

Techniques for donor nephrectomy analysis



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Laparoscopic donor nephrectomy versus robotic assisted laparoscopic donor nephrectomy: A prospective randomised comparative study

Introduction: Donor nephrectomy is unique surgery which is done on person who is not a patient and come forward for purely altruistic reasons. So the margin of error in donor nephrectomy is nil and hence the stress in donor surgeon is quite high. At the same time all attempts should be done to minimize the donor morbidity to minimum. With the same intension in 1995, Ratner reported first laparoscopic living donor nephrectomy (LDN) (1) and later gradually the laparoscopic approach has become almost the standard of care for living donor nephrectomy. Randomised controlled trials (RCT) comparing the laparoscopic vs. open donor nephrectomy suggested that laparoscopic approach was associated lesser postoperative analgesic requirement and lesser hospital stay and faster returned to work compared to open approach without affecting immediate graft outcome although there was significantly increased warm ischemia time and total operative time with LDN group (2, 3). So LDN was associated with decrease in the disincentives associated with voluntary donor nephrectomy. Further course of time saw further refinement in the techniques of LDN and towards further reducing the morbidity associated with donor nephrectomy. These modifications were introduction of laparo- endoscopic single site surgery(LESS) (4), retroperitoneoscopic donor nephrectomy, robotic assisted laparoscopic donor nephrectomy (RDN) (5) and transvaginal laparoscopic donor nephrectomy (6). In 2002 Horgan first reported the RDN. The goal of this study was to compare the outcomes of LDN and RDN.

Materials and methods: The study was started after approval from institutional review board. Study enrollment time was from March 2014 to February 2015. Primary end point was the postoperative visual analogue pain scores of the donors. Secondary end points were donor's postoperative analgesic requirement, haemoglobin drop, hospital stay , lost arterial and venous length, total operative time(TOT) , retrieval time (RT) , warm ischemia time (WIT),. Recipient related secondary end points were graft function at serial follow up. Surgeon difficulty scores for different steps of surgery were also analyzed. Total of 45 donors were to be enrolled into the study with enrollment ratio of 1: 2 for Robotic: Laparoscopy arm for establishing mean pain score difference of 1 with standard deviation of 1 to reject the null hypothesis that the robotic and laparoscopic pain score means are equal with probability (Power) of 0. 871 and the type 1 error (α) of 0. 05. The sample size was calculated with power and sample size program version 3. 0. 7.

After written informed valid consent for inclusion in study, 45 live related voluntary kidney donor who were completely evaluated and planned for right (N= 27) or left donor nephrectomy (N= 18) were randomised into robotic (Da Vinci Si TM-Intuitive surgical [®]) or laparoscopic approach for donor nephrectomy with chit method.(Figure 1).

Exclusion criteria were patient unwilling for inclusion in study, preemptive transplantation, body mass index (BMI)> 35kg/ square meter, multiple renal artery or veins on donor side or ipsilateral adrenal adenoma.

Parameters noted in all donors preoperatively were, age, gender, comorbidities, previous surgeries GFR (Cockcroft-Gault), serum creatinine BMI, length of renal artery and vein (up to level of bifurcation) on CT angiogram.

RDN was done by two surgeons with expertise in robotic surgery. LDN was done by multiple surgeons (including both the surgeons performing RDN) with expertise in LDN. Bed side surgeons in RDN were the same surgeons who were performing LDN. The operative room team in both the group was same.

In Right LDN, access was achieved from three 12 mm ports for camera and working and two 5 mm ports for lifting ureterogonadal packet and liver retraction. In 9 cases additional 12 mm port was placed from Pfannensteil retrieval wound for insertion of vascular stapler. In Left LDN, two 12 mm ports for camera and working and two 5 mm ports for working and lifting ureterogonadal packet were used. Three left LDN could be managed without port for lifting of ureterogonadal packet.

In Left RDN, three 8mm robotic working ports and two 12mm ports , one for robotic camera and another was for bed side surgeon working port were used. In Right RDN in addition to above ports one more 12 mm port in Pfannensteil retrieval wound for stapler insertion was used in 7 cases and one 5 mm port for liver retraction was used in all cases.

