Complications After Kidney Transplantation

Editors

Mutlu DEGER

Çukurova University

Bulent KAYA

Çukurova University

Erkan DEMIR

Çukurova University

ISBN
978-625-362-092-9

Book Title
Complications After Kidney Transplantation

Editors
Mutlu DEĞER
ORCID iD: 0000-0002-8357-5744
Bülent KAYA
ORCID iD: 0000-0003-4697-4815
Erkan DEMIR
ORCID iD: 0000-0003-2676-5346

Publishing Coordinator
Yasin DİLMEN

Page and Cover Design
Typesetting and Cover Design by Akademisyen

Publisher Certificate Number
47518

Printing and Binding
Vadi Printingpress

Bisac Code
MED088000

DOI
10.37609/akya.4215

Library ID Card
Complications After Kidney Transplantation / ed. Mutlu Değer, Bülent Kaya, Erkan Demir.
Ankara : Akademisyen Yayınevi Kitabevi, 2026.
385 p. : figure. ; 160x235 mm.
Includes References.
ISBN 9786253620929

WARNING

The information contained in this product is only presented as a source for licensed medical workers. It should not be used for any professional medical advice or medical diagnosis. It does not constitute a doctor-patient, therapist-patient and / or any other health-presentation service relationship between the Bookstore and the recipient in any way.

This product is not a synonym or a substitute for professional medical decisions. The Academician Bookstore and its affiliated companies, writers, participants, partners and sponsors are not responsible for injuries and / or damage to humans and devices arising from all applications based on product information.

In the case of prescription of drugs or other chemicals, checking over the current product information for each drug defined by the manufacturer to determine the recommended dose, duration, method and contraindications of the drug is recommended.

It is the physician's own responsibility to determine the optimal treatment an dose for the patient, and to establish a basis for the knowledge and experience of the treating physician about the patient.

The Academician Bookstore is not responsible for any changes to the product, repackaging and customizations made by a third party.

GENERAL DISTRIBUTION

Akademisyen Kitabevi AŞ

Halk Sokak 5 / A Yenişehir / Ankara
Tel: 0312 431 16 33
siparis@akademisyen.com

www.akademisyen.com

CONTENTS

Chapter 1 Immunosuppressive Drugs Used in Kidney Transplantation 1
Bulent KAYA

Chapter 2 Acute Rejection in Kidney Transplantation..... 17
Bulent KAYA

Chapter 3 Infections and Prophylaxis Following Kidney Transplantation 39
Damla ERTURK

Chapter 4 Early Postoperative Surgical Complications After Kidney Transplantation 51
Nebil AKDOGAN

Chapter 5 Post-Transplant Vascular Complications in Kidney Transplant Recipients 65
Onur BENLI

Chapter 6 Wound, Soft Tissue and Reconstructive Complications After Kidney Transplantation 85
Ibrahim TABAKAN

Chapter 7 Late Surgical Complications After Kidney Transplantation..... 99
Ismail Onder YILMAZ

Chapter 8 Hematological Complications After Renal Transplantation..... 117
Funda TANRIKULU

Chapter 9 Cardiovascular Complications After Kidney Transplantation..... 129
Caglar OZMEN

Chapter 10 Gastrointestinal Complications and Pancreatitis After Kidney Transplantation 139
Umit KARAOGULLARINDAN

Chapter 11 Hepatobiliary Problems After Kidney Transplantation 147
Ahmet Gokhan SARITAS
Mevlut Harun AGCA

Chapter 12 Immunosuppressive Drugs and Ocular Complications After Kidney Transplantation 163
Burak ULAS

Chapter 13 Infectious, Non-Infectious and Vascular Complications of the Eye After Kidney Transplantation..... 191
Ibrahim Inan HARBIYELI

Chapter 14 Bone and Joint Problems After Kidney Transplantation 213
Melih BAGIR

Chapter 15 Post-Transplant Bone Mineral Disease..... 221
Aylin SARIYILDIZ
Aysegul YETISIR

Chapter 16 Immunosuppression-Related Early Neurological Complications After Kidney Transplantation..... 237
Mehmet Taylan PEKÖZ

Chapter 17 Medium and Long-Term Neurological Complications After Kidney Transplantation 251
Ahmet Yusuf ERTÜRK

Chapter 18 Recurrent Diseases After Kidney Transplantation..... 271
Mutlu DEGER

Chapter 19 Malignancies After Kidney Transplantation..... 291
Yasemin AYDINALP CAMADAN
Tolga KOSECI

Chapter 20 Pregnancy After Kidney Transplantation 307
Mete SUCU

Chapter 21 Bladder Disorders and Voiding Dysfunction After Kidney Transplantation 317
M.Gurkan ARIKAN

Chapter 22 Upper Airway and Otorhinolaryngologic Complications in Renal Transplant Recipients 329
Muhammed DAGKIRAN
Ilda TANRISEVER PEHLİVAN

Chapter 23 Thoracic Complications After Kidney Transplantation..... 335
İsmail Can KARACAOĞLU

Chapter 24 Metabolic Complications After Kidney Transplantation..... 347
Kaniye AYDIN

Chapter 25 Complications in Pediatrics After Renal Transplantation..... 367
Önder ÖZDEN

AUTHORS

Lecturer Mevlut Harun AGCA
Çukurova University, Faculty of Medicine, Department of General Surgery

Assist. Prof. Dr. Nebil AKDOGAN
Department of Urology, Faculty of Medicine, Çukurova University

Assist. Prof. Dr. M.Gurkan ARIKAN
Department of Urology, Faculty of Medicine, Çukurova University

Assoc. Prof. Dr. Kaniye AYDIN
Department of Internal Medicine, Division of Medical Intensive Care Unit, School of Medicine, Çukurova University

Assoc. Prof. Dr. Melih BAGIR
Department of Orthopedics and Traumatology, Faculty of Medicine, Çukurova University

Lecturer Onur BENLI
Department of Cardiovascular Surgery, Faculty of Medicine, Cukurova University

M.D. Yasemin Aydinalp CAMADAN
University of Health Sciences, Sanlıurfa Mehmet Akif İnan Education and Research Hospital, Departmant of Medical Oncology

Assoc. Prof. Dr. Muhammed DAGKIRAN
Cukurova University Faculty of Medicine, Department of Otolaryngology, Head and Neck Surgery

Assoc. Prof. Dr. Mutlu DEGER
Department of Urology, Faculty of Medicine, Cukurova University

M.D. Ahmet Yusuf ERTÜRK
Department of Neurology, University of Health Sciences Adana City Training and Research Hospital

Assist. Prof. Dr. Damla ERTURK
Department of Infectious Diseases and Clinical Microbiology, Faculty of Medicine, Çukurova University

Assoc. Prof. Dr. Ibrahim Inan HARBIYELI
Department of Ophthalmology, Faculty of Medicine, Cukurova University

Assist. Prof. Dr. Umit KARAOGULLARINDAN
Department of Gastroenterology, Faculty of Medicine, Çukurova University

Assist. Prof. Dr. İsmail Can KARACAOĞLU
Çukurova University, Faculty of Medicine, Department of Thoracic Surgery

Assoc. Prof. Dr. Bulent KAYA
Department of Nephrology, Faculty of Medicine, Çukurova University

Assoc. Prof. Dr. Tolga KOSECI
Department of Medical Oncology, Çukurova University Faculty of Medicine

Assoc. Prof. Dr. Önder ÖZDEN
Cukurrova University, Faculty of Medicine, Department of Pediatric Surgery

Assist. Prof. Dr. Caglar OZMEN
Department of Cardiology, Faculty of Medicine, Çukurova University

Lecturer Ilda TANRISEVER PEHLİVAN
Cukurova University Faculty of Medicine, Department of Otolaryngology, Head and Neck Surgery

Assoc. Prof. Dr. Mehmet Taylan PEKÖZ
Department of Neurology, Faculty of Medicine, Cukurova University

Assist. Prof. Dr. Ahmet Gokhan SARITAS
Department of General Surgery, Faculty of Medicine, Çukurova University

Assoc. Prof. Dr. Aylin SARIYILDIZ
Department of Physical Medicine and Rehabilitation, Faculty of Medicine, Cukurova University

Assoc. Prof. Dr. Mete SUCU
Department of Obstetrics and Gynecology, Faculty of Medicine, Cukurova University

Assoc. Prof. Dr. Ibrahim TABAKAN
Department of Plastic Reconstructive and Aesthetic Surgery, Faculty of Medicine, Cukurova University

Assist. Prof. Dr. Funda TANRIKULU
Department of Hematology, Faculty of Medicine, Çukurova University

Assoc. Prof. Dr. Burak ULAS
Ophthalmology Department, Faculty of Medicine, Cukurova University

Assist. Prof. Dr. Aysegul YETISIR
Department of Physical Medicine and Rehabilitation, Faculty of Medicine, Cukurova University

Assist. Prof. Dr. Ismail Onder YILMAZ
Department of Urology, Faculty of Medicine, Çukurova University

Chapter 1

IMMUNOSUPPRESSIVE DRUGS USED IN KIDNEY TRANSPLANTATION

Bulent KAYA[1]

Abstract

Kidney transplantation is the preferred treatment for end-stage kidney disease, and its success relies on the effective use of immunosuppressive therapy. This review summarizes current approaches to induction and maintenance immunosuppression, with a focus on risk-based treatment strategies.

Induction therapy includes lymphocyte-depleting agents such as antithymocyte globulin and alemtuzumab, as well as non-depleting agents like basiliximab, selected according to immunological risk. Maintenance regimens are primarily based on calcineurin inhibitors, antiproliferative agents, and corticosteroids. Key determinants of therapy selection include human leukocyte antigen mismatch, panel reactive antibody levels, and donor-specific antibodies.

Therapeutic drug monitoring is essential for optimizing immunosuppressive efficacy and minimizing toxicity. While potent agents improve rejection prevention in high-risk patients, they are associated with increased risks of infection and malignancy.

In summary, modern immunosuppressive management in kidney transplantation is based on individualized risk assessment and careful balancing of efficacy and safety to achieve optimal graft and patient outcomes.

Keywords: kidney transplantation, immunosuppression, induction therapy, maintenance therapy , therapeutic drug monitoring

[1] Assoc. Prof. Dr., Department of Nephrology, Faculty of Medicine, Çukurova University, ORCID iD: 0000-0003-4697-4815

DOI: 10.37609/akya.4215.c12410

While potent lymphocyte-depleting agents such as ATG and alemtuzumab provide effective rejection prophylaxis in high-risk recipients, their use is limited by increased susceptibility to infections and malignancies. Conversely, non-depleting agents like basiliximab offer a safer alternative in low-risk populations, underscoring the importance of appropriate patient stratification.

Maintenance therapy based on CNI, antiproliferative agents, and corticosteroids remains the backbone of long-term management; however, drug-related toxicity and long-term complications continue to pose significant challenges. In this context, TDM has become indispensable for optimizing therapeutic exposure and reducing adverse outcomes.

Overall, the success of KT depends not only on preventing acute rejection but also on minimizing long-term complications through careful balancing of immunosuppressive intensity. Future strategies should focus on refining personalized treatment algorithms to improve both graft longevity and patient survival.

