Laparoscopic living-donor nephrectomy

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Abstract

Background. In order to increase the number of renal donors, laparoscopic live-donor nephrectomy (LLDN) was first performed 8 years ago. Today, LLDN is a routine procedure in many centres worldwide. We reviewed the literature with regard to extend the use of this method, the feasibility and safety for donor, graft and recipient. Laparoscopic and open-donor nephrectomy are compared, and the impact of LLDN on donors' willingness is evaluated.


Results. More than 200 centres worldwide perform LLDN. It is a feasible and safe surgical procedure. For the donor, LLDN has numerous advantages, while graft and recipient outcome are the same as with the open approach. The learning curve on the way to performing this operation safely is long, and surgeons planning to integrate LLDN into their programme must be trained thoroughly. There are some indications that with LLDN the number of donors willing to donate a kidney can be increased.

Conclusions. LLDN is widely used and will spread further. It is of the utmost importance to undergo thorough laparoscopic training in general urology prior to performing this procedure.

Keywords: kidney transplantation; laparoscopy; laparoscopic techniques; living donor; kidney donation
to expand the donor pool. Besides the increased utilization of marginal cadaveric donors, such as non-heart-beating or marginally aged donors, living organ donation has become an alternative means of increasing the number of kidney transplantations. Kidneys harvested from living donors not only reduce the waiting time for the recipient but also ensure a better graft and patient survival in comparison to HLA-matched cadaveric kidneys [1,2]. In Europe the number of living donor kidney transplantation is rising continuously, accounting for 15–30% of all kidney transplantations performed. In the US half of all kidney donors in 2000 were living donors and today living kidney donors outnumber cadaveric kidney donors. Nevertheless, kidney donation involves an invasive operation. Fear of possible complications, of time spent in the hospital and away from work may well dissuade potential donors despite their altruistic motivation.

With the aim of reducing donor obstacles, Ratner performed the first laparoscopic live-donor nephrectomy (LLDN) 8 years ago. The goal was to utilize the advantages of laparoscopic surgery, such as less pain, shorter hospital stay, reduced time away from work and, finally, a better cosmetic result, and thus to increase the number of renal donors. By now, more than 200 centres worldwide perform LLDN and more than 10 000 kidneys from living donors have been retrieved with this approach.

The method

The evolution of LLDN is reflected in the fact that different methods exist for gaining access to the kidney, dividing the renal vessels and finally harvesting the organ, including extraperitoneal, hand-assisted and gasless approaches [3,4].

Most laparoscopic surgeons prefer the classic transperitoneal approach to the donor kidney. With the donor in full flank position and the kidney to be donated facing upwards, a Verres needle is inserted subumbilically to establish a pneumoperitoneum of
12–15 mm water. A 10 mm camera trocar then replaces the Verres needle and three to four further trocars for the operation are inserted under camera vision (Figure 1). Following detachment of the colon, the retroperitoneal space is entered and access to the kidney gained. The ureter is freed down to the intersection with the iliac vessels and the renal vessels and the kidney itself are prepared. The adrenal gland is dissected and spared. The donor receives intravenous heparin for anticoagulation and mannitol. Then the renal vessels are dissected for which different methods exist [clip, gastrointestinal anastomosis stapler (GIA), TIA]. Anticoagulation can be reversed with protamine directly after the closure of the renal artery. The organ is harvested using an Endo-Bag or with the surgeon’s hand through an incision between 6 and 12 cm [5–7]. The kidney is immediately placed on ice and perfused with a preservation solution.

The donor

Preoperative donor assessment for laparoscopic kidney donation is the same as for the open approach and should be performed according to international guidelines [8]. The same holds true for contraindications to LLDN, which do not differ from those for the open approach. Multiple renal vessels do not generally constitute a contraindication to LLDN [9]. Numerous studies have shown that for kidneys with multiple vessels no differences in complication rates, early and late graft function, rejection rates and graft survival exist between the open and laparoscopic nephrectomy technique [9,10].

Nor does obesity constitute a contraindication to LLDN and donor morbidity and recipient outcome are the same as in slim donors. Depending on the surgeon’s position on the learning curve and his acquaintance with LLDN, though, donors with a high body mass index may not be accepted in all centres [11]. The same holds true for previous abdominal operations in the donor’s medical history.

In LLDN, operating times are often longer [6], but some authors found no difference between the two approaches [5]. Again, the learning curve seems to be a very important factor in reducing operating times. Furthermore, the technique (hand assistance vs pure laparoscopy) plays an important role in minimizing the time required for the operation [7,12,13].

