The Current Practice of Live Donor Nephrectomy in Europe

Niels F.M. Kok,[1] Willem Weimar,[2] Ian P.J. Alwayn,[1] and Jan N.M. IJzermans[1,3]

Background. The increasing number of live kidney donors in the last decade has stimulated interest in the surgical technique of donor nephrectomy. In this study, we evaluated the current status of the surgical approach in European transplant centers.

Methods. A questionnaire was sent to 131 centers in 12 European countries. Questions included the number of donors, the technique used, and the inclusion and exclusion criteria for a technique.

Results. Ninety-two replies (70%) were included. In the responding centers, approximately 1450 live donor nephrectomies were performed in 2004 (more than 80% of all live kidney donations in these countries). The number of living donors ranged from 0 to 95 per center. Nineteen institutions (21%) removed kidneys using endoscopic techniques only. Twenty-two centers (24%) performed both open and laparoscopic donor nephrectomy. Vessel length, difficult anatomy and right-sided donor nephrectomy were common reasons to choose an open technique. Twelve centers had performed laparoscopic donor nephrectomy but quit their program for various reasons. In 51 centers (55%), only open donor nephrectomy was carried out. Lack of evidence that endoscopic techniques provide better results was the main reason for these centers to stick to an open approach. Incisional hernias occurred after all types of open surgery in up to 30% of the donors per center. Twenty-nine clinics still carry out the classic flank incision.

Conclusion. The surgical technique of live donor nephrectomy varies greatly between transplant centers in European countries. To define the optimal surgical approach a European registration of donor nephrectomies would be helpful.

Keywords: Living donors, Laparoscopic donor nephrectomy, Open donor nephrectomy, Survey, Surgical technique, Kidney transplantation, Minimally invasive.

(*Transplantation* 2006;82: 892–897)

Persistent organ shortage has led to renewed interest in live organ donation. The result is an ongoing increase in the number of transplantations from live kidney donors. These developments have inspired transplant surgeons and urologists to adopt less invasive surgical approaches in order to limit discomfort to the donor and encourage even more relatives of patients with end-stage renal disease to consider live donation. Since the introduction of laparoscopic donor nephrectomy by Ratner in 1995 various endoscopic alternatives have been presented to remove a kidney in a healthy individual, including hand-assisted laparoscopic donor nephrectomy and retroperitoneoscopic donor nephrectomy (*1–4*). Meanwhile, open techniques have changed (*5–9*). Current alternatives to classic flank incisions include vertical and transverse anterior incisions and less invasive flank approaches.

A decade after the introduction of laparoscopy in live kidney donation the majority of transplant centers in the United States performs laparoscopic kidney donation. European centers have been more skeptical towards incorporating laparoscopic donor nephrectomy (*10*, *11*). To investigate the status in Europe with respect to the implementation of less invasive techniques of donor nephrectomy, we sent out a questionnaire. In this article, we evaluate which surgical techniques are performed in Western and Northern Europe and what rationale is behind these techniques.

[1] Department of Surgery, Erasmus MC, Rotterdam, the Netherlands.
[2] Department of Internal Medicine, Erasmus MC, Rotterdam, the Netherlands.
[3] Address correspondence to: J.N.M. IJzermans, M.D., Ph.D., Department of Surgery, Erasmus MC, PO Box 2040, 3000 CA Rotterdam, the Netherlands.
E-mail: j.ijzermans@erasmusmc.nl.
Received 31 March 2006. Revision requested 24 April 2006.
Accepted 2 June 2006.

ISSN 0041-1337/06/8207-892
DOI: 10.1097/01.tp.0000235511.19629.0d

METHODS

A questionnaire was sent to 131 transplant centers in Austria, Belgium, Denmark, France, Finland, Germany, Ireland, the Netherlands, Norway, Sweden, Switzerland and the United Kingdom. In each center, either a surgeon, a nephrologist, or an urologist in the field of transplantation was approached by mail or e-mail. Addresses were retrieved from the European Society of Transplantation mailing list, the websites of the national transplant societies and online from the National Library of Medicine.

