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ORIGINAL PAPER

Goldfinger bypassing and en bloc stapling without dissection of renal vessels during laparoscopic nephrectomy

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Summary

Objective: *To test the employment of the Goldfinger Dissector (GD) to bypass and en bloc stapling of renal hilus without vascular dissection. Thus far no study has experimented the use of this integrated technique.*
Patients and methods: *From July 2002 to October 2020, clinical data were collected from 288 patients who underwent transperitoneal laparoscopic nephrectomies. They were divided into two groups: using GD with en bloc stapling (n = 174, group I) or the separation and ligation method (n = 114, group II) using the same Endo GIA Universal (Vascular) Stapler. Comparative analysis was carried out between the two groups, examining blood loss, operative time, intra and postoperative complications and hospital stay.*
Results: *The mean age was 58.3 and 55.1 years in group I and II, respectively. Ratio of 90/84 and 55/59 males/females was found in group I and II, respectively.Blood loss was 65.5 ml and 188.9 ml, operative time was 156.5 and 189.2 minutes, wound infection occurred in three patients in each group (1.7% and 2.6%), ileus in 4 (2.3%) and 1 (0.87%), atrial fibrillation in 1 (0.57%) and 0%, incisional hernia in 0 (0%) and 2 (1.75%), deep vein thrombosis (DVT) in 0 (0%) and 1 (0.87%), conversion to open surgery in 2 (1.15%) and 5 (4.39%), mean hospital stay 3.5 days and 4 days in group I and II, respectively.*
Conclusions: *Routine use of the GD and en bloc stapling of the renal pedicle in laparoscopic nephrectomy is safe and useful. This technique can decrease blood loss, operative time, and have some benefit in conversion to open surgery.*

KEY WORDS: *Goldfinger dissector; Laparoscopic nephrectomy; En bloc; GIA vascular stapler; Hilum dissection.*

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INTRODUCTION

Since the original report of a successful laparoscopic nephrectomy by *Clayman et al.* in 1991, laparoscopic nephrectomy has become an alternative to traditional open surgery (1). This procedure is considered technically difficult because of the vessel injury risk, leading to massive hemorrhage during renal pedicle management (2).
There is no doubt that the main and dangerous part of laparoscopic nephrectomy is the dissection of the kidney blood vessels, as minimal trauma of the large blood vessels can be disastrous, resulting in massive bleeding that requires blood transfusions and opening the abdomen in the most hustle way to save lives. So hilar dissection and control of renal vessels are the most critical steps in laparoscopic nephrectomy. Multiple techniques have been utilized for these steps and several studies have reported their experience with renal pedicle control (2-9). *Rapp et al.* used the technique of en bloc hilar ligation. They deployed a stapler across the renal hilum without individual dissection of the renal artery and vein (9). *Resorlu et al.* found that en bloc ligation of both the renal artery and vein using a stapler is an easy and reliable technique that allows safe and fast control of the renal pedicle during laparoscopic nephrectomy (2). This technique is successful also in laparoscopic nephroureterectomy, without the need for separation between the renal vessels (8). The hilar dissection is even more difficult in laparoscopic nephrectomy after past surgeries (10-11), or in cases with an inflammatory process such as *xanthogranulomatous pyelonephritis* (XGP) (12).
To the best of our knowledge, GD had not been used for this purpose (we explored research published in PUBMED and MEDLINE). Articles were published using the GD in laparoscopic sacrocolpopexy (13) and during liver surgery (14-15). Since there have been previous reports of GIA malfunction, there has been an attempt to safely and inexpensively use both wires and Hem-O-Loc clips simultaneously for renal vein control (6).

PATIENTS AND METHODS

From July 2002 to October 2020, all patients that underwent laparoscopic nephrectomy by the same surgeon were examined. Out of 525 cases undergoing laparoscopic nephrectomy, there were 288 consecutive cases, which had a transperitoneal approach and had all the necessary information according to the working protocol.
The cases were divided into two groups. In the first group (I), a flexible Goldfinger dissector (*Goldfinger Dissector-Ethicon Endo Surgery, Johnson and Johnson, New Brunswick, NJ, USA*) was used for the dissection of the renal hilum and a vascular stapler (*Endo GIA Universal Vascular Stapler,*