REFERENCES

1. Bamoulid J, Staeck O, Crépin T, et al. Anti-thymocyte globulins in kidney transplantation: focus on current indications and long-term immunological side effects. Nephrol Dial Transplant. 2017 Oct 1;32(10):1601-1608. doi: https://doi.org/10.1093/ndt/gfw368
2. Acharya S, Lama S, Kanigicherla DA. Anti-thymocyte globulin for treatment of T-cell-mediated allograft rejection. World J Transplant. 2023 Dec 18;13(6):299-308. doi: 10.5500/wjt.v13.i6.299.
3. Hardinger KL, Brennan DC. Novel immunosuppressive agents in kidney transplantation. World J Transplant. 2013 Dec 24;3(4):68-77. doi: 10.5500/wjt.v3.i4.68.
4. Kidney Disease: Improving Global Outcomes (KDIGO) Transplant Work Group. KDIGO clinical practice guideline for the care of kidney transplant recipients. Am J Transplant. 2009 Nov; 9 Suppl 3:S1-155. doi: 10.1111/j.1600-6143.2009.02834.x.
5. Josi H, Kumar R, Singh A, et al. Our Unique Experience with Low-Dose Alemtuzumab as an Induction Agent for Renal Transplantation: A Case Series. Indian J Transplant. 2024;18(4):440-444. doi: https://doi.org/10.4103/ijot.ijot_41_24
6. van Vugt LK, Zwart TC, Bezstarosti S, et al. Alemtuzumab Exposure and T Lymphocyte Depletion: A Population Pharmacokinetic-Pharmacodynamic Model of Alemtuzumab Induction Therapy for Kidney Transplantation. Clin Pharmacol Ther. 2025 Sep;118(3):662-672. doi: https://doi.org/10.1002/cpt.3714
7. Hanaway MJ, Woodle ES, Mulgaonkar S, et al. INTAC Study Group. Alemtuzumab induction in renal transplantation. N Engl J Med. 2011 May 19;364(20):1909-19. doi: https://doi.org/10.1056/nejmoa1009546
8. Cherukuri, Aravind, and Richard J. Baker, Immunosuppression after Kidney Transplantation, in Sundaram Hariharan (ed.), Long-term Care of Kidney Transplant Patients (New York, 2024; online edn, Oxford Academic, 1 June 2024), p. 53-82. Accessed 15 Apr. 2026. doi: https://doi.org/10.1093/med/9780197697320.003.0004

9. Sawinski D, Trofe-Clark J, Leas B, et al. Calcineurin Inhibitor Minimization, Conversion, Withdrawal, and Avoidance Strategies in Renal Transplantation: A Systematic Review and Meta-Analysis. Am J Transplant. 2016 Jul;16(7):2117-38. doi: https://doi.org/10.1111/ajt.13710
10. Yang K, Zhang M, Zhang B, et al. Systematic review and meta-analysis of calcineurin inhibitors on long-term prognosis of renal transplant patients. Transpl Immunol. 2022 Dec;75:101741. doi: https://doi.org/10.1016/j.trim.2022.101741
11. Bellini A, Finocchietti M, Rosa AC, et al. CESIT study group. Effectiveness and safety of immunosuppressive regimens used as maintenance therapy in kidney transplantation: The CESIT study. PLoS One. 2024 Jan 2;19(1):e0295205. doi: https://doi.org/10.1371/journal.pone.0295205
12. Cheung CY, Tang SCW. Personalized immunosuppression after kidney transplantation. Nephrology (Carlton). 2022 Jun;27(6):475-483. doi: https://doi.org/10.1111/nep.14035
13. Malvezzi P, Rostaing L. The safety of calcineurin inhibitors for kidney-transplant patients. Expert Opin Drug Saf. 2015 Oct;14(10):1531-46. doi: https://doi.org/10.1517/14740338.2015.1083974
14. Sharma S, Kausman J, Craig S, Metz D. A Multi-National Survey on Immunosuppressive Regimens and Mycophenolate Monitoring Practices after Kidney Transplantation. Kidney Blood Press Res. 2026;51(1):27-35. doi: https://doi.org/10.1159/000549997
15. Mohamed ME, Saqr A, Onyeaghala G, et al. A Mycophenolate Pharmacokinetic Study with New Insights into Enterohepatic Recirculation in Kidney Transplant Recipients. Clin Pharmacokinet. 2026 Mar;65(3):479-495. doi: https://doi.org/10.1007/s40262-025-01611-3
16. Kidney Disease: Improving Global Outcomes (KDIGO) Transplant Work Group. KDIGO clinical practice guideline for the care of kidney transplant recipients. Am J Transplant. 2009 Nov;9 Suppl 3:S1-155. doi: https://doi.org/10.1111/j.1600-6143.2009.02834.x
17. Liefeldt L, Waiser J, Bachmann F, et al. Long-Term Outcome after Early Mammalian Target of Rapamycin Inhibitor-Based Immunosuppression in Kidney Transplant Recipients. J Clin Med. 2024 Jul 23;13(15):4305. doi: https://doi.org/10.3390/jcm13154305
18. Masuda S, Lemaitre F, Barten MJ, et al. Everolimus Personalized Therapy: Second Consensus Report by the International Association of Therapeutic Drug Monitoring and Clinical Toxicology. Ther Drug Monit. 2025 Feb 1;47(1):4-31. doi: https://doi.org/10.1097/ftd.0000000000001250
19. Cuadrado-Payán E, Diekmann F, Cucchiari D. Medical Aspects of mTOR Inhibition in Kidney Transplantation. Int J Mol Sci. 2022 Jul 12;23(14):7707. doi: https://doi.org/10.3390/ijms23147707
20. Toniato de Rezende Freschi J, Cristelli MP, et al. A Head-to-head Comparison of De Novo Sirolimus or Everolimus Plus Reduced-dose Tacrolimus in Kidney Transplant Recipients: A Prospective and Randomized Trial. Transplantation. 2024 Jan 1;108(1):261-275. doi: https://doi.org/10.1097/tp.0000000000004749
21. Yakubu I, Moinuddin I, Gupta G. Use of belatacept in kidney transplantation: what's new? Curr Opin Organ Transplant. 2023 Feb 1;28(1):36-45. doi: https://doi.org/10.1097/mot.0000000000001033
22. Di Maria S, Provenzani A. Belatacept in Solid Organ Transplantation: Current Kidney Applications, Future Perspectives in Other Organs, and Clinical Implications. Pharmaceuticals (Basel). 2026 Jan 23;19(2):196. doi: https://doi.org/10.3390/ph19020196
23. Formica RN, Larsen CP, Rostaing L. Tailoring of Immunosuppression With Belatacept in De Novo and Conversion Settings and Risk Mitigation Strategies. Transplantation. 2026 Feb 1;110(2):e302-e323. doi: https://doi.org/10.1097/tp.0000000000005506
24. Lombardi Y, François H. Belatacept in Kidney Transplantation: What Are the True Benefits? A Systematic Review. Front Med (Lausanne). 2022 Jul 14;9:942665. doi: https://doi.org/10.3389/fmed.2022.94266

Chapter 2

ACUTE REJECTION IN KIDNEY TRANSPLANTATION

Bulent KAYA[1]

Abstract

Acute rejection remains a major threat to kidney allograft survival despite substantial advances in immunosuppressive therapy. The incidence of acute rejection has markedly declined over the past three decades; however, it continues to contribute significantly to graft dysfunction and loss. The two principal forms of acute rejection are T cell-mediated rejection (TCMR) and antibody-mediated rejection (ABMR). TCMR is characterized by lymphocytic infiltration and tubular injury, whereas ABMR results from donor-specific antibody–mediated endothelial injury and is associated with microvascular inflammation, C4d deposition, and transplant glomerulopathy. Mixed rejection may also occur and is associated with worse outcomes. ABMR is now recognized as the leading cause of late graft loss, while TCMR remains an important independent risk factor and may precipitate antibody-mediated injury. Diagnosis is based on histopathologic evaluation of kidney allograft biopsy, and treatment depends on the rejection phenotype and severity. Standard therapies include glucocorticoids, antithymocyte globulin, plasmapheresis, and intravenous immunoglobulin. Optimal prevention relies on adequate immunosuppression, medication adherence, and careful donor-recipient matching. Emerging molecular diagnostics and novel targeted therapies may improve future rejection management.

Keywords: kidney transplantation, acute rejection, antibody-mediated rejection, t cell-mediated rejection, donor-specific antibodies

INTRODUCTION

Kidney transplantation is the most effective treatment for patients with end-stage kidney disease. With advances in modern immunosuppressive therapy, short-

[1] Assoc. Prof. Dr., Department of Nephrology, Faculty of Medicine, Çukurova University, bulentkaya32@gmail.com, ORCID iD: 0000-0003-4697-4815

DOI: 10.37609/akya.4215.c12411

immunological mechanisms, clinical course, histopathological features, and treatment strategies; therefore, accurate diagnosis based on biopsy, donor-specific antibody assessment, and emerging molecular tools is essential. Early recognition, individualized immunosuppressive management, medication adherence, and careful immunologic risk assessment are central to preserving graft function. Although current therapies have improved short-term outcomes, long-term graft survival continues to be limited by persistent immune-mediated injury. Future advances in molecular diagnostics, biomarker-guided monitoring, and targeted therapies may provide more precise and effective approaches to the prevention and treatment of acute rejection.

REFERENCES

1. Schinstock CA, Mannon RB, Budde K, et al. Recommended treatment for antibody-mediated rejection after kidney transplantation: the 2019 expert consensus from the Transplantation Society Working Group. Transplantation. 2020;104(5):911-922. doi: https://doi.org/10.1097/tp.0000000000003095
2. Haas M, Sis B, Racusen LC, et al. Banff 2013 meeting report: inclusion of C4d-negative antibody-mediated rejection and antibody-associated arterial lesions. Am J Transplant. 2014;14(2):272-283. doi: https://doi.org/10.1111/ajt.12590
3. Kidney Disease: Improving Global Outcomes (KDIGO) Transplant Work Group. KDIGO clinical practice guideline for the care of kidney transplant recipients. Am J Transplant. 2009;9(Suppl 3):S1-S155. doi: https://doi.org/10.1111/j.1600-6143.2009.02834.x
4. Solez K, Colvin RB, Racusen LC, et al. Banff 07 classification of renal allograft pathology: updates and future directions. Am J Transplant. 2008;8(4):753-760. doi: https://doi.org/10.1111/j.1600-6143.2008.02159.x
5. Halloran PF, Reeve J, Akalin E, et al. Real-time central assessment of kidney transplant indication biopsies by microarrays: the INTERCOM study. Am J Transplant. 2017;17(11):2851-2862. doi: https://doi.org/10.1111/ajt.14329
6. Loupy A, Haas M, Roufosse C, et al. The Banff 2019 Kidney Meeting Report (I): Updates on and clarification of criteria for T cell- and antibody-mediated rejection. Am J Transplant. 2020;20(9):2318-2331. doi: https://doi.org/10.1111/ajt.15898
7. Halloran PF, Chang J, Famulski K, et al. Disappearance of T cell-mediated rejection despite continued antibody-mediated rejection in late kidney transplant recipients. J Am Soc Nephrol. 2015;26(7):1711-1720. doi: https://doi.org/10.1681/asn.2014060588
8. Racusen LC, Solez K, Colvin RB, et al. The Banff 97 working classification of renal allograft pathology. Kidney Int. 1999;55(2):713-723. doi: https://doi.org/10.1046/j.1523-1755.1999.00299.x
9. Sis B, Mengel M, Haas M, et al. Banff '09 meeting report: antibody-mediated graft deterioration and implementation of Banff working groups. Am J Transplant. 2010;10(3):464-471. doi: https://doi.org/10.1111/j.1600-6143.2009.02987.x
10. Mengel M, Sis B, Haas M, et al. Banff 2011 Meeting report: new concepts in antibody-mediated rejection. Am J Transplant. 2012;12(3):563-570. doi: https://doi.org/10.1111/j.1600-6143.2011.03926.x
11. Haas M, Loupy A, Lefaucheur C, et al. The Banff 2017 Kidney Meeting Report: Revised diagnostic criteria for chronic active T cell-mediated rejection, antibody-mediated rejection, and prospects for integrative endpoints for next-generation clinical trials. Am J Transplant. 2018;18(2):293-307. doi: https://doi.org/10.1111/ajt.14625

