Training in LD Nephrectomy: The Trainer’s perspective

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Congratulations to 50 yrs Transplantation in Manchester!
Live Kidney Donation

1954 Dr. Joseph Murray, Boston, USA
Advantages Live Kidney Donation

Elective surgery

Advantages for recipient:
- pre-emptive Tx: prevent dialysis
- alternative programs: AB0i, HLAi, paired exchange, unspecified
- well screened, healthy donor
- short cold ischemia -> superior graft function
- "impossible transplants"

Economic advantages:
- each kidney transplant saves 800,000 Euro / 10 yrs !!
7th Kidney Transplant
SURGICAL REVOLUTION

• Original technique:
  1950: Flank incision (15-25 cm)

• Current techniques:
  1995: Laparoscopic donor nephrectomy
  1995: Mini-incision (7-15 cm)
  2002: Hand-assisted retroperitoneoscopic technique
  2009: Robot-assisted laparoscopic technique
Live Kidney Donation:

- No mortality, No Morbidity
- No harm to the kidney
- No long-term risk
- Good QoL and quick recovery

However:

- "Major" surgery on healthy person
- No direct therapeutic benefit for the donor
- Mortality 1 in 3000 (1 in 8000 in Kortram et al. Transplantation 2016)
- Morbidity 2.3% (intra-op), 7.3% (post-op) Kortram et al. Transplantation 2016
Donor safety and QoL

• Screening:
  – Medical: short-term vs long-term
  – Surgical: short-term vs long-term
  – Psychological: short-term vs long-term

  -> Absolute vs relative contra-indications to donation

• Operative Techniques & Training

• Long-term follow up

• Safety nets
The era of surgeon driven approaches

<table>
<thead>
<tr>
<th>Procedure</th>
<th>N (%)</th>
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<td>Anterior approach</td>
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<td>Lumbar approach</td>
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<tr>
<td><strong>Hand assisted</strong></td>
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<td>trans-peritoneal</td>
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<td><strong>Single port laparoscopic</strong> (SILS)</td>
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<td><strong>Robotic assisted</strong></td>
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Kortram K et al. Transplantation 2016;100(11):2264-2275
Complications live donor nephrectomy

Perioperative Events and Complications in Minimally Invasive Live Donor Nephrectomy: A Systematic Review and Meta-Analysis

Kirsten Kortram, MD, Jan N.M. Ijzermans, MD, PhD, and Frank J.M.F. Dor, MD, PhD

Kortram K et al. Transplantation 2016;100(11):2264-2275
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<td>25842</td>
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</table>
| Pulmonary—other
d                                     | 113          | 20436             | 71         | 0.3 |
| Thromboembolic complications                      | 146          | 23574             | 39         | 0.2 |
| Gastro-intestinal complications                    |              |                   |            |     |
| Ileus                                             | 138          | 24958             | 187        | 0.7 |
| Small bowel obstruction                           | 58           | 13854             | 30         | 0.2 |
| Chylous ascites                                    | 78           | 17564             | 81         | 0.5 |
| GI—bleed                                          | 88           | 16022             | 5          | 0.03|
| GI—other
g                                         | 62           | 12399             | 115        | 0.9 |
| Other complications                               |              |                   |            |     |
| Fascial defect                                    | 121          | 22532             | 3692       | 0.2 |
| Testicular swelling/pain/epididymitis             | 63           | 14390             | 32         | 0.6 |
| Thigh numbness                                    | 51           | 11235             | 95         | 0.3 |
| Pain                                              | 61           | 12062             | 24         | 0.8 |
| Remnant kidney function disorder                  | 41           | 8681              | 100        | 0.3 |
| Urinary retention                                 | 100          | 19537             | 2          | 0.5 |
| Drug reaction                                     | 38           | 7065              | 194        | 0.03|
| Other general complicationsg                      | 101          | 20030             |            | 1.6 |
| Mortality                                         | 142          | 25116             | 3          | 0.01|
| Surgical reinterventions                          | 163          | 28516             | 165        | 0.6 |

* Injury to other organs included spleen (2), bowel (1), mesentery (1).

* Other organs/structures include: pancreas (4), gallbladder (1), diaphragm (18), mesentery (4).

* Other infectious complications included sepsis (3), pyelonephritis (1), phlebitis (8).

* Other pulmonary complications included: atelectasis (35), respiratory distress (13), pulmonary edema (8), pleural effusion (10), hypoxia (5).

* Other GI complications included: gastritis (58), pancreatitis (11), constipation (13), liver function disorder (24), appendicitis (4), cholecystitis (2), gastric ulcer (3).