In May 2005, a first round of questionnaires was sent out, in September 2005 a second. The questionnaire consisted of questions about live kidney donation and transplantation. It was categorized in three parts (Table 1). Part A included questions on how many kidneys were transplanted from a deceased and a living donor respectively, Part B included questions on laparoscopic donor nephrectomy (LDN) and Part C included questions on open donor nephrectomy (ODN). Answers were structured but space was provided for comments.

We mainly used descriptive statistics to present our data. Analyses were conducted using SPSS (version 11.5, SPSS Inc., Chicago, USA). Our aim was to evaluate which surgical techniques were applied in the 12 countries. Furthermore, we were interested to know whether a single technique was applied to all donors and whether a shift had been made towards laparoscopic surgery. If not we asked the participants why they preferred an open approach.

RESULTS

Ninety-four replies were received (72%). Two centers did not practice live donor nephrectomy anymore. Therefore these results are based on 92 replies from all twelve aforemen-

TABLE 1. Questions on live donor nephrectomy

A. Number of kidney transplantations
How many kidney transplantations from a deceased donor were performed in your centre in 2004?
How many kidney transplantations from a living donor were performed in your centre in 2004?
Did these numbers change over the past five years?
Do you have a registration of live donor nephrectomies?
B. Laparoscopic donor nephrectomy (LDN)
Is LDN currently performed in your centre?
In which year was LDN introduced?
To your opinion, has the introduction of LDN contributed to increased live kidney donation in your centre?
How many LDNs have been performed in your centre in 2004 and in total?
How many percent of the LDNs in 2004 was converted to open?
Who does perform LDN in your centre and how is your operation team composed?
Which extraction site is favored?
Which instrument is used to divide the renal vessels?
Is LDN restricted to left kidneys?
Do you use hand-assistance?
Do you operate all donors laparoscopically?
C. Open donor nephrectomy (ODN)
Did you ever try other techniques than ODN?
What kind of open technique do you perform?
Do you perform rib resection?
Do you divide or split the muscles of the abdominal wall?
Could you estimate you average incision length?
Do you see true incisional hernias postoperatively?

tioned countries. The specialists who responded and their affiliations are mentioned in the acknowledgments.

Number of Transplantations

Figure 1 shows the case volume of the responding centers. In 2004 approximately 6,800 transplantations were carried out in total. Seventy-nine percent of the transplants (about 5,350 kidneys) were derived from a deceased donor and 21% (about 1,450 kidneys) were derived from a live donor. The responding centers were responsible for approximately 80.6% of the live kidney donor transplantations in the

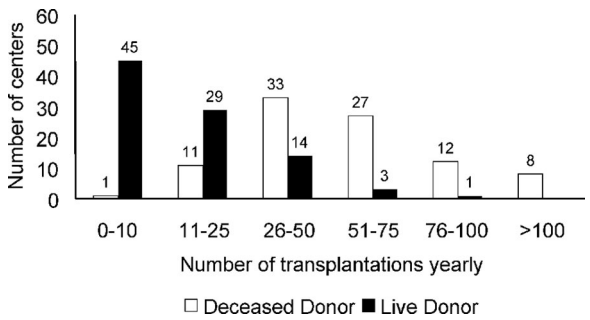

FIGURE 1. Centers categorized according to case volume.

FIGURE 2. Estimated number of live kidney donors in Europe in 2004.

twelve aforementioned countries and for approximately 62% of all European live kidney donor transplantations (*12–17*). In Figure 2, the estimated numbers of live kidney donor transplantations of the responding centers, the remaining centers in the investigated countries, and the rest of Europe respectively are shown. The number of live donor nephrectomies in the investigated countries increased from 1,279 in 2000 to 1,798 in 2004 (41% increase) (*12–17*). The median number of live kidney donor transplantations was 16% (range 0–95). The ratio of live donors to deceased donors ranged from zero to three among the centers. With regard to the annual number of transplantations from a deceased donor 23% of the centers reported a decrease in the last five years, 47% reported no changes and 30% reported an increase. With regard to the annual number of live kidney donor transplantations 7% of the centers reported a decrease, 30% no changes and 63% an increase. Eighty-four percent of the centers have a registration of live donor nephrectomies.

