

NATIONAL INSTITUTE FOR CLINICAL EXCELLENCE

INTERVENTIONAL PROCEDURES PROGRAMME

Interventional procedures overview of laparoscopic live donor simple nephrectomy

Introduction

This overview has been prepared to assist members of the Interventional Procedures Advisory Committee advise on the safety and efficacy of an interventional procedure previously reviewed by SERNIP. It is based on a rapid survey of published literature, review of the procedure by specialist advisors and review of the content of the SERNIP file. It should not be regarded as a definitive assessment of the procedure.

Date prepared

This overview was prepared by ASERNIP-S in November 2002

Procedure name

- Laparoscopic live donor nephrectomy (LLDN).
- Laparoscopic transperitoneal simple nephrectomy.
- Live donor laparoscopic nephrectomy.
- Laparoscopic donor nephrectomy.

Specialty society

- *British Association of Urological Surgeons.*

Description

Indications

The aim of laparoscopic live donor nephrectomy (LLDN) for retrieving kidneys from live donors is to make the donation process more attractive to potential donors by decreasing donor morbidity. In turn this should increase the availability of kidneys for transplantation, the best option for treating patients with end-stage renal disease. Kidneys from live donors are also considered to offer recipients more advantages than cadaveric renal transplants.¹

What the procedure involves

LLDN can be performed via a retroperitoneal approach or a transperitoneal approach. The transperitoneal approach is preferred because it allows more laparoscopic working space and also makes it easier to remove the kidney from the abdomen through a relatively low-pain, midline incision.² Usually four ports are introduced into the peritoneal cavity for the laparoscope and the dissecting

instruments. A pneumo-peritoneum with CO₂ is usually created.³ Sometimes an endocatch bag is used to deliver the kidney, which enables a shorter midline incision.⁴

Only the left kidney is generally removed in the laparoscopic procedure because the vessels are likely to be longer than the vessels for the right kidney, thus avoiding potential problems with the recipient's graft.⁵ However, some authors believe that concerns about right laparoscopic nephrectomy are no longer justified.^{7,8}

For hand-assisted LLDN (LLDN-HA), a transverse Pfannenstiel incision, similar to the LLDN incision, is made in the lower abdomen. The operating surgeon's left hand is inserted through the hand-assisting apparatus and used to retract the viscera, expose the renal vascular pedicle and retract the kidney laterally during vessel transection and kidney extraction.⁶ LLDN is now preferred over open live donor nephrectomy (OLDN) in some centres.⁶

Efficacy

Donor operating time was usually longer for LLDN (including hand-assisted procedures) than for OLDN. Conversely, donor hospital stay was generally shorter for LLDN and, in one study, LLDN-HA was significantly shorter than LLDN. LLDN donors generally returned to work earlier than OLDN donors. Costs were slightly higher for LLDN and LLDN-HA in one study. No difference was detected between LLDN and OLDN for recipient early and late graft function, graft survival and recipient survival, although follow-up is still short.

Safety

LLDN did not appear to have obviously worse results than OLDN although numbers of individual complications were small in both groups, and some studies did not report their OLDN results for comparison. Recipient complications also appeared to be similar, but these were even less reported than the donor complications.

Literature reviews

Rapid review of literature

A systematic search of MEDLINE, PREMEDLINE, EMBASE, Current Contents, PubMed, Cochrane Library and Science Citation Index using Boolean search terms was conducted, covering the period from the inception of the databases until November 2002. The York Centre for Reviews and Dissemination, Clinicaltrials.gov, National Research Register, SIGLE, Grey Literature Reports (2002), relevant online journals and the Internet were also searched in November 2002. Searches were conducted without language restriction.

Articles were obtained on the basis of the abstract containing safety and efficacy data in the form of randomised controlled trials (RCTs), other controlled or comparative studies, case series and case reports. Conference abstracts and manufacturer's information were included if they contained relevant safety and efficacy data. Foreign language papers were included if they contained safety and efficacy data and were considered to add substantively to the English-language evidence base, and could be translated in the time available.

Studies were excluded: if they were historical rather than concurrent comparisons; if they did not state that the LLDN procedure was transperitoneal; and if the LLDN

procedure was hand-assisted. Included studies are highlighted in bold in the reference list. Studies for which data were not tabulated are listed in the Appendix.

