Symposium

Laparoendoscopic single-site donor nephrectomy

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ABSTRACT

A donor would prefer a minimally invasive procedure because of lesser morbidity, this may be the reason that laparoscopic donor nephrectomy (LDN) rates have exponentially increased. The rationale dictates that a virtually scarless surgery would be most beneficial to this patient subgroup. In this article, we review the approach, instrumentation, dissection and retrieval issues and the results of laparoendoscopic single-site donor nephrectomy (LESS-DN). The existing literature on LESS-DN was reviewed in Pubmed. The various access sites described for LESS-DN include the umbilicus and Pfannenstiel incision. The steps of LESS-DN duplicate those of standard LDN. There is a paucity of studies comparing LESS-DN with LDN, particularly randomized studies. The most challenging step of LESS-DN is graft retrieval. Authors have described a variety of methods for graft retrieval which include manual methods, and those using retrieval bags. In the majority of the studies, the graft retrieval time is longer in comparison to standard LDN. However, the graft outcome in recipients is comparable. In this article, we also allude to the complications mentioned in various series. LESS-DN is currently an evolving procedure. The procedure requires a high level of skills in laparoscopic surgery. The choice of access site, access site ports and the type of instruments to be used is a matter of surgeon preference. Although the warm ischemia time in most of the series is longer in LESS-DN, this has not translated into poor recipient outcomes. Further work needs to be done to make the retrieval quick.

Current literature from comparative studies with standard LDN suggests that the results in terms of graft outcome are comparable.

Key words: Laparoendoscopic single-site, laparoscopic donor nephrectomy, renal transplantation

INTRODUCTION

In February 1995, Ratner successfully performed the first laparoscopic donor nephrectomy (LDN).[1] The procedure has gained widespread acceptance since then. The perceived advantages of LDN includes shorter hospital stay, incision and convalesce . It has been argued that these advantages translate into a large living related donor pool. Studies comparing open donor nephrectomy (ODN) with LDN have confirmed that apart from the obvious advantages, LDN offers a comparable recipient outcome.[2] Studies have shown that the quality of life scores were significantly better with LDN.[3] Laparoscopic renal donation befits the dictum of "primum non nocere', as the donor has an altruistic motive. A donor would prefer a minimally invasive procedure because of lesser morbidity, this may be the reason that LDN rates have exponentially increased.[4,5]

The rationale dictates that a virtually scarless surgery would be most beneficial to this patient subgroup. Gill *et al*., described the first LESS donor nephrectomy (LESS-DN).,[6] Since then a number of centers have published their reports.[7-10] Although there is a plethora of terms describing single-port surgery, which include single-incision laparoscopic surgery (SILS) and laparoendoscopic single-site surgery (LESS) describing the single-port approach, we prefer to use the term LESS . Although LESS has been described in a variety of urological conditions, it is preferable that before embarking on this procedure one should be adequately trained in laparoscopy. It has also been suggested that prior to initiating the LESS-DN program the surgeons should be well-versed in LESS procedures such as simple and radical nephrectomy, nephroureterectomy, adrenalectomy.[8]

In this article, we discuss the approach, instrumentation,

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dissection and retrieval issues and the results of LESS donor nephrectomy (LESS-DN).

Approach

LESS-DN has been described using the umbilicus, Pfannenstiel incision or the groin as the access site.

Access

R-port umbilical approach

The R-port is a single-access port device available as a three-channel (Triport ™ Advanced Surgical Concepts, Ireland) or a four-channel (Quadport™ Advanced Surgical Concepts, Ireland) device [Figure 1]. Although for LESS-DN both variants are used, we prefer to use the Quadport™ device. The advantage of using the R-port is the greater degree of retraction that this port offers, thus enabling greater latitude of movement of instruments. The currently available variant of the Quadport™ does not have the gel valves so the chances of smudging are minimized thus improving the operating time; in addition the newer generation R-port™ has a detachable sleeve which has the potential for making graft retrieval faster.[7]

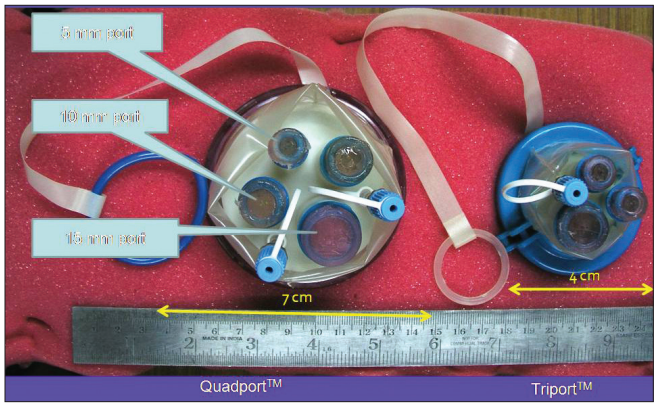

Figure 1: Our preference of access port The R-port™ is available as Triport™ and Quadport™