Laparoscopic Donor Nephrectomy

Forty-one centers reported to perform total laparoscopic donor nephrectomy (n=19, including one center that uses a robot), hand-assisted laparoscopic donor nephrectomy (n=20), either hand-assisted or total laparoscopic donor nephrectomy (n=1), and retroperitoneoscopic donor nephrectomy (n=1). Three of them started their laparoscopic program in 2005. Therefore, data on numbers were available from 38 centers. In 2004, two centers did not perform any LDN. Thirty-six centers together performed 586 LDNs, which implies that 40% of the kidneys in all centers were laparoscopically procured. Altogether 848 live donor nephrectomies were performed in these 36 centers. So, in the centers performing open donor nephrectomy alongside laparoscopic donor nephrectomy (in 2004, n=19), approximately 46% of the donors was still operated on using an open approach.

Fourteen centers (37%) had performed less than 25 laparoscopic procedures up to and including 2004. Eight centers had performed 25 to 50 procedures, eight centers had performed 50 to 100 procedures, six centers had performed 100 to 200 procedures, and two centers had experience in more than 200 procedures. There was a positive association between performance of laparoscopic techniques and higher case volume (mean 22 versus 10 live donors in centers that do and do not perform LDN respectively, $P<0.001$, Mann-Whitney-U test). Eighteen centers (47%) introduced laparoscopic techniques to their transplantation programs within

the last five years. Twenty centers think that laparoscopic techniques have contributed to an increasing number of live kidney donors presenting to their center. Centers that performed more LDNs in 2004 were more likely to answer that laparoscopy had led to more living donors (mean 20 versus 11 donors in centers that answered affirmative and negative respectively to this question, $P=0.002$, Mann-Whitney-U test).

Composition of the Operation Team

In 27 centers (66%), LDN is carried out by a general or a transplant surgeon, in 13 institutions (32%) by an urologist, and in one clinic by either a surgeon or an urologist. In 19 clinics (46%) only one specialist has the expertise to perform laparoscopic kidney donation, in 16 clinics (39%) two specialists in four clinics (10%) three specialists, and in two clinics (5%) four specialists. In total, 71 specialists are trained to perform laparoscopic kidney donation in the responding centers. The operating team is composed of at least two consultants in 19 clinics (46%), and of one consultant and a registrar in the remaining centers.

Instruments, Extraction Site, and Conversion Rate

In one center titanium clips alone are used to secure the renal vessels. Four clinics use self-locking clips and 23 clinics use a vascular endostapler (TA or GIA). The remaining centers use a combination of these three tools. As an extraction site most centers (61%) use a Pfannenstiel incision. Other rather common incisions are sub- and supra-umbilical incisions. Iliac incisions, subcostal incisions and hemi-Pfannenstiel incisions are each practiced in one clinic. In eight centers 14 out of 186 (7.5%) LDNs were converted to open. The conversion rate varied from 1% to 29%. Two of the centers that converted to open performed less than 10 procedures in 2004, two centers performed 11 to 20 LDNs, two centers performed 21 to 30 LDNs, and two centers performed 41 to 50 LDNs. The total experience with LDN in these centers was less than 25 cases in one center, less than 50 cases in two centers, less than 100 in three centers, less than 200 in one center, and more than 200 cases in one center. Three of the centers never used hand-assistance, three centers always and two sometimes. The center that reported a conversion rate of 29% stressed that LDN was being learned.

Right-Sided LDN and Hand-Assistance

In 12 centers (29%) LDN is restricted to the left side. Indications for right-sided LDN are summarized in Table 2. Other reasons to switch to the right side include urinary tract abnormalities and the statement that the best kidney should remain in the donor. Five centers perform right-sided LDN in 50% of the cases or more. Twenty-one centers (51%) use hand-assistance during donor nephrectomy. Reasons are stated in Table 2. Two centers use hand-assistance only in the terminal phase of the operation for quick extraction of the kidney. One center uses hand-assistance because of positive experiences with it during radical nephrectomy for cancer. The center that performs retroperitoneoscopic donor nephrectomy does not use hand-assistance.