List of studies found

Total number of studies:

- Systematic reviews – 1 (data extracted only from the 10 studies that compared LLDN using a transperitoneal approach with OLDN)
- Non-randomised comparative studies – 19 (in addition to the studies in the systematic review) 4 included.

RCTs in progress

None located.

Summary of key efficacy and safety findings

See following tables.

Abbreviations

GIA	gastrointestinal anastomosis.
LD	live donor.
LLDN	laparoscopic live donor nephrectomy.
LLDN-HA	laparoscopic live donor nephrectomy (hand-assisted).
OLDN	open live donor nephrectomy .
pns	statistically nonsignificant.
TP	transperitoneal.
[]	standard deviation.
{ }	variance measure not specified.

Table 2 Summary of key efficacy and safety findings

Study details	Key efficacy findings	Key safety findings	Appraisal/comments																		
Systematic review																					
Merlin et al. 2000 ^{9,10}	<p>Donor operating times (4 studies) – OLDN statistically significantly shorter than LLDN in 3 studies, with no statistically significant difference found in the fourth study</p> <p>Donor analgesia (3 studies) – analgesia amount or duration was significantly less for LLDN than OLDN</p> <p>Donor hospital stay (6 studies) – statistically significantly less for LLDN than OLDN in five studies (LLDN range of means 2.2–3.1 days; OLDN 3.8–5.7 days)</p> <p>Donor resumption of employment (5 studies) – more rapid for LLDN than OLDN in all five studies (LLDN range of means 2.3–3.9 weeks; OLDN 5.3–7.4 weeks)</p> <p>Donor conversion rates (5 studies) – 0%, 0%, 5.7%, 8.3%, 13.3%</p> <p>Recipient creatinine levels (3 studies) – no statistically significant difference found between LLDN and OLDN (at 3 and/or 12 months)</p> <p>Recipient delayed graft function (4 studies) – no statistically significant difference found between LLDN and OLDN in 2 studies; statistical testing not conducted in the other 2 studies</p> <p>Recipient graft survival (6 studies) – no statistically significant difference found between LLDN and OLDN in 4 studies; statistical testing not conducted in the other 2</p> <p>Recipient survival (3 studies) – no statistically significant difference found between LLDN and OLDN in 3 studies</p>	<p>Donor mortality – none reported in any of the comparative studies, case series or case reports</p> <p>Donor complication rates (5 studies)</p> <table border="1"> <thead> <tr> <th>study</th> <th>LLDN</th> <th>OLDN</th> </tr> </thead> <tbody> <tr> <td>1</td> <td>11% (n = 9)</td> <td>15% (n = 27)</td> </tr> <tr> <td>2</td> <td>14% (n = 70)</td> <td>35% (n = 65)</td> </tr> <tr> <td>3</td> <td>5% (n = 19)</td> <td>0% (n = 20)</td> </tr> <tr> <td>4</td> <td>17% (n = 12)</td> <td>5% (n = 21)</td> </tr> <tr> <td>5</td> <td>20% (n = 30)</td> <td>3% (n = 30)</td> </tr> </tbody> </table> <p>Donor blood loss (3 studies) no clinically significant differences between LLDN and OLDN</p> <p>Recipient ureteral complication rates (3 studies) LLDN: ranged from 3.3% to 10.8% OLDN: ranged from 3.0% to 6.3%</p>	study	LLDN	OLDN	1	11% (n = 9)	15% (n = 27)	2	14% (n = 70)	35% (n = 65)	3	5% (n = 19)	0% (n = 20)	4	17% (n = 12)	5% (n = 21)	5	20% (n = 30)	3% (n = 30)	<p>Potential for bias: OLDN complications likely to be underreported; small studies lacked power to detect any differences should they exist, short follow-up times; lack of rigorous study designs; inappropriate or no statistical testing done for some outcomes in some studies.</p> <p>Outcome measures and their validity: most outcomes appeared to be reasonably objective, although less stringent measurement was applied to OLDN outcomes in some studies.</p>
study	LLDN	OLDN																			
1	11% (n = 9)	15% (n = 27)																			
2	14% (n = 70)	35% (n = 65)																			
3	5% (n = 19)	0% (n = 20)																			
4	17% (n = 12)	5% (n = 21)																			
5	20% (n = 30)	3% (n = 30)																			