Three-port approach

Umbilical approach

Dubey *et al*., have described transumbilical LESS-DN using three ports inserted through a 4.5-cm transumbilical incision. Three ports are used, one 10 mm and two 5 mm. The patient is placed in a position similar to a standard LDN. An extra-long bariatric laparoscope was used by the authors. The authors note a greater degree of freedom of movement with the use of these ports.[8]

Figure 2: The different ways to reduce clashing and crowding are a) Use one short instrument in one hand and a long one in the other. Use a curved instrument in one hand and a straight one in the other. Use assistant hand ergonomically, assistant holds the telescope proximally on the shaft. The cameraman sits and the surgeon stands.

Pfannenstiel approach

Andonian *et al*., have shown the feasibility of LESS-DN through a pfannenstiel approach.[9] After establishing the pneumoperitoneum, a 5-cm Pfannenstiel incision is placed and the skin flaps are developed. Three ports are placed in triangular fashion, two ports are placed lateral to the midline while, one port is placed lateral. The inferior port is used for the laparoscope. As in the series by Dubey *et al*.,[8] the 5-mm port is exchanged with a 10-mm port just prior to retrieval.[9] The authors argue that a Pfannenstiel incision is associated with lower morbidity. In a study by Tisdale *et al* patients with Pfannenstiel incision following nephrectomy had a shorter hospital stay, less morphine requirement and lower risk of extraction site complications .[10]

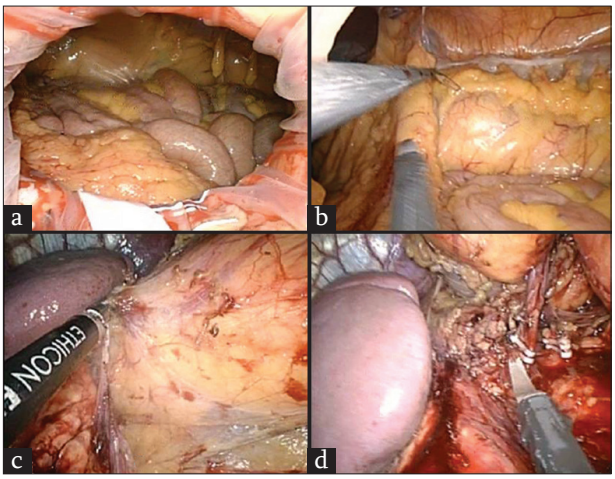

Figure 3: Dissection of the kidney a) The view of the abdomen through the R-port™. b) Inline movement of the instruments makes the dissection difficult. c) An extra-long harmonic scalpel is useful for the dissection of the upper pole. d) The hilum is secured with hem-o-lok™ clips.

Gelpoint™-Umbilical approach

Gimenez *et al*., have described LESS-DN with the Gelpoint™ (Applied Medicals, Rancho Santa, Margarita, CA). A 5-cm vertical incision is made, an anterior rectus faciotomy is created and the abdomen is entered. Two 5-mm and one 15-mm trocar is used.[11] The authors opine that Gelpoint™ provides greater space for triangulation and thus decreases instrument clashing. It also allows easy and rapid modification of port configuration, thus decreasing the need for extra ports.

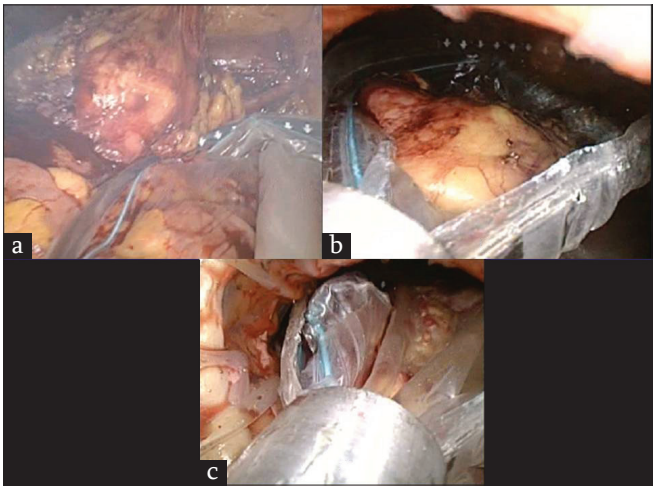

Figure 4: The graft retrieval is quick if the Endocatch bag™ is used a) The graft is entrapped in the bag. b) The bag is withdrawn without closing it