* Other general complications included: Seroma (68), neuropathy/neurapraxia (23), subcutaneous emphysema (18), ocular complications (16), rhabdomyolysis (12), skin complications (16), electrolyte disorder (8), urethral injury (12), headache (4), ear hematoma (1), parotitis (1), depression (5), vertigo (1).
Extended Criteria Live Kidney Donors
Challenges in Live Kidney Donation

Obesity
Challenges in Live Kidney Donation

Vascular multiplicity
So, how do we teach live donor nephrectomy?
Laparoscopic Donor Nephrectomy Training in the UK: Results From an Independent Trainee Survey.
Sharma, H.1,2; Wong, C.1; Al-Bakry, A.1,2; Ridgway, D.1; Sharma, A.1; Mehra, S.1; Augustine, T.2; Hammad, A.1

- 96% < 10 laparoscopic donor nephrectomies as primary surgeon
- 58% first assistant in 11-25 donor nephrectomies
- 24% assisted in 26-50 donor nephrectomies
- 40% trainees had been on a course for donor nephrectomy.
- No correlation in seniority in training grade compared to donor nephrectomies as primary surgeon
- The likelihood of a trainee to perform >10 LDN in transplant training was < 1 in 25.

Conclusions: This study confirms poor training opportunities in LDN in UK. The trainers need to address this issue urgently. UK training system has no LDN fellowship training opportunities hence developing LDN fellowships can be a way forward.
My Training

– High volume centre (Rotterdam): 120->150 live donor nephrectomies/year

– “transplant surgery fellowship” during final year surgical residency: “only” Tx fellow: 2-3 live donors/week

– Trained by 3 different surgeons, common protocol/approach

– Good experience with laparoscopic surgery: appendicectomy, cholecystectomy, splenectomy, adrenalectomy, colectomies, etc.

– Within 6-9 months through learning curve (full lap, HARP, HALS), including more complex cases
Training in live donor nephrectomies

- Theory
- Videos/e-learning
- Cadaver course
- Assisting surgeon
- Proctoring (in own centre)
- Step up operating surgeon
- What is learning curve? -> varies and depends on previous laparoscopic experience
LIDO COURSE
since 2009, participants from:

- Belgium
- Netherlands
- Germany
- France
- Sweden
- Finland
- UK
- Italy
- Saudi Arabia
- Georgia
- Macedonia
- Slovenia
- South Africa
- USA
- Colombia
- Australia
- New Zealand
- Turkey
- Costa Rica
- Poland
- Russia
- Nigeria
- India
- Filippines
- Czech Republic
- Argentina
LIDO COURSE

- Focus on Hands on: 2 days of operating: choice of technique (Lapsc, HALS, HARP)

- Live demos

- 3rd day: 3 live cases in Theatres (different techniques)

- Short theoretical lectures / interactive

- Experts (1:2), faculty refreshed every year

- Building network

- Opportunities for proctoring
LIDO COURSE
What Should the Finished Product Be?

- Knowledgeable
- Competent
- Safe
- Efficient
- Independent
- Flexible
- Understanding of the recipient needs
- “Fearful”/Respectful of complications
“.....and smart people do stupid things far more often than most people realize.”

From:
The Mathematician’s Shiva
By
Stuart Rojstaczer
Ratner’s Mantra

Meticulous attention to technical detail

Respect our patients and colleagues | Encourage innovation in all that we do | Provide the highest quality care | Work together for the achievement of outstanding results | Take pride in our success
Pre-requisites

• Laparoscopic experience
• Know donor history & work up
• Reviewed the CT Angiogram
• Seen the donor prior to surgery
• Know the equipment
Teaching LLDN

- Operative steps
- Understanding the operation
- Technical skills
- Mishap avoidance
- Damage control
- Anomalous anatomy
- Right side
- Unusual cases
Operative Steps

1. Port placement
2. Mobilization of the colon
3. Identification of ureter & gonadal vein
4. Dissection of the ureter
5. Identification & preservation of gonadal artery
6. Identification of renal vein
7. Dissection of renal vein
   • Division of lumbar veins
8. Dissection of Artery
9. Division of adrenal vein
10. Mobilization of the upper pole
11. Division of attachments between the artery & adrenal gland
12. Division of gonadal vein
13. Freeing remainder of the kidney from peri-renal fat & Gerota’s fascia
14. Creation of Pfannenstiel Incision
15. Stapling of vessels
16. Delivery of kidney
17. Hemostasis
18. Check/repair mesentery
19. Closure
   — Ports
   — Pfannenstiel
General Principles

