The French Journal of Urology 35 (2025) 102940

Contents lists available at ScienceDirect

The French Journal of Urology

journal homepage: www.elsevier.com/locate/fjurol

Recommendations

Allograft nephrectomy: Indications and surgical techniques. Association Française d'Urologie and Société Francophone de Transplantation guidelines

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ARTICLE INFO

Keywords:
Kidney transplantation
Nephrectomy
Embolization
Therapeutic
Histocompatibility antigens
Immunization

ABSTRACT

Introduction: After kidney graft failure, the question of maintaining or removing the graft arises. The indications and surgical techniques of transplant nephrectomy as well as the peri-procedure immunosuppressor management are poorly codified and are not the subject of any specific guidelines. The aim of this work was to provide clinical guidelines focused on four clinical questions: (i) indications and timing of transplant nephrectomy; (ii) immunological impact and immunosuppressant management before, during and after transplant nephrectomy; (iii) surgical techniques; and (iv) alternatives to transplant nephrectomy/conservative treatments (e.g. embolization).

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http://doi.org/10.1016/j.fjurol.2025.102940
Received 15 July 2025; Accepted 21 July 2025

Methods: These guidelines were based on a systematic review of studies published between January 2000 and March 2024 performed following the Preferred Reporting Items for Systematic Reviews and Meta-Analyses criteria. In total, 2144 publications were screened and 84 met the inclusion criteria. These guidelines were elaborated by a multidisciplinary task force and reviewed by independent experts.
Results: Routine transplant nephrectomy to limit anti-HLA immunization is not recommended (Grade C). The indications for early and late transplant nephrectomy have been clarified as well as the importance of patient information. The data do not provide conclusive evidence in favor of the abrupt discontinuation or gradual withdrawal of immunosuppressors after transplant nephrectomy (expert agreement, EA). Decision-making about immunosuppressor tapering or low-dose immunosuppressor maintenance after transplant nephrectomy should take into account the perspective of retransplantation and the development of anti-HLA antibodies (EA). Transplant nephrectomy should be carried out using the intracapsular approach in patients with corticosteroid-resistant graft intolerance syndrome (Grade C). The extracapsular approach should be chosen when transplant nephrectomy is performed early or for kidney graft tumors and the intracapsular approach for late procedures (EA). Embolization may be proposed as an alternative to graft nephrectomy in patients with graft intolerance syndrome and frailty or who refuse surgery (EA).
Conclusions: These guidelines describe the indications, surgical techniques, immunological context and alternatives to transplant nephrectomy in order to improve the management of patients with kidney graft failure. Many questions remain about the immunological impact of transplant nephrectomy.

1. Introduction

Despite advances in regular monitoring and immunosuppressive therapy, kidney transplants often do not work for the whole recipient's lifetime. Although nearly half of graft losses are due to the death of the recipient with a functioning graft [1], many patients return to dialysis because of graft failure (≈40%) [1]. In a cohort of 1000 patients who underwent kidney transplantation in Belgium, late death-censored graft failure (>1 year) was mainly related to chronic allograft dysfunction (31.1%), acute or chronic rejection (17.9%), recurrence of the recipient's initial nephropathy in the graft (11.3%), hemodynamic causes, shock, hepato- and cardio-renal syndromes (11.3%), BK-virus-related nephropathy (10.4%), tumor in the graft (1.9%), vascular thrombosis, narrowing and necrosis of the graft ureter (1.9%), and infections (0.6%) [1]. The causes of early transplant failure (< 1 year) were mainly vascular and ureteric complications (33.3%), primary non-function (25%), acute rejection (16.7%), BK-virus-related nephropathy (10.4%), hemodynamic causes (6.3%), and recurrence of the recipient's initial nephropathy in the graft (2.1%).

Kidney allograft survival has not improved in the last four decades. In France, the median renal allograft survival was 10.7 years for patients who underwent transplantation between 1986 and 1990 and reached 14.8 years for patients who received a graft between 1996 and 2000 [2]. Then, it gradually decreased with the increase in the recipients and donors' age to 11 years between 2012 and 2014. According to the French Renal Epidemiology and Information Network (REIN) registry, in 2022, 41,422 patients had a functioning kidney allograft in France and 1091 recipients experienced graft failure [3]. Of these 1,091 patients, 83.7% returned to hemodialysis, 4.2% started peritoneal dialysis, 0.3% received another graft within one month after graft failure, and 1.8% died early after graft failure before starting dialysis.