In most studies the overall complication rate of LLDN does not differ from the open approach, ranging from 0 to 20% for laparoscopy and 0 to 35% for open surgery. Haemorrhage, the necessity for blood transfusion and postoperative prolonged bowel obstruction are the most frequently reported complications in LLDN [3,4,6,7,14]. In a recently published survey involving 171 kidney transplant centres and covering almost 11000 LLDN performed between 1999 and 2001, Matas et al. [14] found a significant difference in favour of open kidney harvesting with respect to the necessity of a reoperation, postoperative complications and readmission rates. Interestingly, Finelli et al. [2], reported in a survey of the 31 centres performing the most kidney transplantations in the US, that LLDN has more than doubled over the last 3 years, the period during which Matas et al. acquired their data. Therefore, we believe that the difference in complication rates Matas identified between open and LLDN reflects the learning curves of the increasing number of transplant centres newly introducing this approach.

Conversion to open-donor nephrectomy has been reported in 0–4.7% of cases [3,5–7]. Merlin et al. [6] reviewed 25 publications on LLDN and found an overall conversion rate of 0.9%. Intraoperative complications leading to conversion are mostly vascular problems and the inability to control bleeding as well as malfunctioning of the technical devices used for vessel dissection [12]. Ratner et al. [15]
performed a study including imaging techniques (CT) and anatomic assessment of donors aimed at identifying preoperative factors that might predict intraoperative technical difficulties likely to be encountered during LLDN. Interestingly, the authors found no anatomic, demographic or radiological parameters that could anticipate the difficulties faced during the operation. This observation, together with the wide range of conversion and complication rates reported, once more underlines the crucial role of the laparoscopic surgeon’s individual learning curve in LLDN.

As already mentioned, a better postoperative course for the donor (Table 1) with regard to pain, hospital stay and sick leave was the reason for introducing LLDN. Interestingly, the authors found no anatomic, demographic or radiological parameters that could anticipate the difficulties faced during the operation. This observation, together with the wide range of conversion and complication rates reported, once more underlines the crucial role of the laparoscopic surgeon’s individual learning curve in LLDN.

As already mentioned, a better postoperative course for the donor (Table 1) with regard to pain, hospital stay and sick leave was the reason for introducing LLDN. With respect to postoperative pain and use of analgesic medication, numerous studies have shown a markedly better convalescence with laparoscopic organ donation. As a consequence, laparoscopic donors leave the hospital significantly earlier [3,4,6,7,13,16]. Also, most studies found fewer long-term complications and significantly earlier return to work for laparoscopic than for open surgical donors, with differences of up to 7 weeks. Lind et al. [17] showed that the donor’s sick leave time depends not only on the donation method applied but also on the attitude of the donor and the advice of his doctor/caretaker.

Increased costs resulting from a prolonged operating time and additional material needed are often advanced as an argument against the laparoscopic approach. It could, however, be shown that the shorter hospital stay in laparoscopic organ donation compensates for the higher costs [4].

### The recipient

In the beginning LLDN was confronted with much criticism, since a new method always has to be measured against the ‘gold standard’ of the established surgical approach [18].

LLDN was initially associated with more ureteral complications (Table 2) than the open approach. This was most probably due to a too radical preparation technique during explantation, which especially involved too much dismantling of tissue surrounding the ureter, compromising the blood supply and leading to ureteral necrosis. Today, the problem that was associated with the early learning curve has been solved. With the actual knowledge of the necessity for a meticulous preparation of the ureter and its surrounding fatty tissue, the proportion of ureteral complications no longer differs between laparoscopic and open live-donor nephrectomy. Some authors even describe fewer ureteral complications with the laparoscopic approach [6,7,12,13,16,19].