• Skills assessment
• Non-linear graduated approach
  – Master individual parts of the operation
  – Combine mastered parts
• Repetition in rapid succession
  – Each fellow scrubs on at least 3 LLDN in a row
• Start with the more difficult portions of the operation first
• Pose hypothetical situations
  – Improved exposure
  – Damage control
  – Open conversion
## Phase I Training – Skills Assessment

### Operative Steps

1. Port placement
2. Mobilization of the colon
3. Identification of ureter & gonadal vein
4. **Dissection of the ureter**
5. Identification & preservation of gonadal artery
6. **Identification of renal vein**
7. Dissection of renal vein
   - Division of lumbar veins
8. **Dissection of Artery**
9. Division of adrenal vein
10. Mobilization of the upper pole
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14. Creation of Pfannenstiel Incision
15. **Stapling of vessels**
16. **Delivery of kidney**
17. Hemostasis
18. Check/repair mesentery
19. Closure
   - Ports
   - Pfannenstiel
Phase I Training – Skills Assessment

Operative Steps

• Laparoscopic sense
  – Where instruments are
  – Inserting instruments safely
• Working with 2 hands in concert
• Gentleness
• Precision
• Efficiency
• Knowledge of equipment
Phase II Training – Vascular Dissection

Operative Steps

1. Port placement
2. Mobilization of the colon
3. Identification of ureter & gonadal vein
4. Dissection of the ureter
5. Identification & preservation of gonadal artery
6. Identification of renal vein
7. Dissection of renal vein
   • Division of lumbar veins
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Donor deaths and bleeding complications can be prevented by using transfixation techniques on renal artery and vein.

Hem-o-Lock clips contra-indicated for donor nephrectomy
## Phase II Training – Vascular Dissection

### Operative Steps

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<thead>
<tr>
<th>Step</th>
<th>Description</th>
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<tbody>
<tr>
<td>1.</td>
<td>Port placement</td>
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<tr>
<td>2.</td>
<td>Mobilization of the colon</td>
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<tr>
<td>3.</td>
<td>Identification of ureter &amp; gonadal vein</td>
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<tr>
<td>4.</td>
<td>Dissection of the ureter</td>
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<tr>
<td>5.</td>
<td>Identification &amp; preservation of gonadal artery</td>
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<td>6.</td>
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<td>7.</td>
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<td>8.</td>
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<td>9.</td>
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<td>14.</td>
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<td>– Ports</td>
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<td>– Pfannenstiel</td>
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Phase II Training – Vascular Dissection

Operative Steps

• Three instruments
  – Atraumatic graspers
  – Suction-irrigator
  – Bipolar cautery (Ligasure)

• Subtle cues where branches are

• Get around tissue to avoid passed pointing

• Avoid getting too high into the hilum
Hypotheticals

- When you are in trouble is not the time to be devising a plan to get out of trouble
- Devise hypothetical situations at each point in the operation for discussion
- Bleeding
- Bowel injury
- CO₂ Embolus
- How to avoid open conversion
  - Additional port placement
  - Upsizing ports
  - Better retraction
- How to open convert (trainees with suboptimal open experience)
  - What type of incision
  - What additional resources are needed
  - Command and control of the OR
Phase III Training – Difficult Dissection

Operative Steps

1. Port placement
2. Mobilization of the colon
3. Identification of ureter & gonadal vein
4. Dissection of the ureter
5. Identification & preservation of gonadal artery
6. Identification of renal vein
7. Dissection of renal vein
   • Division of lumbar veins
8. Dissection of Artery
9. Division of adrenal vein
10. Mobilization of the upper pole
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15. Stapling of vessels
16. Delivery of kidney
17. Hemostasis
18. Check/repair mesentery
19. Closure
   – Ports
   – Pfannenstiel
Phase IV Training – Easy Dissection (Should Know)

Operative Steps

1. Port placement
2. Mobilization of the colon
3. Identification of ureter & gonadal vein
4. Dissection of the ureter
5. Identification & preservation of gonadal artery
6. Identification of renal vein
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15. Stapling of vessels
16. Delivery of kidney
17. Hemostasis
18. Check/repair mesentery
19. Closure
   – Ports
   – Pfannenstiel
Phase V Training – Putting It Together