Recipients with graft failure represent a special population [4]. The return to dialysis is often late and is started in emergencies in half of them. Moreover, it is poorly accepted by the patient and the transplant team. Mortality increases after transplant failure and return to dialysis mainly due to cardiovascular and infectious causes. Many of these patients have a chronic inflammatory syndrome and require more erythropoietin due to multiple causes (effects of chronic rejection, immunosuppression maintenance, and possible occult graft infections) that increase their morbidity and mortality [4]. According to a study by the North American Organ Procurement and Transplantation Network/Scientific Registry of Transplant Recipients (OPTN/SRTR), mortality increased by 78% in patients with failed renal allograft who returned to dialysis (HR 1.78; 95% IC [1.71–1.86]; $P < 0.0001$) compared to transplant-naïve dialyzed patients on the waiting list [5]. In France, 9.7% of patients with failed allograft die within 3 months after returning to hemodialysis [3].

Once graft failure has been established, two major questions concern immunosuppression management and maintenance or not of the kidney transplant. Maintaining immunosuppression preserves the residual kidney function, which is important for the quality of life in hemodialysis and essential in peritoneal dialysis [4]. However, it increases the risk of cardiovascular and infectious events and also of malignancies and diabetes. Abrupt immunosuppression discontinuation increases the risk of graft intolerance syndrome and anti-HLA immunization, which may be a problem for a possible retransplantation project. Currently, there is no well-established consensus on immunosuppressor management after graft failure; however, antimetabolites are often reduced as soon as dialysis is initiated and anti-calcineurin and corticosteroids are gradually decreased [6,7]. Then, the complete withdrawal or maintenance of immunosuppressors is decided in function of the perspective of a new graft, the patient's morbidity, the occurrence of graft intolerance syndrome, and immunosuppressor drug tolerance.

Graft management after failure (graft nephrectomy or not) is a debated issue. Currently, there are guidelines on the management of patients after graft failure [6,7], but not specifically on kidney allograft nephrectomy. Some studies suggested that transplant nephrectomy may be necessary in patients with graft intolerance syndrome, chronic infection, vascular thrombosis, or to make space for a new graft [6,8,9]. Other indications are more discussed, such as the need to stop immunosuppression, primary non-function, chronic BK-virus -related nephropathy, and systematic transplant nephrectomy before relisting. The timing of transplant nephrectomy also is important. In the North American MEDICARE registry ($n = 19,107$ patients with graft failure), transplant nephrectomy was performed in 56% of the 3,707 patients who had graft failure in the year after transplantation and in 27% of the other 15,400 patients with graft failure occurring later after transplantation [10]. Overall, 89.3% of allograft nephrectomies were performed within one year of graft failure. It also appears that allograft nephrectomy is performed more frequently in children (41% of 186 pediatric recipients across 14 transplant centers in a USA cohort study) [11]. Therefore, it is necessary to determine whether the pediatric population presents specific features concerning the indications and practice of transplant nephrectomy.

The relationship between graft maintenance or nephrectomy and immunity is not well established and much discussed. Many studies showed an increase in Panel Reactive Antibody (PRA) rates after allograft nephrectomy, particularly in the 6 months following the procedure [4]. In a French study of 69 patients with graft failure, the rates of donor-specific antibodies (DSA) detected by the Luminex® assay were 14% before and 81% after allograft nephrectomy (median follow-up of 680 days) in the 48 patients who underwent allograft nephrectomy [12]. In the 21 patients who did not undergo allograft nephrectomy, DSA rate was 12% at graft failure and increased to 52% after a median follow-up of 836 days ($P = 0.02$). Even when graft removal is performed early after transplantation, anti-HLA antibodies are produced. Indeed, in a French study of 32 patients who underwent allograft nephrectomy within 3 months after

transplantation, DSA were detected (Luminex® assay) in 57% of patients and non-donor-specific anti-HLA antibodies in 64% of patients [13]. According to some authors, allograft nephrectomy would act as an immunizing process responsible for antigenic stimulation, leading to the production of the new anti-HLA antibody. For other authors, DSA are present before allograft nephrectomy, but are fixed to their target and undetectable in the blood. Allograft nephrectomy would only reveal these pre-existing antibodies (sponge theory) [4]. This theory has led to propose systematic allograft nephrectomy before relisting in order to reveal possible anti-HLA antibodies. A prospective study in which patients were randomized between systematic allograft nephrectomy vs. graft maintenance was performed in France from March 2013 to November 2022 (DESYRE study, ANSM identifier: 2012-A00421-42, NLM identifier: NCT01817504); however, the results are not available yet.