12. Bloom RD, Bromberg JS, Poggio ED, et al. Cell-free DNA and active rejection in kidney allografts. J Am Soc Nephrol. 2017;28(7):2221-2232. doi: https://doi.org/10.1681/asn.2016091034
13. Choi J, Aubert O, Vo A, et al. Assessment of tocilizumab (anti-interleukin-6 receptor monoclonal) as a potential treatment for chronic antibody-mediated rejection and transplant glomerulopathy in HLA-sensitized renal allograft recipients. Am J Transplant. 2017;17(9):2381-2389. doi: https://doi.org/10.1111/ajt.14228
14. Crespo E, Lucia M, Cruzado JM, et al. Pre-transplant donor-specific T-cell alloreactivity is strongly associated with early acute cellular rejection in kidney transplant recipients not receiving T-cell depleting induction therapy. PLoS One. 2015;10(2):e0117618. doi: https://doi.org/10.1371/journal.pone.0117618
15. Hart A, Smith JM, Skeans MA, et al. OPTN/SRTR 2019 Annual Data Report: Kidney. Am J Transplant. 2021;21 Suppl 2:21-137. doi: https://doi.org/10.1111/ajt.16502
16. Schinstock CA, Sapir-Pichhadze R, Naesens M, et al. Banff survey on antibody-mediated rejection clinical practices in kidney transplantation: diagnostic misinterpretation has potential therapeutic implications. Am J Transplant. 2019;19(1):123-131. doi: https://doi.org/10.1111/ajt.14979
17. Halloran PF, Famulski KS, Reeve J. The molecular phenotypes of rejection in kidney transplant biopsies. Curr Opin Organ Transplant. 2015;20(3):359-367. doi: https://doi.org/10.1097/mot.0000000000000193
18. Valenzuela NM, Reed EF. Antibody-mediated rejection across solid organ transplants: manifestations, mechanisms, and therapies. J Clin Invest. 2017;127(7):2492-2504. doi: https://doi.org/10.1172/jci90597
19. Cornell LD, Schinstock CA, Gandhi MJ, et al. Positive crossmatch kidney transplant recipients treated with eculizumab: outcomes beyond 1 year. Am J Transplant. 2015;15(5):1293-1302. doi: https://doi.org/10.1111/ajt.13168
20. Haas M. The Revised (2013) Banff Classification for Antibody-Mediated Rejection of Renal Allografts: Update, Difficulties, and Future Considerations. Am J Transplant. 2016;16(5):1352-1357. doi: https://doi.org/10.1111/ajt.13661
21. Sellares J, Reeve J, Loupy A, et al. Molecular diagnosis of antibody-mediated rejection in human kidney transplants. Am J Transplant. 2013;13(4):971-983. doi: https://doi.org/10.1111/ajt.12150
22. Loupy A, Lefaucheur C. Antibody-mediated rejection of solid-organ allografts. N Engl J Med. 2018;379(12):1150-1160. doi: https://doi.org/10.1056/nejmra1802677

Chapter 3

INFECTIONS AND PROPHYLAXIS FOLLOWING KIDNEY TRANSPLANTATION

Damla ERTURK[1]

Abstract

Although kidney transplantation is one of the most effective treatment options for end-stage renal disease, infections in the post transplant period are among the primary complications that determine patient and graft outcomes. The incidence and spectrum of these infections vary depending on surgical complications, allograft function, the intensity of the immunosuppressive regimen used, and prophylactic measures. In the early period, surgical site infections, catheter and catheter related infections, and hospital acquired bacterial infections are predominant, while opportunistic pathogens such as cytomegalovirus (CMV), BK polyomavirus, and *Pneumocystis jirovecii* become more prominent within the first 6 months. In the late phase, community-acquired infections predominate; however, the risk of opportunistic infections persists in patients receiving intensive or repeated immunosuppression. Urinary tract infections are the most common group of infections in kidney transplant recipients and are particularly associated with graft dysfunction, bacteremia, and hospitalization in the early phase. Although fungal infections are less common, they require early diagnosis and appropriate antifungal treatment due to their high mortality rate. Prophylactic and preemptive strategies play a critical role in the management of these infections, which directly impact both patient and graft survival. In this section, post-kidney transplant infections are addressed within a time-based framework; their clinical characteristics, diagnostic approach, treatment principles, and current prophylaxis strategies are summarized.

[1] Assist. Prof. Dr., Department of Infectious Diseases and Clinical Microbiology, Faculty of Medicine, Çukurova University, damlaerdogan_@hotmail.com, ORCID iD: 0000-0002-2163-5844

DOI: 10.37609/akya.4215.c12412

Successful management requires evaluating a time based approach in conjunction with the patient's current immunosuppression status, implementing structured viral monitoring programs, rational antimicrobial use, and multidisciplinary collaboration. Through appropriate prophylaxis, early diagnosis, and rapid, targeted treatment, both the infection burden and graft loss due to infection can be significantly reduced.

REFERENCES

1. Fishman JA. Infection in organ transplantation. Am J Transplant. 2017;17(4):856-879. DOI: 10.1111/ajt.14208
2. Roberts MB, Fishman JA. Immunosuppressive agents and infectious risk in transplantation: managing the "net state of immunosuppression". Clin Infect Dis. 2021;73(7):e1302-e1317. DOI: 10.1093/cid/ciaa1189
3. Karuthu S, Blumberg EA. Common infections in kidney transplant recipients. Clin J Am Soc Nephrol. 2012;7(12):2058-2070. DOI: 10.2215/CJN.04410512
4. Fishman JA. Infection in solid-organ transplant recipients. N Engl J Med. 2007;357(25):2601-2614. DOI: 10.1056/NEJMra064928
5. Jackson KR, Motter JD, Bae S, et al. Characterizing the landscape and impact of infections following kidney transplantation. Am J Transplant. 2021;21(1):198-207. DOI: 10.1111/ajt.16106
6. Agrawal A, Ison MG, Danziger-Isakov L. Long-term infectious complications of kidney transplantation. Clin J Am Soc Nephrol. 2022;17(2):286-295. DOI: 10.2215/CJN.15971020
7. Dorschner P, McElroy LM, Ison MG. Nosocomial infections within the first month of solid organ transplantation. Transpl Infect Dis. 2014;16(2):171-187. DOI: 10.1111/tid.12203
8. Abbo LM, Grossi PA; AST ID Community of Practice. Surgical site infections: guidelines from the American Society of Transplantation Infectious Diseases Community of Practice. Clin Transplant. 2019;33(9):e13589. DOI: 10.1111/ctr.13589
9. Schreiber PW, Hoessly LD, Boggian K, et al. Surgical site infections after kidney transplantation are independently associated with graft loss. Am J Transplant. 2024;24(5):795-802. DOI: 10.1016/j.ajt.2023.11.013
10. Bratzler DW, Dellinger EP, Olsen KM, et al. Clinical practice guidelines for antimicrobial prophylaxis in surgery. Am J Health Syst Pharm. 2013;70(3):195-283. DOI: 10.2146/ajhp120568
11. Boiko O, Garcia-Alonso I, Padilla J, Lecumberri D, Boiko M. Complications and outcomes of post-transplant lymphocele management: a 30-year retrospective analysis. Int Urol Nephrol. 2025;57(6):1747-1753. DOI: 10.1007/s11255-024-04348-3
12. Goldman JD, Julian K. Urinary tract infections in solid organ transplant recipients: guidelines from the American Society of Transplantation Infectious Diseases Community of Practice. Clin Transplant. 2019;33(9):e13507. DOI: 10.1111/ctr.13507
13. Pérez-Nadales E, Fernández-Ruiz M, Gutiérrez-Gutiérrez B, et al. Extended-spectrum β-lactamase-producing and carbapenem-resistant Enterobacterales bloodstream infection after solid organ transplantation: recent trends in epidemiology and therapeutic approaches. Transpl Infect Dis. 2022;24(4):e13881. DOI: 10.1111/tid.13881
14. Parasuraman R, Julian K; AST Infectious Diseases Community of Practice. Urinary tract infections in solid organ transplantation. Am J Transplant. 2013;13(Suppl 4):327-336. DOI: 10.1111/ajt.12124
15. Nicolle LE, Gupta K, Bradley SF, et al. Clinical practice guideline for the management of asymptomatic bacteriuria: 2019 update by the Infectious Diseases Society of America. Clin Infect Dis. 2019;68(10):e83-e110. DOI: 10.1093/cid/ciy1121

16. Kotton CN, Kumar D, Manuel O, et al. The fourth international consensus guidelines on the management of cytomegalovirus in solid organ transplantation. Transplantation. 2025;109(7):1066-1110. DOI: 10.1097/TP.0000000000005374
17. Avery RK, Alain S, Alexander BD, et al. Maribavir for refractory cytomegalovirus infections with or without resistance post-transplant: results from a phase 3 randomized clinical trial. Clin Infect Dis. 2022;75(4):690-701. DOI: 10.1093/cid/ciab988
18. Kotton CN, Kamar N. New insights on CMV management in solid organ transplant patients: prevention, treatment, and management of resistant/refractory disease. Infect Dis Ther. 2023;12(2):333-342. DOI: 10.1007/s40121-022-00746-1
19. Stewart AG, Kotton CN. What's new: updates on cytomegalovirus in solid organ transplantation. Transplantation. 2024;108(4):884-897. DOI: 10.1097/TP.0000000000004855
20. Kotton CN, Kamar N, Wojciechowski D, et al. The second international consensus guidelines on the management of BK polyomavirus in kidney transplantation. Transplantation. 2024;108(9):1834-1866. DOI: 10.1097/TP.0000000000004976
21. Aslam S, Rotstein C; AST Infectious Disease Community of Practice. Candida infections in solid organ transplantation: guidelines from the American Society of Transplantation Infectious Diseases Community of Practice. Clin Transplant. 2019;33(9):e13623. DOI: 10.1111/ctr.13623
22. Husain S, Camargo JF. Invasive aspergillosis in solid-organ transplant recipients: guidelines from the American Society of Transplantation Infectious Diseases Community of Practice. Clin Transplant. 2019;33(9):e13544. DOI: 10.1111/ctr.13544
23. Baddley JW, Forrest GN; AST Infectious Diseases Community of Practice. Cryptococcosis in solid organ transplantation: guidelines from the American Society of Transplantation Infectious Diseases Community of Practice. Clin Transplant. 2019;33(9):e13543. DOI: 10.1111/ctr.13543
24. Fishman JA, Gans H; AST Infectious Diseases Community of Practice. Pneumocystis jiroveci in solid organ transplantation: guidelines from the American Society of Transplantation Infectious Diseases Community of Practice. Clin Transplant. 2019;33(9):e13587. DOI: 10.1111/ctr.13587