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Medtronic Parkway Minneapolis, MN, USA) was used to close and cut the kidney hilus without separating the renal vessels.
In the second group (II) a dissection of the blood vessels was carried out, and the closure of the renal artery and renal vein separately was done with the same previously cited stapler.
There were various causes for nephrectomy including cancers, benign tumours or dysfunctional kidneys.
All cases were operated by one surgeon (MA), and in all cases there was a transperitoneal surgical approach.
The surgical technique is the same in both groups up until access to the kidney hilum. Five trocars were used on the right side (two 5 mm, two 12 mm and one 11 mm) and four were used on the left (5 mm, 11 mm, and two of 12 mm).
The patient was laying on the flank, with the operated side upwards, in the position of lateral decubitus. The abdominal cavity was entered with medialization of the colon and dissection of duodenum when operating the right side. The ureter was identified and cut between clips and dissected towards the kidney hilum. The kidney was dissected outside the boundaries of *Gerota*'s fascia. From this step the surgical approach was different between the two groups. In the first group, the GD device was inserted caudal and posterior to the renal hilus tissue creating a small window above the hilum of the kidney and under the adrenal to have the feeling of controlling the whole hilum (Figure 1). At this moment, the GD is removed, and with all devices kept in place without movement, a 60 mm Vascular GIA stapler is inserted for ligation and dividing (Figure 2).
In contrast, in the second group the dissection was continued between the renal artery and renal vein in the renal hilum until they were completely separated, and then the stapler was used on the renal artery and later on the renal vein individually.
The tip of the stapler was visualized beyond the hilum and free from any adjacent tissue before engaging the stapler mechanism.
The first group (I) consisted of 174 cases in which the entire hilum was closed together (en bloc stapling) by using GD. The second group (II) consisted of 114 cases in which a dissection was performed between the artery and renal vein and the closure of each blood vessel was done separately with GIA from the same company.
We evaluated the following clinical and perioperative data: age at surgery; sex; laterality; history of ureteroscopy, *percutaneous nephrolithotomy* (PCNL), peritoneal or retroperitoneal operations, pyonephrosis, nephrostomy insertion; complications, estimated blood loss (EBL), operation time, and length of stay (LOS).
Operation time was defined as the time from the beginning (incision) to the end of procedure (closure of the skin).

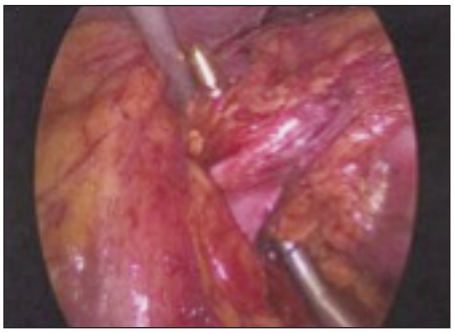

Figure 1.
Goldfinger bypassing the renal hilus.

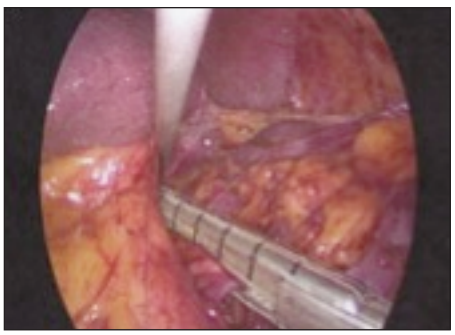

Figure 2.
GIA vascular stapler- en bloc stapling of renal hilus.

Results

The mean age was 58.3 and 55.1 years in group I and II respectively. Ratio of 90/84 and 55/59 males/ females were observed in group I and II respectively (Table 1).
Blood loss was 65.5 ml and 188.9 ml, operative time was 156.5 and 189.2 minutes, wound infection occurred in three patients in each group (1.7% and 2.6%), ileus in 4 (2.3%) and 1 (0.87%), atrial fibrillation in 1 (0.57%) and 0%, incisional hernia in 0 (0%) and 2 (1.75%), deep vein thrombosis (DVT) in 0 (0%) and 1 (0.87%), in group I and II respectively (Table 2). Conversion to open surgery occurred in 2 (1.15%) and 5 (4.39%), mean hospital stay was 3.45 days and 3.9 days in group I and II, respectively.

Table 1.
Patient demographics.