The prevalence of allograft nephrectomy varies greatly depending on the center, ranging from 1.26% to 38% of patients with graft failure. Most studies reported allograft nephrectomy rates between 4 and 14% [14–19]. In France, data from the national health insurance fund show that 306 allograft nephrectomies were performed in 2023 and the mean hospital stay was 15.6 days [20]. The morbidity and mortality of this procedure are significant. The complication rate is between 25 and 31% [15,19], mainly due to intra- and postoperative bleeding, hematoma, surgical site infection, sepsis, cardiovascular pathology decompensation. Allograft nephrectomy mortality is between 1.5 and 9.5% [19,21]. Transplant nephrectomy is often complicated by inflammation around the graft, particularly when performed for graft intolerance syndrome, as well as by the patients' significant comorbidity, tissues weakened by long-term corticosteroid treatment, atheromatous vessels, and coagulopathy linked to the chronic kidney disease. The surgical technique is poorly codified. Two techniques are described:

- intracapsular allograft nephrectomy: the kidney transplant capsule is incised and the graft is dissected under the renal capsule, the vessels are clamped "en masse" or electively at the level of the renal hilum;
- extracapsular allograft nephrectomy: this is a classic nephrectomy that can be performed retroperitoneally or transperitoneally [22], but only if the plane of the graft capsule can be dissected.

The intracapsular technique is generally the only possible approach in patients with graft intolerance syndrome where the renal capsule plane cannot be dissected due to inflammation around the graft. Cases of laparoscopic allograft nephrectomies [23–25] or robot-assisted laparoscopy [26–28] have been described.

For patients with frailty and patients who refuse allograft nephrectomy, graft embolization has lower mortality than allograft nephrectomy (0.1%, 95% CI [0.1–0.5] vs. 4%, 95% CI [2–7]) and lower morbidity (1.2%, 95% CI [0.7–2.1] vs. 18%, 95% CI [13–26]) [29]. Its role in the treatment of patients with graft failure remains to be defined.

In this context, the Committee on Transplantation and Chronic Renal disease of the French Association of Urology (CTAFU) and the Francophone Society of Transplantation (SFT) have decided to carry out a systematic review of the literature and to produce clinical practice guidelines to address four clinical questions:

- indications for allograft nephrectomy and timing;
- immunological impact and management of immunosuppressors before, during and after allograft nephrectomy;
- surgical techniques;
- alternatives to allograft nephrectomy.

2. Methods

2.1. Evidence acquisition

These guidelines were based on a systematic review performed following the Preferred Reporting Items for Systematic Reviews and Meta-Analyses (PRISMA) criteria [30].

2.2. Literature search

A systematic literature search was performed in PubMed/Medline® to identify reports (in French or English) on transplant nephrectomy, published between January 2000 and March 2024, following the PRISMA criteria. The full search strategy is in Supplementary Table 1. Publications were selected based on the PICOS criteria:

- population (P): patients with kidney graft failure after a first transplant regardless of their severity or age;
- intervention (I): transplant/graft nephrectomy, different surgical techniques;
- compared intervention (C): other surgical techniques, immunosuppression management, dialysis, embolization;
- outcome (O): morbidity and mortality (cardiovascular impact, immunological impact); side effects (e.g. myocardial infarction, congestive heart failure, sepsis); time to new graft or access to a new graft, post-nephrectomy transplantability, quality of life and acceptability;
- study design (S): meta-analysis, randomized controlled trial, prospective non-randomized study, or retrospective study.

The literature data were completed by literature monitoring (up to June 2024), consultation of the websites of international organizations (e.g. European Association of Urology, American Urological Association, British Transplantation Society, UK Kidney Association, American Society of Transplantation), search of systematic reviews in the Cochrane Library database, and suggestions from the working group members, particularly on studies not indexed in Medline® at the time of the bibliographic search.

2.3. Study selection

The inclusion and exclusion criteria were defined before the study. Only studies on transplant nephrectomy indications or techniques and on alternatives for patients with graft failure after a first transplant, regardless of their severity or age, were included. Publications deemed ineligible were:

- health economic studies because they depend largely on the country healthcare system;
- case reports, general reviews, editorials, letters or comments;
- experimental studies in animals or in vitro;
- studies on aspects of laboratory technology;
- studies on clinical practices;
- studies out of scope (e.g., non kidney-specific, effectiveness of immunosuppressive therapy, transplantation techniques, nephrectomy techniques for living donors, dialysis type, retransplantation, on non-functional graft after cancer).

Studies were selected by the methodologist (DK) using these criteria, after reading the abstract. The selection was independently validated by the steering committee (TC, AF, AG, TP, ADB) and then by the whole working group. The full text of the selected publications was read. After an initial round of data extraction by the steering committee, article selection was confirmed by the steering committee and disagreements were solved by discussion with the working group.