Study details	Key efficacy findings	Key safety findings	Appraisal/comments
Non-randomised comparative studies			
Hawasli et al. 2001 ¹¹ USA January 1997 to February 2000 59 donors: 30 LLDN; 29 OLDN 46 recipients (*see Appraisal/comments): 24 LLDN; 22 OLDN Selection criteria: not stated Follow up: not stated	<p>Donor operating time, mean (hours:mins) LLDN 3:01 (range 1:54–5:21) OLDN 2:30 (range 1:55–2:59)</p> <p>Donor hospital stay, mean (days) LLDN 1.3 (range 1–3) OLDN 4.1 (range 3–7) p < 0.001</p> <p>Donor return to work, mean (days) LLDN 14.8 (range 7–30) OLDN 28.4 (range 7–100) p < 0.01</p> <p>Donor pain – OLDN patients needed an epidural catheter; LLDN patients required only intramuscular or oral analgesia</p> <p>Donor conversions from LLDN to OLDN: 1 (3.3%) – to control bleeding</p> <p>Recipient creatinine level at 1 month was similar for LLDN and OLDN patients</p> <p>Recipient kidney function – all kidneys in both groups functioned immediately postoperatively, none suffered from acute necrosis and no kidneys were lost post-transplantation</p>	<p>Donor complications LLDN: 2 (6.7%) intraoperative bleeding no ureteral complications; 4 (13.3%) postoperative complications</p> <ul style="list-style-type: none"> • 1 pancreatitis, • 1 flank ecchymosis, • 2 wound haematomas <p>OLDN: no intraoperative or ureteral complications 4 (13.8%) postoperative complications</p> <ul style="list-style-type: none"> • 1 incisional hernia • 1 pneumothorax • 2 atelectasis <p>Donor blood loss, mean (ml) LLDN: 125 (10–2000) OLDN: 130 (25–350)</p>	<p>Potential for bias: patients were consecutive, but method of allocation to OLDN or LLDN was not stated; LLDN complications gathered prospectively, but OLDN complications were gathered from a retrospective chart review</p> <p>Outcome measures and their validity: Although most outcome measures appeared to be objective, some were gathered differently for LLDN and OLDN patients (see above).</p> <p>Other comments: *13 recipients either required re-operation or were diagnosed with vascular rejection; all LLDN performed by an experienced laparoscopic surgeon – learning curve stated to be 7 cases</p>
Montgomery et al. 2001 ¹² ; Ratner et al. 2000 ⁴ USA January 1995 to July 1999 Recipients: 248–200 LLDN; 48 OLDN	<p>Donor conversion rate – 5 (10%)</p> <p>Recipient hospital stay – median was 7 days for both LLDN and OLDN groups</p> <p>Recipient acute rejection (first month) LLDN (n = 110): 30.1% OLDN (n = 48): 31.3%, pns</p>	<p>Donor complications LLDN: 34 (17%) OLDN: not stated</p> <p>Specific complications for LLDN: 4 retroperitoneal haematoma (1 required reoperation), 2 splenic capsule injury, 6 wound complications, 5 thigh paresthesia, 2 pneumonia, 3</p>	<p>Potential for bias: retrospective review of all living donor nephrectomies; the majority of OLDN were performed early in the study period, and the LLDN later, so this is partly an historical comparison.</p> <p>Outcome measures and their validity: Most outcome measures appeared to</p>

