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REVIEW

Renal transplantation: technical aspects, diagnosis and management of early and late urological complications

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ABSTRACT

INTRODUCTION: Renal transplantation (RT) represents actually the most effective therapy in patients with end-stage renal failure as it is cost effective, allows for a normal life style and reduces the risk of mortality from dialysis related complications. The purpose of the present review is to update the recent published literature regarding the technical aspects, diagnosis and the urological complications associated with renal transplantation.
EVIDENCE AVCUISITION: A comprehensive literature review was performed using PubMed and Thomson-Reuters Web of Science between February 2014 and June 2016. Using free-text protocol, the following terms were applied: "chronic kidney failure", "renal transplantation", "robot-assisted surgery", "laparoscopy", "living donor nephrectomy", "surgical techniques", "urological complications".
EVIDENCE SYNTHESIS: RT represents actually the most effective therapy in patients with end-stage renal failure as it is cost effective, allows for a normal life style and reduces the risk of mortality from dialysis related complications. In the last 2 years, an increased number of published studies on the use of robot-assisted surgery for RT has been presented.
CONCLUSIONS: We could expect that in the next future RKT and LDN are both destined to replace open surgery also in a special field as RT.

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Key words: Kydney transplantation - Kidney failure, chronic - Surgery - Complications.

Renal transplantation has been widely accepted as the most effective form of renal replacement in patients with end-stage renal failure (ESRD). The procedure is performed on patients ranging in age from 12 months to 75 years. Approximately 20% of all children and 5% of all adults with ESRD have renal failure secondary to urological disease. Urological diseases in children include vesicoureteric reflux (40%), posterior urethral valves (40%), and prune belly syndrome (10%).[1] Chronic pyelonephritis represent the primary urological condition in adults that leads to ESRD. It is therefore not surprising that renal transplant recipients of all ages are regularly assessed both before and after transplantation by an urologist.[2] Actually, renal transplantation should be offered to all patients with advanced and irreversible renal failure, comprising stage IV disease with a glomerular filtration rate of under 30 mL/min/1.73 m^2. Nevertheless, while the number of organs available for transplantation is limited, the number of patients with ESRD is increasing.[3-5]

Renal transplantation can be classified in deceased-donor or living-donor transplantation, depending on the source of the donor organ.

In the last years, the demand for kidney transplantation has increased dramatically, which has been associated with an increase in living-donor organ procurement. Most organs still come from deceased donors, brain-dead donors, and from the non-heart-beating donor (NHBD) procurement program, which is now used

by several transplant centres.[6] Generally, the gap between the supply and demand of kidneys has tended to stabilize in countries with a donation rate greater than 40 kidneys per million population, but has increased in countries with a lower donation rate. The elderly donors (>60 years) and the living-donors represent a valid solution to this problem. Moreover, the advantages of live-donor renal transplantation are several.

First, cold ischemia time is significantly shorter than in cadaveric-donor kidney transplantation and thus there is an almost complete absence of ischemic injury to the transplanted kidney. This results in a relative insensitivity to poor tissue matching and better long-term function. Second, kidneys harvested from living donors represent perfect organs from perfectly healthy donors, ensuring a better graft and recipient survival compared with human leukocyte antigen (HLA)–matched cadaveric transplants. Third, live-donor nephrectomy (LDN) reduces the waiting time for the recipient and therefore allows renal transplantation earlier, with the recipient still in better general condition and health.[7-9]

The purpose of the present review is to update the recent published literature regarding the technical aspects, diagnosis and the urological complications associated with renal transplantation.

Materials and methods

A comprehensive literature review was performed using PubMed and Thomson-Reuters Web of Science between February 2014 and June 2016. Using free-text protocol, the following terms were applied: "chronic kidney failure", "renal transplantation", "robot-assisted surgery", "laparoscopy", "living donor nephrectomy", "surgical techniques", "urological complications".

Review articles, editorials, commentaries, and letters to the editor were included only if deemed to contain relevant information. In addition, cited references from the selected articles and from review articles retrieved in the search were assessed for significant manuscripts not previously included. Subsequently, studies published only as abstract or presented without abstract, and reports from meetings and studies not published in English were not included in the review. Lastly, 33 articles were selected.