2.4. Project methodology

This project was carried out by the AFU transplantation and end-stage chronic kidney disease committee with a multidisciplinary task force that included urologists, nephrologists, immunologists and other healthcare professionals involved in the management of patients with renal graft failure (e.g., immunology biologists, pediatric surgeons, vascular surgeons). The recommendations were defined following the Clinical Practice Guideline methodology based on the systematic review and the

experts' judgment. The methodological quality of the selected studies was analyzed using dedicated grids. The level of evidence (LoE) of each study and its conclusions was assessed by taking into account the result consistency. These conclusions and the working group members' arguments were used to define the recommendations as follows:

- the recommendation is the clinical practice unanimously acknowledged as the reference by the experts:
- if a clinical practice was considered acceptable on the basis of literature data and expert opinion, but was not unanimously acknowledged as the reference, it is indicated that it can be discussed/proposed;
- in the absence of experts consensus, no recommendation is proposed.

The classification of conclusions by LoE (LoE1 is the highest; LoE4 the lowest) and the recommendation grading [grade A is the highest; grade C the lowest; Expert Agreement (EA) in the absence of data] are based on the grid proposed by the French Higher Health Authority [31]. In October 2024, the document was reviewed using the Appraisal of Guidelines for Research and Evaluation II tool [32] by 33 independent experts from all medical and surgical specialties involved in the management of patients with renal graft failure (10 urologists, 4 nephrologists, 4 pediatric nephrologists, 3 immunologists, 3 vascular surgeons, 2 pediatric urologists, 1 pediatric surgeon, 1 infectiologist and 6 patient representatives). Their comments were incorporated in the final version of the guideline in November 2024. The complete document, including the project rationale, methodology, detailed study analysis, conclusions, recommendations and review process, can be consulted on Urofrance (https://www.urofrance.org/themereco/transplantation/).

3. Results and guidelines

The study selection is outlined in the PRISMA flow diagram (Fig. 1): 2144 publications were screened for eligibility and 82 were selected. After full-text reading, literature monitoring and working group's suggestions, 84 studies were retained for the analysis. The systematic review corresponding to the detailed analysis will be available in a future report.

3.1. Indications for transplant nephrectomy and its timing

For this clinical question, the following studies were included: two recommendations [6,7], three systematic reviews or meta-analyses [33–35], one prospective study (non-randomized) [11], ten comparative studies [8,9,14,17,36–40,41], twenty-two observational studies [10,15,16,18,19,21,42–57], and three retrospective studies [58–60].

3.1.1. Conclusions based on the data analysis

3.1.1.1. Prevalence. The prevalence of transplant nephrectomy varied widely among studies (1.26 to 43%), but was $<10\%$ in most publications (LoE4).

3.1.1.2. Morbidity and mortality. The morbidity of transplant nephrectomy was ~18%, but with strong variability among studies (5 to 59%) [15,16,19,35] (LoE3). Morbidity has decreased significantly since the advent of cyclosporine [14]. It is higher for early than late transplant nephrectomies [10,40,50], and much higher if surgery is performed as an emergency [18,49] (LoE4). The main complications of transplant nephrectectomy are bleeding, surgical site infection, sepsis, multi-visceral failure and vascular complications [14,17,40,60,61] (LoE4).

The mortality after transplant nephrectectomy was ~4%, but with wide variations among studies (0 to 38%) [33,35] (LoE3) [15,21,53] (LoE4).

After retransplantation, recipient survival is similar between patients who underwent or not transplant nephrectomy [33,35] (LoE3).

3.1.1.3. Timing and indications. Transplant nephrectomy can be performed early or late after transplantation , depending on the etiology. Several thresholds are used in the literature (1 month, 2 months, 3 months, 6 months, 12 months) [8,10,17,40,45–48,50,60–62]. According to the literature, the majority of late transplant nephreectomies are performed within 1 year after returning to dialysis [10,18] (LoE4).

Early transplant nephrectomies are mainly indicated for vascular problems (thrombosis of the graft artery or vein, graft rupture, hemorrhage), refractory acute rejection or hyper-acute rejection [8,10,45–48,60,62]. More rarely, transplant nephrectomy is performed early for uncontrolled infection, non-primary function, or the need to stop immunosuppression. According to the literature, early transplant nephrectomy is often performed in an emergency, due to the presence of a vascular complication (arterial or venous thrombosis, bleeding, graft rupture) (LoE4).

Late transplant nephrectomies are mostly indicated for corticoid-resistant graft intolerance syndrome (painful graft tension, fever, hematuria, inflammatory anemia, inflammatory syndrome) [8,10,45–48,60,62]. More rarely, this procedure is performed late for poorly controlled infection, chronic infection, graft or recipient tumor, need to stop immunosuppression, proteinuria, poorly controlled hypertension, need to make room for a future transplant (LoE4).

