Mini-incision for strictly retroperitoneal nephrectomy in living kidney donation \textit{vs} flank incision

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Abstract

Background. Mini-incision donor nephrectomies (MIDNs) were established during the last decade, as an alternative to traditional open donor nephrectomy (ODN) via flank incision. In this study, we investigated intra-operative and post-operative data on outcome following MIDN in comparison with ODN data.

Methods. Data of 70 living kidney donations, performed at the University of Regensburg Medical Center since 1996, were evaluated. Donor operation was performed as either strictly retroperitoneal MIDN ($n=34$) or as traditional ODN ($n=36$) via flank incision. Total operation time, warm ischaemia time (WIT), perioperative pain-medication usage and creatinine levels as well as length of hospital stay, return to complete enteral nutrition and regular digestion were evaluated retrospectively.

Results. Total operation times were similar in MIDN, $n=34$ (132 ± 26 min) and in ODN, $n=36$ (140 ± 37 min) ($P=0.424$). WIT was also similar in both: MIDN (0.9 ± 0.4 min) and ODN (0.9 ± 0.4 min) ($P=0.568$). The requirement for post-operative opioids in morphine equivalent doses was significantly lower in MIDN (8.4 ± 16 mg) compared with ODN (44 ± 57 mg) ($P=0.001$). Additional application of non-opioids (metamizole) (MIDN: 4.8 ± 6.3 g, ODN: 3.4 ± 3.9 g) and non-steroidal anti-rheumatic (NSAR) (diclofenac) (MIDN: 322 ± 361 mg, ODN: 247 ± 474 mg) revealed no significant differences between the groups. The hospital stay was 4.9 ± 1.4 days in MIDN which was significantly shorter than that in ODN (9.3 ± 3.3 days) ($P=0.001$). Patients achieved fully independent mobility earlier in MIDN than in ODN ($P=0.934$). Start of enteral nutrition with fluids was significantly quicker in MIDN (1.9 ± 7 h) compared with ODN (12 ± 13 h) ($P=0.05$). Full enteral nutrition was accomplished significantly earlier in MIDN (1.6 ± 0.8 days) ($P=0.023$). Return to normal digestion revealed no significant differences between groups. Serum creatinine levels of all kidney donors were in the normal range (66 ± 18 μmol/l) one day before nephrectomy, increased on day 1 after surgery (119 μmol/l ± 31 μmol/l) and were stable on day 3 (115 μmol/l ± 30 μmol/l) without significant differences.

Conclusion. Strictly, retroperitoneal MIDN in living kidney donation is a fast and safe method for the procurement of a living donor graft, giving the patient a significantly shorter period of recovery, and thus is an attractive and recommendable alternative to traditional ODN procedures.

Keywords: donor nephrectomy; mini-incision; retroperitoneal

Introduction

Living kidney donation is an increasingly important option for patients with end-stage renal disease requiring transplantation, since the availability of cadaveric kidneys remains rather low in Germany with increasing numbers of patients on the waiting lists [1]. The number of living kidney donors in Germany has increased to 15–20% in Germany in recent years and is much higher in Scandinavia, the US (30–50%) and Japan (≈99%) [2,3]. Living kidney donation reduces time on the waiting lists and offers the possibility to prevent long periods on dialysis or even avoid dialysis completely [4]. Historically, donors were operated with a large flank incision, a technique that is well-standardized but associated with several disadvantages such as hyp- and dysparaesthesias, hernias or unpleasant cosmetic outcome. In the last decade, evolution of surgical techniques has led to the introduction of laparoscopic lumbar donor nephrectomy (LDN) and mini-incision donor nephrectomy techniques (MIDN) [5–7]. In this study, we present the results of 34 cases of strictly
retroperitoneal donor nephrectomy via anterior mini incision, focusing on surgical procedure and perioperative period; we then compare these with data from 36 cases of traditional open donor nephrectomy (ODN) via flank incision. The aim of this study was to compare procedure-specific differences concerning operation time, warm ischemia time (WIT) and analgesic drug requirements in MIDN vs ODN. Furthermore, parameters of recovery and actual nutrition were evaluated.