Results

Technical aspects

Robotic kidney transplantation

In most surgical disciplines where minimally invasive techniques are established, laparoscopic procedures (with or without robotic assistance) are believed to allow superior outcomes over their open counterparts with less postoperative pain, shorter length of stay, and/or less blood loss among other potential benefits.[10] These goals may assume even greater importance in kidney transplantation (KT) patients due to their already fragile health and the effects of immunosuppression on healing and complications. Laparoscopic techniques, although well established for donor nephrectomy,[12-15] have not been significantly adopted in recipient surgery. Performing the critical vascular anastomoses laparoscopically is a challenging task and may have hindered adoption. Another potential barrier is the ability to maintain cold ischemia of the graft. Renal cooling reduces ischemic injury and improves graft function.[16] Although laparoscopic techniques of renal cooling have been attempted (primarily in partial nephrectomy), they are not routinely used because they are cumbersome and poorly reproducible.[17-21] Therefore, the initial studies of robotic kidney transplantation (RKT) were performed under warm ischemia.[22, 23]

In 2010, Giulianotti *et al*. [22] reported a technique of RKT without renal cooling, describing a slightly slower return of graft function. Considering that warm ischemia may have played a role in the slight delay in recovery of graft function, in 2014 Menon *et al*. [14, 15] sought to develop a technique for RKT that eliminated warm ischemia during the recipient surgery by using regional hypothermia. Fifty patients underwent RKT successfully. Most grafts were left- sided (88.0%) and had a single renal artery (80.0%). Mean graft glomerular filtration rate was 46.7 mL/min. All grafts were cooled to 18-20° C with no change in core body temperature. All grafts functioned immediately post-transplant and the mean serum creatinine level at discharge was 1.3 mg/dL.

No patient developed anastomotic leaks, wound complications, or wound infections. No patient experienced delayed graft function, vascular or urine leaks, wound complications, or wound infections. One patient developed acute cellular rejection and was successfully

treated with good response to steroids. Two of the 50 patients were re-explored, one during the phase 1 studies and an additional patient in the phase 2 study was explored immediately following skin closure for low blood flow on Doppler ultrasound and lack of urine production.

The results of these two studies were encouraging and could demonstrate that RKT with regional hypothermia is safe and reproducible when performed by a team skilled in robotic surgery. In the same year, Abaza *et al*. [24] reported postoperative functional outcomes in 39 patients who underwent RKT with regional hypothermia. At a mean follow-up of 3 months, all of the grafts functioned. Overall, it was recoreded a marked reduction in pain and analgesic requirement compared with patients undergoing open KT, propensity towards quicker graft recovery and lower complication rate.

Actually, the only study reporting 6 month follow-up after RKT was published in 2015 by Sood *et al*.,[25] reporting 67 consecutive end-stage renal disease patients underwent live-donor robotic KT at a single tertiary care institution between January 2013 and June 2014.

All patients successfully underwent robotic KT with regional hypothermia. The mean graft-surface temperature was 19.2° C with zero incidence of systemic hypothermia. None of the cases required conversion to open surgery. There were no instances of graft vascular thromboses/stenoses/leaks and no delayed graft function. Mean 6-month serum creatinine was 1.2 mg/dL. Patient survival was 96.3%, and death-censored graft survival was 100% at a median follow-up of 13.4 months.

Although prospective randomized study comparing RKT and OKT are still missing, minimally invasive KT appears to be a safe surgical alternative to the standard open approach of KT.

RKT is associated with reduced postoperative pain, analgesic requirement, and better cosmesis, even if presenting excellent graft outcomes.