An increase in warm ischaemic time for the laparoscopic approach has been criticized as well, since it might trigger rejection and increase the proportion of delayed graft function (DGF). In many studies, warm ischaemic time of the laparoscopic approach cannot be compared with the open approach, though, since

### Table 1. Donor outcome—comparison of length of hospital stay and absence from work between open and laparoscopic live donor nephrectomy in different series

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<thead>
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<th>Hospital stay (days)</th>
<th>Absence from work (weeks)</th>
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<tr>
<td></td>
<td>Open</td>
<td>Laparoscopic</td>
</tr>
<tr>
<td>Lennerling et al. [3]</td>
<td>6</td>
<td>5</td>
</tr>
<tr>
<td>Wolf et al. [4]</td>
<td>2.6a</td>
<td>1.7a</td>
</tr>
<tr>
<td>Merlin et al. [6]</td>
<td>3.8–5.7a</td>
<td>2.2–3.1a</td>
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<tr>
<td>Ratner et al. [7]</td>
<td>5.5a</td>
<td>2.9a</td>
</tr>
<tr>
<td>Rawlins et al. [13]</td>
<td>4.7a</td>
<td>3.3a</td>
</tr>
<tr>
<td>Waller et al. [16]</td>
<td>6.0a</td>
<td>4.1a</td>
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<td>Lind et al. [17]</td>
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*aStatistically significant difference.

### Table 2. Recipient outcome—ureteral complications and graft survival in recipients of living-donor kidneys after open vs laparoscopic retrieval

<table>
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<th>Ureteral complications (%)</th>
<th>Graft survival (%)</th>
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<tr>
<td></td>
<td>Open</td>
<td>Laparoscopic</td>
</tr>
<tr>
<td>Wolf et al. [4]</td>
<td>4</td>
<td>9</td>
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<tr>
<td>Merlin et al. [6]</td>
<td>3.0–6.3</td>
<td>3.3–10.8</td>
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<tr>
<td>Montgomery et al. [12]</td>
<td>6.3</td>
<td>6.5</td>
</tr>
<tr>
<td>Rawlins et al. [13]</td>
<td>6</td>
<td>2</td>
</tr>
<tr>
<td>Waller et al. [16]</td>
<td>0</td>
<td>11</td>
</tr>
<tr>
<td>Ratner et al. [19]</td>
<td>6.3</td>
<td>9.1</td>
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</table>
in open-donor nephrectomy, due to the lack of a competitive surgical method for decades, ischaemic times were not registered precisely but often estimated [18]. Due to the technical demands of the laparoscopic approach, warm ischaemic time is prolonged compared to open surgery. The extent to which warm ischaemic time is prolonged in the laparoscopic approach depends on the technique applied and the number of LLDN performed [11]. Some authors did not find a significant difference between the open and the laparoscopic approach [5].

Many studies investigating the occurrence of DGF could not detect a difference when comparing the different surgical techniques [3,20]. Merlin et al. [6], in a review of 25 publications on LLDN, either found no or contradictory evidence, in favour of open or laparoscopic surgery.

The number of rejection episodes has been found not to differ between the laparoscopic and the open approach [3,4,19,20]. Ratner et al. [7] found that the time at which rejections occurred and their severity were equal for both surgical techniques. The same applies to graft survival: numerous studies found no difference between the organ retrieval techniques (Table 2), indicating that laparoscopy provides organs of the same quality as open surgery [4–7,12,20]. Also, recipient survival is the same for the two organ retrieval techniques. Recipients are not endangered when receiving a laparoscopically harvested organ [6,12,19,20].

Different authors offering LLDN report an increase in living-kidney donation of up to 100%. Even though this may be partly attributed to a centre effect and only reflect a donor shift to the hospitals performing the minimal invasive method, reports state that 20% of donors say they would not have donated a kidney if laparoscopy had not been available [7,20]. Therefore, even though the organ retrieval technique does not directly influence the recipient, he still profits from the supposedly increased number of willing organ donors by LLDN.

Conclusion

Today, LLDN has become the standard approach for kidney harvesting in many centres [2,14]. Numerous trials have demonstrated that LLDN is feasible and safe for the donor and recipient alike. The aim of implementing LLDN to increase the number of donors while at the same time obtain a transplant of the same quality as in open-donor nephrectomy, seems to have been achieved [3–5,16,17,19].

Nevertheless, it cannot be stressed enough that the learning curve is the central issue in LLDN and maximum safety for donor and recipient is the most important issue [7,19,20]. The complication rate for the donor as well as for the recipient decreases with the growing number of laparoscopic LLDN performed [12,13]. This may be the reason for some authors’ opinions that LLDN does not offer advantages necessitating transplant units to change their open retrieval technique. A surgical team planning to incorporate LLDN into their programme must therefore train thoroughly with surgeons already performing this operation. Also, training on large animals prior to performing LLDN is recommended [6].

Future development will show the impact of LLDN on willingness to donate a kidney and the further spread of this method, fuelled by the evolution of technical improvements in LLDN.

Conflict of interest statement. None declared.

References


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