Patients and methods

Patients
The kidney transplantation programme at the University of Regensburg Medical Center was established in 1995. From 1996 to June 2005, 78 living donor kidneys were transplanted, with a number increasing to 30% of all kidney transplantations in the last 2 years. The study comprised 36 patients in the ODN (1996–2003) and 34 patients in the MIDN (2003–05) group.

Donor evaluation
Living kidney donors were evaluated according to §8 of the German Transplantationsgesetz. Specific evaluation included magnetic resonance angiography and renal scintigraphy to specify renal vessel anatomy as well as renal function. Furthermore, ABO blood group compatibility with negative cross-match and permission by the local ethics committee were the requirements for acceptance. Demographic data in all three groups were comparable.

Surgical technique
For MIDN, patients were in a supine position under general anaesthesia. A vertical pararectal incision with a length of 8–10 cm was performed beginning below the costal arch (Figure 1A). The abdominal wall was divided layer by layer up to the peritoneum, which was not opened (Figure 1B). Hooks were used to retract the peritoneum medially. No fixed retractor system was used, in order to keep the surgery as non-traumatic as possible. After identification of the renal fascia it was incised and the kidney was dissected out of the peri-renal fat in a stepwise fashion. The ureter was then identified, encircled by a vessel-loop and mobilized distally. The ureter then was divided just below the iliac junction and the distal stump was ligated. After adequate mobilization of the kidney, artery and vein were identified and separately encircled with vessel-loops. The kidney was identified and exposed. Clamps were placed on the ureter and the vessels without clamping, to control perfect exposition of the graft in order to minimize incidental bleeding while removing the kidney later and to achieve very short WITs. The artery was then clamped close to the aorta when a left nephrectomy was performed and close to the vena cava in right nephrectomies, followed by clamping of the renal vein at the vena cava. Vessels were divided, the kidney was removed and then perfused with about 500–1000 ml of standard HTK solution (Custodiol®, Dr F. Köhler-Chemie, Alsbach, Germany) after flushing the artery with heparinized saline. The artery was sutured with a stitch ligature and the vein with a double running suture. Finally, the situs was inspected for further bleeding. a 20F silicon drain was placed and the abdominal wall and skin were closed in bilayer technique with one PDS and intracutaneous absorbable suture technique.

ODN was performed via a muscle-cutting flank incision with the patient in the decubitus position and the operation table broken to open the angle between the iliac crest and costal arch. The Gerota’s fascia was identified extraperitoneally. The further procedure was carried out in the same way as in MIDN.
Pre- and post-operative data

Data were collected retrospectively from patient charts, surgical procedure protocols and analgesia protocols. All patients were hospitalized 1 day before surgery. No special pre-operative bowel preparation was performed in the patients, except abstinence from oral fluids and food from 10:00 p.m. on the day before surgery. The standard surgical thrombosis prophylaxis protocol was performed with weight adapted enoxaparin. Standard gastric ulcer prophylaxis protocol was performed with ranitidin 150 mg/day in patients without history of gastric ulcers, pantoprazole 40 mg/day for patients with past ulcer history and pantoprazole 80mg/day for patients with a recent ulcer history.

Daily doses of post-operative pain medication with various opioid, non-opioid and non-steroidal antirheumatic (NSAR)-drugs were documented as daily applied total dose in milligrams or grams from the charts and analgesia protocols. There were no fixed protocols for analgesic management.

Average operation-time, WITs, duration of hospital stay as well as time from end of surgery to oral fluid intake and complete enteral nutrition, return to independent mobilization and digestion, defined as first stool after surgery were also recorded. The first time of primary mobilization was defined as sitting at the edge of the bed and/or standing up with the help of a nurse. Independent mobilization was defined as patients being able to stand up alone to reach the bathroom or walk around at least on ward.

All patients received an urinary catheter intra-operatively and diuresis was supervised closely for at least 2 days after surgery. High volume turnover was achieved by application of 3–4 l of fluids orally or intravenously and application of diuretics when needed. Post-operative stimulation of bowel movement was supported by early mobilization and application of a rectal clysma on day 2 after surgery if the patient did not already have digestion.