Dual kidney transplantation

There is a well-known and amply demonstrated negative effect of an age-related low nephron mass on graft survival, especially in kidneys transplanted from 'expanded criteria' donors. This carries an inherent risk of poor long-term outcome, but has been balanced by transplanting both donor kidneys into a single recipient (dual kidney transplantation, DKT).[26]

Although no randomized prospective studies comparing the results of single and dual kidney transplantation from elderly donors have been published, several authors have reported acceptable graft survival and renal function with the utilization of DKT, sometimes when those kidneys have been considered unacceptable to others.[26-30]

Furthermore, if the kidneys are appropriately evaluated,[31] DKT represents a means of increasing the number of transplants performed by widening the donor pool.

Considering the literature in the last 2 years, we found only new 4 studies on DKT.

In 2016, Mariani A *et al*. [32] reported their experience with 38 DKT. Delayed graft function was present in 21 recipients. Explantation of both kidneys was performed in 1 patient and explantation of 1 kidney in 6 patients. Post-operative complications were present in 8 patients and 5 patients returned to hemodialysis after DKT. One recipient died of medical post-operative sepsis. Graft survival and patient survival were 86.84% and 97.93%, respectively.

The authors could confirm that strategy of DKT allocation in elderly recipients is safe, even if it would be optimized the selection of the recipients for DKT not to disadvantage younger patients in the transplant waiting list.

Similarly, Stratta *et al*. [33] conducted a single-center retrospective review of outcomes in adult recipients of DKTs from adult marginal deceased donors (DD) defined by limited renal functional capacity.

Over 11.5 yr, 72 DKTS were performed with an actual patient and graft survival rates of 84.7% and 70.8%, respectively, at a mean follow-up of 58 months. One year and death-censored graft survival rates were 90% and 80%, respectively. The incidence of delayed graft function DGF was 25%; with two cases (2.8%) of primary non-function.

Even this study supported DKT, using kidneys from adult marginal DDs that otherwise might be discarded, as a viable option to counteract the growing shortage of acceptable single kidneys, with excellent medium-term outcomes.

Always in 2016, De Paolis *et al*. [34] reported a retrospective assessment of 99 patients who underwent renal transplantation with kidneys harvested from expanded

criteria donors (ECD) and who were included in two groups: SKT (67 recipients that received a single kidney) and DKT (32 patients that received dual kidney transplant). The transplantation of kidneys obtained from expanded criteria donor, allowed increase in the number of kidney transplants and in the respect of values of biopsy score and the donor renal function, showed in single or dual kidney transplantation with similar graft and patient survival.

If DKT has been demonstrated a valid surgical alternative, there are still a question concerning the optimal immunosuppression therapy which should be used in these patients.[35]

Because of the increased risk of poor graft function, calcineurin inhibitor (CNI)-induced nephrotoxicity, increased incidence of infections, cardiovascular risk, and malignancies, elderly recipients of an ECD kidney transplant are a special population that requires a tailored immunosuppressive regimen. Recipients of ECD kidneys are often excluded from transplant trials and, therefore, the optimal induction and maintenance immunosuppressive regimen for them is not known. Approaches are largely center specific and based upon expert opinion. Some data suggest that antithymocyte globulin might be the preferred induction agent for elderly recipients of ECD kidneys. Maintenance regimens that spare CNIs have been advocated, especially for older recipients of ECD kidneys. CNI-free regimens are not universally accepted due to occasionally high rejection rates. However, reduced CNI exposure and CNI-free regimens based on mammalian target of rapamycin inhibitors have shown acceptable outcomes in appropriately selected ECD transplant recipients.