Centers Performing ODN Alongside LDN

Nineteen centers (46%) only perform laparoscopic donor nephrectomy or retroperitoneoscopic donor nephrectomy. The other 22 centers prefer an open approach in some cases. Reasons are stated in Table 3. Other reasons include the absence of the laparoscopic surgeon in two centers, multiple previous abdominal operations in one center, conduction of a randomized controlled trial comparing ODN and LDN in one center and the statement of one center that LDN is an exception and ODN the standard.

TABLE 2. Indications for right-sided laparoscopic donor nephrectomy and reasons for hand-assistance

Indication for:	No. of times mentioned (%)
Right-sided LDN (no. of institutions)	27
Multiple vessels on the left side	21 (78%)
Stenosis right renal artery	10 (37%)
Smaller right kidney	10 (37%)
The right side is easier	7 (26%)
Other	3 (11%)
Hand-assisted LDN (no. of institutions)	22
Shorter warm ischemia time	8 (36%)
Shorter operation time	7 (32%)
Easier than traditional LDN	7 (32%)
Safety	6 (27%)
Learning setting	2 (9%)
Other	3 (14%)

LDN, laparoscopic donor nephrectomy.

TABLE 3. Reasons for centers also performing LDN to choose an open approach instead and reasons for centers that never tried LDN to stick to ODN

Reason for:	No. of times mentioned (%)
Centers also performing LDN choosing an open approach (no. of institutions)	22
Right-sided donor nephrectomy	12 (55%)
Vessel anatomy	8 (36%)
Difficult anatomy	6 (27%)
Patient's preference	5 (23%)
High BMI	2 (9%)
Safety	2 (9%)
Logistics	2 (9%)
Other	5 (23%)
Centers never trying LDN	39
Lack of evidence that LDN is better	22 (56%)
Other techniques hard to learn	8 (21%)
Evolution ODN	6 (15%)
Costs	6 (15%)
Too few cases	4 (10%)
Safety	3 (8%)
Other	4 (10%)

LDN, laparoscopic donor nephrectomy; ODN, open donor nephrectomy; BMI, body mass index.

Open Donor Nephrectomy

Seventy-three centers (79%) reported to perform ODN. Fifty-one centers (55%) use open approaches only. Thirty-nine clinics have never tried a laparoscopic technique for live donation for reasons summarized in Table 3. Lack of evidence that other techniques are better appears to be an important reason to stick to ODN. Other reasons than stated in the table include no trained people, too long operation times, no experience in laparoscopic surgery at all and the statement that good techniques should never be changed. The other 12 centers practiced endoscopic techniques in the past. One clinic performed complete laparoscopic LDN, hand-assisted LDN and retroperitoneoscopic donor nephrectomy but judged the results of a vertical pararectal open approach better. Three clinics performed both complete LDN and hand-assisted LDN but quit their laparoscopic programs because of temporary leave of the laparoscopic surgeon, results equivalent to open surgery and higher costs, or because other techniques were difficult to learn. Six clinics performed complete laparoscopic donor nephrectomy but switched to ODN again because of too few cases in one clinic, results equivalent to open surgery in two clinics, a combination of equivalent results but higher costs in one clinic, a combination of equivalent results and difficulty with vascular variations in one institution and one clinic has LDN currently under evaluation. One clinic performed hand-assisted LDN but felt the results to be equivalent to open surgery. Retroperitoneoscopic donor nephrectomy was practiced in one clinic but the surgeons felt they had too few cases to perform this technique. In four of the aforementioned 12 clinics, conventional open techniques are practiced (classic lumbotomy in three and median laparotomy in one).

