

Role of Agarwal Sliding-clip Renorrhaphy in the Expansion of Partial Nephrectomy

ABSTRACT

The evolution of renorrhaphy technique has continuously change the landscape of partial nephrectomy (PN), pushing boundaries to further improve patients' oncological and functional outcomes. The introduction of Agarwal sliding-clip technique is a prominent example, initially allowing for better closure and reducing the risk of parenchymal injury. In addition, the technique has served as a stepping stone, allowing for improved operating experience during robot-assisted PN. This review will revisit the milestones and adaptations of the Agarwal sliding-clip renorrhaphy techniques for partial nephrectomies.

Key words: Laparoscopy, Partial Nephrectomy, Renorrhaphy

INTRODUCTION

The current guidelines recommended surgery as the gold standard for curative treatment for localized renal cell carcinoma. Among which, the utility of partial nephrectomy (PN) for the management of small renal masses has been described with nephron-sparing approach having comparable or even better oncological and functional outcomes, such as in terms of post-operative renal function, when compared with radical nephrectomy.^[1,2] Despite its benefits, early PNs were often plagued with challenges surrounding hemostasis and closure of collecting system, which contributed to increased operating time, complication rates, and recovery time.^[3,4]

It is not until 2007 that Agarwal *et al.* introduced the sliding-clip renorrhaphy technique. The principles of the approach include the use of Hem-o-lok® clips (Teleflex Medical, Research Triangle Park, NC, USA) to fix the entry and exit points of the horizontal mattress suture that was placed to close the renal parenchymal defect. The benefits of this approach include shorter operating and warm ischemia time due to the abolished need for intracorporeal knot tying as well as allowing for stable, sustained, and adjustable suture tension on renal parenchyma that may further ensure hemostasis and closure of collecting system.^[3,4]

Although initially introduced for laparoscopic PN (LPN), the rising incidence of incidentally diagnosed small renal mass and growing popularity of nephron-sparing surgeries have seen sliding-clip renorrhaphy technique now also applied in open and robotic approaches. This article will provide a short narrative review on the utility and adaptations of this game-changing technique across the landscape of partial nephrectomies.

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RENORRHAPHY IN LPN

Historically, renorrhaphy was completed using a double-layer suture technique with inner medullary and outer cortical sutures, as initially described by Gill *et al.*^[5,6] The technique may involve the use of running or interrupted sutures, as well as the use of surgical bolsters and/or various hemostatic agents.^[5] The transition away from intracorporeal knot tying using surgical clips was first proposed by Orvieto *et al.* in 2005. In their series of transperitoneal LPN, closure of renal parenchyma was achieved by the use of Lapra-Ty clips fixated over 0-0 Polysorb sutures. Surgicel bolster was also utilized in larger defects where tissue approximation may possess additional challenge.^[7] Similar concept was also introduced by Heinrich *et al.* in 2006 where pledged locking clips were used on both ends of the wound, which were later tightened over surgical bolster and Flowseal® to ensure further hemostasis.^[8]

Following the introduction of sliding-clip technique, Silagy *et al.* performed a prospective review of patients who underwent partial nephrectomies with incorporation

of sliding-clip renorrhaphy. Based on the 48 LPN cases, the group concluded the sliding-clip approach as a safe and efficient technique for hemostasis and shortening of ischemia time. Risk of major complications was reportedly low with the absence of urine leak and only two patients requiring perioperative blood transfusion.^[3] Further study comparing sliding-clip renorrhaphy (Group I) with intracorporeal suturing techniques (Group II) was undertaken by Kim *et al.*, which identified similar complication profiles with relatively better post-operative renal function, despite the latter not achieving statistical significance. However, they identified significantly reduced operating time (Groups I vs. II; 148.7 ± 31.9 vs. 170 ± 27 min; $P = 0.004$), warm ischaemia time (Groups I vs. II; 21.5 ± 5.8 vs. 32.3 ± 6.5 min; $P = 0.001$), and intraoperative blood loss (Groups I vs. II; 254 ± 162 vs. 369 ± 201 mL; $P = 0.008$).^[9]

APPLICATION OF SLIDING-CLIP RENORRHAPHY IN OPEN PN (OPN)

In the advent of minimally-invasive surgeries, OPN has often been considered as the thing of the past with its declining popularity often attributed to increased risks of complications and prolonged recovery time. Nonetheless, certain challenges may similarly be encountered as during LPN whereby the sliding-clip technique may be of benefit. Similar instruments, such as Hem-o-Lok and Lapra-Ty clips, may also be used, as demonstrated by Gorin *et al.* In addition to favorable outcomes with mean warm ischemia time <20 min and intraoperative blood loss of approximately 280 mL, they identified that combining the two clips provided the best tensile force with the least risk of clip displacement. This was compared with increased risk of dislodgement with only Hem-o-Lok clips and increased risk of violating the renal collecting system with only Lapra-Ty clips due their smaller surface area.^[10] Nevertheless, a single-center study by Crestani *et al.* comparing patients subjected to sliding-clip with Hem-o-Lok (Group I) and traditional renorrhaphy techniques (Group II) demonstrated the former as being superior in reducing median operating time (Group I vs. II; 130 vs. 150 min; $P = 0.02$), median warm ischemia time (Group I vs. II; 10 vs. 14 min; $P = 0.01$); and median intraoperative blood loss (Group I vs. II; 140 vs. 300 mL; $P = < 0.001$).^[11]