3.1.1.4. Retransplantation outcomes. The findings on acute rejection, primary non-function, delayed graft function, glomerular filtration rate, complication, graft loss rate and time between loss of renal function and retransplantation in patients who underwent or not transplant nephrectomy are contradictory and did not allow us to conclude. However, it seems that high PRA rate ($>70\%$) is associated with higher risk of acute rejection and delayed graft function [54] (LoE4), and patients who underwent transplant nephrectomy tend to have higher PRA rates [33,35] (LoE3).

3.1.1.5. Pediatric population. In children, transplant nephrectomy rates are higher than in the general population [11]. The advantage of transplant nephrectomy is that immunosuppressive drugs can be discontinued more rapidly, thereby reducing their impact on growth [11] (LOE4).

3.1.1.6. Quality of life, acceptability. The review of the literature carried out by the working group did not find any specific data on the psychological impact of transplant nephrectomy besides the consequences of the kidney graft failure. Indeed, the literature describes the negative psychological impact of dialysis compared with transplantation, which improves the patients' quality of life [63,64] (LoE4). A retrospective single-center study that compared outcomes after early (<3 months post-transplant) and late graft nephrectomy (≥ 3 months post-transplant) reported seven patients with early depression and three patients with "psychosis" in the early graft nephrectomy group [61]. In another study that compared kidney transplant-naive patients on hemodialysis and patients returning to dialysis after graft failure, two patient committed suicide in the "return to dialysis after graft" group [53].

3.1.2. Working group discussion

The working group stresses the importance of explaining the reasons for the indication to the patient because this improves the acceptability of transplant nephrectomy and contributes to better management.

Most of the works analyzed were retrospective, single-center studies, with the associated biases, and had small patient numbers and confounding factors. The results were sometimes contradictory, particularly on the impact of transplant nephrectomy on possible retransplantation. There is heterogeneity in the studies between the groups of patients who underwent transplant nephrectomy and those who did not because data on immunosuppression withdrawal after graft failure were often missing.