The procedure

Instruments

The choice of instruments to be used varies from surgeon to surgeon. Dubey *et al*., have described the use of a 10-mm, 45-cm long telescope , used usually for bariatric surgery.[8] The extra length of these instruments helps to keep the camera driver away from the operating field and hence decreases the clashing. We have been using the Olympus Endoeye™ telescope with a coaxial light source. The coaxial arrangement of the light source allows the use of camera without interfering with the movements of the surgeon. The Olympus Endoeye™ telescope with an 'extender' also serves the same purpose. The flexible telescope helps to visualize the posterior aspect of the renal hilum and dissection along the psoas. This is of importance in LESS donor nephrectomy as meticulous and precise dissection of the hilum is the 'key' to success. Andonian *et al*., have used the flexible camera; the procedure was done using the Pfannenstiel incision site as the site of access.[9] and Canes *et al*.,[12] have used straight articulating instruments for dissection. Dubey *et al*.,[8] have used non-articulating instruments. In our series we have been using standard non-articulating laparoscopic instruments for the purpose. Our belief is that the use of articulating instruments adds to the learning curve of the operating surgeon [Figure 2]. During the dissection of the upper pole, we use long harmonic scalpel and extra-long suction. In our opinion, this is one of the most challenging steps in LESS donor nephrectomy because of the enhanced clashing, abnormal viewing angle and inline movement and alignment of the camera and instruments.

Canes *et al*., have used a bariatric laparoscope with a right-angle extender[12] [Figure 2]. Gemeniz *et al*., used the right-angle extender.[11] This was introduced through a 15-mm port of a Gelpoint™ device. Standard non-articulating instruments were used in most of the procedures. When performing on the right side a diamond flex retractor (Genzyme surgical products, Tucker, GA) which is a curved retractor of the liver operated by the camera assistant is used. Occasionally articulating instruments (Cambridge Endo, Framingham, MA) are used.[13]

Troubleshooting

Different ways to avoid instrument clashing and crowding include [Figure 2 a-d]:

1. Use one long and one short instrument, this helps to keep away the working hand from the retracting hand. Similarly, one can use one bent and one straight instrument to improve triangulation.
2. In donor nephrectomy, upper pole dissection can be facilitated by switching ports or hand.
3. A camera driver should be preferably an experienced laparoscopist and should understand the nuances of laproscopy. In order to avoid clashing and crowding in the operating field it is better if the assistant sits and the surgeon stands.

Dissection

The steps of LESS-DN mirror those of LDN. Once the ports are inserted the steps include reflecting the colon along the white line of Toldt. The plane of dissection should be kept outside the Gerotas fascia [Figure 3]. It is essential that the surgical plane should be maintained at this point. The splenorenal ligament should be taken down so that the space between the spleen and the kidney "opens like a book". This is of significance while dissecting the upper pole and the adrenal. The ureterogonadal packet should be lifted en bloc to avoid skeletonizing the ureter. The sequential steps during the procedure include dissecting and securing the adrenal vein, followed by upper pole dissection, this is followed by securing the lumbar vein. We prefer to secure the hilum with hem-o-lock clips (two on the patient side) for both the vein and the artery.

Retraction

Dubey *et al*., have described ways of reducing the need for accessory ports and novel ways for retraction of the ureterogonadal packet.[8] A part of the infant feeding tube is cut and fed into the open end of a plastic needle cap. A port closure needle is passed through into the abdomen from the subcostal area. The needle is passed into the open end of the cap, this assembly helps in retraction of kidney and adjacent organs. Just prior to retrieval one 5-mm port is exchanged with a 10-mm port. This assembly obviates the need for an additional port , the use of port closure device helps in avoiding a additional skin incision. Although arguably an extra 3-mm port inserted subcostally helps to provide retraction, in our initial cases the extra port helped to bring the graft near the incision thus expediting the retrieval. The use of a sling made of thread or an infant feeding tube can serve as a retractor for the ureterogonadal packet.

Graft retrieval

Prior to retrieval the protocol of adequate fluid resuscitation,

furosemide and mannitiol administration is followed. This ensures good perfusion of the graft. In our series the graft retrieval technique evolved over a period of time. In the initial few cases, the kidney was retrieved by inserting two fingers in the wound, the fascia was cut keeping the skin intact just prior to retrieval and the kidney realigned along the long axis. The fascial incision was extended without increasing the length of the skin incision to retrieve the kidney . In the initial few cases the kidney was realigned with the extra 3/5-mm port placed in the subcostal area. As we gained experience we realized that realigning the kidney in the bag would make the retrieval quick. We used the Endocatch bag™ for the purpose [Figure 4]. We did not close the Endocatch bag prior to retrieval, this helped us to realign the kidney.