ABO incompatible kidney transplantation: results and complications

Considering the shortage of available organs for transplantation, efforts have been made worldwide to expand the donor pool. For living donor kidney transplantation, the expansion of new and potent immunosuppressive drugs, allowed us to overcome traditional "immunologic barriers" as blood group incompatibility and transplantation to recipients with preformed donor specific antibodies, which had previously been considered as "impossible". Especially in countries with long waiting lists for patients on maintenance dialysis, AB0-incompatible (AB0i) kidney transplantation constitutes an attractive alternative therapeutic option.[36] Although the risks for graft rejection are still high, in the last years several studies reported new encouraging restults. In 2015 Melexopoulou *et al*.[37] compared 30 consecutive AB0i *vs.* AB0 compatible (AB0c) kidney transplantation. All patients received rituximab one month prior to transplantation and intravenous immunoglobulin and oral immunosuppression consisting of tacrolimus in combination with either everolimus or mycophenolate acid. Patient survival in ABOi group in comparison to ABOc group at 1, 3, 5 and 8 years did not differ significantly (100% *vs.* 100%, 96% *vs.* 100%, 92% *vs.* 100% and 92% *vs.* 100%, P=ns). None of the patients in the ABOi group developed acute or chronic antibody- mediated rejection evidenced by histological signs. Four patients (13.3%) in the ABOi group and 3 (10%) in the ABOc group experienced acute cellular rejection, which was treated successfully in all cases. Bacterial and viral infections were also similar between the two groups.

The safety of ABOi kidney transplantation was also confirmed in a recent multi-institutional study, analyzing the outcomes of 1420 cases.

Three-year death-censored graft survival and patient survival were virtually identical for ABO-incompatible transplants versus matched and center controls. Early patient survival was lower in ABO-incompatible grafts because of a higher rate of early infectious death.[38]

An issue of special interest in AB0i transplantation is the concern about the incidence of infectious and hemorrhagic complications.[39-41] Concerning the risk for postoperative bleeding, Renner suggested that postoperative hemorrhage after AB0i kidney transplantation was associated with the amount of heparin used for graft perfusion after donor nephrectomy,[39] whereas a recent study concluded that impairment of hemostatic factors at pre-transplant explained the increased risk of a post-transplant bleed in AB0-i patients.[40]

Laparoscopic living-donor nephrectomy

In 2010 Greco *et al*.[9] have demonstrated that both laparoscopic (LDN) and open (ODN) techniques of donor nephrectomy have comparable complications and equal functional graft outcomes. Laparoscopic techniques of donor nephrectomy may have advantages in postoperative recovery and duration of pain, but these differences

are difficult to quantify and difficult to assess in their impact on long-term outcome. Laparoscopic techniques of donor nephrectomy have reported disadvantages in terms of longer operating time (OPT) and longer warm ischemia time (WIT). However, the available evidence suggests that the longer WITs do not result in reduced graft function or survival, with the caveat that follow-up for transplantations following laparoscopic donor nephrectomy is still considerably shorter than for the open donor techniques. Furthermore, in a recent study, LDN was associated with decreased donor intraoperative complications and hospital length of stay but higher rates of readmission and long-term complications.[41]

Based on the actual evidence, both LDN and ODN can be considered standard of care in experienced hands.

Selecting an appropriate donor for LDN requires a careful evaluation and the involvement of various medical disciplines. Irrespective of the chosen technique of LDN, the left kidney is generally preferred for renal transplantation by most surgeons because of its longer vein, which facilitates the vascular anastomotic procedure.[9, 42] The right kidney is selected when significant anatomic variations of the left renal vascular supply are seen on preoperative donor angiography or if split renal function on nuclear scintigraphy is <40% in the right kidney, according to the principle that the kidney with the better function remains with the donor.[9]

Nevertheless, a meta-analysis published in 2015 assessed the safety and efficacy of right versus left LDN.[43] There were 15 studies included with 3073 patients The right group had shorter operative time and lower operative blood loss than the left group. There was a higher rate of overall donor intraoperative complications in the left group, but no differences between groups in hospital stay, delayed graft function, recipient 1-year graft loss, conversion to open donor nephrectomy, donor blood transfusion, and donor or recipient postoperative complications. This meta-analysis could demonstrate that right and left LDN were similar in the effect of surgery and postoperative graft function, even if the longer renal vein of the left kidney could decrease operative difficulty.

In 2016, a retrospective study [44] performed an analysis of UNOS database for adult living donor transplants, considering the differences for right *vs.* left LDN. Also in this study, the differences between left and right kidney donor nephrectomies on recipient outcomes were extremely small and not significant. We believe that the choice for right/left LDN should be based only surgeon experience and on renal function.