The steps for the surgery were similar in LDN as well as RDN. The difficulty scores (visual analogue score 0-10; 0 being easiest and 10 being most difficult) of donor surgeon were noted on for bowel reflection, lifting up the
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ureterogonadal packet, hilar dissection, upper pole dissection, clipping the ureterogonadal packet, clipping renal artery and vein, cutting renal artery and vein and retrieval of graft in laparoscopy group. The console surgeon difficulty scores were noted for bowel reflection, lifting up the ureterogonadal packet, hilar dissection, and upper pole dissection, cutting renal artery and vein in robotic cases. Bed side surgeon difficulty scores were noted for tasks done by him like clipping ureterogonadal packet, clipping of renal artery and vein and retrieval in robotic cases.

A 5-7cm Pfannensteil incision is placed and deepened to the level of parital peritoneum for graft retrieval. In 2 right RDN kidney was flipped for getting longer renal artery stump. Mannitol was given intravenous before cutting ureterogonadal packets. After cutting the ureter brisk urine output was observed from cut ureter before clipping of hilar vessles. After cutting renal vein, graft was freed of lateral attachments and kept free in peritoneal cavity. After incising this parital peritoneum in Pfannensteil incision, graft is retrieved in longitudinal axis by hand introduced into peritoneum by donor surgeon in LDN and patient side surgeon in RDN. During retrieval undocking of fourth arm of robot was necessary in most of the cases with RDN.

Intraoperatively noted parameters in robotic as well as laparoscopic cases were number of ports, retrieval time, warm ischemia time total operative time, length of artery and vein (Up to level of bifurcation) on bench, intraoperative complications. Retrieval time was considered from clipping of artery up to the retrieval from donor. Warm ischemia time was considered from clipping of artery up to reperfusion of kidney with perfusion fluid till the

time when efflux from renal vein is clear. Docking time was noted in robotic cases.

Post operative visual analogue pain scores (VAS) were noted in donor at 6 hours, 24 hours and 48 hours. Donors were discharged when they were allowed full oral diet, passed motions, ambulant and comfortable. Other donor parameters noted postoperatively were analgesic requirement in milligrams of tramadol, complication grades by Clavien –Dindo complication scale, hospital stay, haemoglobin drop, and serum creatinine at 1 month follow up. Recipient parameters noted were e GFR (Cockcroft-Gault) at 7 days, 1month, 3 month, 6 months and 9 months, graft complications, graft loss.

Statistical analysis was done with Statistical package for social sciences (SPSS) version 15. 0. Analysis was done for comparing RDN vs. LDN.

Subgroup analysis was done to compare Right RDN vs. Right LDN and Left RDN vs. Left LDN. The Chi-square test and Student's t-test was used for categorical and continuous variables respectively.

Results: The demographic parameters in donors are as shown in table 1. Demographic parameters in right and left subgroup are shown in table 2 and 3 respectively. Both the RDN and LDN groups as well as right and left donor subgroups were similar in age, gender, BMI, preoperative renal function, previous surgeries and comorbidities and preoperative artery and vein lengths.

All 15 RDN were completed without conversion to LDN or open donor nephrectomy. All 30 LDN were completed without conversion to open donor

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nephrectomy. There were no intraoperative complications in any of RDN or LDN. In all the RND and LDN the ureter was cut at pelvic brim level. All the recipients (N= 45) in both the groups had good urine output on table after vascular anastomosis.

2 surgeons (one on console and one on patient side) were necessary in RDN compared to single donor surgeon in LDN. The difficulty score on VAS scale 0-10 for donor surgeon in LDN and console surgeon and patient side surgeon in RND is shown in table 4 for right side and table 5 for left side. The VAS score of patient side surgeon in RDN was higher in graft retrieval compared to donor surgeon in LDN in both right and left subgroup. In right subgroup, the VAS scores of RDN surgeons were less than LDN surgeon except in step of upper pole dissection and adrenal sparing which have comparable VAS scores. In left subgroup, the VAS scores of RDN surgeon and LDN surgeon are similar other than step of renal artery and vein cutting which was easier in RDN group.

The analysis of intraoperative and postoperative parameters as well as recipient and graft outcomes is shown in table 6. The subgroup analysis in right and left group is shown in table 7 and 8 respectively.

Donor VAS pain score at 6 hours, 24 hours and 48 hours, analgesic requirement, hospital stay was less in RDN group compared to LDN group. There was no significant difference in donor haemoglobin drop, donor complications, donor serum creatinine at 1 month, recipient eGFR at 7 days, 1month, 3 months, 6 months and 9 months or graft complications between

RDN and LDN group. More ports were necessary in RDN in either of the subgroups.