Study details	Key efficacy findings	Key safety findings	Appraisal/comments
<p>Selection criteria: all paediatric and adult LD recipients during the study period</p> <p>Follow up: 3 years</p>	<p>Recipient graft loss LLDN: 8 (16%) (*see Appraisal/comments): – 3 secondary to vascular thrombosis, 2 rejection, 1 haemolytic uremic syndrome, 1 cholesterol emboli, 1 patient non-compliance OLDN: 4 (8.3%), pns</p> <p>Recipient graft function LLDN – creatinine clearance at 36 months 69.3 [27.2] ml/min</p>	<p>bowel injury (1 delayed open repair), 1 epigastric artery injury, 1 thrombophlebitis, 4 open conversions – early (1 stapler malfunction, 1 GIA malfunction, 1 renal vein tear, 1 loss of pneumoperitoneum), 6 transfusions</p> <p>Recipient deaths LLDN: 7 (14%) – 4 sepsis, 2 cardiovascular, 1 haemorrhage OLDN: 1 (2.1%) – 1 sepsis</p> <p>Recipient ureteral complications LLDN 13 (26%) OLDN 3 (6.3%)</p>	<p>be objective, although not all OLDN outcomes (e.g. complications) were reported; rejection was diagnosed histologically.</p> <p>Other comments: *all 3 grafts lost to vascular thrombosis occurred with donation of right kidneys (authors believe thrombosis was due to short donor renal vein and now avoid using right kidneys if possible) Authors make the observation that LLDN has increased the numbers of people prepared to make live kidney donations</p>
<p>Ruiz-Deya et al. 2001¹³, Slakey et al. 2002¹⁴</p> <p>USA</p> <p>Dates: not stated, but LLDN was introduced in 1997 and LLDN-HA in 1998</p> <p>Donors (and recipients): 48</p> <ul style="list-style-type: none"> • 11 LLDN (TP) • 23 LLDN-HA • 14 OLDN <p>Selection criteria: donors with more than 1 year follow up and complete charts</p> <p>Follow up: 1 year</p>	<p>Operating time, mean (hours) LLDN (TP) 3.59 [0.2] LLDN-HA 2.75 [0.2]</p> <p>Donor conversion rates – 1 LLDN-HA</p> <p>Donor pain – none of the LLDN (TP or HA) patients required parenteral narcotics</p> <p>Donor hospital stay (days) LLDN (TP) 1.6 [1.3] LLDN-HA 2 [0.1] pns</p> <p>Recipient serum creatinine – similar in all 3 groups at 12 months</p> <p>Recipient graft function – all grafts harvested laparoscopically functioned well</p> <p>Recipient graft rejection – acute LLDN (TP) 1 (9%) LLDN-HA 4 (17%) OLDN 2 (14%)</p>	<p>Donor complications LLDN-HA</p> <ul style="list-style-type: none"> • 1 adrenal vein injury, not repairable endoscopically, was converted to open • 2 postoperative ileus <p>LLDN (TP) –</p> <ul style="list-style-type: none"> • 1 deep venous thrombosis • 1 incarcerated hernia <p>Donor blood transfusions – none required in any of the 3 groups</p> <p>Recipient ureteral complications – none_reported for any of the 3 groups</p>	<p>Potential for bias: Laparoscopic procedures were consecutive; method of allocating patients to LLDN and OLDN was not stated; small patient numbers in each of 3 groups</p> <p>Outcome measures and their validity: Most outcome measures appeared to be objective, although OLDN outcomes were often not reported</p>

Study details	Key efficacy findings	Key safety findings	Appraisal/comments
<p>Velidedeoglu et al. 2002⁶; Velidedeoglu et al. 2001¹⁵ USA</p> <p>Donors (and recipients): 150</p> <ul style="list-style-type: none"> • 50 OLDN • 40 LLDN • 60 LLDN-HA <p>Dates: June 1997 to May 2001</p> <p>Selection criteria: not stated</p> <p>Follow up: probably 6 weeks</p>	<p>Recipient graft rejection – chronic LLDN (TP) 1 (stabilised by adjusting immunosuppression)</p> <p>Donor operating time (mins) – based on 125 donors only OLDN: 185 {5.7} (n = 50) LLDN: 258 {5.4} (n = 40) LLDN-HA: 260 {7.1} (n = 35) p < 0.001 (OLDN compared with either LLDN or LLDN-HA)</p> <p>Donor length of hospital stay (days) OLDN: 4.4 LLDN: 3.2 {0.2} LLDN-HA: 2.6 {0.1} p < 0.001 (OLDN compared with either LLDN or LLDN-HA)</p> <p>Donor conversion LLDN 3/40 (7.5%) LLDN-HA 1/60 (1.7%)</p> <p>Recipient graft function mean serum creatinine less than 1.5 (units not given) for all groups by 6 weeks</p> <p>Costs —11% greater for LLDN and LLDN-HA than for OLDN</p>	<p>Donor complications OLDN:</p> <ul style="list-style-type: none"> • 1 arterial injury • 1 reoperation for sponge removal <p>LLDN:</p> <ul style="list-style-type: none"> • no complications <p>LLDN-HA:</p> <ul style="list-style-type: none"> • 2 mild postoperative ileus • 1 kidney suffered an arterial intimal injury <p>Donor blood loss, mean (ml) LLDN + LLDN-HA: 118.5 {11.3} range 50-1100)</p> <p>Recipient complications OLDN: 1 thrombosis of the renal vein LLDN: 1 thrombosis of the renal artery (needed to remove graft 2 days after transplantation); 2 urine leaks LLDN-HA: 1 death (pulmonary fibrosis)</p>	<p>Potential for bias: Demographics similar for all 3 groups; retrospective record review – not clear whether cases were sequential; not stated how patients were allocated to the three groups, although the authors state that laparoscopic procedures were offered mainly on renal arterial anatomy; not all results presented for all groups;</p> <p>Other comments: All laparoscopic procedures were for left kidneys. Operating time is presented as a graph in the later paper with 150 donors; however variances are not given, so the results based on only 125 donors have been shown here. The mean operating times are very similar in both papers.</p>