The length of hospital stay was defined as the duration of hospitalization in which the day of admission and day of discharge were calculated together as one day. Serum creatinine levels were measured 1 day before and on days 1 and 3 after surgery. They were in a normal range in all patients in 36 patients, 31 underwent a left-sided and 15 a right-sided nephrectomy with an average operation time of 132 ± 26 min. The ODN (n = 36) group (21 male and 15 female patients with a mean BMI of 26 ± 2.8). Out of 36 patients, 31 underwent a left-sided and 15 a right-sided nephrectomy with an average operation time of 140 ± 37 minutes.

WITs were similar in MIDN and ODN (Table 1).

Statistics

Data were collected and statistically evaluated with Sigma Stat 3.1 (Systat Software Inc., Richmond, California, USA). Descriptive statistics, t-tests and analysis of variance (ANOVA) tests were applied to describe and compare the three groups. Where appropriate, one way ANOVA (Tukey) was used. P-values of ≤0.05 were defined as statistically significant.

Results

Demographic and surgical data

MIDN (n = 34) was performed in 16 male and 18 female patients (n = 34) with an average age of 49 ± 11 years and a mean body mass index (BMI) of 26 ± 2.7. The left kidney was removed in 17 cases and the right

<table>
<thead>
<tr>
<th>Table 1. Patient data</th>
<th>MIDN (n = 34)</th>
<th>ODN (n = 36)</th>
<th>P-values</th>
</tr>
</thead>
<tbody>
<tr>
<td>Gender (M/F)</td>
<td>16/18</td>
<td>21/15</td>
<td></td>
</tr>
<tr>
<td>Age (years)</td>
<td>49 ± 11</td>
<td>49 ± 11</td>
<td></td>
</tr>
<tr>
<td>BMI</td>
<td>26 ± 2.8</td>
<td>26 ± 2.8</td>
<td></td>
</tr>
<tr>
<td>Side (l/r)</td>
<td>17/17</td>
<td>31/5</td>
<td></td>
</tr>
<tr>
<td>Procedure time (min)</td>
<td>132 ± 26</td>
<td>140 ± 37</td>
<td>0.424</td>
</tr>
<tr>
<td>WIT (min)</td>
<td>0.9 ± 0.4</td>
<td>0.9 ± 0.4</td>
<td>0.568</td>
</tr>
<tr>
<td>P-RBC (total number)</td>
<td>0</td>
<td>2 in one patient</td>
<td>0.171</td>
</tr>
<tr>
<td>Mobilization Ia (h)</td>
<td>2.9 ± 7.9</td>
<td>9.4 ± 13</td>
<td></td>
</tr>
<tr>
<td>Mobilization IIb (days)</td>
<td>1.4 ± 0.7</td>
<td>1.5 ± 0.8</td>
<td>0.934</td>
</tr>
<tr>
<td>Nutrition Ic (h)</td>
<td>1.9 ± 7.0</td>
<td>12 ± 13</td>
<td>0.05</td>
</tr>
<tr>
<td>Stool (days)</td>
<td>2.4 ± 1.0</td>
<td>2.9 ± 1.3</td>
<td>0.125</td>
</tr>
<tr>
<td>Hospital stay (days)</td>
<td>4.9 ± 1.4</td>
<td>9.3 ± 3.3</td>
<td>0.001</td>
</tr>
</tbody>
</table>

*First mobilization at the bedside post-operative, †fully mobilized, ‡first nutrition with fluids post-operative and §able to eat a whole meal.

P-RBC, packed red blood cells.

in 17 cases, depending on anatomical and functional reasons such as creatinine clearance, arterial supply and venous anatomy. Operation time was calculated as incision-to-suture time in minutes with a mean of 132 ± 26 min. The ODN (n = 36) group (21 male and 15 female patients with a mean BMI of 26 ± 2.8). Out of 36 patients, 31 underwent a left-sided and 15 a right-sided nephrectomy with an average operation time of 140 ± 37 minutes.

Serum creatinine levels

Serum creatinine levels of all kidney donors were measured 1 day before and on days 1 and 3 after surgery. They were in a normal range in all patients before surgery, with a mean of 66 µmol/l (range 50–91 µmol/l), increased on day 1 post-operation to 119 µmol/l (range 74–167 µmol/l) and did not further increase on post-operative day 3 with a mean of 115 µmol/l (range 75–143 µmol/l).