Chapter 4

EARLY POSTOPERATIVE SURGICAL COMPLICATIONS AFTER KIDNEY TRANSPLANTATION

Nebil AKDOGAN[1]

ABSTRACT

Kidney transplantation is the most ideal treatment method for end-stage renal disease; however, early surgical complications developing within the first 30 to 90 days postoperatively remain a significant threat to graft and patient survival. This chapter reviews the incidence, pathophysiology, diagnosis, and management of major early urological and surgical complications, including ureteral strictures, urinary leaks, ureteral necrosis, and perigraft collections (hematomas, urinomas, lymphoceles, and abscesses). Ischemia, primarily due to the disruption of the "golden triangle" blood supply, and the presence of multiple arteries in the donor are the main risk factors for ureteral complications. The early diagnostic process relies heavily on ultrasonography, biochemical fluid analysis, and targeted radiological imaging. Treatment strategies emphasize the critical role of prompt intervention, ranging from percutaneous drainage and endoscopic procedures to early surgical revision. Furthermore, the advantages and disadvantages of routine prophylactic Double-J stent placement are discussed, highlighting its protective role against strictures and leaks when properly managed alongside the risk of infection. In conclusion, a multidisciplinary approach involving nephrology, transplant surgery, and interventional radiology ensures the successful management of these early complications, achieving long-term graft survival rates similar to those of uncomplicated transplants.

Keywords: kidney transplantation; early postoperative complications; ureteral stricture; urinary leak; lymphocele; urinoma.

[1] Dr. Assist. Prof. Department of Urology, Faculty of Medicine, Çukurova University, nebilakdogan@hotmail.com, ORCID iD: 0000-0001-9756-8775

DOI: 10.37609/akya.4215.c12413

complication is accompanied by a perigraft hematoma or a severe infection, the risk of early graft loss significantly increases. Furthermore, the severity of the complications developing in the first 30 days post-transplant deeply affects the clinical course; while high-grade (Clavien Grade 3-4) surgical complications increase hospital readmission rates, even low-grade complications can elevate the risk of death with a functional graft in the long term. Although these conditions requiring early hospitalization negatively affect graft functions within the first year, their long-term effects remain limited.

Thoroughly analyzing the recipient and donor-related factors in the development of complications is of great importance. The presence of multiple arteries in the donor kidney and the use of expanded criteria donors (ECD) stand out as independent factors that elevate the risk of vascular and urological complications by increasing the probability of the graft remaining ischemic. On the other hand, an older recipient age (60 years and above) does not increase the risk of surgical complications compared to young recipients; when correct patient selection is made, kidney transplantation is a surgically highly safe procedure in patients of advanced age as well. However, additional factors such as diabetes, a high body mass index, and prior dialysis duration create extra risks in terms of both wound site and infectious complications.

Finally; minimizing the incidence and destructive effects of early surgical complications relies on the meticulous preservation of the donor graft's distal ureteral blood supply, called the "golden triangle," uncompromising adherence to surgical principles, and the routine use of prophylactic Double-J stents for anastomosis safety. In the post-transplant period, it is of vital importance for the nephrology, transplant surgery, and interventional radiology teams to work in coordination so that complications can be treated in a timely manner without leading to graft loss.

REFERENCES

1. Timsit MO, Kleinclauss F, Richard V, Thuret R. Complications chirurgicales de la transplantation rénale. Prog Urol. 2016;26(15):1066-1082. doi:10.1016/j.purol.2016.09.052
2. Król R, Ziaja J, Chudek J, et al. Surgical Treatment of Urological Complications After Kidney Transplantation. Transplant Proc. 2006;38(1):127-130. doi:10.1016/j.transproceed.2005.12.100
3. Khadjibaev F, Sultanov P, Ergashev D, et al. Frequency of Complications After Kidney Transplant in the Early Postoperative Period. Exp Clin Transplant. 2024;Suppl 1:195-199. doi:10.6002/ect.MESOT2023.P25
4. Król R, Cierpka L, Ziaja J, Pawlicki J, Budziński G. Surgically Treated Early Complications After Kidney Transplantation. Transplant Proc. 2003;35(6):2241-2242. doi:10.1016/S0041-1345(03)00769-3

5. Benoit G, Benarbia S, Bellamy J, Charpentier B, Schrameck E, Fries D. [Urologic complication of renal transplantation. Importance of the length of the ureter]. Ann Urol. 1985;19(3):165-171.
6. Webster AC, Lee VWS, Chapman JR, Craig JC. Target of rapamycin inhibitors (sirolimus and everolimus) for primary immunosuppression of kidney transplant recipients: a systematic review and meta-analysis of randomized trials. Transplantation. 2006;81(9):1234-1248. doi: 10.1097/01.tp.0000219703.39149.85.
7. Karam G, Hétet JF, Maillet F, et al. Late ureteral stenosis following renal transplantation: risk factors and impact on patient and graft survival. Am J Transplant. 2006;6(2):352-356. doi: 10.1111/j.1600-6143.2005.01181.x.
8. Benoit G, Blanchet P, Eschwege P, et al. Insertion of a double pigtail ureteral stent for the prevention of urological complications in renal transplantation: a prospective randomized study. J Urol. 1996;156(3):881-884.
9. Osman Y, Shokeir A, Ali-el-Dein B, et al. Vascular complications after live donor renal transplantation: study of risk factors and effects on graft and patient survival. J Urol. 2003;169(3):859-862. doi: 10.1097/01.ju.0000050225.74647.5a.
10. Malovrh M, Kandus A, Buturović-Ponikvar J, et al. Frequency and clinical influence of lymphoceles after kidney transplantation. Transplant Proc. 1990;22(4):1423-1424.
11. Fuller TF, Kang SM, Hirose R, Feng S, Stock PG, Freise CE. Management of lymphoceles after renal transplantation: laparoscopic versus open drainage. J Urol. 2003;169(6):2022-2025. doi: 10.1097/01.ju.0000063800.44792.61.
12. Karam G, Maillet F, Parant S, Soulillou JP, Giral-Classe M. Ureteral necrosis after kidney transplantation: risk factors and impact on graft and patient survival. Transplantation. 2004;78(5):725-729. doi: 10.1097/01.tp.0000131953.13414.99.
13. Streeter EH, Little DM, Cranston DW, Morris PJ. The urological complications of renal transplantation: a series of 1535 patients. BJU Int. 2002;90(7):627-631. doi: 10.1046/j.1464-410x.2002.03004.x.
14. Rahnemai-Azar AA, Gilchrist BF, Kayler LK. Independent risk factors for early urologic complications after kidney transplantation. Clin Transplant. 2015;29(5):403-408. doi: 10.1111/ctr.12530.
15. Wilson CH, Rix DA, Manas DM. Routine intraoperative ureteric stenting for kidney transplant recipients. Cochrane Database Syst Rev. 2013;(4):CD004925. doi: 10.1002/14651858.CD004925.pub3.
16. Skrabaka D, Franczyk S, Kolonko A, et al. Early Complications After Kidney Transplantation in Patients Aged 60 Years and Older: A Single-Center, Paired-Kidney Analysis. Transplant Proc. 2020;52(8):2376-2382. doi: 10.1016/j.transproceed.2020.01.093.
17. Verloh N, Doppler M, Hagar MT, et al. Interventional Management of Vascular Complications after Renal Transplantation. Fortschr Röntgenstr. 2023;195:495-504. doi: 10.1055/a-2007-9649.
18. Kolli KP, LaBerge JM. Interventional Management of Vascular Renal Transplant Complications. Tech Vasc Interv Radiol. 2016;19(3):228-236. doi:10.1053/j.tvir.2016.07.008
19. Leertouwer TC, Gussenhoven EJ, Bosch JL, et al. Stent placement for renal arterial stenosis: where do we stand? A meta-analysis. Radiology. 2000;216(1):78-85. doi: 10.1148/radiology.216.1.r00jl0778.
20. Hurst FP, Abbott KC, Neff RT, et al. Incidence, predictors and outcomes of transplant renal artery stenosis after kidney transplantation: analysis of USRDS. Am J Nephrol. 2009;30(5):459-467. doi: 10.1159/000242431.
21. Minkovich M, Gupta N, Liu M, et al. Impact of early surgical complications on kidney transplant outcomes. BMC Surg. 2024;24(1):165. doi: 10.1186/s12893-024-02463-7.
22. Kang IC, Kim IK, Son S, Ju MK. Impact of Early Hospital Readmissions After Kidney Transplantation on Graft Function. Transplant Proc. 2018;50(8):2359-2362. doi: 10.1016/j.transproceed.2017.12.062.

Chapter 5

POST-TRANSPLANT VASCULAR COMPLICATIONS IN KIDNEY TRANSPLANT RECIPIENTS

Onur BENLİ[1]

Abstract

Vascular complications after kidney transplantation are relatively uncommon but may have a major impact on graft survival and patient morbidity. These complications involve the graft arterial inflow, graft venous outflow, or recipient iliac vessels, and may present in the early or late post-transplant period. Their mechanisms are multifactorial and commonly reflect varying contributions of vessel wall injury, disturbed flow, and thrombotic predisposition. Among them, transplant renal artery stenosis is the most frequent vascular complication and is often amenable to endovascular or surgical treatment, whereas arterial and venous thrombosis remain major causes of early graft loss. Biopsy-related arteriovenous fistulae and intrarenal pseudoaneurysms are usually benign but may require intervention in selected patients. Mechanical lesions such as arterial kinking, venous compression, and iliac vessel pathology should also be recognized, as delayed diagnosis may result in irreversible graft injury. This chapter reviews the classification, mechanisms, risk determinants, clinical presentation, imaging findings, and treatment principles of the major vascular complications after kidney transplantation, with emphasis on practical diagnostic reasoning and timely management.

Keywords: kidney transplantation; vascular complications; transplant renal artery stenosis; renal vein thrombosis; arteriovenous fistula; pseudoaneurysm.

INTRODUCTION

Kidney transplantation is the preferred treatment for patients with end-stage renal disease. Despite advances in surgical techniques, immunosuppressive therapy, and

[1] Lecturer, Department of Cardiovascular Surgery, Faculty of Medicin, Cukurova University, onur.benli@tedu.edu.tr, ORCID iD: 0000-0003-3623-6130

DOI: 10.37609/akya.4215.c12414

CONCLUSION

Although vascular complications after kidney transplantation may appear uncommon, their clinical impact is disproportionately large. Among these complications, TRAS is often recognized after the immediate postoperative period and is frequently treatable, whereas arterial and venous thrombosis remain among the leading causes of early graft loss. Although post-biopsy AVF and intrarenal pseudoaneurysm more often follow a benign course, they require intervention in selected patients. Iliac vessel complications, because of their effects on both graft and extremity circulation, should be assessed carefully, especially in recipients with atherosclerotic disease.

