Original Article

Risk reduction strategies in laparoscopic donor nephrectomy: A comparative study

T. Manohar, Kishore Wani, Rahul Gupta, Mahesh R. Desai

Department of Urology, Muljibhai Patel Urological Hospital, Dr. Virendra Desai Road, Nadiad - 387 001, Gujarat, India

ABSTRACT

OBJECTIVES: As the advancements, modifications and standardization of laparoscopy are taking place, there is a need for the reduction in morbidity associated with laparoscopic live donor nephrectomy. This study was performed to determine and reconfirm the advantages of laparoscopic donor nephrectomy over its open counterpart. **MATERIALS AND METHODS:** Two hundred open live donor nephrectomy (ODN) cases were compared to 264 cases of laparoscopic live donor nephrectomy (LDN). Pretransplant functional and radiological evaluation was done routinely by excretory urogram and renal arteriography. In case of vascular variations, CT angiography was preferred. Open cases were done by conventional method and laparoscopic group underwent certain technical and surgical modifications, including meticulous planning for the port placement. Operative time, analgesia requirement, start of the orals, hospital stay, blood loss, late allograft function, incidence of rejection, complications and technical problems were analyzed. **RESULTS:** Operative time was 135.8 ± 43 and 165 ± 44.4 min ($P<0.0001$), requirement of analgesia was 60.5 ± 40 and 320 ± 120 mg ($P<0.0001$), hospital stay was 4 ± 0.04 and 5.7 ± 2.03 days ($P<0.0001$), warm ischemia time was 6.1 ± 2.0 and 4.1 ± 0.80 min ($P<0.0001$) and time taken for the serum creatinine to stabilize in the recipient was 4.1 ± 1.6 and 4.32 ± 1.40 days ($P=0.06$) for LDN and ODN groups respectively. There was a significant reduction in the blood loss in LDN group ($P=0.0005$). Overall complications were 6.81 and 14.5% and ureteric injury was seen in 0.37 and 1% in LDN and ODN respectively. **CONCLUSION:** Laparoscopic live donor nephrectomy can now be performed with low morbidity and mortality to both donors and recipients and is proving to be the preferred operation to open donor nephrectomy. Our continued innovations in technical modifications have made this novel operation successful.

Key words: Laparoscopic donor nephrectomy, open donor nephrectomy, warm ischemia time

INTRODUCTION

Since the beginning of the last decade (1990), when Claymen *et al* reported the first successful laparoscopic nephrectomy,[1] laparoscopy has been on the rise in the field of urology. Ratner *et al*[2] effectively utilized these advances when he did the first successful laparoscopic donor nephrectomy (LDN) in 1995. The early experiences have shown some risk of allograft complications in the recipients,[3,1] indicating early graft loss rate of 2.9 to 5.4% and ureteral complications around 10%. LDN is currently being accepted as the procedure of choice and is an attractive alternative to open donor nephrectomy (ODN),[4-8] alleviating the early fear of effect of pneumoperitoneum. Since then, LDN has undergone several technical changes, decreasing the rate of ureteral complications to 2%.[9]

For correspondence: Mahesh R Desai,
Department of Urology, Muljibhai Patel Urological Hospital,
Nadiad - 387 001, Gujarat, India. E-mail: mrdesai@mpuh.org

We believe that with some technical modifications, it is still possible to reduce the existing complications to minimum possible with the application of risk reduction strategies. We present our experience of laparoscopic live donor nephrectomy to determine and reconfirm the advantages of LDN over ODN. In particular, early and late allograft function, incidence of rejection, complications and technical problems were carefully scrutinized for this novel operation.

MATERIALS AND METHODS

Two hundred sixty-four patients who underwent laparoscopic donor nephrectomy via transperitoneal route were compared retrospectively with 200 consecutive open donor nephrectomy cases which were taken as historical controls. These cases were undertaken after a reasonably large experience with laparoscopy (i.e., after performing 50-plus simple nephrectomies and 100 other simple laparoscopic ablative and reconstructive procedures). The study was undertaken after obtaining approval from our institutional ethical committee. Donor suitability was confirmed by medical, surgical, immunological and psychological

assessment; and a complete detailed informed consent, including consent for open conversion, was obtained. Pretransplant functional and radiological evaluation was done routinely by excretory urogram and renal arteriography. In case of arterial variations, we prefer CT angiography to know the associated venous anomaly.

