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CONGRESS PAPER

Mini-incision open donor nephrectomy as an alternative to classic lumbotomy: evolution of the open approach*

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Summary

In Europe, the vast majority of transplant centres still performs open donor nephrectomy. This approach can therefore be considered the gold standard. At our institution, classic lumbotomy (CL) was replaced by a mini-incision anterior flank incision (MIDN) thereby preserving the integrity of the muscles. Data of 60 donors who underwent MIDN were compared with 86 historical controls who underwent CL without rib resection. Median incision length measured 10.5 and 20 cm (MIDN versus CL, $P < 0.001$). Median operation time was 158 and 144 min ($P = 0.02$). Blood loss was significantly less after MIDN (median 210 vs. 300 ml, $P = 0.01$). Intra-operatively, 4 (7%) and 1 (1%) bleeding episodes occurred. Postoperatively, complications occurred in 12% in both groups ($P = 1.00$). Hospital stay was 4 and 6 days ($P < 0.001$). In one (2%) and 11 (13%) donors ($P = 0.02$) late complications related to the incision occurred. After correction for baseline differences, recipient serum creatinine values were not significantly different during the first month following transplantation. In conclusion, MIDN is a safe approach, which reduces blood loss, hospital stay and the number of incision related complications when compared with CL with only a modest increase in operation time.

Introduction

Transplantation from living donors has successfully stabilized the number of end-stage renal disease patients awaiting renal transplantation in the Netherlands (http://www.transplantatiestichting.nl/). In order to further reduce the number of patients on the waiting list and consequently the number of patients dying while waiting, live kidney donation programmes have to be expanded. It is still a matter of debate, which operation technique should be used for live donor nephrectomy. Europeans have been more reluctant towards laparoscopic donor nephrectomy than Americans [1]. Recently, a survey was sent from our department to transplant centres in twelve European countries. Of all centres the vast majority still performed open donor nephrectomy. Supported by the results of a recent clinical trial [2] open donor nephrectomy can truly be considered the gold standard in Europe.

Stimulated by the introduction of minimal invasive laparoscopic techniques, there have been refinements of the open technique. Omission of rib resection [3] and employment of smaller incisions [4] both contributed to decreased morbidity and faster recovery of the donor when compared with classic lumbotomy (CL). A recent study showed that both laparoscopic and mini-incision open donor nephrectomy (MIDN) can improve donors' recovery [5]. However, most of these modified open approaches damage the abdominal muscles and harm the integrity of the abdominal wall. Splitting instead of transecting the muscles could potentially leave the oblique and transverse muscles intact. At our institution CL

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performed without rib resection, was replaced by a mini-incision muscle-splitting anterior flank approach. The aim of this study was to describe the outcome of a smaller incision in terms of preservation of abdominal wall integrity of the donor.

Patients and methods

Patient characteristics

From January 1994 to December 2000, CL was performed in 86 donors at our institution. In 2001, MIDN was developed at our institution to offer donors a less invasive open approach. The operation technique is described in detail below. From September 2001 to May 2005 MIDN was performed in 60 donors. CL was not carried out anymore. As laparoscopic donor nephrectomy (LDN) was also performed during this period and evidence was lacking that LDN was better than MIDN, MIDN was presented to patients as a technique with results equivalent to laparoscopy. In these 60 patients, MIDN was either the patient's or surgeon's preference. Patient's preferences for MIDN included shorter operation time and no conversion risk. Surgeon's preferences included the recipient's need for maximum vessel length, shorter operation time or lack of experience in LDN. Donors with complicated renovascular anatomy, obesity, donors with suitable right kidneys only or elderly donors were not restricted from LDN. An independent researcher intra-operatively and postoperatively recorded all data of donors who underwent MIDN.

All donors were preoperatively evaluated by nephrologists and cardiologists. Follow-up at the surgical outpatient clinic occurred at 3 weeks and 2 months after discharge and at the nephrology outpatient clinic at 3 months and 1 year.