Technique of ODN

The surgical techniques used for ODN are displayed in Table 4. Classic lumbotomy was defined as a classic 15 to 20 cm loin incision. Anterior horizontal incisions also include transverse subcostal incisions. One center performs both classic lumbotomy and minimal flank incision. Other techniques include a transverse anterior muscle-splitting incision in the upper part of the abdomen denoted as the "Groningen" muscle-splitting incision and an intercostal rib-tip incision. Two of the 28 centers performing classic lumbotomy always use a rib resection to explore the retroperitoneal space. Four additional centers sometimes perform a rib resection. Two of the centers performing a minimal incision flank approach standard carry out a rib resection. Sixteen of the centers performing classic lumbotomy divide the abdominal muscles, 11 centers split the muscles and one center either divides or splits the muscles. In the minimal flank approach group, 10 centers divide the muscles, 13 split the muscles and one center either divides or splits the muscles. The center that performs either classic lumbotomy or a minimal incision flank approach divides the muscles. Two centers performing vertical anterior incisions divide the muscles, three split the muscles and four make an incision in the aponeurosis. Seven centers that carry out horizontal incisions divide the muscles and one center splits the muscles. The centers performing a median laparotomy or a rib-tip incision both divide the muscles.

TABLE 4. Open techniques practiced in the centers that perform open donor nephrectomy (n = 73)

Technique	N (%)
Classic lumbotomy: 15–20 cm flank incision	28 (38%)
Minimal incision flank approach	24 (33%)
Anterior vertical, pararectal incision	9 (12%)
Anterior horizontal incision	8 (11%)
Median laparotomy	1 (1%)
Other	3 (4%)

Incisional Hernias and Incision Length

Incisional hernias are reported for all types of incisions except for the "Groningen" incision and the rib-tip incision. Nine centers (31%) in the lumbotomy group, 10 centers (40%) in the minimal incision flank group, three centers (33%) in the vertical anterior incision group and four centers (50%) in the horizontal anterior incision group encounter incisional hernias. Four centers report 1% incisional hernia rate, four centers report 2%, three centers report 3%, eight centers report 5%, seven centers report 10% and one center, which uses a minimal incision flank approach reported incisional hernias in up to 30% of the donors. Median average incision length for classic lumbotomy is 15 cm (range 10 to 22 cm). Median incision lengths for minimal flank, vertical and horizontal incisions are 12 cm (range 7 to 20 cm), 11 cm (range 7 to 17.5 cm) and 12.5 cm (range 10 to 20 cm) respectively. The "Groningen" incision is on average 8 cm, the median laparotomy 12 cm and the rib-tip incision 12.5 cm. A relation between incision length and occurrence of hernias was not observed. Median incision length in the group with and without hernias was 12 and 13 cm respectively ($P=0.40$). Eleven out of 29 centers (38%) reported hernias despite a muscle-splitting concept. This was not different from the 15 out of 37 (41%) centers that reported hernias after division of the abdominal muscles ($P=1.00$). Appliance of a muscle splitting concept did not correlate with higher case volume ($P=0.43$). Centers that performed more open procedures tended to have a higher chance of encountering hernias. In case of no hernias, the annual number of ODNs was seven and in case of hernias the annual rate was 15 ODNs ($P=0.06$).

DISCUSSION

This audit confirms the trend of increasing live kidney donor transplantations in the majority of Western European transplant centers. The number of centers performing laparoscopic donor nephrectomy and its variants doubled in the last five years. However, the vast majority of centers still perform open donor nephrectomy, including classic lumbotomy, minimal flank approaches, vertical and horizontal anterior incisions. Forty percent of the live donor nephrectomies in Western-Europe is performed laparoscopically. This rate is smaller than in the United States. American surveys indicated that this percentage increased from approximately 48% in 2000 to approximately 67% in 2003 (*18*, *19*). The most recent survey clarified that 36% of the surgeons involved in live kidney donation in the United States was trained in open donor nephrectomy only. An audit from Australia and New Zealand revealed that approximately 25% of the live donors

was operated using laparoscopy in the period from February 1999 until June 2003 (*20*).

Transplant centers in the United States in general have higher case volumes than those in Europe and Australia. This partly explains the earlier expansion of laparoscopic donor nephrectomy. Laparoscopic donor nephrectomy is a difficult procedure that requires extensive experience in endoscopy. Lack of fellowships in minimally invasive surgery may be another reason. Therefore, it is not only important to develop guidelines for laparoscopic donor nephrectomy, but also for open donor nephrectomy. This survey is a first attempt to describe the practice of live donor nephrectomy in Europe.