SLIDING-CLIP RENORRHAPHY AS INHERENT STEP IN ROBOT-ASSISTED PN (RAPN)

The introduction of robotic technology has opened a new frontier and forever altered the landscape of minimally-invasive surgeries in urology. The addition of a robotic arm, improved dexterity, and reduced reliance on surgical assistant have allowed for more complex tasks, such as renorrhaphy, to be accomplished more efficiently.^[5,12] Similar to prior experiences in OPN and LPN, the favorability of the sliding-

clip technique in RAPN can be credited to its primary benefit of allowing higher tensile force to facilitate closure without causing any “cheese-wire” laceration injury of the renal parenchyma. It was shown that this approach allowed for mean maximum tension of 32.7N compared to the required 3.24N in normotensive patients, 11.3N with suture-only closure and 16.7N from an assistant-placed Lapra-Ty clip.^[13]

Different adaptations of Agarwal sliding-clip renorrhaphy in RAPN have been described. In 2008, Benway *et al.* elaborated

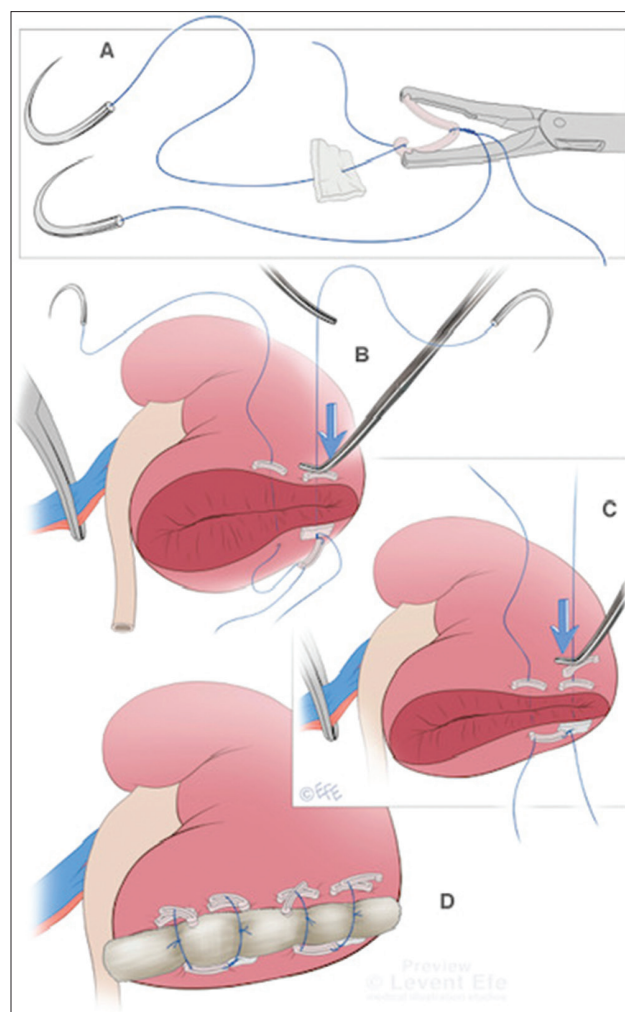


Figure 1: (A) A double arm suture is prepared with a gold hem-o-lok clip (Teleflex Medical, Research Triangle Park, NC, USA) using 0 vicryl suture (Ethicon Inc., Bridgewater, NJ, USA). (B) The parenchymal defect is closed with 2–3 double arm sutures placed 1 cm apart. Hem-o-lok clips are applied and slid down over the vicryl suture to compress the parenchyma achieving haemostasis. (C) Additional hem-o-lok clips are applied with a locking end to secure the clips. (D) If there is any oozing from the wound, the renal defect is filled with loose SURGICEL (Ethicon Inc., Bridgewater, NJ, USA) and Floseal (Baxter Healthcare Corporation, Freemont, CA, USA) and the suture ends

on his technique using both Lapra-Ty and Hem-o-Lock clips that were further secured by a Lapra-Ty clip to avoid any displacements.^[14] Several years after, Kaouk *et al.* published his experience based on the original technique using horizontal mattress suture and only Hem-o-Lock clips.^[15] Favorable outcomes were reported by both with minimal rates of major complications, which included one perirenal hematoma in the former and the need for redo-clamp in the latter.^[14,15] In a subsequent study comparing traditional renorrhaphy (Group I) with sliding-clip techniques (Group II), Williams *et al.* demonstrated a significantly lower mean warm ischemia time in the latter (Group I vs. II; 17.3 vs. 19.6 minutes; $P = 0.04$) without any statistical differences in the total operating time, intraoperative blood loss, and complication profile.^[13]

CONCLUSION

The introduction of sliding-clip renorrhaphy was an innovative success and an example of the commitment within the urological community to continue in pushing the boundaries for better surgical outcomes. The technique, which has now been considered as the gold standard for renorrhaphy, has allowed clinicians to not only minimize the risk of bleeding and urine leak but also to optimize remaining vascular renal parenchyma to ensure the best functional outcome. We believe that the technique will continue to be adapted and modified along with the continuing evolution of PN techniques.

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