From a practical standpoint, the fundamental principle is to consider vascular complications early in the setting of sudden graft dysfunction and to use Doppler ultrasonography without delay. Delay between diagnosis and treatment, particularly in thrombotic complications, may lead to irreversible graft loss. In contrast, in clinically significant stenotic or procedure-related lesions, timely endovascular or surgical intervention may preserve graft function.

Therefore, in post-transplant follow-up, a high index of suspicion for vascular complications, a standardized imaging approach, and close collaboration between surgical and endovascular teams are essential to preserving graft function.

REFERENCES

1. Blichová T, Kleinová P, Vnučák M, et al. Surgical Complications After Kidney Transplantation. Ann Transplant. 2025;30:e948531. Published 2025 Jun 10. doi:10.12659/AOT.948531
2. de Boer SE, Knobbe TJ, Kremer D, et al. Kidney Transplantation Improves Health-Related Quality of Life in Older Recipients. Transpl Int. 2024;37:12071. Published 2024 Apr 15. doi:10.3389/ti.2024.12071
3. White-Dzuro CE, Geanon DJ, Fagel BM, et al. Vascular and lymphatic complications after renal transplant. Abdom Radiol (NY). 2025;50(12):6085-6105. doi:10.1007/s00261-025-05032-5
4. Verloh N, Doppler M, Hagar MT, et al. Interventional Management of Vascular Complications after Renal Transplantation. Interventionelle Therapieoptionen vaskulärer Komplikationen nach Nierentransplantation. Rofo. 2023;195(6):495-504. doi:10.1055/a-2007-9649
5. Gunawardena T. Update on Vascular Complications After Renal Transplantation. Exp Clin Transplant. 2022;20(4):333-341. doi:10.6002/ect.2021.0303
6. El Zorkany K, Bridson JM, Sharma A, Halawa A. Transplant Renal Vein Thrombosis. Exp Clin Transplant. 2017;15(2):123-129. doi:10.6002/ect.2016.0060
7. Tamara F, Fajar JK, Gersom C, et al. Global prevalence and contributing factors of transplant renal artery stenosis in renal transplant recipients: A systematic review and meta-analysis. Narra J. 2024;4(3):e1782. doi:10.52225/narra.v4i3.1782
8. Pini A, Faggioli G, Pini R, et al. Assessment and Management of Transplant Renal Artery Stenosis. A Literature Review. Ann Vasc Surg. 2022;82:13-29. doi:10.1016/j.avsg.2022.01.011

9. Mirza A, Baig U, Khan M, Beigh S, Gani I. Clinical Utility of Duplex Ultrasonography in the Recognition of Transplant Renal Artery Stenosis: A Single Center Experience. Diagnostics (Basel). 2025;15(14):1766. Published 2025 Jul 13. doi:10.3390/diagnostics15141766
10. Costa Silva A, Pina-Vaz T, Pinho A, et al. Vascular Complications Following Kidney Transplantation From Uncontrolled Donation After Circulatory Death: A Prospective Study. Clin Transplant. 2025;39(12):e70417. doi:10.1111/ctr.70417
11. Stigler J, Tiefenthaler M. Value and limitations of sonography in kidney transplant recipients with special attention to the resistive index - An update. Front Nephrol. 2022;2:997839. Published 2022 Sep 30. doi:10.3389/fneph.2022.997839
12. Uchida N, Miyajima K, Yanagiswa T, et al. Transplant renal vein thrombosis and stenosis were rescued by interventional radiology. IJU Case Rep. 2024;7(5):387-390. Published 2024 Jul 27. doi:10.1002/iju5.12764
13. Uchida N, Miyajima K, Yanagiswa T, et al. Transplant renal vein thrombosis and stenosis were rescued by interventional radiology. IJU Case Rep. 2024;7(5):387-390. Published 2024 Jul 27. doi:10.1002/iju5.12764
14. Konopa J, Komorowska-Jagielska K, Łaski D, Chamienia A, Budyńko Ł, Dębska-Ślizień A. Kidney Transplant Loss Due to May-Thurner Syndrome: Case Report and Review of the Literature. Transplant Proc. 2024;56(4):972-975. doi:10.1016/j.transproceed.2024.04.006
15. Granata A, Clementi S, Londrino F, et al. Renal transplant vascular complications: the role of Doppler ultrasound. J Ultrasound. 2014;18(2):101-107. Published 2014 Apr 11. doi:10.1007/s40477-014-0085-6

Chapter 6

WOUND, SOFT TISSUE AND RECONSTRUCTIVE COMPLICATIONS AFTER KIDNEY TRANSPLANTATION

Ibrahim TABAKAN[1]

Abstract

Wound-related, soft tissue, and reconstructive complications remain important causes of morbidity after kidney transplantation despite advances in surgical technique, perioperative care, and immunosuppressive therapy. Common complications include surgical site infection, hematoma, seroma, lymphocele, wound dehiscence, skin necrosis, and incisional hernia. Kidney transplant recipients are particularly vulnerable because diabetes mellitus, obesity, malnutrition, vascular disease, and chronic immunosuppression may impair wound healing.

Early recognition is essential, as delayed diagnosis may lead to deep infection, graft dysfunction, prolonged hospitalization, repeated operations, or complex abdominal wall defects. Clinical evaluation should be supported by laboratory studies and imaging, with ultrasonography serving as the first-line modality for perigraft collections. Management ranges from conservative wound care and targeted antimicrobial therapy to drainage procedures, operative debridement, fascial repair, and reconstructive surgery.

Reconstructive options include delayed closure, skin grafting, local or regional flaps, mesh reinforcement, and abdominal wall reconstruction in selected cases. Negative pressure wound therapy is a useful adjunct in both treatment and staged reconstruction. Optimal outcomes depend on timely intervention and a multidisciplinary approach involving transplant surgeons, nephrologists, infectious disease specialists, radiologists, and reconstructive surgeons.

[1] Assoc. Prof. Dr., Department of Plastic Reconstructive and Aesthetic Surgery, Faculty of Medicine, Çukurova University, ibrahimtabakan@gmail.com, ORCID iD: 0000-0003-1031-1868

DOI: 10.37609/akya.4215.c12415

delayed recognition may result in deep infection, graft dysfunction, prolonged hospitalization, repeated operations, or complex abdominal wall defects.

Successful management depends on early diagnosis, accurate differentiation of fluid collections and infectious processes, prompt control of local pathology, and optimization of systemic factors that impair healing. Because transplant recipients frequently present with diabetes, obesity, vascular disease, malnutrition, and chronic immunosuppression, treatment strategies must be individualized rather than extrapolated from routine general surgical patients.

Reconstructive surgery has an important role in selected cases, ranging from delayed closure and skin grafting to flap coverage and formal abdominal wall reconstruction. Early involvement of reconstructive surgeons may simplify management, reduce morbidity, and improve functional outcomes in complex wounds.

Ultimately, the best results are achieved through a multidisciplinary approach involving transplant surgeons, nephrologists, infectious disease specialists, radiologists, wound care teams, and reconstructive surgeons. As transplant populations become older and medically more complex, continued refinement of preventive strategies, minimally invasive interventions, biomaterials, and personalized immunosuppressive protocols will be essential to further reduce postoperative wound complications and preserve long-term graft success.

REFERENCES

1. Wolfe RA, Ashby VB, Milford EL, et al. Comparison of mortality in all patients on dialysis, patients awaiting transplantation, and recipients of a first cadaveric transplant. N Engl J Med. 1999;341(23):1725-1730.
2. Røine E, Bjørk IT, Oyen O. Targeting risk factors for impaired wound healing and wound complications after kidney transplantation. Transplant Proc. 2010;42(7):2542-2546.
3. Ranghino A, Segoloni GP, Lasaponara F, et al. Lymphatic disorders after renal transplantation: New insights for an old complication. Clin Kidney J. 2015;8(5):615-622.
4. Troppmann C, Pierce JL, Gandhi MM, et al. Higher surgical wound complication rates with sirolimus immunosuppression after kidney transplantation: A matched-pair pilot study. Transplantation. 2003;76(2):426-429.
5. Dean PG, Lund WJ, Larson TS, et al. Wound-healing complications after kidney transplantation: A prospective, randomized comparison of sirolimus and tacrolimus. Transplantation. 2004;77(10):1555-1561.
6. Webster AC, Nagler EV, Morton RL, et al. Chronic kidney disease. Lancet. 2017;389(10075):1238-1252.
7. D'Souza K, Crowley SP, Hameed A, et al. Prophylactic wound drainage in renal transplantation: A systematic review. Transplant Direct. 2019;5(7):e468.
8. Kim PJ, Attinger CE, Constantine T, et al. Negative pressure wound therapy with instillation: International consensus guidelines update. Int Wound J. 2020;17(1):174-186.

9. Kim SD, Kim JI, Moon IS, et al. Comparison of minimal skin incision technique in living kidney transplantation and conventional kidney transplantation. Chin Med J (Engl). 2016;129(8):917-921.
10. Ahmad J. Aftercare of solid abdominal organ transplant recipients. J Intensive Care Med. Published online July 15, 2025;40(1):
11. Ostaszewska A, Wszola M, Olszewska N, et al. Reoperation in early kidney post-transplant period as a strong risk factor of surgical site infection occurrence. Transplant Proc. 2019;51(8):2724-2730.
12. Lu H, Zheng P, Chen RY, et al. Analysis of risk factors for impaired wound healing after kidney transplantation. Int Wound J. 2023;20(1):140-144.
13. Mehrabi A, Fonouni H, Wente M, et al. Wound complications following kidney and liver transplantation. Clin Transplant. 2006;20(Suppl 17):97-110.

Chapter 7

LATE SURGICAL COMPLICATIONS AFTER KIDNEY TRANSPLANTATION

Ismail Onder YILMAZ[1]

Abstract

Late-stage surgical complications affecting long-term graft survival after kidney transplantation typically present with atypical symptoms—such as an increase in creatinine, decreased urine output, or asymptomatic hydronephrosis—rather than classic pain or fever. This is due to the immunosuppressive drugs used by patients and the lack of a neural network (denervation) in the transplanted kidney.

Ureteral strictures, which are among the leading complications and develop due to ischemic injury in most cases, are managed using ultrasonography for diagnosis and the insertion of a percutaneous nephrostomy to preserve kidney function. While endoscopic methods such as lasers or balloons are preferred for strictures shorter than three centimeters, surgical repair (reconstruction) utilizing the patient's own healthy ureter is mandatory for longer and resistant cases.

Stone disease, another significant issue, has a bidirectional relationship with ureteral strictures and infections, and patients do not experience typical kidney stone pain. In the treatment of stones, those smaller than 4 mm are monitored, while depending on the size and location, extracorporeal shock wave lithotripsy (ESWL), retrograde intrarenal surgery (RIRS) performed with flexible ureteroscopes, or percutaneous nephrolithotomy (PCNL) for stones larger than 2 cm are applied.