Gill *et al*., described a retrieval technique wherein after freeing the kidney laterally it was pre-entrapped in a15-mm Endocatch bag™. The bag was detached from the metallic ring and inserted through a12-mm inlet of the R-port™, once the graft was trapped in the bag, it was cinched around the renal pedicle, thus the pre-entrapped kidney was extracted through a transumbilical incision.[6] Dubey *et al*., retrieved the graft by connecting the three laparoscopic ports. A pre-tied vicryl thread on the lower pole fat is pulled and the axis of the kidney changed to assist retrieval.[8] The graft is retrieved manually.

Canes *et al*., describe a retrieval wherein prior to retrieval the kidney was mobilized circumferentially.[12] The Endocatch bag is used for the purpose, the retrieval being similar to that described by Gill *et al*. The introducer was detached. A stiff guide wire introduced through the drawstring seam The 12-mm port of the R-port is used for introduction of the bag. The ends of the guide wire are externalized, the kidney is pre-entrapped prior to securing the hilum. Once the hilum is secured the bag is retrieved by pulling [Figure 4].

Various modifications have been described to minimize the length of the skin incision. Canes *et al*., have conceptualized that a midline faciotomy approximately 6-7 cm which is extended cranially and caudally limits the need to extend the umbilical skin incision, in addition the umbilical fold stretches which allows the bag to easily come through without traumatizing the graft .[12]

Gimenez[11] *et al*., have used the Endocatch bag™ for entrapping the graft, once this is done the gel cap is removed and the graft retrieved. They describe extension of the fascial incision for a centimeter with care taken to prevent extending the skin incision.

RESULTS

A number of studies have been published describing "single-centre experience" in LESS-DN. There is a paucity of Level 1 literature describing the results of LESS-DN. There are two adequately powered comparative studies comparing results of LESS-DN with LDN, one being randomized.[12,14] Kurien *et al*., excluded right-sided donors, any abnormal vascular anomaly, and donors having a body mass index BMI of more than 25 Kg/M^2 from the study.[14]

Technical standpoint

Canes *et al*., note that adequacy of exposure, appearance of vessel, kidney and vessel length was comparable to standard LDN.[12] Kuiren *et al*., have done a more objective evaluation of this aspect, they divided LESS-DN into the

Table 1: Summary of two comparative studies between laparoscopic donor nephrectomy and laparoendoscopic single-site donor nephrectomy

	Kurien *et al*.[14]			Canes *et al*.[12]		
	Standard laparoscopic donor nephrectomy	LESS donor nephrectomy	*P* value	Standard laparoscopic donor nephrectomy	LESS donor nephrectomy	*P* value
Operating room time (min)	175.83 + 47.57	172.20 + 38.33	0.38	239 + 54	269 + 86	0.3
Estimated blood loss (ml)	92.40 + 28.33	84.00 + 29.15	0.16	141 + 65	108 + 67	0.2
Warm ischemia time (min)	5.11 + 1.01	7.15 +1.84	<0.0001	3+0.6	6.1 + 2	<0.0001
Graft artery length (mm)	24.36 + 2.43	25.25 + 6.23	0.26	NA	30.20 + 0.70	-
Graft vein length (mm)	28.68 + 3.42	28.80 + 7.15	0.47	NA	30.60 + 0.90	-
Graft ureter length (mm)	113.96 + 24.79	123.00 + 18.44	0.08	NA	140.90 + 10.10	-
Length of incised wounds (mm)	133.60 +16.99	51.47 + 14.37	<0.0001	NA	40.10 + 0.80	-
Hospital stay (days)	4.56 + 0.82	3.92 + 0.76		3.5 + 1.2	3 +1.2	-
Warm ischemia time (min)	5.11 + 1.01	7.15 + 1.84	0.003	3.0 + 0.6	6.1 + 2.6	-
Total ischemia time (min)	62.55 + 9.46	62.71 + 12.14	0.48	NA	NA	-
On-table graft output	25 (100%)	25 (100%)				-
Complications	Bladder injury (n=1) Minor splenic tear (n=1)	Splenic capsular tear-2 Diaphragmatic injury-2 Renal capsular tear-2				

following steps, namely port insertion, colonic reflection, ureterogonadal packet mobilization, adrenal vein division, upper pole separation, lumbar vein division, renal pedicle division, hilar securing and graft retrieval . They compared the surgeons' visual analogue scoresVAS in the two groups. The only difference was significantly greater difficulty in graft retrieval. However, none of the patients required conversion to standard LDN.[14] Andonian *et al*., note that the surgeon needs to be accustomed to the laparoscopic view from the pelvis rather than from the umbilicus. Secondly, the lateral traction/countertraction on the kidney as placed from an umbilical approach is lost.[9]