Evolution of minimally invasive techniques has furthered an impetus in the surgical community to reduce the invasiveness of laparoscopic surgery. More recently, novel minimally invasive techniques have been introduced in this setting, *e.g.* laparoendoscopic single-site surgery (LESS), natural orifice transluminal endoscopic surgery (NOTES)-assisted laparoscopy, mini-laparoscopy, and robot-assisted laparoscopy.[45] In a systematic review and meta-analysis of studies comparing laparoscopic and LESS nephrectomy, including over 1000 cases, Fan *et al*. [46] showed that LESS patients benefit from less postoperative pain, lower analgesic requirement, shorter hospital stay, faster recovery time, and not surprisingly, a better cosmetic outcome. There were no significant differences in other main surgical outcomes and postoperative renal function. Nevertheless, the authors found that LESS takes more operative time and the procedure carries a greater chance of conversion.

Application of LESS to donor nephrectomy poses unique challenges and risks. However, the concept of minimising the skin incision in a healthy (and frequently young) individual is appealing and can be regarded as a potential incentive to organ donation.

A recent meta-analysis has systematically reviewed the available evidence comparing the outcomes of LESS with those of conventional LDN.[47]

Nine publications meeting eligibility criteria were identified, including 461 LESS-LDN and 1006 LDN cases. There were more left-side cases in the LESS-LDN group (96.5% *vs.* 88.6%, P<0.001). Meta-analysis of extractable data showed that LDN had a shorter operative time, without a significant difference in warm ischaemia time. Hospital stay was similar as well as the visual analogue pain score at discharge, but the analgesic requirement was lower for LESS-LDN. Moreover, there was no difference in the postoperative complication rate. Renal function of the recipient, as based on creatinine levels at 1 month, showed similar outcomes between groups. LESS-LDN represents an emerging option for living kidney donation. This procedure offers comparable surgical and early functional outcomes to the conventional LDN, with a lower analgesic requirement. However, it is more technically challenging than LDN, as shown by a greater likelihood of conversion. The role of LESS-LDN remains to be defined.

Unfortunately, up to date, we have still only few prospective studies concerning NOTES-assisted LDN.

Recently, Peri *et al*. [48] reported their experience with 78 women underwent transvaginal NOTES-assisted LDN.

The pre- and post- FSFI (Female Sexual Function Index) scores was 27.47±1.02/27.27±1.10 (P>0.05) and all sexually active women reported unaltered sexual function after surgery and satisfaction with the results. Transvaginal NOTES-assisted LDN resulted to be safe with excellent cosmetic results and no sexual effect.

In 2015, a prospective data analysis included a total of 27 female donors who underwent laparoscopic removal of a single kidney for living donor nephrectomy through conventional or transvaginal route. No significant differences between the transvaginal and conventional groups were observed in VAS scores and morphine consumption at postoperative 1, 3, 6, 12, and 24 hours, thus suggesting that, with a more desirable cosmetic result, transvaginal NOTES- assisted LDN is a suitable new minimally invasive laparoscopic technique associated with reduced postoperative pain and analgesic requirements in select women.[49]

Despite promising results, randomized controlled studies with longer follow-up are warranted to further elucidate the potential of transvaginal NOTES-assisted LDN.

Urological complications: diagnosis and management

Urologic complications comprise the second most common adverse post-transplant event, occurring in 2.5% to 14% of patients and are associated with high morbidity, graft loss, and mortality. Early and late urologic complications, including hematuria, hematoma, lymphocele, urine leak, ureteral stricture, nephrolithiasis, and vesicoureteral reflux, represent common complications after RT.[50-52] Results have improved over the past decade as a direct application of less invasive endourologic diagnostic and therapeutic techniques of the surgical complications.[50-52]

A recent study evaluated traditional and novel potential risk factors for urologic complications following RT.[53]

Six houndred thirty-five consecutive RT recipients were evaluated for overall urologic complications accounting for donor, recipient, and transplant characteristics. Urologic complications occurred in 29 cases (4.6%) at a median of 40 days post-transplantation and included 17 ureteral strictures (2.6%), five (0.8%) ureteral obstructions due to donor-derived stones or intraluminal thrombus, and seven urine leaks (1.1%). All except two complications occurred within the first year of transplantation. Risk factor for urologic complications on multivariate analysis was renal artery multiplicity, whereas donation after cardiac death, non-mandatory national share kidneys, donor peak serum creatinine >1.5 mg/dL or creatinine phosphokinase >1000 IU/L, and donor down time were not associated with urologic complications.