	GD and en bloc-I (Std. dev.)	Hilum Dissection-II (Std. dev.)	Difference [P-value]
Age mean (years)	58.3 (16.77)	55.1 (20.41)	3.2 [0.155]
Male	90 (51.7%) (0.50)	55 (48.2%) (0.50)	3.5% [0.565]
Stricture side			
Right	80 (46%) (0.50)	54 (47%) (0.50)	-1% [0.818]
Left	94 (54%) (0.50)	60 (53%) (0.50)	1% [0.818]
Observations (N)	174	114	

Standard deviations in parentheses. P-values in square brackets.

Table 2.
Post-operative complications.

	GD and en bloc-I (%)	Hilum Dissection-II (%
Wound Infection Ileus	3 (1.7%) 4 (2.3%)	3 (2.6%) 1 (0.87%)
Atrial Fibrillation	1 (0.57%)	0 (0%)
Incisional Hernia	0 (0%)	2 (1.75%)
DVT	0 (0%)	1 (0.87%)
Observations (N)	8	7
Total (%)	4.6%	6.1%

DVT: Deep Vein Thrombosis.

Discussion

Laparoscopic nephrectomy has become a standard surgery since the description of the surgery by *Clayman et al.* in 1991 (1). The difficulty arises when dissecting the kidney hilum, separating the renal blood vessels, as an injury and bleeding from the blood vessels vastly increases the chances of a conversion to open surgery, rendering the patients losing all the advantages of the laparoscopic surgery over the open one. Early on, *Chan et al.* described the technique of rapid ligation of the renal hilum, and in their technique, they proposed a dissection of the renal vein, which is anterior, and tying all the posterior tissue (posterior packet) containing the renal artery, and subsequently closing the renal vein separately, thus providing a safe and quick approach to closing the hilum (17). In several studies there was a discussion regarding dissection of blood vessels, and cases where blood vessel were ligated en bloc due to the fear to separate blood vessels when there was no progress with the surgery or for other reasons in the attempt to control the blood vessels (2, 4, 6-7, 9, 16). The efficacy of en bloc method has also been observed during laparoscopic nephroureterectomy in the first part of the surgery, before the completion of the ureteral dissection from the bladder (7-9).

Table 3 shows the list of peritoneal and retroperitoneal surgeries that were done before laparoscopic nephrectomy in the same kidney unit. A difference was shown only in the number of ureteroscopies between the two groups ($p < 0.05$). This difference in ureteroscopies should not be relevant because these procedures have not much effect on the tissues around the kidney hilus and should not affect the results. History of PCNL, peritoneal and retroperitoneal operations, pyonephrosis and percutaneous nephrostomy, were not different when comparing the two groups (Table 3).

In the current study we compared group I and II, and we found a significant difference in the average surgery time and in bleeding in favor of the group that used GD with closing and cutting the kidney hilum en bloc at the same time. The values of our study were not higher when compared to other series where even longer times and higher volumes were observed (Table 4). One of the reasons for this difference is that some cases were at the beginning of the learning curve, whereas years later duration of surgeries became shorter, yet the significant advantage of group I over group II is apparent. The differences in conversion rate from laparoscopic surgery to open surgery and complications also were in favor of the first group (Table 4), but the difference is not statistically significant. The average bleeding is much lower in the first group compared to the second, and relatively lower than other world series (Table 4). We observed a statistically difference in hospital stay, although most patients were discharged three days post-surgery.

We have no information about the use of the GD device in laparoscopic nephrectomy in other world series, although whoever is trying this device can feel full confidence when bypassing the entire renal hilum from all directions. The use of the device allows to evaluate the entire thickness of the tissue before employment the GIA- stapler. If tissue appears to be too bulky, it can be divided by the same GD to identify another surgical plane in order to safely employ the GIA- stapler twice without seeing the blood vessels.

In both groups, the nephrectomy was performed for various reasons as detailed in Table 5 including cancerous renal

Table 3.
Prior peritoneal or retroperitoneal operations and invasive procedures.