Surgical technique

Classic lumbotomy

With the donor placed in a lateral decubitus position, lumbotomy was performed in the eleventh intercostal space or below the 12th rib. No rib resection was performed. Muscles were transected. A mechanical retractor (Omnitract surgical, St Paul, MN, USA) was installed. The retroperitoneal space was opened. The kidney was meticulously dissected and arterial and venous structures were identified. After dissection, the ureter was divided and sutured distally. After administration of 5000 U of Heparin (Leopharma, Breda, The Netherlands) the renal artery and vein were clamped and divided. Thereafter, the kidney was extracted, flushed with 4 °C Eurocollins (Fresenius, Bad Homburg, Germany) and stored on ice. Protamine sulphate (5000 U; ICN Pharmaceuticals, Zoetermeer, The Netherlands) was administered. The renal artery and vein were controlled using Prolene 4/0 continuous sutures (Ethicon, Hamburg, Germany). The fascias of the abdominal muscles were closed using Vicryl 1/0 sutures (Ethicon). The subcutaneous fascia was approximated and the skin was sutured intracutaneously using Monocryl 3/0 sutures (Ethicon). Postoperatively, pain was controlled using an epidural catheter or a patient controlled analgesia device administrating intravenous morphine.

Mini-incision muscle-splitting anterior flank approach (MIDN)

With the patient placed in a lateral decubitus position and the operation table maximally flexed, a horizontal 10–15 cm skin incision was made anterior to the 11th rib towards the umbilicus. The fascia and muscles of the abdominal wall were carefully split avoiding harm to the intercostal nerves between the internal oblique and transverse abdominal muscles. A mechanical retractor (Omnitract surgical) was installed. The peritoneum was displaced medially and Gerota's fascia was opened on the lateral side of the kidney. The working space was limited, given the fact that only the fingers of a medium sized hand could enter the wound. Therefore, long instruments were used. Further dissection and preparation of the vascular structures was performed as described above. Following the administration of heparin, the renal artery and vein were clamped and ligated using conventional clamps or an endostapler (EndoGia; US Surgical, Norwalk, CT, USA). The endostapler was only used in case of multiple arteries and/or veins and if multiple clamps would hinder overview. Then, no additional Prolene sutures were required to secure the renal arteries and veins. Postoperatively, pain was controlled using a patient controlled analgesia device administrating intravenous morphine and oral administration of two 500-mg tablets acetaminophen.

Recipients

All recipients underwent renal transplantation using the standard technique of preperitoneal placement in the iliac fossa. Intra-operatively, urine production of the transplanted kidney was recorded. A calcineukin inhibitors (CNI)-based immunosuppressive regimen was given to all recipients. For the first month postoperatively serum creatinine values were compared between recipients of a transplant procured by either MIDN or CL.

Definitions and statistical analysis

Classic lumbotomy was compared with MIDN concerning operative and postoperative characteristics, early and late

complications and recipient serum creatinine. Warm ischaemia time was defined as time elapsing between occlusion of the first renal artery and flushing of the artery. Time until kidney removal was defined as the time elapsing between incision of the skin and extraction of the kidney. Operation time was defined as time elapsing between incision of the abdomen and tying the last suture. Intra-operative complications were defined as events unintentionally lengthening the operation and causing potential harm to the donor or the graft. Postoperative complications were defined as events requiring an intervention or causing unintentionally prolonged hospital stay of the donor. Intra-operative and postoperative complications were further categorized in major complications and minor complications. Late complications related to the chosen incision were defined as hernias, pseudo hernias (i.e. protrusion of the abdominal wall without presence of a hernia), intervention because of severe pain around the incision and not resolving sensibility loss of the skin surrounding the incision.

Categorical variables were compared with the chi-square test and displayed as number (percentage). Continuous variables were compared with the Mann–Whitney *U*-test and displayed as median (minimum–maximum). Recipient serum creatinine values were corrected for donor's sex, age and relation to the recipient and calculated with repeated measurements ANOVA using mixed model analysis. All analyses were conducted using SPSS (version 11.5; SPSS Inc., Chicago, IL, USA). A P-value < 0.05 (two-sided) was considered statistically significant.

Results

Baseline characteristics

Baseline characteristics are shown in Table 1. All donors received the operation as planned. Rib resections were not performed in the CL group and incisions were not enlarged nor were muscles divided in the MIDN group. The MIDN group consisted of significantly more females. Other baseline characteristics of the donor did not significantly different between MIDN and CL. Recipients were older in the MIDN group and more frequently unrelated to the donor. Figure 1 demonstrates the abdomen of a patient several weeks after MIDN. The scar is relatively small and is located subcostally in the natural shadow of the costal margin.