Operative Steps

1. Port placement
2. Mobilization of the colon
3. Identification of ureter & gonadal vein
4. Dissection of the ureter
5. Identification & preservation of gonadal artery
6. Identification of renal vein
7. Dissection of renal vein
   • Division of lumbar veins
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15. Stapling of vessels
16. Delivery of kidney
17. Hemostasis
18. Check/repair mesentery
19. Closure
   - Ports
   - Pfannenstiel
Things I Do Myself – Little Educational Value

Operative Steps

1. **Port placement**
2. Mobilization of the colon
3. Identification of ureter & gonadal vein
4. Dissection of the ureter
5. Identification & preservation of gonadal artery
6. Identification of renal vein
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14. **Creation of Pfannenstiel Incision**
15. Stapling of vessels
16. Delivery of kidney
17. **Hemostasis**
18. **Check/repair mesentery**
19. Closure
   – Ports
   – Pfannenstiel
Summary & Conclusions

- Safety primary concern
- "Takes" a while before the trainee really understands the operation
- Need to adjust for trainees’ differing skill sets
- Graduated, non-linear approach allows for trainee to spend the most time on the most difficult aspects of the case
- Minimize variation in approach, instruments, and technique
- Need to verbally rehearse hypothetical adverse events
- After mastering each portion of the operation trainee is then capable of putting it all together
One of the few centres with expertise all major minimally-invasive techniques for live donor nephrectomy:

- Mini-open
- Full laparoscopic
- Hand-assisted laparoscopic
- Hand-assisted retroperitoneoscopic

Good opportunity for training!

Patient choice

Tailor-made approach
Imperial College Renal and Transplant Centre, Hammersmith Hospital, London, UK

– Training done by one consultant transplant surgeon

– Tailor-made approach to trainee (consultant, fellow) based on previous experience, in different techniques

– Simulation training for all theatre staff
Which surgical approach?
Laparoscopic – How? Key questions?

• Transperitoneal vs retroperitoneal
  • Retroperitoneal – less complications

• Hand assisted vs full lap
  • No differences if hand assistance used

Kortram K et al. Transplantation 2016;100(11):2264-2275
### Bleeding

<table>
<thead>
<tr>
<th>Study or Subgroup</th>
<th>Handassisted</th>
<th>Pure</th>
<th>Risk Ratio</th>
<th>Year</th>
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<td><strong>Total (95% CI)</strong></td>
<td>30</td>
<td>56</td>
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**Total events**: 777

**Heterogeneity**: Tau² = 0.00; Chi² = 6.09, df = 13 (P = 0.94); I² = 0%

**Test for overall effect**: Z = 1.74 (P = 0.08)
Learning curve?
ATC 2016

• 2 surgeons >180 LDNs. Cumulative sum analysis (CUSUM): operating time, hospital stay, occurrence of major and minor complications, need for readmission or reoperation

• Learning curve: inflexion point which would represent a stability of process? Number of procedures required to arrive at this point was assumed to represent successful ascent of the learning curve.

• CUSUM analysis: no discernible inflexion points for hospital stay (zL = 0.3 p=0.07), occurrence of Clavien 2 and above complications (zL =0.84, p=0.337), readmission (zL =0.696 p=0.243) or reoperation (zL = -0.366 p=0.643).

• Operating time: a visible stability of process initially at case 25 but this was more sustained by case 40 to 45 for both surgeons.

• True ascent of the learning curve may mean the performance of up to 50 procedures rather than 20 – 25.

Serrano OK¹, Bangdiwala AS², Vock DM³, Berglund D¹, Dunn TB¹, Finger EB¹, Pruett TL¹, Matas AJ¹, Kandaswamy R¹. Am J Transplant. 2017 Jul;17(7):1868-1878.

- **UNOS**: fellowship-trained surgeons participate in 15 LDNs procedures to be considered proficient. **ASTS**: mandates 12 LDNs during an abdominal transplant surgery fellowship.

- Retrospective intraoperative case analysis (risk-adjusted cumulative summation (RACUSUM) model) to assess the learning curve of 30 novice Tx fellows.

- Measures of surgical performance included intraoperative time, estimated blood loss, and incidence of intraoperative complications.

- Rates of adverse surgical events novice fellows>senior fellows. Univariable analysis: multiple renal arteries, high BMI, prior abdominal surgery, male donor, and nephrolithiasis were correlated with higher incidence of adverse surgical events.

- **RACUSUM model:**
  - high intraoperative time is mitigated after 28 procedures,
  - incidence of intraoperative complications tends to diminish after 24 procedures
  - improvement in estimated blood loss did not remain consistent.