	GD and en bloc-I (Std. dev.)	Hilum Dissection-II (Std. dev.)	Difference [P-value]
URS	0.376 (0.49)	0.254 (0.44)	0.121*** [0.029]
PCNL	0.046 (0.21)	0.079 (0.27)	-0.033 [0.277]
RP. Operation	0.238 (0.43)	0.227 (0.42)	0.011 [0.830]
Pyonephrosis	0.231 (0.42)	0.234 (0.43)	-0.003 [0.963]
PCN	0.150 (0.36)	0.216 (0.41)	-0.066 [0.169]
Peritoneal operation	0.438 (0.50)	0.456 (0.50)	-0.018 [0.763]
Observations (N)	174	114	

URS: Ureteroscopy, PCNL: Percutaneous nephrolithotomy, RP: Retroperitoneal, PCN: Percutaneous nephrostomy.
**** P-value < 0.05.*

Table 4.
Transperitoneal Laparoscopic Nephrectomy series dealing with renal vessels.

Reference	D/E	N	BL ML	OT Min.	Conversion %	Complications %	HS-Days
Resorlu et al. (2)	E	27	225	98	0	3.7	5.1
Conradie et al. (7)	E	93	32	56	2.1	2.2	2.9
Ma et al. (4)	E	33	75.2	99.6	3	12.1	4.8
Zhang et al. (5)	D	191	94.8	171.5	0.52	4.2	5.6
Sherer et al. (16)	E	433	155	169	1.4	1.4	-
This study:							
Asali et al.	E	174	65.5 (68.81)	156.5 (45.21)	1.15 (0.11)	4.6 (0.21)	3.45 (0.87)
	D	114	188.9 (306.44)	189.2 (53.64)	4.39 (0.21)	6.1 (0.24)	3.90 (1.98)
Difference E-D [P-value] P-value < 0.05			-123.50 [0.000] ***	-32.75 [0.000] ***	-3.2 [0.124]	-1.5 [0.577]	-0.45 [0.023] ***
Adj. difference [P-value] P-value < 0.05			-128.64 [0.000] ***	-31.79 [0.000] ***	-3.49 [0.115]	-2.07 [0.468]	-0.49 [0.019] ***

D: Vascular dissection; E: En bloc stapling; HS: Hospital stay; GIA: Endo Vascular GIA: Medtronic, H: Hem-o-lock; OT: Operating time; BL: Blood loss; Min.: Minute. Device used in all studies is GIA, except for D. Zhang et al. which is H/GIA. Adj. difference refers to the statistical difference in the respective variable between the two groups when controlling for the demographic variables of age, gender, and right or left kidney.
**** P-value < 0.05.*

Table 5.
Kidney pathology.

Group	No	RCC	UCC	Pyelo./Hydro./NF.	AML	Onco.	XGP	AS.
En bloc- I	174	74	26	74	4	2	0	1
Dissection- II	114	30	20	65	0	2	4	1

RCC: Renal Cell Carcinoma; UCC: Urothelial Cell Carcinoma; Pyelo: Pyelonephritis; Hydro: Hydronephrosis; NF: Nonfunctioning Kidney; AML: Angiomyolipoma; Onco: Oncocytoma; XGP: Xanthogranulomatous Pyelonephritis; AS: Angiosarcoma.

tumors (renal cell carcinoma, urothelial cell carcinoma, angiosarcoma), some benign tumors (oncocytoma, angiomyolipoma), and chronic renal inflammatory processes related to history of recurrent urinary tract infections or stone disease. Although the causes of nephrectomy are different, the surgery performed in all the cases was the same, and the kidney was always dissected on a plane outside the *Gerota*'s fascia even when it was affected by an inflammatory non-tumor process, because this surgical plane is less involved in the inflammatory process as shown by *Ma et al.* (4). Laparoscopic nephrectomy outside *Gerota*'s fascia of the kidney could reduce the difficulty of procedure (4).
The strength of this article is related to several factors. First, it was introduced the use of an endoscopic device for the purpose of bypassing the renal blood vessels, that was never used elsewhere in the world for this purpose. Secondly, the larger number of cases in which ligation of renal blood vessels was carried out simultaneously (en bloc) in relation to other most known series in the world. Thirdly, all cases were operated by a single surgeon. Finally, in all cases GD and vascular GIA-stapler from the same companies were used. The major limitation of our study is that data were acquired in a retrospective manner.

Conclusions

Routine use of the GD and en bloc stapling of the renal pedicle in laparoscopic nephrectomy is safe and useful. This technique can decrease blood loss, operative time and have some benefit in conversion to open surgery.

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