Another known complication after RT is represented by transplant renal artery stenosis (TRAS) whose incidence was reported from 1% to 23%.[54] Patients with this complication may present clinically silent for a long time, or develop resistant hypertension, graft dysfunction, and even graft loss.[54] The main risk factors of TRAS include atherosclerotic disease in the donor kidney or in the recipient arteries, immunological factors, trauma during the operation, and anatomical abnormalities in the graft.[55]

Diagnosis of TRAS can be done by routine follow-up, normally by noninvasive imaging studies, such as Doppler ultrasonography (DUS) [56, 57] and contrast-enhanced magnetic resonance imaging (MRI). Angiography is the gold-standard study and can provide the definitive diagnosis and also image guidance to subsequent endovascular therapy.[58]

Several studies demonstrated that the endovascular approach for TRAS is safe and balloon angioplastyis is actually considered the treatment of choice for TRAS, resulting effective for restore and maintain the renal function in transplant kidney grafts with a low rate of restenosis.[59, 60] In 2015, Braga *et al.* [59] reported their experience in 16 patients who developed TRAS after RT. Mean time from transplantation to TRAS diagnosis was 201.8 days. Stenoses or hemodynamic significant kinkings were located at the anastomosis (7), proximal (5) and middle (4) portions of the transplant artery. All patients were treated with angioplasty and primary balloon-expanding stenting. Early technical success was 93.75% and local complication rate was 12.5%. No deaths occurred. Mean serum creatinine level dropped from 3.87 mg/dL to 2.91 mg/dL after 24 hours; 1.85 mg/dL after one month; and 1.67 mg/dL after three months.

Mean estimated glomerular filtration rate increased from 31.60 mL/min to 39.53 mL/min after 24 hours; 50.92 mL/min after one month; and 55.05 mL/min after three months. Doppler ultrasound criteria normalized after the procedure. Only one patient had a restenosis and required surgical intervention to restore graft function.

Another recent study [60] investigated the safety and efficiency of TRAS endovascular therapy in 17 patients presenting with TRAS. The median time to presentation was 40 days. The predominant presentation was graft function alteration (82.3%). Percutaneous balloon angioplasty was performed in five patients (29.4%), while stenting was performed in the remaining 12 patients (70.6%). The stenosis-free primary patency rate and freedom from reintervention rate was higher after stenting (76.5% and 88.2%, respectively). The median follow-up was 19.6 months with 88.2% graft survival. Serum creatinine levels decreased significantly and the glomerular filtration rates increased from 32.1 mL/min to 41.7 mL/min.

Basing on the actual literature, in presence of TRAS after RT, an endovascular approach should be always used and balloon angioplasty, alone or using stent, should be preferred.

Although intraoperative vascular complications during renal transplantation are rare, injuries associated with prolonged ischemia may lead to graft threatening early and late complications. In 2015, Mekeel *et al*. [61] described a novel technique for intraoperative repair of vascular complications in five patients over a 3-year period. The method consisted of rapid graft nephrectomy and re-preservation of the graft with cold University of Wisconsin solution, which allows for controlled/precise back table repair of the vascular injury without incurring prolonged warm ischemia time. In three cases, the donor renal vein (2) and donor renal artery (1) were damaged and required back table reconstruction. In two cases, the recipient iliac artery needed reconstruction. Three of the five cases used deceased donor iliac vessels from another donor for reconstruction. All grafts were functioning at 17 months after transplant, with a median serum of 1.61 mg/dL. This study demonstrated the effectiveness of kidney clamp, perfuse, resuscitate as an effective intraoperative technique to salvage grafts after vascular injury. Although the grafts suffered from delayed or slow graft function, excellent long-term function was attainable.