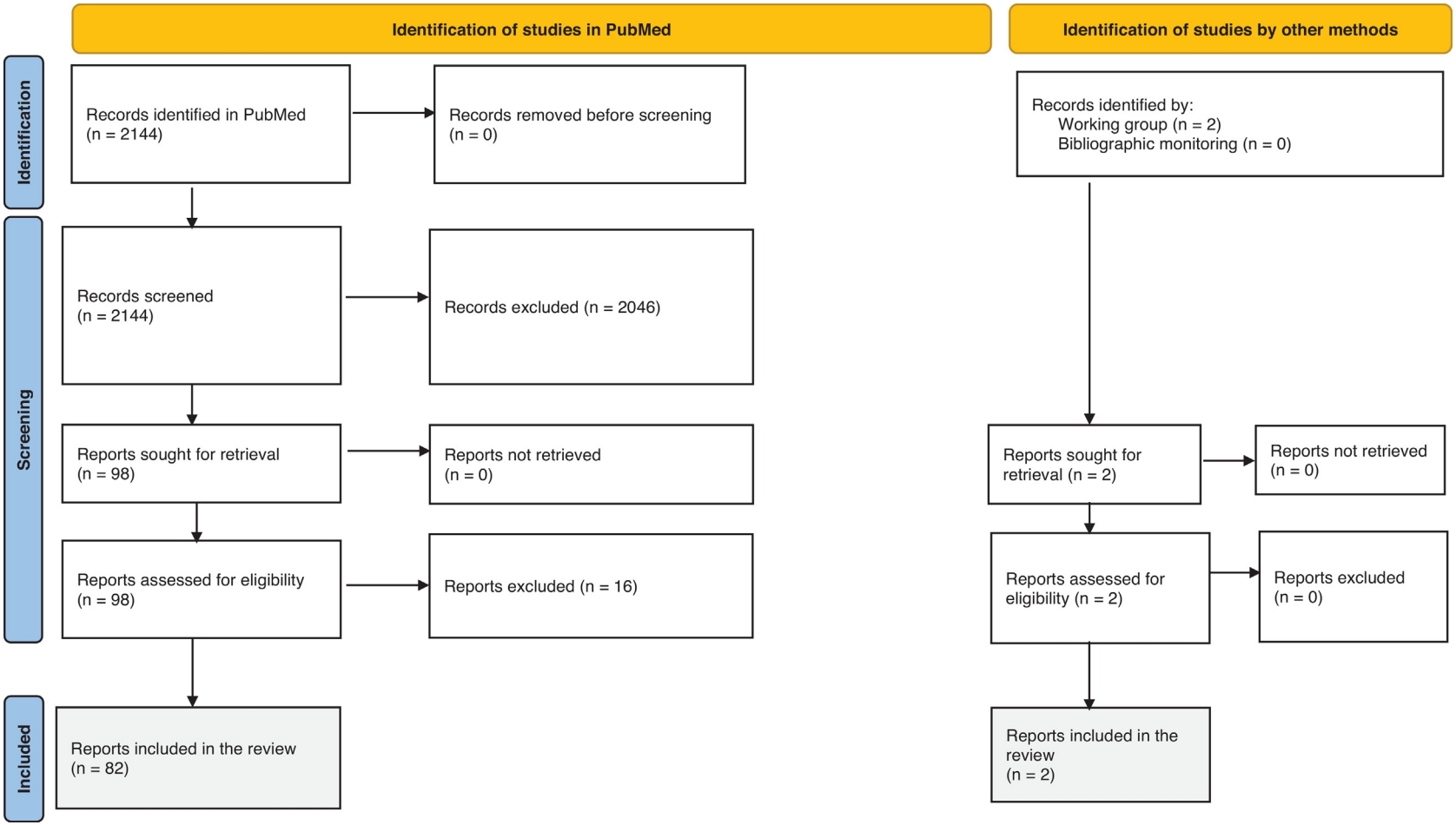

Fig. 1. PRISMA 2020 flow diagram for new systematic reviews that include searches of databases, registers, and other sources.

The working group reminds that the guidelines on renal cell carcinoma in the transplanted kidney published in 2021 [65] and those on urothelial carcinoma in kidney transplant recipients [66] apply to transplant nephrectomy for renal cell carcinoma or upper urinary tract urothelial carcinoma of the kidney graft.

3.1.3. Guidelines

Systematic transplant nephrectomy in the event of asymptomatic graft failure is not recommended in adults and children (Grade C).

Early transplant nephrectomy may be indicated for vascular problems (graft artery or vein thrombosis, graft rupture, uncontrolled hemorrhage), refractory acute rejection or hyper-acute rejection, uncontrolled infection, non-primary function, and when immunosuppression must be stopped (EA).

Late transplant nephrectomy may be proposed for graft intolerance syndrome refractory to corticosteroid treatment, poorly controlled infection, chronic infection, graft or recipient tumor, severe proteinuria, poorly controlled severe hypertension, need to make room for a future transplant (Grade C).

The reasons for removing or not removing the symptomatic non-functional graft (EA) must be discussed with the patient.

3.2. Immunological impact and management of immunosuppressants before, during and after transplant nephrectomy

For this clinical question, the following studies were included: three systematic reviews/meta-analyses [33–35], three comparative studies [12,13,67], fourteen observational studies [62,68–80], and seven retrospective studies [81–87].

3.2.1. Working group conclusions based on the literature data

After early transplant nephrectomy, the type of induction therapy used does not appear to influence morbidity and mortality [17] or alloimmunization at one year post-surgery [13].

In patients with late graft failure, systematic transplant nephrectomy before stopping immunosuppression does not seem to prevent anti-HLA immunization after the return to dialysis [82] (LoE4).

The rate of anti-HLA immunization (PRA rate $>$ 50%) is higher in recipients who underwent transplant nephrectomy than in those who did not [34–35,72] (LoE4).

After late graft failure, immunosuppressive treatment continuation appears to be well tolerated (at least in the early years after return to dialysis) concerning infection or tumor development [68,69] (LoE4).

3.2.2. Working group discussion

After return to dialysis, systematic transplant nephrectomy in the case of asymptomatic graft failure is poorly accepted by patients and doctors (few centers and patients agreed to participate in the DESYRE study) in the absence of proof of its efficacy on alloimmunization. Transplant nephrectomy does not appear to be associated with a reduced risk of anti-HLA immunization compared with immunosuppression tapering. The DESYRE study suggests that maintaining immunosuppression after transplant nephrectomy may reduce the risk of anti-HLA immunization.

Immunization after graft nephrectomy seems to be mainly linked to immunosuppression withdrawal rather than to the surgery (possible role of the vascular patches that remain in place after transplant nephrectomy).

A national hospital program of clinical research (TACITE) will shortly be launched in France with the aim of assessing the benefits of maintaining or not the immunosuppressive treatment based on calcineurin inhibitors on anti-HLA immunization and access to a second kidney transplantation.