Specialist Advisor's opinions

Specialist advice was sought from consultants who have been nominated by their Specialist Society or Royal College.

One Advisor commented that it had not been proven that recovery rates were quicker and post-operative pain lower than for open surgery. The other Advisors did not raise any concerns regarding the efficacy of this procedure.

The Specialist Advisors considered the main safety concerns to be bleeding, injury to nearby organs and conversion to open surgery.

Issues for consideration by IPAC

No further issues noted.

References

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2. Ratner LE, Montgomery RA, Kavoussi LR. Laparoscopic liver donor nephrectomy: the four year Johns Hopkins University experience. *Nephrology Dialysis Transplantation* 1999;14:2090–3
3. Waller JR, Hiley AL, Mullin EJ, Veitch PS, et al. Living kidney donation: a comparison of laparoscopic and conventional open operations. *Postgraduate Medical Journal* 2002;78(917):153–7
4. **Ratner LE, Montgomery RA, Maley WR, Cohen C, et al. Laparoscopic live donor nephrectomy: the recipient. *Transplantation* 2000;69(11):2319–23**
5. Nicholson ML, Veitch PS. Laparoscopic live donor nephrectomy. *Nephrology Dialysis Transplantation* 2000;(15):1124–6
6. **Velidedeoglu E, Williams N, Brayman KL, Desai NM, et al. Comparison of open, laparoscopic, and hand-assisted approaches to live-donor nephrectomy. *Transplantation* 2002;74(2):169–72**
7. Lind MY, Hazebroek EJ, Hop WCJ, Weimar W, et al. Right-sided laparoscopic live-donor nephrectomy: is reluctance still justified? *Transplantation* 2002;74(7):1045–7
8. Buell JF, Edey M, Johnson M, Li C, et al. Are concerns over right laparoscopic donor nephrectomy unwarranted? *Annals of Surgery* 2001;233(5):645–51
9. **Merlin TL, Scott DF, Rao MM, Wall DR, et al. The safety and efficacy of laparoscopic live donor nephrectomy: a systematic review. *Transplantation* 2000;70(12):1659–66**

10. Merlin TL, Scott DF, Rao MM, Wall DR, et al. *Systematic review of laparoscopic live donor nephrectomy – update and re-appraisal*. 2nd ed – Adelaide: ASERNIP-S, 2000 (www.surgeons.org/open/asernip-s.htm)
11. Hawasli A, Boutt A, Cousins G, Schervish E, et al. Laparoscopic versus conventional live donor nephrectomy: experience in a community transplant program. *American Surgeon* 2001;67(4):342–5
12. Montgomery RA, Kavoussi LR, Su L-M, Sinkov V, et al. Improved recipient results after 5 years of performing laparoscopic donor nephrectomy. *Transplantation Proceedings* 2001;33(11):1108–10
13. Ruiz-Deya G, Cheng S, Palmer E, Thomas R, et al. Open donor, laparoscopic donor and hand assisted laparoscopic donor nephrectomy: a comparison of outcomes. *Journal of Urology* 2001;166(4):1270–4
14. Slakey DP, Hahn JC, Rogers E, Rice JC, et al. Single-center analysis of living donor nephrectomy: hand-assisted laparoscopic, pure laparoscopic, and traditional open. *Progress in Transplantation* 2002;12(3):206–11
15. Velidedeoglu E, Williams N, Brayman KL, Desai NM, et al. Surgical options for live-donor nephrectomy. *Transplantation Proceedings* 2001;33:3789–90

Appendix: Additional studies not included in the summary table

Berney T, Malaise J, Mourad M, Morel P, et al. Laparoscopic and open live donor nephrectomy: a cost/benefit study. *Transplantation International* 2000;13(1):35–40
- *mostly cost outcomes*