Another common complication associated to RT is represented by the development of postoperative lymphocele and lymphorragia as due to the extensive perivascular dissection of the lymphatics associated with iliac vessels of the recipient. Nevertheless, during the past three decades other factors such as certain immunosuppressive drugs, obesity, delayed graft function, alteration in the blood coagulation and rejection episodes have been correlated with the development of lymphatic complications after RT.[52, 62] Surgical causes of lymphatic complications are: 1) dissection of the lymphatic around the iliac vessels of the recipient; and 2) dissection of renal lymphatic of the donor either during the time of organ procurement surgery or during 'back table' work. If these fragile lymphatic tissues are not clipped or sutured, they remain open and become an important source of free retroperitoneal lymph, setting up the basis for the development of lymphatic complications. Accordingly, different surgical techniques that implied less lymphatic derangement of the recipients, such as the implantation of the allograft in the omolateral iliac fossa with anastomoses of the renal artery and vein on the common iliac vessels, resulted in a lower rate of lymphocele (2.1 versus 8.5%).[62] Medical causes of lypmhatic complicated are often associated to the immunosuppressive therapy. Consistently, several studies indicated that the use of rapamycin was associated with a significant increase in the incidence of lymphocele compared with other immunosuppressive regimens.[62-64]

Treatment of lymphocele should start with minimally invasive measures.[52, 62] Generally, lymphatic disorders resolve spontaneously and do not require treatment but rather only a close fol- low-up. The incidence of lymphoceles requiring treatment varies from 0.04 to 14.6%.[65] In the last 2 years, we found only 1 study concerning new surgical strategy in the therapy of lymphocele after RT. In 2015, a review of the literature presented the drainage using a Tenckhoff catheter as effective treatment for recurrence of symptomatic lymphoceles.[66] The reports covered 15 cases in which 11 patients were treated for a primary lymphocele whereas 4 were treated for a recurring lymphocele.

Intraperitoneal drainage with a Tenckhoff catheter seemed to be an effective and safe method for treating recurrent, symptomatic lymphoceles after renal transplantation, with no evidence of lymphocele recurrence or infections.

A rare complication of RT is represented by kidney stones, which may be transplanted with the kidney or may be acquired. The incidence is less than 1% of transplants. The stones manifest themselves by haematuria, infection, or obstruction. Nevertheless, nephrolithiasis in recipients does not have a significant effect on the transplant survival.[67]

In 2015, Sevinc *et al*. [68] evaluated the safety and effectiveness of flexible ureterorenoscopy (F-URS) and laser lithotripsy for the treatment of allograft kidney lithiasis. A total of 5 patients underwent 6 F-URS procedures and laser lithotripsy operations for renal graft lithiasis. The mean stone size was 9.2 mm (7.5-11 mm). F-URS resulted to be a safe, effective, and minimally invasive treatment modality for small- and medium-sized stones in allograft kidney lithiasis.

Conclusions

Renal transplantation represents actually the most effective therapy in patients with end-stage renal failure as it is cost effective, allows for a normal life style and reduces the risk of mortality from dialysis related complications. In the last 2 years, we have assisted to an increased number of published studies on the use of robot-assisted surgery for RT. Although prospective randomized study comparing RKT and OKT are still missing, minimally invasive KT is a safe surgical alternative with excellent graft outcomes. Similarly, LDN has demonstrated to present comparable complications and equal functional graft outcomes to open living donor nephrectomy. We could expect that in the next future RKT and LDN are both destined to replace open surgery also in a special field as renal transplanatation.

Considering the shortage of available organs for transplantation, efforts have been made worldwide to expand the donor pool. In this scenario DKT and AB0i kidney transplantation represent a valid form of renal transplantation, reporting acceptable graft survival and renal function also in kidneys considered unacceptable to others.

Concerning the urological complications, they represent the most common surgical complication after renal transplantation, causing significant morbidity and mortality. Nevertheless, the frequency of these complications has dropped significantly and results have improved over the past decade as a direct application of less invasive endourologic diagnostic and new therapeutic surgical techniques.

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