The risk of allo-sensitization and maintenance immunosuppression withdrawal was also discussed. The combination of "no immunosuppression" and "transplant nephrectomy" increases the risk of alloimmunization. The "sponge" theory, according to which the preserved failed graft could trap anti-HLA antibodies that will be released into the circulation after transplant nephrectomy, is not supported by recent studies. The majority of anti-HLA antibodies appears before graft nephrectomy in patients with late kidney graft failure, and in the first year after transplant nephrectomy (most often before 6 months) in patients with immediate kidney graft failure.

3.2.3. Guidelines

Transplant nephrectomy in the event of asymptomatic graft failure is not recommended in adults and children (Grade C).

The available data do not allow us to recommend or not the abrupt cessation or gradual reduction of immunosuppressants after transplant nephrectomy (EA).

The decision to stop (abrupt discontinuation/tapering) or continue maintenance immunosuppression after transplant nephrectomy must take into account the retransplantation perspectives and the appearance of anti-HLA antibodies (EA).

Systematic transplant nephrectomy, with the aim of limiting anti-HLA immunization, cannot be recommended (Grade C).

3.3. Surgical techniques

For this clinical question, the following studies were included: one guideline [6], three comparative studies [8,17,88], two observational studies [42,50] and six retrospective studies [22,89–93].

3.3.1. Working group conclusions based on the literature data

In patients with graft intolerance syndrome, intracapsular transplant nephrectomy reduces the operating time, intraoperative bleeding and intraoperative vascular complications [42,88] (LoE4).

Findings are conflicting concerning the comparison of morbidity between extracapsular and intracapsular transplant nephrectomy [42,88] (LoE4) vs. [17,50,89] (LoE4).

Conversely, there is no difference in the impact on alloimmunization [88] (LoE4).

The literature contains several case reports on laparoscopic and robotic-assisted transplant nephrectomy [24–28] that do not allow us to conclude whether it is more beneficial or safer than the open approach.

3.3.2. Working group discussion

Extracapsular transplant nephrectomy may be performed retroperitoneally or intraperitoneally. In the literature, transplant nephrectomy is mainly performed using the extracapsular approach in the case of early procedures ($<$ 6 months) and the intracapsular route in the case of late procedures ($>$ 6 months).

Some authors described the closure of the renal capsule by suture; they suggested that the application of hemostatic compresses or instillation of betadine inside the lodge reduces the rate of postoperative complications.

Intracapsular transplant nephrectomy has the disadvantage of leaving more graft tissue in place than extracapsular transplant nephrectomy. Conversely, the extracapsular procedure carries a greater risk of vascular wounds.

3.3.3. Guidelines

When transplant nephrectomy is indicated for graft intolerance syndrome resistant to corticosteroid treatment, it may be performed via the intracapsular route (Grade C).

Transplant nephrectomy can be via the extracapsular route if performed early and via the intracapsular route if performed late (EA).

Extracapsular transplant nephrectomy is the gold standard in patients with suspected graft malignancy (EA).

Extracapsular transplant nephrectomy may be performed retroperitoneally or intraperitoneally (Grade C).

Robot-assisted laparoscopic transplant nephrectomy is feasible, but cannot be recommended based on the current state of knowledge (EA).

3.4. Alternatives to transplant nephrectomy

For this clinical question, the following studies were included: two guidelines [7,94], one systematic review/meta-analysis [29], one comparative study [95], seven observational studies [96–102], and three retrospective studies [103–105].

3.4.1. Working group conclusions based on the literature data

Compared with transplant nephrectomy, embolization has lower mortality (0.1% vs. 4%) and morbidity rates (1.2% vs. 18%) [29] (LoE3). However, post-embolization syndrome (fever, myalgia, pain, nausea) occurs in 60–70% of patients [29] (LoE3), transplant nephrectomy is required in 20% of patients after embolization [29] (LoE3), and a second embolization is needed in 6–16% of patients [96,102] (LoE4).

The main complications of embolization are: graft abscess [101,103,104] (LoE4) [29] (LoE3), graft infection [29] (LoE3), and puncture site hematoma [98] (LoE4) [29] (LoE3).

Embolization of the graft artery before transplant nephrectomy appears to reduce perioperative bleeding and operative time [95,97,99,100,105] (LoE4).

There are no data on the impact of embolization on immunization and access to retransplantation.

3.4.2. Working group discussion

In most studies, the patients included were highly selected. Moreover, prospective comparative studies were absent. The embolization technique used in the studies was not standardized.

3.4.3. Guidelines

Embolization may be proposed as an alternative to transplant nephrectomy in the event of graft intolerance syndrome in patients with frailty or patients who refuse surgery (EA).

If embolization fails, a second embolization may be proposed (EA).

In the event of failure or complication following embolization, transplant nephrectomy is recommended (Grade B).

Patients should be informed on the alternatives to transplant nephrectomy (EA).