Brown SL, Biehl TR, Rawlins MC, Hefty TR. Laparoscopic live donor nephrectomy: a comparison with the conventional open approach. *Journal of Urology* 2001;165(3):766–9
- *not clear whether approach is transperitoneal; historical comparison*

Koffron A, Herman C, Gross O, Ferrario M, et al. Laparoscopic donor nephrectomy: analysis of donor and recipient outcomes. *Transplantation Proceedings* 2001;33:1111
- *not clear whether approach is transperitoneal; historical comparison*

Kuo PC, Johnson LB. Laparoscopic donor nephrectomy increases the supply of living donor kidneys: a center-specific microeconomic analysis. *Transplantation* 2000;69(10):2211-3
- *historical comparison*

Kuo PC, Johnson LB, Sitzmann JV. Laparoscopic donor nephrectomy with a 23-hour stay: a new standard for transplantation surgery. *Annals of Surgery* 2000;231(5):772–9
- *not clear whether approach is transperitoneal; historical comparison*

Lennerling A, Blohme I, Ostraat O, Lonroth H, et al. Laparoscopic or open surgery for living donor nephrectomy. *Nephrology Dialysis Transplantation* 2001;16:383–6
- *not clear whether approach is transperitoneal*

Leventhal JR, Deeik RK, Joehl RJ, Rege RV, et al. Laparoscopic live donor nephrectomy – is it safe?: analysis of 80 consecutive cases and comparison with open nephrectomy. *Transplantation* 2000;70(4):602–6
- *historical comparison*

Lindstrom P, Haggman M, Wadstrom J. Hand-assisted laparoscopic (HALS) for live donor nephrectomy is more time- and cost-effective than standard laparoscopic nephrectomy. *Surgical Endoscopy* 2002;16:422–5
- *not clear whether approach is transperitoneal; historical comparison*

Malaise J, Mourad M, Squifflet J-P. Video-assisted live donor nephrectomy: a comparison with open surgery. *Transplantation Proceedings* 2000;32:473–4
- *concurrent but retrospective comparison; smaller numbers than included studies*

Rudich SM, Marcovich JC, Magee JC, Punch JD, et al. Hand-assisted laparoscopic donor nephrectomy: comparable donor/recipient outcomes, costs, and decreased convalescence as compared to open donor nephrectomy. *Transplantation Proceedings* 2001;33:1106–7
- *concurrent comparison of hand-assisted laparoscopic versus open (no LLDN arm); same patients as Wolf et al. 2001*

Sasaki TM, Finelli F, Bugarin E, Fowlkes D, et al. Is laparoscopic donor nephrectomy the new criterion standard? *Archives of Surgery* 2000;135(8):943–7
- *not clear whether approach is transperitoneal; historical comparison*

Shalhav AL, Siqueira TM, Gardner TA, Paterson RF, Stevens LH. Manual specimen retrieval without a pneumoperitoneum preserving device for laparoscopic live donor nephrectomy. *Journal of Urology* 2002;168(3):941-4

- *historical comparison*

Stifelman MD, Hull D, Sosa RE, Su L-M, Hyman M, Stubenbord W, Shichman S. Hand assisted laparoscopic donor nephrectomy: a comparison with the open approach. *Journal of Urology* 2001;166(2):444-8

- *concurrent comparison of hand-assisted laparoscopic versus open (no LLDN arm)*

Waller JR, Hiley AL, Mullin EJ, Veitch PS, Nicholson ML. Living kidney donation: a comparison of laparoscopic and conventional open operations. *Postgraduate Medical Journal* 2002;78(917):153-7

- *historical comparison*

Wolf JS, Marcovich R, Merion JW, Konnak RM. Prospective case matched comparison of hand assisted laparoscopic and open surgical live donor nephrectomy. *Journal of Urology* 2000;163(6):1650-3

- *concurrent comparison of hand-assisted laparoscopic versus open (no LLDN arm); same patients as Rudich et al. 2001*

Wolf JS, Merion RM, Leichtman AB, Campbell DA, Magee JC, Punch JD, Turcotte JG, Konnak JW. Randomized controlled trial of hand-assisted laparoscopic versus open surgical live donor nephrectomy. *Transplantation* 2001;72(2):284-90

- *RCT of hand assisted laparoscopic versus open live donor nephrectomy (no LLDN arm)*