All minimally invasive approaches, both laparoscopic and open, have been associated with shorter hospital stay and more rapid convalescence as compared to classic open approaches (*2*, *7–9*, *21–23*). Classic lumbotomy can still be considered the gold standard with regard to safety to the donor and the graft and can be advocated because of its universal suitability for live donor nephrectomy (*24*). A recent survey showed that life threatening bleeding episodes can occur during both open and laparoscopic approaches, and the case reports of living donors who died during laparoscopic donor nephrectomy toned down the original enthusiasm towards laparoscopic kidney donation (*18*). There are other reasons mentioned by the responders to the questionnaire in favor of open donor nephrectomy. One important argument is that many responders are not convinced by current evidence suggesting that the endoscopic technique is better. Although a recent review stated that evidence has mounted that laparoscopic donor nephrectomy is superior to an open technique (*25*), only three randomized controlled trials have been published to date (*2*, *24*, *26*). These studies have shown that there is, at least in some donors, a benefit for (hand-assisted) laparoscopic donor nephrectomy over classic open donor nephrectomy. The conclusion of the most recent study by Oyen et al. (*24*) that open donor nephrectomy is a secure technique that is superior with regard to safety, may support centers to maintain open donor nephrectomy. This study was performed in one of the largest transplant centers in Europe where nearly one hundred live donor nephrectomies are performed yearly. Other arguments to maintain an open approach are, first, that a not well-defined learning curve exists for laparoscopic donor nephrectomy, and, second, that an open approach will remain necessary for certain cases, such as right kidneys. This has become clear from the present study and from the randomized trials that only included left-sided laparoscopic donor nephrectomies. Low volume centers in particular may interpret these data as evidence for a conventional approach and therewith justify their approach.

However, a low case volume alone is not a reason to stick to open methods for all centers. Eleven centers have a laparoscopic kidney donation program with an annual number of living donors up to 10. One center even performs laparoscopic donor nephrectomy with the Da Vinci Robot while the annual number of living donors is 15 only.

Twelve centers have practiced laparoscopic techniques, but felt that these techniques had results equivalent to open surgery. Nevertheless, the number of centers incorporating (hand-assisted) laparoscopic donor nephrectomy or retroperitoneoscopic donor nephrectomy in their programs is still rising. These techniques are performed with good results. An estimated total number of 14 conversions in 586 procedures in 2004 indicates an adequate expertise in these techniques. It should be noted that we did not collect data on complications and re-operations. To set standards for donor nephrectomy in Europe we need to collect the data from smaller and larger centers in an international registry.

Half of the centers use hand-assistance and the other half do not. This is comparable with the experience in the United States (*19*). Only two centers reported to use hand-assistance because they were in a learning phase. This rebuts the prejudice some may have that hand-assistance should be used during a learning phase only and confirms that hand-assisted laparoscopic donor nephrectomy has become a true alternative to traditional transperitoneal laparoscopy (*27*). As high-level evidence to support either technique is not available, the choice to use hand-assistance at some stage during the operation should be left to the center. Only one center performs retroperitoneoscopic donor nephrectomy. Some good early results have been reported with this technique (*3*, *4*) and several centers state that they will further explore this technique in the future.

It might encourage other centers considering initiating a laparoscopic live kidney donation program that the operation team consists of one consultant only in about half of the centers. It is conceivable that the continuous presence of two consultants during live kidney donation is not feasible in smaller transplantation centers.

This audit shows that about half of the centers that perform laparoscopic donor nephrectomy also perform open donor nephrectomy, mainly for right-sided donor nephrectomy. Half of all centers manage to operate all donors laparoscopically. Several reports demonstrate that right-sided laparoscopic donor nephrectomy is feasible (*28*, *29*). Transfer of knowledge between transplant centers may help to overcome difficulties in laparoscopic kidney donation.

In the present survey we did not study changes in the open technique. There is evidence in the literature that minimal incisions (*7*, *9*), omission of rib resection (*30*) and anterior incisions (*5*, *31*) improve the results of open donor nephrectomy. Currently, 40% of the centers maintain classic loin incisions. We believe that muscle-splitting incisions are important in open surgery to preserve abdominal wall integrity. It would be valuable to start studies that compare muscle division and muscle splitting to see if muscle-splitting incisions can further improve the surgical technique of open donor nephrectomy. In the Netherlands and the United Kingdom, three clinical trials comparing modern open approaches and (hand-assisted) laparoscopic donor nephrectomy are in a final stage. These studies will determine the position of less invasive, modified open approaches alongside laparoscopic donor nephrectomy and will probably set new standards for the future.