Disclosure of interest

The authors declare that they have no competing interest.

Acknowledgements

The authors thank the Association Française d'Urologie (AFU) for facilitating this work. The AFU mission is to promote urological research in all its forms and to enable the emergence of large-scale, interdisciplinary research programs.

The working group was coordinated by Thibaut Culty (urologist, CHU, Angers) and the AFU and SFT members Alexandre Frontczak, Anna Goujon, Arnaud Del Bello, Thomas Prudhomme, with the help of Diana Kassab (methodologist).

This work brings together cooperating groups, scientific associations and researchers working on transplant nephrectomy in France. The authors would like to thank the following scientific societies and associations for their support: Association Française d'Urologie (AFU), Société Francophone de Transplantation (SFT), Agence de la Biomédecine [ABM], Association Française des Urologues en Formation (AFUF), Société Francophone d'Histocompatibilité et d'Immunogénétique (SFHI), Société Francophone de Néphrologie Dialyse et Transplantation (SFNDT), Société de Chirurgie Vasculaire et Endovasculaire de Langue Française (SCVE), Société Francophone d'Urologie Pédiatrique et de l'Adolescent (SFUPA), Société de Néphrologie Pédiatrique (SNP) and the patients' representatives, France rein, Renaloo, Trans-forme, as well as the following working group members Yanish Soorojebally, urologist, Hôpital Foch, Suresnes, François Kleinclauss, urologist, CHRU, Besançon, Albane Brodin-Sartorius, nephrologist, CHU, Le Kremlin-Bicêtre, Pierre Olivier Delpech, urologist, CHU Poitiers, Myriam Pastural, nephrologist and kidney graft referent physician at ABM, Emilien Seizilles de Mazancourt, urologist, Paris, Nicolas Congy, Laboratoire HLA-Histocompatibilité, CHU de Toulouse, Cyril Garrouste, nephrologist, CHU, Clermont-Ferrand, Emmanuel Morelon, nephrologist, CHU, Lyon, Brigitte Thevenin-Lemoine, France Rein, Paris, Nicolas Piffault, Renaloo, Paris.

The authors would also like to thank the following reviewers: Aberkane Aziz, patient representative, France rein, Lyon; Anglicheau Dany, nephrologist, SFNDT, Paris; Antoine Corinne, nephrologist, ABM, Seine-Saint-Denis; Atinault Alain, patient representative, Renaloo, Paris; Baboudjian Michael, urologist, AFU, Marseille; Basse Odile, patient representative, Renaloo, Paris; Baujard Michel, patient representative, Trans-forme, Paris; Blanc Thomas, pediatric surgeon, SFUPA, Paris; Boufi Mourad, vascular surgeon, SCVE, Saint-Etienne; Champy Cécile, urologist, AFU, Créteil; Charbit Marina, pediatric nephrologist, SNP, Paris; Clerget Alexandra, urologist, AFUF, Paris; Cléro Bernard, anesthesiologist, patient representative, Renaloo, Montigny le Bretonneux; Demède Delphine, pediatric urologist, SFUPA, Bron; Drouin Sarah, urologist, SFT, Paris; Duprey Ambroise, vascular surgeon, SCVE, Reims; Lejay Anne, vascular and kidney transplant surgeon, SCVE, Strasbourg; Levy Stephan, urologist, AFUF, Toulouse; Malvezzi Paolo, nephrologist, SFNDT, Grenoble; Matillon Xavier, urologist, AFU, Lyon; Mesnard Benoît, urologist, AFUF, Nantes; Pedini Pascal, laboratory physician Immunologie HLA, SFHI, Marseille; Peycelon Matthieu, pediatric urologist, SFUPA, Paris; Pinar Ugo, urologist, AFU, Paris; Provot Francois, nephrologist, SFT, Lille; Roussey Gwenaelle, pediatric nephrologist, SNP, Nantes; Sarrazin Clément, urologist, AFUF, Grenoble; Sellier-Leclerc Anne-Laure, pediatric nephrologist, SNP, Bron; Sotto Albert, infectious and tropical diseases specialist, CI-AFU, Nîmes; Thuret Rodolphe, urologist, AFU, CHU, Montpellier; Toutirais Olivier, immunology professor, SFHI, Caen; Tsimaratos Michel, pediatric nephrologist, deputy director-general, ABM, Seine-Saint-Denis; Visentin Jonathan, laboratory physician – Immunology – HLA, SFHI, Bordeaux.

We are grateful to Mrs Elisabetta Andermarcher for editing the manuscript.

Appendix A. Supplementary data

Supplementary data associated with this article can be found, in the online version, at https://doi.org/10.1016/j.fjurol.2025.102940.

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