Complications

In the ODN group, one patient received two packed red blood cells on day 3 with decreased haemoglobin of 64.4 g/dl due to prolonged oozing without requirement for surgical intervention. In another patient, a sigma perforation occurred due to diverticulosis on day 6, so that sigmoid resection had to be performed. The post-operative stay in this patient was 25 days. One patient developed fever on day 4 after surgery. Diagnostics revealed Citrobacter freundii in the blood culture. Under calculated antibiotic treatment, the fever decreased and infectious parameters returned to normal values within 3 days. Another female patient in the ODN group developed a urinary and wound infection. Microbiological diagnostics revealed Enterococcus faecalis and Escherichia coli in the urine
and E. faecalis and Candida albicans in the wound, which were also treated with calculated application of antibiotics and daily wound cleansing, without further complications. The patient was treated as an outpatient where the secondary wound healing was finished after a month. A single case had to be treated in the intensive care unit for 3 days, due to occurrence of cardio-pulmonary decompensation 20 h after surgery, due to fluid overload in the perioperative period. The patient’s history was negative for cardiopulmonary disease. The X-ray of the chest showed massive pulmonary congestion and a pulmonary oedema was diagnosed. Under diuretic therapy and intermittent non-invasive continuous positive airway pressure-breathing, the patient was recompensated after 3 days. None of the patients in the MIDN group needed any blood transfusion during surgery or in the perioperative course.

In the MIDN group, one patient developed a wound infection on day 3 after surgery. The wound was opened and treated locally, with daily cleansing and disinfection. The secondary healing wound was followed in ambulatory, where wound healing was finished after 6 weeks. In one female patient in the MIDN group, increased liver transaminases and cholestatic parameters were found after nephrectomy. Ultrasound of the abdomen did not reveal any reason for this and laboratory controls of liver parameters in the following 3 days showed a spontaneous decrease to normal values. Furthermore, one female patient in the MIDN group developed a deep vein thrombosis in the left femoral and iliac vein 4 weeks after discharge. Pre-operative evaluation showed no increased risk profile for thrombosis and surgical as well as post-operative course were uneventful, with easy mobilization and anticoagulation with 40 mg of enoxaparin s.c. At home, there were no longer periods of immobilization. She was admitted to the hospital and treated with oral anticoagulation medication after diagnosis of mild lung embolia. One year after surgery, there are neither residuals of the thrombosis nor of the lung embolia left.

**Analgesic therapy, mobilization, nutrition, digestion and hospital stay**

Analgesia was managed with opioid (piritramid, tramadol), non-opioid (metamizol) and NSAR (diclofenac) drugs without fixed regimen. The average total application of opioids in morphine equivalent dose in the MIDN group during hospital stay was $8.4 \pm 16\,mg$ compared with $44 \pm 57\,mg$ in the ODN ($P=0.001$). Only 13 patients in the MIDN group were treated with opioids whereas in the rest, a combination of non-opioids and NSAR achieved sufficient analgesia. The usage of non-opioids and NSAR revealed no significant differences between groups (Table 2).

Patients were mobilized the first time after $2.9 \pm 7.9\,h$ (MIDN), $9.4 \pm 13\,h$ (ODN), and fully independent after $1.4 \pm 0.7\,days$ (MIDN), $1.5 \pm 0.8\,days$ (ODN) with faster mobilization intervals in the MIDN group.

Early nutrition with fluids was started after $2 \pm 7\,h$ (MIDN), $12 \pm 13\,h$ (ODN) ($P=0.05$), and full nutrition was accomplished after $1.6 \pm 0.8\,days$ (MIDN), $2.3 \pm 1.2\,days$ (ODN) ($P=0.023$).

Return to normal digestion was roughly similar in the groups (Table 1).

**Discussion**

In our comparative retrospective study on donor procedure, recovery and outcome, MIDN revealed significant advantages compared with ODN. MIDN procedure is performed via an anterior pararectal approach with retroperitoneal preparation, which leads to significantly shorter recovery periods than flank incision procedures.