In these patients, who have an increased risk of cancer due to the suppression of the immune system, macroscopic hematuria (visible blood in the urine) should always be considered a critical early symptom for urothelial carcinoma; cystoscopy and careful imaging that does not put kidney function at risk must be performed. Additionally, it is of vital importance to conduct annual ultrasound screenings

[1] Dr. Assist. Prof. Department of Urology, Faculty of Medicine, Çukurova University, onderyilmaz8701@yahoo.com, ORCID iD: 0000-0003-2325-177X

DOI: 10.37609/akya.4215.c12416

A forgotten/encrusted stent can lead to stone formation and infection; a stent follow-up protocol (timely removal) can be documented as a quality indicator. In transplant patients who are on immunosuppressive therapy and have a single functioning kidney, forgotten ureteral stents represent a urological problem with highly devastating consequences. The rates of encrustation, stone formation, and fragmentation increase exponentially in stents left in the body for an extended period (e.g., more than 6 months). An encrusted stent leads to obstructive nephropathy, resistant infections, and urosepsis, putting both the graft and the patient's life at risk. Although there are rare cases in the literature of stents forgotten for 13 years that fortunately did not develop encrustation, the removal of encrusted stents generally requires a challenging and multimodal endourological approach combining methods such as ESWL, ureteroscopy (URS), and percutaneous nephrolithotomy (PCNL). To completely prevent such severe morbidities, the clinical implementation of a stent registry and follow-up protocol to ensure the timely removal of stents (typically within 2-4 weeks) should be recognized as a crucial indicator of quality and patient safety.

CONCLUSION

Late surgical complications following kidney transplantation remain a significant clinical challenge that directly impacts long-term graft survival and patient quality of life. Ureteral strictures, stone disease, urological malignancies, and ureteral fistulas/stent-related complications each require a tailored, multidisciplinary approach. The atypical clinical presentation caused by denervation and immunosuppression necessitates a high index of suspicion and strict follow-up protocols. Early diagnosis through ultrasonography, timely decompression, and appropriate endourological or surgical interventions are critical for preserving graft function. Additionally, the elevated cancer risk in immunosuppressed patients mandates lifelong urological surveillance. Implementing institutional stent follow-up registries and adhering to evidence-based guidelines, such as the updated 2026 EAU Guidelines on Renal Transplantation, are essential quality measures to minimize preventable complications and improve overall transplant outcomes.

REFERENCES

1. Alwesali SM. A long forgotten ureteral stent for 13 years post renal transplantation. Urol Case Rep. 2022;44:102156. https://doi.org/10.1016/j.eucr.2022.102156
2. Seito T, Kondo T, Takagi T, et al. Bladder preservation after bilateral kidney loss and bladder cancer after renal transplantation: A case report. Transplant Proc. 2023;55(3):660-663. https://doi.org/10.1016/j.transproceed.2023.02.029

3. Lee HJ, Kim SH, Lee JY, et al. De novo urological malignancies after renal transplantation: An Asian 30-year experience. Clin Transplant. 2024;38(2):e15415. https://doi.org/10.1111/ctr.15415
4. Coleman JA, Clark PE, Bixler BR, et al. Diagnosis and management of non-metastatic upper tract urothelial carcinoma: AUA/SUO guideline. J Urol. 2023;209(6):1071-1081. https://doi.org/10.1097/JU.0000000000003480
5. Yin S, Zhang X, Liu Y, et al. Do ureteral stents improve clinical outcomes in renal transplantation? A systematic review and meta-analysis comparing stented and non-stented anastomosis techniques. PeerJ. 2026;14:e20665. https://doi.org/10.7717/peerj.20665
6. Wang Y, Liu X, Chen J, et al. Dynamic viral integration patterns in BK polyomavirus-associated diseases after renal transplantation. Am J Transplant. 2023;23(10):1694-1708. https://doi.org/10.1016/j.ajt.2023.07.014
7. Kusuma MHH, Ghinorawa T, Hardjo IS, et al. Early ureteral stent removal reduces urinary tract infection risk without increasing complications in living donor kidney transplantation: A systematic review and meta-analysis. Clin Transplant. 2025;39(3):308-316. https://doi.org/10.4285/ctr.24.0069
8. Guvence N, Oskay K, Karabulut I, et al. Effects of ureteral stent on urologic complications in renal transplant recipients: A retrospective study. Ren Fail. 2009;31(10):899-903. https://doi.org/10.3109/08860220903216105
9. Faba OR, Breda A, Budde K, et al. European Association of Urology guidelines on renal transplantation: Update 2024. Eur Urol Focus. 2025;11(2):365-373. https://doi.org/10.1016/j.euf.2024.10.012
10. Tillou X, Le Bloa L, Courteille V, et al. First full intracorporeal robotic cystectomy and neobladder in a renal transplant recipient. J Surg Case Rep. 2025;2025(1):rjaf009. https://doi.org/10.1093/jscr/rjaf009
11. Bhuva S, Kennish SJ, Wah TM. Forgotten indwelling stent in a transplanted kidney: A case report. Cases J. 2009;2:27. https://doi.org/10.1186/1757-1626-2-27
12. Harza M, Baston C, Preda A, et al. Impact of ureteral stenting on urological complications after kidney transplantation surgery: A single-center experience. Transplant Proc. 2014;46(10):3459-3462. https://doi.org/10.1016/j.transproceed.2014.09.091
13. Chewcharat A, Thongprayoon C, Bathini T, et al. Incidence and mortality of renal cell carcinoma after kidney transplantation: A meta-analysis. J Clin Med. 2019;8(4):530. https://doi.org/10.3390/jcm8040530
14. Cheungpasitporn W, Thongprayoon C, O'Corragain OA, et al. Incidence of kidney stones in kidney transplant recipients: A systematic review and meta-analysis. World J Transplant. 2016;6(4):790-797. https://doi.org/10.5500/wjt.v6.i4.790
15. Li D, Zhang Y, Wang H, et al. Ipsilateral synchronous papillary renal neoplasm with reverse polarity and urothelial carcinoma in a renal transplant recipient: A rare case report. Diagn Pathol. 2023;18(1):120. https://doi.org/10.1186/s13000-023-01406-7
16. Piana A, Rizzo M, Amparore D, et al. Kidney stones in renal transplant recipients: A systematic review. Actas Urol Esp (Engl Ed). 2024;48(2):79-104. https://doi.org/10.1016/j.acuroe.2023.10.005
17. Małyszko SJ, Małyszko J, Kozłowska K, et al. Malignancy of urinary tract in kidney transplant recipients: A narrative review. Cancers (Basel). 2026;18(3):695. https://doi.org/10.3390/cancers18030695
18. Patel S, Shah S, Patel N, et al. Risk factors and rates of ureteral stricture formation following renal transplantation: A literature review. Exp Clin Transplant. 2024;22(6):655-663. https://doi.org/10.6002/ect.2024.0162
19. Ito A, Ohyama T, Minamisono K, et al. Second renal transplantation with simultaneous ileal conduit creation following transplant nephroureterectomy and native cystectomy. IJU Case Rep. 2025;8(5):377-381. https://doi.org/10.1002/iju5.70044

20. Yamanaka K, Tanaka T, Fujimoto K, et al. Surgical and infectious complications following kidney transplantation: A contemporary review. J Clin Med. 2025;14(10):3307. https://doi.org/10.3390/jcm14103307
21. Fakhr Yasseri A, Roshani D, Kachooei AR, et al. Prevalence of renal stones and outcomes of conservative treatment in kidney transplantation: A systematic review and meta-analysis. Urol J. 2021;18(3):252-258. https://doi.org/10.22037/uj.v18i02.6531
22. Figaroa OJA, van der Heijden AG, Witjes JA, et al. Incidence of upper tract urothelial carcinoma following renal transplantation in the Netherlands. Eur Urol Open Sci. 2025;76:1-6. https://doi.org/10.1016/j.euros.2025.03.004
23. Kumar S, Sharma A, Ganesamoni R, et al. Ureteral obstruction following renal transplantation: Causes, diagnosis and management. Br J Radiol. 2014;87(1039):20140169. https://doi.org/10.1259/bjr.20140169
24. Novacescu D, Radu D, Mischie A, et al. Ureteric complications and urinary tract reconstruction techniques in renal transplantation: A surgical essay. J Clin Med. 2025;14(12):4129. https://doi.org/10.3390/jcm14124129
25. Mirza A, Khan S, Ahmed S, et al. Ureteric trauma following stent removal in kidney transplant recipient: A case report. Case Rep Transplant. 2021;2021:9959074. https://doi.org/10.1155/2021/9959074
26.

Chapter 8

HEMATOLOGICAL COMPLICATIONS AFTER RENAL TRANSPLANTATION

Funda TANRIKULU[1]

Abstract

Hematologic complications after renal transplantation are significant clinical issues that can occur in both the early and late post-transplant periods and directly affect patient prognosis. The most common of these complications include anemia, leukopenia, and thrombocytopenia; and their etiology involves surgical blood loss, graft dysfunction, immunosuppressive medications, infections, and nutritional deficiencies. Additionally, more specific conditions such as post-transplant erythrocytosis, post-transplant lymphoproliferative disease, and thrombotic microangiopathy may also be observed. Management focuses on addressing the underlying cause and includes modification of immunosuppression, treatment of infections, and targeted therapies when necessary. This section discusses the pathogenesis, diagnostic approach, and current treatment strategies for hematologic complications that develop after renal transplantation.

Keywords: Renal transplantation, Hematologic complications, Anemia, Immunosuppression, Post-transplant lymphoproliferative disease

INTRODUCTION

After renal transplantation, a wide range of hematologic complications may arise due to both the surgical procedure and the immunosuppressive therapies used to prevent graft rejection. While the most common disorders are post-transplant anemia and erythrocytosis, many hematological disorders, such as post-transplant lymphoproliferative disease and thrombotic microangiopathy, which are rare but associated with increased morbidity and mortality, play a significant role in the management of the post-transplant period. In this section, hematological

[1] Dr. Assist. Prof., Department of Hematology, Faculty of Medicine, Çukurova University, tanrikulumfunda@gmail.com, ORCID iD: 0000-0003-1878-1872

DOI: 10.37609/akya.4215.c12417

Hemophagocytic Syndrome

Hemophagocytic syndrome is a rare but potentially fatal hematologic disorder that occurs following renal transplantation. The pathogenesis of the disease involves uncontrolled macrophage activation resulting from T/NK cell dysfunction, leading to hyperinflammation associated with a cytokine storm. Patients present to the clinic with fever, hepatosplenomegaly, pancytopenia, lymphadenopathy, rash, jaundice, and neurological symptoms. Post-transplant lymphoproliferative disease and various infections: particularly EBV, as well as CMV, herpes simplex virus, and fungal infections can trigger the development of hemophagocytic syndrome. For diagnosis, the condition should first be considered in patients with suspicious clinical findings, and the diagnosis must be supported by laboratory tests, primarily elevated ferritin levels, as well as elevated triglycerides and low fibrinogen. Both the diagnosis and treatment of the disease require multidisciplinary management.

CONCLUSION

Hematologic complications observed in the post-kidney transplant period are among the leading causes of morbidity and mortality in kidney transplant patients. Early diagnosis and identification of the etiology are of great importance in the treatment of these complications. The effective implementation of appropriate immunosuppressive therapy and infection prevention measures, along with regular monitoring of hematologic side effects, are key factors in reducing the incidence and severity of these complications. Furthermore, collaboration among nephrology, hematology, infectious diseases, and organ transplantation teams is of utmost importance in these patients.