Surgery

Intra-operative data are shown in Table 2. MIDN was performed using an 8–15-cm incision. The length of the incision was significantly correlated with body mass index

Table 1. Baseline characteristics of donors and recipients.

	MIDN ($n = 60$)	CL ($n = 86$)	P-value
Donor			
Gender			
Male	16 (27)	37 (43)	0.05
Female	44 (73)	49 (57)	
Age in years, median (range)	51 (22–90)	49.5 (20–77)	0.07
Kidney			
Left	27 (45)	47 (55)	0.31
Right	33 (55)	39 (45)	
American Society of Anesthesiologists classification			
II	43 (72)	68 (79)	0.33
II	17 (28)	18 (21)	
Body Mass Index in kg/m^2, median (range)	27.2 (19.9–41.0)	25.2 (16.2–36.0)	0.11
Renal arteries			
1	50 (83)	62 (72)	0.16
≥2	10 (17)	24 (28)	
Renal veins			
1	56 (93)	76 (88)	0.40
≥2	4 (7)	10 (12)	
Recipient			
Gender			
Male	31 (52)	46 (53)	0.87
Female	29 (48)	40 (47)	
Age in years, median (range)	44.5 (8–77)	36 (18–67)	0.003
Relation between donor and acceptor			
Living related	37 (62)	81 (94)	<0.001
Living unrelated	23 (38)	5 (6)	

MIDN, mini-incision donor nephrectomy; CL, classic lumbotomy. Donors underwent either MIDN or CL. Data are presented as number (%) unless stated otherwise.

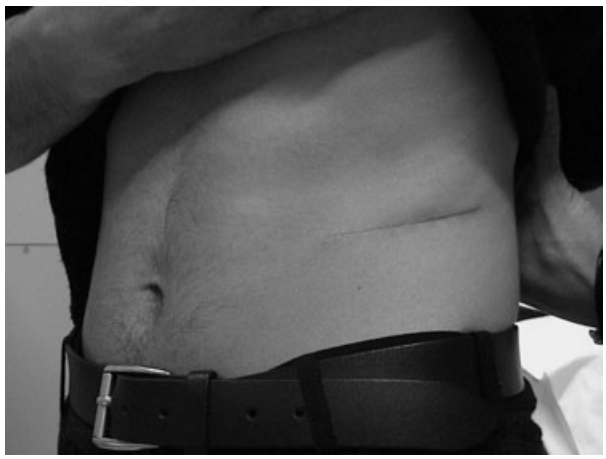

Figure 1 The scar of a male donor following mini-incision donor nephrectomy. In upright position, the scar is located just below the costal margin.

Table 2. Intra-operative results of the donors undergoing mini-incision donor nephrectomy (MIDN) or classic lumbotomy (CL).

	MIDN ($n = 60$)	CL ($n = 86$)	*P*-value
Incision length in cm, median (range)	10.5 (8–15)	20 (8–30)	<0.001
Warm ischaemia time in minutes, median (range)	2.5 (1–9)	3 (1–7)*	0.22
Time until kidney removal in minutes, median (range)	118 (60–196)	93.5 (55–195)	<0.001
Skin-to-skin time in minutes, median (range)	158 (84–251)	144 (76–310)	0.02
Intra-operative complications			
Major	–	–	1.00
Minor	4 (7)	1 (1)	0.16
Bleeds	4	1	
Blood loss in ml, median (range)	210 (30–1400)	300 (50–1000)	0.01

Data are presented as number (%) unless stated otherwise.
*Only recorded in 15 patients.