Warm ischemia time

Canes *et al*., noted that LESS-DN had a longer warm ischemia time (WIT) as compared to standard laparoscopic donor nephrectomy (6.1 versus 3 min). There was no difference in the mean serum creatinine levels at three months. The retrieval incision cannot be placed prior as this may lead to loss of pneumoperitoneum. The authors attribute the longer WIT to the time required for preparation of the fascial incision prior to retrieval. Another reason attributed for a longer WIT is the challenges involved in entrapping the specimen.[12] Kuiren *et al*., noted a mean WIT of 7.15+1.84 min. In comparison to LDN it is significantly longer [Table 1].[14] A longer WIT in this study did not translate into poor graft outcome. There was no difference in glomerular filtration ratesGFR), incidence of acute tubular necrosis (ATN and graft loss on the recipient side in the two groups. Ramaswamy *et al*., however, noted that the mean WIT was marginally lower in the LESS-DN nephrectomy group (3.9 vs. 4 min, $P = 0.03$).[15] Kurien *et al*., noted that the hospital stay and incision length was significantly shorter in LESS-DN as compared to LDN.[14]

Complications

Canes *et al*., in their series do not report any intraoperative complications, however, postoperative complications occurred in two patients. Among them corneal abrasion occurred in one. Another patient had allograft thrombosis, subsequently he required a graft nephrectomy. [12] In a comparative study Kurien *et al*., noted two wound-related complications which resolved with daily dressings. No intraoperative complications occurred in this patient cohort.[14] Dubey *et al*., and Andonian *et al*., did not report any complications.[8,9]

Gemeniz report a laceration during extraction of the graft. The laceration was visible on the back table after perfusion. The bench dissection revealed that there was a communication with the pelvicalyceal system. The authors attribute this to a small extraction incision. They also note one case of umbilical wound infection.[11]

Ramaswamy R. retrospectively compared the complications of LESS-DN (n=101) and standard LDN (n=663). The 30-day complication rate was compiled and graded using the modified Clavien complication scale. LESS-DN had a shorter hospital stay and less estimated blood loss but longer operative time ($P < 0.05$) as well as higher oral but lower intravenous in-hospital analgesic requirements ($P < 0.05$). Mean WIT was marginally lower in the LESS-DN group (3.9 vs. 4 min, $P = 0.03$). At 30 days there was no difference in the overall complication rate between the LDN and LESS-DN groups (7.1% vs. 7.9%, $P > 0.05$).[15].

In one of our cases of right LESS-DN, we encountered a renal vein tear apparently during graft retrieval;[16] this required reconstruction of the renal vein with a segment of the gonadal vein. In one case with a reteroaortic vein, we encountered a large-bowel injury which required exploratory laparotomy, the injury was sustained during refection of the colon. One case required open conversion because of arterial injury, the smaller artery was at the upper pole which accidently got severed during dissection.

Patient selection

In our experience, a xiphoid-umbilical length of more than 17 cm and BMI of more than 25 makes the dissection of the upper pole challenging. In our opinion, donors having xiphoid-umbilical length of more than 17 cm, BMI of more than 25, multiple vessels, an abnormal anatomy such as reterocaval ureter and an inexperienced donor surgeon should be contraindications for LESS-DN. Although sparse there are a few reports of LESS-R(right)DN . The limitations in LESS-RDN include the need for an additional port for retraction of the liver, this further reduces the available working space. Afaneh *et al*., report their experience with five LESS-RDN. The mean WIT was 3.9+0.2 min. There were no operative complications. All allografts functioned well.[13] We have done LESS-RDN using the R-port™, as in left side the retrieval is challenging. The additional port provided in R-port helps in easy introduction of the EndoGIA stapler for the renal vein.

CONCLUSIONS

LESS-DN is currently an evolving procedure and is in its infancy. The procedure requires a high level of skills in laparoscopic surgery. The choice of access site, access site ports and the type of instruments to be used is a matter of surgeon preference. Although the WIT in most of the series is longer in LESS-DN, this has not translated into poor recipient outcomes. Further work needs to be done to make the retrieval quick.

A prerequisite before performing LESS-DN should be adequate expertise in standard laparoscopic surgery and LESS procedures. Current literature from comparative studies with standard LDN suggests that the results in terms of graft outcome are comparable.

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