The total operative time was not significantly different in RDN and LDN group as well as in right and left subgroup. However the retrieval time was higher in RDN group overall as well as in both right and left subgroup. The warm ischemia time is higher in RDN group overall as well as in left subgroup. However it is not significantly different in right subgroup.

There was no difference in lost length of vein during clipping in RND or LDN in both subgroups. However in right RDN longer artery length could be preserved compared to right LDN. This was not found in left subgroup.

Discussion:

More important than introduction of any new technology is safety associated with the technique. This is more so in transplant as there are outcomes in two persons are at stake. As found in our study the RDN is safe technique. It is associated with similar immediate and early postoperative outcomes in donors as well as corresponding recipient's graft function. Previous literature also suggest that RDN is safe(5, 8, 9).

Study comparing robotic versus laparoscopy suggest that robotic approach is associated with less pain than laparoscopic approach (10). The possible reason for less pain in robotic surgery is robotic arms which are pivoted around port site are moved at fixed remote centre. So there is less leverage around the port site and lesser pressure at port sites which leads to lesser trauma to abdominal wall tissues around the port. Our study suggested that

RDN is associated with lesser pain score and lesser analgesic requirement compared to LDN. This also transforms into earlier recovery and discharge from the hospital. Although the voluntary kidney donors donate with altruistic approach, any donor will prefer approach which further reduces the morbidity associated with donor surgery. It is for this reason that live donor nephrectomy rates increase after advent of LDN compared to open donor nephrectomy (11, 12). RDN may further reduce morbidity associated with donor nephrectomy.

Most of the transplant centres prefer left sided graft kidney over right in view of small right vein length and need for retrocaval dissection or flipping of kidney on right side to achieve good graft artery length (13, 14) which may be technically more challenging. Studies also propose that the robotic approach with its 3 Dimensional vision, 7 degrees of freedom, higher magnification and enhanced dexterity compared to standard laparoscopic approach facilitate the renal hilar dissection(15). In our study we found that the VAS of donor surgeon for right hilar dissection was lesser in RDN than LDN. Right kidney was flipped in two RDN. The preserved renal artery length was more in right RDN than right LDN. The technical ease was felt in right RDN compared to right LDN in all steps other than upper pole dissection and retrieval. However it is worth noting that this technical ease did not reach level of significance in any steps of left RDN vs. LDN except cutting of renal artery and vein. The lost artery or vein length was not different in left RDN and LDN. This suggest that robotic approach may provide some technical advantage compared to laparoscopic on right side but not so significantly on left side. At the time of writing this manuscript and during the conduct of this

study instruments like robotic vascular stapler are not available. Availability of such instruments will further reduce the role of patient side surgeon and may influence the technical ease of this surgery. It may also reduce the steep learning curve associated with LDN(9).

The total operative time was not different in RDN vs. LDN. However the warm ischemia time was significantly more in Left RDN group than LDN ($p=0.01$, power of test for this parameter= 87.8%) which is definitely a matter of concern. The retrieval time was more in RDN in both subgroups. The difference in WIT did not reach level of significance on right side. Possible cause for this increased WIT and RT is need to undock the fourth arm during retrieval. This is also a cause for increased patient side surgeon VAS during retrieval in RDN.

The increase in WIT does not correlate with recipient graft function in limited range of time (16, 17). In our study as well the recipient graft related complications or e GFR was not different between RDN and LDN group at 7 days, 1 month, 3 month, 6 month, 9 month follow up.

We acknowledge the limitation of our study that although it is well powered for its primary end point of post operative visual analogue pain scores of donor, it is less powered for few of the secondary end points. The longest recipient graft follow up is 1 year in our study and we don't have any longer follow up. Last but not least, our study does not focus on the economic aspects of comparison between RDN and LDN. The RDN increased the cost of surgery for donor nephrectomy(18). It remains to be determined if the

benefits of RDN in reducing donor morbidity and technical ease associated with it out weight the cost implications associated with it.

Conclusion:

RDN is safe procedure and is associated with better postoperative pain scores, analgesic requirement as well as lesser hospital stay compared to LDN. Robotic approach in right donor nephrectomy is associated with more technical ease to console surgeon compared to laparoscopic donor surgeon in most of the steps of surgery and facilitates preservation of longer length of right renal artery. However there is no significant technical ease associated with left RDN compared to left LDN. Left RDN is associated with longer WIT than LDN however this does not reflect adversely into early graft function from 7 days up to 9 months.