- **Fellows’ tipping point in LDN performance by 24-28 cases and proficiency by 35-38 cases.**
Training Techniques in Laparoscopic Donor Nephrectomy
Adrian Billeter, MD, PhD, Elizabeth Lucich, Soloman Levy, MD, Eric Davis, MD, Michael Marvin, MD, Erica Sutton, MD

• Systematic Review. Majority centers performing <25 LDN/ year each year

• Simulation-based training methods were discussed in 4 articles, all of which described the use of *porcine* models.

• The proffered learning curve averaged 35 cases (range 10-95) measured as a decrease in operating time.

• Improved intraoperative, patient and recipient outcomes were observed for *centers performing ≥50 LDN annually when compared to centers <25 LDN.*

• Current OPN Network recommendations: 15 cases as surgeon or assistant for LDN fall well below the learning curve for high quality outcomes in LDN as described in the literature.

• Though simulation has demonstrated utility in ascending the learning curve for LDN, it is rarely discussed or evaluated as a training method.

• Assessment of training and competency for LDN: heterogeneous and objective learner-based metrics could help surgeons and institutions safely reach a quality standard for performing this high stakes operation.
Learning curves in full laparoscopic and hand-assisted retroperitoneoscopic donor nephrectomy.
Klop KWJ, Kok NFM, Tran TCK, Terkivatan T, Toorop R, P Berger, Dor FJMF, IJzermans JNM.

**Figure x.** Skin-to-skin times and linear regression of all operating surgeons for both LDN (circles with line) and HARP (triangles with dashed line). In panel E skin-to-skin times and for HARP for both surgeon E (squares with line) and F (diamonds with dashed line) are demonstrated.
Learning curves in full laparoscopic and hand-assisted retroperitoneoscopic donor nephrectomy.

Klop KWJ, Kok NFM, Tran TCK, Terkivatan T, Toorop R, P Berger, Dor FJMF, IJzermans JNM.
Learning curves in full laparoscopic and hand-assisted retroperitoneoscopic donor nephrectomy.
Klop KWJ, Kok NFM, Tran TCK, Terkvatan T, Toorop R, P Berger, Dor FJMF, IJzermans JNM.
Retroperitoniscopic Hand-Assisted (HARP) Donor Nephrectomy as the Standard Procedure - Experience with the Transition from Anterior Approach Open Retroperitoneal Donor Nephrectomy
Stippel, D. L.¹; Wahba, R.¹; Özcan, H.¹; Teschner, S.²; Kisner, T.² Transplantation 2012 Nov 27;94:p1107

• First 50 consecutive (HARP) compared to last 30 anterior approach open donor nephrectomies.

• To evaluate a learning curve operation time, blood loss and warm ischemia was compared for groups of ten consecutive patients each. For a comparison of the two approaches the 30 donors with the open approach (O) were compared to patients 21 - 50 with HARP (H) procedure.

Conclusion:
• The learning curve for hand-assisted retroperitoniscopic donor nephrectomy is short under the condition of sufficient previous experience in donor nephrectomy and laparoscopic surgery.

• Warm ischemia and blood loss reach a minimum after only 10 cases. Overall operative time improves over a longer period of time.

• There was no learning curve visible in the recipient renal function.

S. Yamanaga,1,2,3 A. Posselt,1 C. Freise,1 C. Niemann,1 A. Rosario,1 D. Fernandez,1 T. Kobayashi,3 A. Ahearn,4 M. Tavakol,1 S.-M. Kang.1

ATC 2017, UCSF data

Figure 1.

A Overall LOESS analysis on operative time

B Each surgeon’s LOESS analysis on operative time
Which surgical approach?

Laparoscopic experience

- Early: Hand assisted
- Established-expert: Laparoscopic / single port
- Robotic?

Proficiency in LD procedures

- Early: 15-30 cases
- Established: 30-100 cases
- Expert: >100 cases
Recommendations training in live donor nephrectomies

- Theory: Theoretical course / online
- Videos / elearning: still preliminary
- Cadaver course indispensable: LIDO course unique
- Fellowship in high volume centre or centre with high volume per surgeon
  - Training in phases (e.g. Ratner’s mantra)
  - Assisting surgeon -> Step up operating surgeon
  - Experience: HARP technique safest and most easy to learn
  - Proctoring (in own centre) after fellowship
Unresolved issues:

• Should every Kidney Transplant Center do Live Donor Nephrectomies?

• How long is the learning curve?

• When is training finished/failed?

• What is the minimum number of LDN per surgeon to ensure safety?
Thanks for your attention!

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