REFERENCES

1. Zucker K, Tsaroucha A, Olson L, et al. Evidence that tacrolimus augments the bioavailability of mycophenolate mofetil through the inhibition of mycophenolic acid glucuronidation. Ther Drug Monit. 1999;21(1):35-43. https://doi.org/10.1097/00007691-199902000-00006
2. Webster AC, Lee VW, Chapman JR, et al. Target of rapamycin inhibitors (TOR-I; sirolimus and everolimus) for primary immunosuppression in kidney transplant recipients. Cochrane Database Syst Rev. 2006;(2):CD004290. https://doi.org/10.1002/14651858.cd004290.pub2
3. Dale LA, Freed JA. Hematologic Considerations in Kidney Transplantation: Core Curriculum 2025. Am J Kidney Dis. 2025;86(6):828-842. https://doi.org/10.1053/j.ajkd.2025.07.010
4. Kidney Disease: Improving Global Outcomes (KDIGO) Transplant Work Group. KDIGO clinical practice guideline for the care of kidney transplant recipients. Am J Transplant. 2009;9 Suppl 3:S1-155. https://doi.org/10.1111/j.1600-6143.2009.02834.x
6. Reindl-Schwaighofer R, Oberbauer R. Blood disorders after kidney transplantation. Transplant Rev (Orlando). 2014;28(2):63-75. https://doi.org/10.1016/j.trre.2013.10.001

7. Mix TC, Kazmi W, Khan S, et al. Anemia: a continuing problem following kidney transplantation. Am J Transplant. 2003;3(11):1426-33. https://doi.org/10.1046/j.1600-6135.2003.00224.x
8. Vanrenterghem Y. Anaemia after renal transplantation. Nephrol Dial Transplant. 2004;19Suppl 5:V54-58. https://doi.org/10.1093/ndt/gfh1057
9. Massicotte-Azarniouch D, Sood MM, Fergusson DA, et al. Blood Transfusion and Adverse Graft-related Events in Kidney Transplant Patients. Kidney Int Rep. 2021;6(4):1041-1049. https://doi.org/10.1016/j.ekir.2021.01.015
10. Vlahakos DV, Marathias KP, Agroyannis B, et al. Posttransplant erythrocytosis. Kidney Int. 2003;63(4):1187-94. https://doi.org/10.1046/j.1523-1755.2003.00850.x
11. Vlahakos DV, Marathias KP, Madias NE. The role of the renin-angiotensin system in the regulation of erythropoiesis. Am J Kidney Dis. 2010;56(3):558-65. https://doi.org/10.1053/j.ajkd.2009.12.042
12. Afrouzian M, Kozakowski N, Liapis H, et al.Thrombotic Microangiopathy in the Renal Allograft: Results of the TMA Banff Working Group Consensus on Pathologic Diagnostic Criteria. Transpl Int. 2023;36:11590. https://doi.org/10.3389/ti.2023.11590
13. Hanto DW. Classification of Epstein-Barr virus-associated posttransplant lymphoproliferative diseases: implications for understanding their pathogenesis and developing rational treatment strategies. Annu Rev Med. 1995;46:381-94. https://doi.org/10.1146/annurev.med.46.1.381
14. Achkar R, Chiba AK, Zampieri-Filho JP, et al. Hemolytic anemia after kidney transplantation: a prospective analysis. Transfusion 2011;51:2495-9. https://doi.org/10.1111/j.1537-2995.2011.03192.x
15. Henter JI. Hemophagocytic Lymphohistiocytosis. N Engl J Med. 2025;392(6):584-598. https://doi.org/10.1056/nejmra2314005

Chapter 9

CARDIOVASCULAR COMPLICATIONS AFTER KIDNEY TRANSPLANTATION

Caglar OZMEN[1]

ABSTRACT

Cardiovascular disease remains the leading cause of morbidity and mortality in kidney transplant recipients, accounting for 20–30% of all post-transplant deaths and arises from a multifactorial interaction between traditional risk factors — hypertension, dyslipidemia, diabetes mellitus, and smoking — and transplant-specific determinants including immunosuppressive drug toxicity, graft dysfunction, acute rejection, and prolonged pre-transplant dialysis. Immunosuppressive agents drive a distinct pathophysiological cascade — calcineurin inhibitors increase the risk of hypertension and dyslipidemia relative to tacrolimus, corticosteroids promote metabolic syndrome and post-transplant diabetes mellitus, and mTOR inhibitors exacerbate dyslipidemia via PCSK9 upregulation — collectively culminating in accelerated atherosclerosis, coronary artery disease, and de novo heart failure occurring in 10–18% of recipients within 36 months of transplantation. Addressing this burden demands a risk-stratified, multidisciplinary strategy that integrates pretransplant cardiac screening, guideline-directed blood pressure and lipid control, immunosuppression optimisation, and the judicious adoption of emerging cardiorenal therapies — and it is only through dedicated randomised trials in this population that the persistent evidence gap can be closed and the full promise of kidney transplantation realised.

Keywords: kidney transplantation; cardiovascular disease; immunosuppressive therapy; post-transplant hypertension; post-transplant diabetes mellitus; coronary artery disease; heart failure; risk stratification

[1] Dr. Assist. Prof., Department of Cardiology, Faculty of Medicine, Çukurova University, caglarozm@hotmail.com, ORCID iD: 0000-0002-7285-991X

DOI: 10.37609/akya.4215.c12418

hypertriglyceridemia and hypercholesterolemia. Paradoxically, despite their adverse metabolic profile, mTOR inhibitors may exert some anti-atherosclerotic effects by inhibiting intimal proliferation and stabilizing plaques, though their overall impact on cardiovascular events remains complex and requires careful patient selection.

This drug-induced dyslipidemia, often presenting as a more atherogenic profile with small, dense LDL particles susceptible to oxidation, directly contributes to the progression of atherosclerosis. The link between post-transplant cholesterol levels and adverse outcomes is well-established. Early studies identified hypercholesterolemia as an independent predictor of post-transplant vascular disease and a significant factor influencing patient survival. However, management is complicated by drug-drug interactions, as CNIs (especially CsA) can inhibit statin metabolism via the cytochrome P450 system, increasing the risk of myopathy. Therefore, statins like fluvastatin or pravastatin, which have fewer interactions, are often preferred, and careful dose adjustments are necessary.

CONCLUSION

Cardiovascular disease remains the leading cause of death and morbidity after kidney transplantation, driven by traditional risk factors and transplant-specific contributors — most notably immunosuppressive drug toxicity. A risk-stratified, multidisciplinary approach combining pretransplant screening, guideline-directed medical therapy, and individualized immunosuppression remains essential.

REFERENCES

1. Shin HS. Cardiovascular complication after kidney transplantation. J Adv Med Med Res. 2019;30(10):1-10. DOI:10.9734/JAMMR/2019/v30i1030241
2. Lentine JA, Costa MA. Cardiac disease evaluation and management among kidney transplant candidates. J Am Coll Cardiol. 2012;60(5):434-480. DOI: 10.1016/j.jacc.2012.05.008
3. Rajnochova Bloudickova S, Janek B, Machackova K, et al. Standardized risk-stratified cardiac assessment and early posttransplant cardiovascular complications in kidney transplant recipients. Front Cardiovasc Med. 2024;11:1322176. DOI: 10.3389/fcvm.2024.1322176
4. Lentine JA, Collins AJ, Wanner C, et al. Cardiovascular disease in kidney transplant recipients: epidemiology, diagnosis and management. Nat Rev Nephrol. 2019;15(11):699-713. DOI: 10.1038/s41581-019-0178-8
5. Lentine KL, Schnitzler MA, Abbott KC, et al. De novo congestive heart failure after kidney transplantation: a common condition with poor prognostic implications. Am J Kidney Dis. 2005;46(4):720-733. DOI: 10.1053/j.ajkd.2005.06.019
6. Aalten J, Hoogeveen EK, Roodnat JI, et al. Associations between pre-kidney-transplant risk factors and post-transplant cardiovascular events and death. Transpl Int. 2008;21(10):985-991. DOI: 10.1111/j.1432-2277.2008.00710.x

7. Rangaswami J, Mathew RO, Parasuraman R, et al. Cardiovascular disease in the kidney transplant recipient: epidemiology, diagnosis and management strategies. Nephrol Dial Transplant. 2019;34(5):760-773. DOI: 10.1093/ndt/gfy367
8. Ghimire A, Al-Zaneen G, Michaud JB, et al. Heart failure in kidney transplant recipients: narrative review of risk factors, therapy, and current gaps in management. Cardiol Ther. 2026;15(1):1-23. DOI: 10.1007/s40119-025-00395-2
9. Kim EJ, Chang S, Kim SY, et al. Predictive value of echocardiographic abnormalities and the impact of diastolic dysfunction on in-hospital major cardiovascular complications after living donor kidney transplantation. Int J Med Sci. 2016;13(8):620-628. DOI: 10.7150/ijms.15524
10. Park WD, DeLonais-Parker A, Okeke B, et al. Machine learning for predicting long-term cardiovascular outcomes in kidney transplant recipients. JACC Adv. 2025;4(12):102364. DOI: 10.1016/j.jacadv.2025.102364
11. Reggiani F, Moroni G, Ponticelli C. Cardiovascular risk after kidney transplantation causes and current approaches to a relevant burden. J Pers Med. 2022;12(8):1200. DOI: 10.3390/jpm12081200
12. Van Craenenbroeck AH, Chinnappa S, Dounousi E, et al. New kidneys, old risks: cardiovascular challenges after transplantation. Nephrol Dial Transplant. 2025;40(1):1-13. DOI: 10.1093/ndt/gfae299
13. Hansen CM, Bachmann S, Su M, et al. Calcineurin inhibitor-associated nephrotoxicity in kidney transplantation: a transplant nephrologist's perspective. Acta Physiol (Oxf). 2025;241(5):e70047. DOI: 10.1111/apha.70047
14. Luke RG. Pathophysiology and treatment of posttransplant hypertension. J Am Soc Nephrol. 1991;2(1 Suppl):S37-44. DOI: Not available
15. Jiwani S, Chan WC, Majmundar M, et al. Impact of pre-existing coronary artery and peripheral artery disease on outcomes in diabetic patients after kidney transplant. Vasc Med. 2024;29(2):135-142. DOI: 10.1177/1358863X231205574
16. Franquet Q, Terrier N, Pirvu A, et al. Aortic bypass surgery for asymptomatic patients awaiting a kidney transplant: a word of caution. Clin Transplant. 2018;32(8):e13218. DOI: 10.1111/ctr.13218
17. Kasiske BL, Cangro CB, Hariharan S, et al. The evaluation of renal transplantation candidates: clinical practice guidelines. Am J Transplant. 2001;1(Suppl 2):3-95. DOI: 10.1034/j.1600-6143.2001.10201.x
18. Liu Y, Yang MS, Yuan J. Immunosuppressant utilization and cardiovascular complications among Chinese patients after kidney transplantation: a systematic review and analysis. Int Urol Nephrol. 2013;45(3):885-892. DOI: 10.1007/s11255-012-0365-4
19. Murakami N, Riella LV, Funakoshi T. Risk of metabolic complications after conversion to mTOR inhibitors in kidney transplantation: a systematic review and meta-analysis. Am J Transplant. 2014;14(10):2317-2327. DOI: 10.1111/ajt.12855
20. Kasiske BL. Risk factors for accelerated atherosclerosis in renal transplant recipients. Am J Med. 1988;84(6):985-992.