Technique

While laparoscopic learning curve is being achieved, we adopted certain technical modifications suitable to both thin lean donors (those with body mass index (BMI) of more than 30) and female donors alike. All donors underwent overnight hydration and simple bowel enemas. Nasogastric tube and urethral catheter were secured preoperatively. Ports were placed as shown in Figure 1 after thorough radiographic evaluation, taking into consideration the level of hilum at its bifurcation with the rib (topography of the kidney) and corresponding vertebral level. Further modifications were made in patients with high BMI and in isolated truncal obesity patients, wherein all the ports were placed more lateral to the desired landmarks. Kidney retrieval incisions were planned after the first port placement. Pneumoperitoneum was created by closed technique. First port was placed blindly and the rest (two) were under vision. Port placement pressure was 20 mm of Hg and working pressure was maintained around 15 mm of Hg. After the medial reflection of the colon, splenic flexure with its attachments was released by dividing the spenocolic and splenorenal ligaments. Time was spent on identifying the gonadal vein just below the level of the lower pole of the kidney where it crosses the ureter, medial to lateral, caudally. At this point, the whole bulk of periureteral tissue with the gonadal vein was separated and lifted off from the adjoining mesentery till the psoas muscle was evident, taking care not to create a window in the mesentery and to close any immediately, if created. Further, the dissection was carried up to the iliac bifurcation inferiorly and up to the renal vein superiorly without disturbing the golden triangle with upward traction on the lower pole of the kidney. Most of the dissection in and around the ureter was done using harmonic scalpel. The adrenal vein was approached first and was clipped using ligaclip®Allport (U pin, Ethicon endosurgery). Further, adrenal gland was released off from the upper pole of the kidney using harmonic scalpel, carrying the dissection till the point when the upper portion of the psoas muscle was seen. It is our practice to tackle the adrenal vein first and then tackle the lumbar vein, once the upper pole is free and renal vein is evident. Renal artery was dissected up to its origin towards aorta using the combination of harmonic (mostly) and short burst of monopolar hook cautery (as and when required) away from the renal artery. Extra care and judicious dissection was exercised at this level. Throughout the procedure, kidney perfusion was maintained with a urine output of 10 ml/min. Once the hilum was dissected, free papaverine (60 mg in 10 ml) bathing of the renal artery was done. For organ retrieval, pfannensteil incision was put at the pubic hairline level Figure 1, dissecting up to the peritoneum. Ureter, renal artery and renal vein were clipped and cut in that order. We use two hem-o-locks (weck closure systems, Teleflex medical) for the renal artery, on the side of the aorta and two for the renal vein. When the vein is too large, we use vascular loop-assisted weck clip application. After the manual retrieval of the graft, bed was inspected for the residual ooze and sensorcaine (0.25%) spraying (10 ml) was done to the peritoneal reflection. Ports were closed under vision.

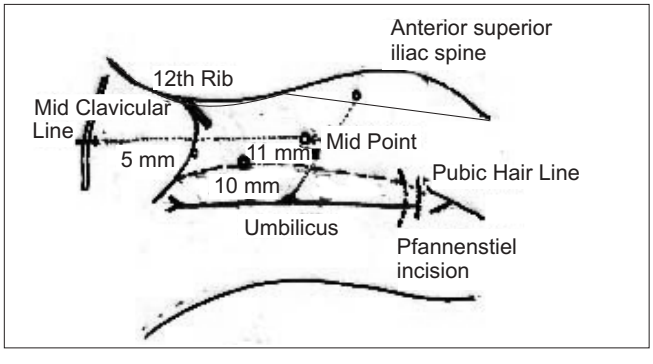

Figure 1: Port placement and organ retrieval incision site

Open donor nephrectomy was done by the conventional method using rib resection muscle cutting approach.

Statistical analysis

Two sample 't' tests were used for both equal variance and unequal variance. Nonparametric Wilkinson Mann Whitney test and Chi-square tests were used wherever appropriate. For all statistical tests, $P<0.05$ was considered statistically significant.