(BMI), indicating that incisions tended to be longer in patients with a higher BMI (Spearman correlation, $r = 0.32$, $P = 0.02$). In the CL group, incisions were significantly longer, reaching up to 30 cm ($P < 0.001$). In this group, no significant relation between incision length and BMI was assessed (spearman correlation, $r = -0.10$, $P = 0.50$). Warm ischaemia time did not significantly differ between both groups. However, warm ischaemia time was only recorded in 15 of the 86 patients who underwent CL, because it was not considered relevant at that time as no alternatives to CL were available at our institution. Removal of the kidney took on average 25 min longer in the MIDN group ($P < 0.001$). Operation time was only 14 min longer ($P = 0.02$) in the MIDN group indicating that closure of the renal vessels and approximating the fascias of the abdominal muscles is considerably faster in this group. Major intra-operative complications did not occur. Iatrogenic bleeding occurred in four patients during MIDN (maximum total blood loss 1285 ml). These included one donor in whom the vascular clamp slipped of the renal artery during extraction (total blood loss 900 ml). One bleeding occurred during CL (total blood loss 800 ml) due to bleeding from an aberration of the gonadal vein. None of these five patients required a blood transfusion. Some other patients lost up to 1400 and 1000 ml blood during MIDN and CL respectively. Blood loss was diffuse in these cases and there was no single bleeding. Over all, median blood loss was significantly reduced by MIDN (210 vs. 300 ml, $P = 0.01$).

Table 3. Postoperative results of donors undergoing mini-incision donor nephrectomy (MIDN) or classic lumbotomy (CL).

Donor	MIDN ($n = 60$)	CL ($n = 86$)	*P*-value
Hospital stay in days, median (range)	4 (2–9)	6 (3–14)	<0.001
Postoperative complications			
Major	–	–	1.00
Minor	7 (12)	10 (12)	1.00
Blood transfusion	1	–	
Haematoma	1	1	
Pneumonia	–	1	
Ileus	–	1	
Prolonged nausea	1	–	
Urinary tract infection	1	2	
Fever	–	3	
Allergic reaction	–	1	
Pain necessitating intervention	1	–	
Infected left eye	1	–	
Psychosis	–	1	
Slowly declining serum creatinine	1	–	

Data are presented as number (%) unless stated otherwise.

Postoperative data

Postoperative data and complications are depicted in Table 3. Major complications (i.e. requiring re-operation or re-admission) did not occur. Seven minor complications occurred in seven patients following MIDN. These included delayed discharge in one patient. She had a slow decline in serum creatinine values to 150 μmol/l that led to prolonged hospital stay. In the CL group, 10 complications occurred in nine patients. Median postoperative hospital stay was 4 days in the MIDN group and 6 days in the CL group ($P < 0.001$).

Late complications

During follow-up (mean 19 vs. 113 months) late complications related to the incision occurred in one patient following MIDN and 11 following CL ($P = 0.02$, Table 4). The single patient in the MIDN group presented with an incisional hernia, which was treated laparoscopically. In the CL group, four patients presented with incisional hernia. One of these patients needed three repair operations. Four others presented with pseudo hernias and two

Table 4. Late complications related to the incision of donors undergoing mini-incision donor nephrectomy (MIDN) or classic lumbotomy (CL).

Donor	MIDN ($n = 60$)	CL ($n = 86$)	*P*-value
Incisional hernia	1 (2)	4 (5)	0.02
Pseudo hernia	–	4 (5)	
Pain necessitating intervention	–	2 (2)	
Analgesia skin surrounding scar	–	1 (1)	
In total	1 (2)	11 (13)	

Data are presented as number (%) unless stated otherwise.

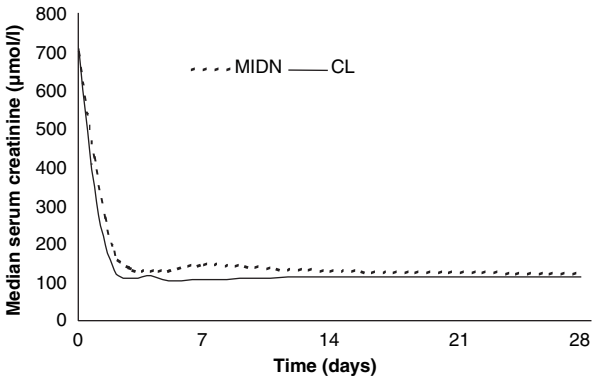

Figure 2 Median recipient serum creatinine following donor nephrectomy by either mini-incision donor nephrectomy (MIDN, interrupted line) or classic lumbotomy (CL, continuous line).

patients were referred to the outpatient pain clinic for treatment of unbearable pain. One patient had prolonged analgesia in the skin around the scar, which did not resolve at all.

