? J Endourol 2009;23:639-43.
12. Huang KC, Lin WR, Chen M, Chiu AW, Chen CW. Does the stapler for en bloc resection of renal pedicles during kidney removal surgery increase the risk of arteriovenous fistula? J Chin Med Assoc 2019;82:221-4.
13. Schatloff O, Lindner U, Lindner A. Current status of en bloc stapling of the renal hilum during laparoscopic nephrectomy. J Laparoendosc Adv Surg Tech A 2010;20:631-3.
14. Chan D, Bishoff JT, Ratner L, Kavoussi LR, Jarrett TW. Endovascular gastrointestinal stapler device malfunction during laparoscopic nephrectomy: Early recognition and management. J Urol 2000;164:319-21.
15. Ma L, Yu Y, Ge G, Li J. Laparoscopic nephrectomy outside gerota fascia and En bloc ligation of the renal hilum for management of inflammatory renal diseases. Int Braz J Urol 2018;44:280-7.