RESULTS

Group 1 constitutes LDN; and group 2, open ODN. All the donors who underwent the procedures were on the left side. The average BMI in our operated cases was 24.36. There was no difference in the age group or the associated comorbidity in each group. Requirement of analgesia and patient comfort was at a statistically significant level when compared to the open group [Table 1]. Postoperative recovery was fast with starting of oral fluids earlier compared to the open counterpart ($P<0.0001$). Hospital stay was around 4 days as compared to open group ($P<0.0001$), which is statistically significant. Blood loss (PCV) was significantly less in LDN as compared to ODN [Table 1].

Table 1: Operative and postoperative statistics

Parameter	LDN (n=264)	ODN (n=200)	*P* value
Operative time (min)	135.8 ± 43.0	165 ± 44.4	<0.0001
*Dose of analgesia	60.5 ± 40	320 ± 120	<0.0001
Starting of oral fluids (hours)	19.4 ± 3.0	20.8 ± 2.59	<0.0001
§Drop in PCV	3.4 ± 1.7	4.12 ± 2.9	0.0005
Hospital stay (days)	4 ± 0.04	5.7 ± 2.03	<0.0001

LDN - Laparoscopic donor nephrectomy, ODN - Open donor nephrectomy
*Tramadol hydrochloride in mg, §Packed cell volume (hematocrit drop)

Although the warm ischemia time and the total ischemia time were comparatively less in the ODN group, the time taken for the serum creatinine to stabilize in the recipient was not significant [Table 2]. Figure 2 shows the long-term follow-up and the drop in serum creatinine in both the open and laparoscopic groups, which is comparable and there was no difference in the outcome in terms of graft function.

Overall complications were 6.81% in LDN group as compared to 14.5% in the ODN group and there was no open conversion in the laparoscopic group. We had one case of intestinal obstruction, which on exploration showed that the loop of intestine was herniated through the mesocolon rent. One case had port site hernia, which had to be re-explored for its reduction; and the other had incisional hernia (previously operated for hysterectomy) through the pfannensteil incision, which required mesh closure. Three cases had intraoperative hemorrhage - including two renal vein injuries and one lumbar vein tear - which was managed laparoscopically. One patient in the laparoscopic group had post-nephrectomy fossa collection, which was managed conservatively by aspiration; and the fluid for analysis revealed increased amylase levels, suggestive of pancreatic tail injury. One case of splenic tear was suture-closed using surgical bolster without postoperative sequelae. Minor complications like right shoulder pain (15%), left lower limb paresthesia (2 cases) and hydrocele (0.86%) were noted in laparoscopic group.

Recipient morbidity rates were comparable to open group, with ureteric injury seen in less than 0.5% in laparoscopic group [Table 3]. This patient had ureteric leak on 9th postoperative day, which required re-exploration and ureteroneocystostomy.

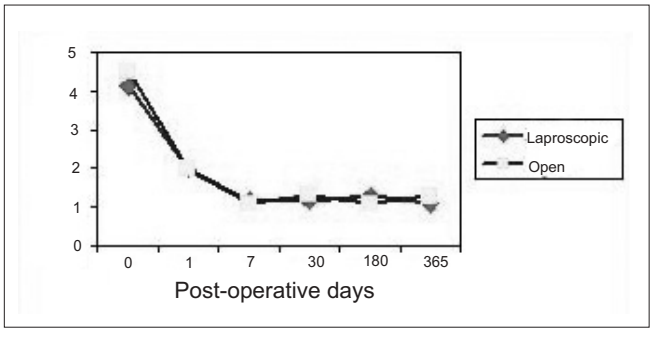

Figure 2: Drop in serum creatinine in recipients

Table 2: Ischemia time and recipient outcome

Parameter	LDN	ODN	*P* value
*Warm ischaemia time	6.1 ± 2.0	4.1 ± 0.80	<0.0001
Total ischaemia (min)	57.7 ± 11.8	49 ± 10	<0.0001
Creatinine at day 5	0.94 ± 1.7	1.0 ± 0.2	0.31
Days to stabilize	4.1 ± 1.6	4.32 ± 1.40	0.06

*Warm ischemia time: Time from the arterial clamping to the initiation of graft perfusion till the perfusate becomes clear, LDN - Laparoscopic donor nephrectomy, ODN - Open donor nephrectomy