In conclusion, with an increasing annual number of living donors, the preferred operation technique varies between and within European countries. Although the number of centers that perform laparoscopic donor nephrectomy increases, most centers still practice open donor nephrectomy. Open techniques will probably remain their place in the surgical armamentarium in Europe because the majority of transplant centers perform a small number of live donor nephrectomies only. In the Eurotransplant countries several

characteristics of the live donor including age, gender, side and warm ischemia time are already being registered. By adding other parameters such as complications, reoperations, and length of stay a useful registry may be developed that will help to set new standards and guidelines to optimize the surgical approach in live kidney donation programs.

ACKNOWLEDGMENTS

Niels F.M. Kok is partly funded by the Dutch Kidney Foundation. The authors would like to thank the following persons for their contributions to this study: K. Rigg, Nottingham, N.R. Brook, Leicester, L.J. Buist, Glasgow, J.L. Forsythe, Edinburgh, D. Hickey, Dublin, P.A. Rowe, Plymouth, N. Mamode, London, N. West, Coventry, A.T. Raftery, Sheffield, R.W. Chang, London, A. Asderakis, Cardiff, P.A. Lear, Bristol, R. Praseedom, Cambridge, N. Ahmad, Leeds, A. Obed, Regensburg, C.E. Broelsch, Essen, M. Karaorman, Mannheim, J. Schmidt, Heidelberg, M. Neipp, Hannover, T. Kälbe, Fulda, G. Offermann, Berlin, A. Homburg, Aachen, M. Giessing, Berlin, D. Abendroth, Ulm, H. Riedmiller, Würzburg, E. Domínguez, Marburg, M. Stöckle, W. Steurer, Tübingen, K.M. Schrott, Erlangen, B. Grabensee, Düsseldorf, N. Senninger, Münster, H. Seiter, Rostock, M. Stangl, München, J.W. Thüroff, Mainz, L. Mirow, Lübeck, F. Fändrich, Kiel, P. Fornara, Halle, P. Pisarski, Freiburg, S. Leike, Dresden, K. Dreikorn, Bremen, Th. Steiner, Jena, Ph.E. Nagel, Augsburg, H.U. Klehr, Bonn, R. Viehbahn, Bochum, P. Merkle, Stuttgart, R. Függer, Linz, C. Groβ, Linz, R. Margreiter, Innsbruck, F. Mühlbacher, Vienna, H. Müller, Graz, C.C. Abbou, Creteil, J. Hubert, Nancy, M. Devonec, Lyon, B. Hurault de Ligny, Caen, F. Iborra, Montpellier, Y. Lebranchu, Tours, B. Bourbigot, Brest, F. Berthoux, Saint Etienne, F. Kleinclauss, Besançon, Y. Chretien, Paris, B. Dore, Poitiers, G. Karam, Nantes, J.F. Subra, Angers, B. Bourgeon, St Denis, P. Wolf, Strasbourg, J. Chanard, Reims, P. Grise, Rouen, B. Barrou, Paris, G. Benoît, Le Kremlin Bicêtre, M. Mouzin, Toulouse, E. Lechevallier, Marseille, Ø. Øyen, Oslo, J.M. Hansen, Herlev, Ø. Østraat, Århus, N. Rohr, Odense, S.S. Sørensen, Copenhagen, K. Salmela, Helsinki, M. Idu, Amsterdam, R.J. Ploeg, Groningen, J. Ringers, Leiden, L.W.E. van Heurn, Maastricht, J.A. van der Vliet, Nijmegen, R.W.H. van Reedt Dortland, Utrecht, M. Matter, Lausanne, M. Weber, Zürich, D. Candinas, Bern, P. Morel, Geneva, L. Gürke, Basel, G. Tufveson, Uppsala, L. Mjörnstedt, Göteborg, N.H. Persson, Malmö, D. Ysebaert, Antwerpen.

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