The limitations of our investigation must be seen in the retrospective, non-randomized fashion of the study although it was possible to reconstruct surgical and post-operative parameters in an exact fashion to the minute, due to excellent documentation by the nursing staff. ODN was performed from 1996 to 2003 and MIDN since 2003 which gives a bias to our data. During the mentioned time periods, policies concerning oral intake of fluids, food or pain medication might have changed, and results therefore have to be discussed critically. Although there are limitations, most of the evaluated data is in agreement with data from the literature on MIDN and ODN.

The data on surgery times are in good agreement with data from the literature. MIDN procedure times from Neipp (133 min) and Lewis (147 min) as well as ODN data from Waller (155 min), Yang (191 min), Lewis (121 min) and Neipp (129 min) show almost identical values compared with our findings [5–8].

Through a clear and optimal access to kidney vessels and ureter in open procedures (ODN and MIDN), a significantly shorter WIT is achieved which is confirmed by two prospectively randomized studies by Lewis et al. [6] and Oyen et al. [9]. In both, as in our patients, WIT is very short in open procedures. This makes it possible to start perfusion of the graft with a very small time-gap after procurement of the organ, reducing the probability for delayed graft function [6,10,11].

Short procedure time also means shorter time of anaesthesia for the donor and contributes

| Table 2. Average total pain medication in MIDN and ODN |
|----------------|----------------|----------|
|                | MIDN           | ODN      | P-values |
| Opioids (mg)   | 8.4 ± 16       | 44 ± 57  | 0.001    |
| Non-opioids (g)| 4.8 ± 6.3      | 3.4 ± 3.9| 0.819    |
| NSAR (mg)      | 322 ± 361      | 247 ± 474| 0.070    |
to its recovery. Indeed MIDN patients had shorter recovery periods than ODN patients, although surgery times were similar: mobilization was divided into two domains. First domain included mobilization at the bedside as first mobilization after surgery and second domain included the fully mobilized patient on the ward. Nutrition was also divided into two domains, consisting of primary nutrition with fluids and accomplishing nutrition by eating a whole meal prior to surgery. Reuptake of those parameters was faster in MIDN than in ODN.

The short hospital stay of 4.6 days also emphasizes quick recovery in MIDN patients. ODN patients were hospitalized almost twice as long as MIDN patients. Literature data gives a great variety of values for hospital stay in the two groups: in MIDN, hospital stays vary from 2.5 (Yang) to 7.9 days (Neipp), ODN from 4.6 (Yang) to 9 days (Neipp).

MIDN patients had a significantly lower requirement for pain medication compared with ODN. It has to be emphasized that only 13 out of 34 patients in the MIDN group required analgesia with opioids in lower total overall dosages than in ODN, whereas in the ODN group, 29 out of 36 patients needed opioids. Opioids were reduced earlier in the MIDN group.

Data from the literature regarding pain medication should be interpreted carefully. For MIDN, Lewis [6] reports a dosage of 86 mg of opioids as the total overall dose, which is 4-fold higher than the 22 mg in our MIDN group. Except for the dosages from Lennerling (45 mg), which is approximately the same than the 54 mg, ODN opioid dosages from Waller (179 mg) and Lewis (182 mg) are far above 100 mg in total [6,8,12]. The reduced dosage of opioids in the ODN data from Lennerling as well as in our two groups may be an effect of the parallel application of NSAR.

The overall complication rate was similar in all groups. There were no serious adverse events requiring any additional surgical procedures and the described complications could be managed completely in all of our patients.

Strictly, retroperitoneal access and placement of hooks pulls the peritoneal cavity away from the area of interest with two advantages: firstly, the peritoneum does not have to be opened, no small bowel can irritate the view by slipping into the operating field and consecutively the risk of injuries, adhesions, postoperative intestinal irritations, peritonitis and paralysis is reduced. This is in good agreement with data on patient nutrition, mobilization and return to normal digestion. Secondly, the usage of hooks permits an optimization of the overview in a small access [5]. This surely contributes to the quick recovery of patients in MIDN.

In conclusion, we suggest that a retroperitoneal mini-incision for living donor nephrectomy is an attractive alternative to ODN, and reveals significant advantages in hospitalization and recovery from the procedure, low analgetic drug requirements and good cosmetic results to donors.

Conflict of interest statement. None declared.

References


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