DISCUSSION

In our early series, we noted a significant blood loss of 157 ± 67 ml as compared to late cases, wherein blood loss was reduced to 65 ± 34 ml [Table 1] with a overall PCV drop of 3.4 ± 1.7 (P=0.0005). Overall complication rate was 6.81%. All the major complications [Tables 3 and 4] like ureteric leak (1), intestinal obstruction (1), splenic injury (1), port site hernia requiring exploration (1) and incisional hernia (1) were noted during the first half of the cases operated. Major complications of open surgery were atelectasis; pneumotharax (4.5%); and prolonged Ileus (4.5%), which was conspicuous by its absence in LDN. Nearly 70% of the complications, including major ones, were observed during our early 50 cases. We reduced these complications by judicious planning and with ongoing technical modifications. Proper reflection of the large bowel after releasing the splenocolic and splenorenal ligaments helps in preventing the mesenteric rents, which if found, were to be suture-closed (large rents) or clipped (small rents). One of the major steps in preventing the ureteric injury is to not to dissect the ureter but to visualize it while taking the whole bulk of periureteric tissue without disturbing the plane between the gonadal vein and ureter while dissecting the golden triangle. Intraoperative bleeding is the major reason for the open conversion[4,10,11] (1-2%) and we fortunately didn't have to convert any of the 264 cases. Upper pole dissection inside the gerota's fascia prevents splenic injury. We first dissect the adrenal vein to its complete length to its origin before clipping and then dissect the more dangerous lumbar vein, last, once the renal vein and the aortic pulsation are evident, thereby creating ample space and length for its clipping. By this time, the whole kidney would be free and any catastrophe of this vein can be tackled without subjecting the graft kidney to undue compression and vasospasm. The failure of available endovascular staplers, clips and certain other devices may lead to catastrophic bleeding. Slippages of ligaclips have been a major concern reported by some[11] and it is also our experience in our earlier cases. Ole Oyen *et al*[11] reported higher reoperation rates in laparoscopic group as compared to open group and questioned the safety of laparoscopic approach. Since then, we have been using more secure ligaclips - Allport clips (lock mechanism at the distal end with'u' pin mechanism) - for the lumbar vein and adrenal veins, which helps in preventing major catastrophe. It is our observation that use of weck clips for the vascular occlusion has a similar outcome as that of EndoGI stapler. We prefer harmonic dissection for the periureteric tissue and around the renal

Table 3: Recipient morbidity

Procedure	Graft artery thrombosis (%)	Vascular rejection (%)	ATN (%)	Ureteric complications (%)
LDN	0.37	3.03	2.65	0.37
ODN	1	4	4	1

LDN - Laparoscopic donor nephrectomy, ODN - Open donor nephrectomy

artery, which has minimal thermal injury and hence lower incidence of renal artery spasm and ureteric injury (less than 0.5%). Our usage of monopolar cautery (short burst) is only restricted to lymphatic dissection around the renal vein, away from the renal artery and to few fibrous tissues around the kidney. We believe that the reduced cautery (monopolar) time has definite bearing on the overall results we achieved in LDN. Under-vision closure of the ports is extremely important in preventing port site hernia. We prefer manual removal of the kidney.

There are distinct advantages of laparoscopic approach to ODN in terms of early recovery and minimal hospital stay without compromising the graft function.[12,13] Shalav *et al*[14] reported reduced warm ischemia time associated with manual removal of the kidney via pfannensteil incision and we prefer the same approach. Nongueira *et al*[15] reported slower graft function after laparoscopic approach in 132 patients; however, this is not observed in our series [Table 4].

Finally, following are the certain strict operative protocol and risk reduction strategies that we applied while doing laparoscopic donor nephrectomy:

- Transperitoneal route.
- Judicious planning for the port placement.
- Proper plane of reflection of the bowel, including early division of the splenorenal and renocolic ligaments.
- Identification of the ureter at the level of gonadal vein crossing, taking care not to disturb the plane between ureter and the gonadal vein.
- Tackling the adrenal vein and upper pole first, reserving the lumbar vein dissection for the end.
- Extensive use of harmonic scalpel in and around the hilum
- Manual removal of the kidney.