Recipients

Of the transplanted kidneys 88% and 86% (MIDN versus CL, $P = 0.80$) produced urine within 1 h following reperfusion. Recipient serum creatinine values declined fast and not statistically different between both the groups (Fig. 2). Serum creatinine values at day 1–7, 14, 21 and 28 did not differ. None of the recipients required dialysis in the postoperative phase.

Discussion

The effort to use a smaller, muscle-splitting incision in MIDN is rewarding. MIDN results in similar donor safety, as reflected by the absence of major complications, a similar number of minor intra- and postoperative complications and equivalent graft function. With marginally longer operation time, donors benefit from reduced blood loss, shorter hospitalization and preservation of continuity of abdominal muscles. A small number of late, incision-related complications occurred in the MIDN group. Except for the single incisional hernia that occurred in one of the first 10 cases all later donors recovered uneventful after MIDN.

Open donor nephrectomy is an evolving technique. In our opinion, muscle-splitting is the logical next step in the development of open surgical techniques. Previously, anterior extraperitoneal incisions [6,7], omission of rib resection [3], and smaller incisions [4] have improved open donor nephrectomy and reduced harm to the donor. The use of muscle-splitting incisions, which has been practised for other surgical procedures to the kidney [8], is a logical next step. Similar to muscle-splitting incisions for cholecystectomy [9], these types of incisions can probably reduce postoperative pain and facilitate sooner recovery.

The survey we recently sent to European centres has clarified that many European surgeons still prefer open approaches for donor nephrectomy (Niels F.M. Kok, Willen Weimar, Ian P.J. Alwayn, Jan N.M. Yaermans, unpublished data). Moreover, CL is often being performed and sometimes even includes rib resection. Neipp *et al.* [10] presented excellent results with a small, vertical anterior approach. MIDN in our series adds preservation of the transverse abdominal muscle and provides a scar that usually disappears in the natural shade of the costal margin. As the incision we present is lateral to vertical and subcostal incisions, but medial to classic flank incisions, this incision combines traditional easy access to the retroperitoneal space and preservation of the integrity of the abdominal musculature. Under supervision of a transplant surgeon, residents in the fifth and sixth year of their training carry out these procedure at our institution. This technique is easily learned and the advantage from the donor's perspective is clear. This might encourage transplant surgeons and urologists in the field to adopt less invasive open techniques.

Further prospective studies will classify the role of MIDN alongside LDN. A recent trial [2] suggested that conventional open donor nephrectomy was superior to LDN with regard to safety. Except for the omission of rib resection, none of the other mentioned improvements was applied. This study suggests that more refined, minimally invasive open approaches might be safer than laparoscopy, while providing quick recovery and good cosmetic outcomes. A nonrandomized comparative study [5] using small muscle cutting incisions suggests that both MIDN and LDN have good and probably equivalent outcomes. Therefore, in our view MIDN is not an inferior technique compared with the laparoscopic technique. This technique probably saves costs [11] and might be a good alternative for traditionally trained surgeons [12].

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An ideal technique for donor nephrectomy is one that is applicable to all donors and all surgeons. The ongoing debate on selection for donor nephrectomy suggests that some donors will always require open approaches [2]. MIDN can be used for obese donors, right kidneys and donors having multiple renal vessels, as demonstrated in this study. Despite the limited working space, minimally invasive open techniques probably require little more experience than conventional open techniques.

Finally, for transplantation surgeons and urologists who prefer open surgery because of the potential hazardous effects of longer warm ischaemia time, pneumoperitoneum and traumatic extraction applied in LDN, MIDN is an acceptable alternative. For those favouring LDN, MIDN is a feasible approach to convert to if necessary. Conversion has been reported to occur in up to 13% during LDN [13]. Conversion to MIDN does not necessarily threaten donor's recovery and cosmetic outcome.

In conclusion, muscle-splitting MIDN is another step in improving open donor nephrectomy. Good outcomes with regard to safety of donor and graft, and favourable recovery when compared with CL establish MIDN as the open approach of choice. We strongly encourage transplant surgeons and urologists who still practice conventional open donor nephrectomy to improve their results with smaller, muscle-splitting incisions. Prospective comparisons with LDN are necessary to further explore the position of modern open donor nephrectomy in transplant surgery.

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