CONCLUSION

Laparoscopic live donor nephrectomy can now be performed with low morbidity and mortality to both donors and recipients and is proving to be the preferred operation compared to open donor nephrectomy. Our continued innovations in technical modifications, along with meticulous attention to port placement, extensive use of ultrasonic diathermy (harmonic scalpel) and careful manual kidney retrieval, have made this novel operation successful. It is for sure that as technology (and technique) improves, the procedure will continue to evolve for its own benefits and outcome.

REFERENCES

1. Claymen RV, Kavoussi LR, Soper NJ, Dierks SM, Meretyk S, Darcy MD, *et al*. Laparoscopic nephrectomy: Initial case report. Urology 1991;146:278-82.
2. Ratner LE, Cisek LJ, Moore RG, Cigarroa FG, Kaufman HS, Kavoussi LR. Laparoscopic live donor nephrectomy. Transplantation 1995;60:1047-9.
3. Annual Report of the US Scientific Registry of Transplant Recipients and Organ Procurement and Transplantation Network - Transplant data: 1988 - 1996 Rockville, Maryland: United Network for Organ sharing and Division of Transplantation, Bureau of health Resources and services Administration, United states, Department of Health and Human Services, 1997.
4. Harman PK, Kron IL, McLachlan HD, Freedlender AE, Node SP. Elevated intra abdominal pressure and Renal function. Ann Surg 1982;196:594-7.
5. London E, Neuhaus A, Ho H, Wolf B, Rudich S, Perer. Beneficial effect of volume expansion on the altered renal hemodynamics of prolonged pneumoperitoneum. Presented at the 24th annual Scientific meeting of the American society of Transplant surgeons. Chicago IL; May 1998.
6. Kirsch AJ, Hensle TW, Chang DT, Kayton ML, Olsson CA, Sawczuk IS. Renal effect of CO_2 insufflation: Oliguria and acute renal acute renal dysfunction in a rat Pneumoperitoneum model. Urology 1994;43:453-9.
7. Shoskes DA, Parfrey NA, Halloran PF. Increased MHC complex antigen expression in acute tubular necrosis in the mouse. Transplantation 1990;49:201-7.
8. Ibrahim S, Jacobs F, Zukin Y, Enriquez D, Holt D, Baldwin W 3rd, *et al*. Immunohistochemical manifestation of unilateral kidney ischemia. Clin Transplant 1996;10:646-52.
9. Brown SL, Biehl TR, Rawlins MC, Hefty TR. Laparoscopic live donor nephrectomy: A comparison with the conventional open approach. Urology 2001;165:766-9.
10. Jacobs SC, Cho E, Dunkin BJ, Flowers JL, Schweitzer E, Cangro C, *et al*. Laparoscopic donor nephrectomy: The university of Maryland 6-year experience. J Urol 2000;164:1494-9.
11. Oyen O, Andersen M, Mathisen L, Kvarstein G, Edwin B, Line PD, *et al*. Laparoscopic versus open living donor nephrectomy: Experiences from a prospective randomized single centre study focusing on donor safety. Transplantation 2005;79:1236-40.
12. Simforoosh N, Basiri A, Tabibi A, Shakhssalim N, Hosseini Moghaddam SM. Comparison of laparoscopic and open donor nephrectomy: A randomized controlled trial. BJU Int 2005;95:851-5.
13. Lee BR, Chow GK, Ratner LE, Kavoussi LR. Laparoscopic live donor nephrectomy: Outcomes equivalent to open surgery. J Endourol 2000;14:811-20.
14. Shalhav AL, Siqueira TM Jr, Gardner TA, Paterson RF, Stevens LH. Stevens Manual specimen retrieval without a Pneumoperitoneum preserving device for laparoscopic live donor nephrectomy. J Urol 2002;168:941-4.
15. Nongueira JM, Cangro CB, Flank JC, Schweitzer E, Wiland A, Klassen DK, *et al*. A comparison of recipient out comes with laparoscopic versus open Live Donor Nephrectomy. Transplantation 1999;67:722-8.

How to cite this article: Manohar T, Wani K, Gupta R, Desai MR. Risk reduction strategies in laparoscopic donor nephrectomy: A comparative study. Indian J Urol 2006;22:201-4.

Source of Support: Nil, **Conflict of Interest:** None declared.