Chapter 10

GASTROINTESTINAL COMPLICATIONS AND PANCREATITIS AFTER KIDNEY TRANSPLANTATION

Umit KARAOGULLARİNDAN[1]

Abstract

Gastrointestinal complications are common after kidney transplantation and are an important cause of morbidity in transplant recipients. These complications arise from multiple mechanisms, including immunosuppressive drug toxicity, opportunistic infections, metabolic disturbances, and pre-existing gastrointestinal diseases. Post-transplant diarrhea is the most frequent clinical manifestation and may interfere with the absorption of immunosuppressive medications. Upper gastrointestinal disorders, such as gastritis and peptic ulcer disease, are also frequently encountered, particularly in patients receiving corticosteroids or antithrombotic therapy. Acute pancreatitis is less common but remains clinically relevant because of its potential severity. This chapter reviews the epidemiology, pathophysiology, clinical presentation, diagnostic evaluation, and management of gastrointestinal complications after kidney transplantation, with particular emphasis on post-transplant diarrhea and pancreatitis.

Keywords: kidney transplantation; gastrointestinal complications; post-transplant diarrhea; acute pancreatitis; immunosuppressive therapy; opportunistic infections; peptic ulcer disease; transplant recipients.

INTRODUCTION

Gastrointestinal complications constitute one of the most frequently encountered categories of non-renal medical problems following kidney transplantation. Advances in transplant surgery and modern immunosuppressive therapy have significantly improved graft survival and longevity. Consequently, long-

[1] Dr. Assist. Prof., Department of Gastroenterology, Faculty of Medicine, Çukurova University
umit2462@hotmail.com, ORCID iD: 0000-0003-4309-7845

DOI: 10.37609/akya.4215.c12419

toxicity from infectious causes. Although less frequent, acute pancreatitis represents a potentially serious complication that warrants prompt recognition and management. Early diagnosis, appropriate adjustment of immunosuppressive therapy, and multidisciplinary care are essential for optimizing patient outcomes and preserving graft function.

REFERENCES

1. Fishman JA. Infection in solid-organ transplant recipients. N Engl J Med. 2007;357(25):2601-2614. doi:10.1056/NEJMra064928.
2. Gioco R, Corona D, Ekser B, et al. Gastrointestinal complications after kidney transplantation. World J Gastroenterol. 2020;26(38):5797-5811. doi:10.3748/wjg.v26.i38.5797.
3. Patil AD, Saxena NG, Thakare SB, et al. Diarrhea after kidney transplantation: A study of risk factors and outcomes. J Postgrad Med. 2023;69(4):205-214. doi:10.4103/jpgm.jpgm_601_22.
4. Loucif Y, Mackenzie C, Tselikmann O, et al. Infectious diarrhea in kidney transplant recipients. Cureus. 2025;17(4):e82194. doi:10.7759/cureus.82194.
5. Sonambekar A, Mehta V, Desai D, et al. Diarrhea in kidney transplant recipients: Etiology and outcome. Indian J Gastroenterol. 2020;39(2):141-146. doi:10.1007/s12664-020-01022-1.
6. Ding U, Ooi L, Wu HHL, et al. Clostridioides difficile infection in kidney transplant recipients. Pathogens. 2024;13(2):140. doi:10.3390/pathogens13020140.
7. Nair SN, Bhaskaran A, Chandorkar A, et al. Noroviral diarrhea in solid organ transplant recipients: An analysis of interventions and outcomes. Clin Transplant. 2023;37(2):e14855. doi:10.1111/ctr.14855.
8. Razonable RR, Humar A. Cytomegalovirus in solid organ transplantation. Am J Transplant. 2013;13(Suppl 4):93-106. doi:10.1111/ajt.12103.
9. Muhammad A, Khan RTY, Waqar T, et al. Cytomegalovirus-associated colitis as a cause of lower gastrointestinal bleeding in kidney transplant recipients: A single-centered study. Cureus. 2024;16(6):e62422. doi:10.7759/cureus.62422.
10. Gil-Vernet S, Amado A, Ortega F, et al. Gastrointestinal complications in renal transplant recipients: MITOS study. Transplant Proc. 2007;39(7):2190-2193. doi:10.1016/j.transproceed.2007.07.015.
11. Shin HS, Chandraker A. Causes and management of postrenal transplant diarrhea: An underappreciated cause of transplant-associated morbidity. Curr Opin Nephrol Hypertens. 2017;26(6):484-493. doi:10.1097/MNH.0000000000000368.
12. Li Y, Yang Y, Yang N, et al. Recent advances in fecal microbiota transplantation for Clostridium difficile infection-associated diarrhea after kidney transplantation. Front Microbiomes. 2024;3:1409967. doi:10.3389/frmbi.2024.1409967.
13. Chadban SJ, Ahn C, Axelrod DA, et al. KDIGO clinical practice guideline on the evaluation and management of candidates for kidney transplantation. Transplantation. 2020;104(4 Suppl 1):S11-S103. doi:10.1097/TP.0000000000003136.
14. Woillard JB, Rerolle JP, Picard N, et al. Risk of diarrhoea in a long-term cohort of renal transplant patients given mycophenolate mofetil: The significant role of the UGT1A8 2 variant allele. Br J Clin Pharmacol. 2010;69(6):675-683. doi:10.1111/j.1365-2125.2010.03625.x.
15. Hiramoto LL, Tedesco-Silva H, Medina-Pestana JO, et al. Tolerability of mycophenolate sodium in renal transplant recipients. Int J Clin Pharm. 2018;40(6):1548-1558. doi:10.1007/s11096-018-0727-4.

Chapter 11

HEPATOBILIARY PROBLEMS AFTER KIDNEY TRANSPLANTATION

Ahmet Gokhan SARİTAS[1]
Mevlut Harun AGCA[2]

Abstract

Hepatobiliary complications are frequently encountered in kidney transplant recipients and represent an underappreciated cause of morbidity in this population. The post-transplant milieu — characterized by chronic immunosuppression, polypharmacy, and metabolic derangement — creates a unique substrate for hepatic injury that differs substantially from that seen in the general population. This chapter provides a comprehensive review of the principal categories of hepatobiliary disease following kidney transplantation, including drug-induced liver injury (DILI) attributable to immunosuppressants, antifungals, antibiotics, and statins; viral hepatitis reactivation and de novo infection with hepatitis B (HBV) and hepatitis C (HCV) viruses; biliary tract disease including cholelithiasis, cholangitis, and choledocholithiasis; and metabolic-associated fatty liver disease (MAFLD/NAFLD) driven by post-transplant metabolic syndrome. Diagnostic evaluation is structured around liver function test (LFT) pattern analysis — hepatocellular, cholestatic, or mixed — supplemented by viral serology, abdominal imaging, and liver biopsy where indicated. A stepwise algorithmic approach and multidisciplinary management framework are presented. Figures illustrating the diagnostic algorithm and pathophysiological mechanisms are provided to facilitate clinical application. With up to 50% of kidney transplant recipients experiencing clinically relevant LFT abnormalities at some point post-transplant, systematic surveillance and early intervention are paramount to preserving both hepatic and allograft function.

[1] Dr. Assist. Prof., Department of General Surgery, Faculty of Medicine, Çukurova University, drags0001@hotmail.com, ORCID iD: 0000-0003-2715-6390

[2] Lecturer, Department of General Surgery, Faculty of Medicine, Çukurova University, ORCID iD: 0000-0001-9007-0704

DOI: 10.37609/akya.4215.c12420

prevention and hepatoprotection. Advances in antiviral therapy for HBV and HCV, evolving immunosuppressive strategies, and emerging metabolic therapies offer increasingly effective tools for the prevention and treatment of post-transplant liver disease. Multidisciplinary collaboration, regular monitoring, and patient engagement remain the cornerstones of optimal hepatobiliary care in this vulnerable population.

REFERENCES

1. Pottanat N, Friederich A, LaMotte J. End-stage kidney disease, dialysis, and transplant basics. In: *Psychosocial Considerations in Pediatric Kidney Conditions: Guidance for Collaborative Practice*. Springer; 2024. p. 67–94.
2. Gabrielli F, Bernasconi E, Toscano A, Avossa A, Cavicchioli A, Andreone P, et al. Side effects of immunosuppressant drugs after liver transplant. *Pharmaceuticals*. 2025;18(3):342.
3. El Sibai R, Freedman SR, Gatz JD. A narrative review of the evaluation and management of liver transplant complications in the emergency department. *The Journal of Emergency Medicine*. 2023;64(5):596–609.
4. Moura AF, Moura-Neto JA, Ribeiro BdM, Oliveira PR, Freitas AGd, Costa AL, et al. Post-liver transplant kidney dysfunction: incidence of acute kidney injury and chronic kidney disease and risk factors related to chronic kidney disease development. *Diseases*. 2025;13(5):144.
5. Jothimani D, Marannan NK, Rela M. Acute liver failure and liver transplantation. *Indian Journal of Gastroenterology*. 2025;44(3):298–310.
6. Sharma P, Izzy M, Ghabril MS, Serper M, Clark VC, Ison MG, et al. AASLD AST practice guideline on adult liver transplantation: diagnosis and post-transplant management of non-graft-related complications. *Liver Transplantation*. 2025;31
7. Mistry A, Bhattacharya A, Mondal M, Bhattacharjee S, Bhattacharya A, Ghosh SB, et al. Calcineurin inhibitors: current role, toxicity management, and future frontiers in immunosuppression. *Molecular Neurobiology*. 2026;63(1):275
8. Vij M. Pathology of liver transplantation. In: *Fundamentals of Transplant Hepatology*. Springer; 2026. p. 637–677.
9. Irving PM, Gecse KB. Optimizing therapies using therapeutic drug monitoring: current strategies and future perspectives. *Gastroenterology*. 2022;162(5):1512–1524.
10. Lou Y, Wang Y, Liu J, Wang YJ, Wang J, Ma S, et al. Voriconazole-induced liver injury: incidence patterns and risk factors in a retrospective cohort. *Antimicrobial Agents and Chemotherapy*. 2025;69(9):e00487-25.
11. Lamprecht DG Jr, Saseen JJ, Shaw PB. Clinical conundrums involving statin drug-drug interactions. *Progress in Cardiovascular Diseases*. 2022; 75:83–89.
12. Teschke R, Danan G. Advances in idiosyncratic drug-induced liver injury issues: new clinical and mechanistic analysis due to RUCAM use. *International Journal of Molecular Sciences*. 2023;24(13):10855.
13. Maertens J, Pagano L, Azoulay E, Warris A. Liposomal amphotericin B—the present. *Journal of Antimicrobial Chemotherapy*. 2022;77(Suppl 2):11–20.
14. Vutien P, Nguyen MH. HBV reactivation in immunosuppressed patients: screening, prevention, and management including solid organ transplant recipients. *Viruses*. 2025;17(3):388.
15. Chang Y, Jeong SW, Jang JY. Hepatitis B virus reactivation associated with therapeutic interventions. *Frontiers in Medicine*. 2022; 8:770124.
16. Mak LY, Hu TH, Yap DY. Renal safety profiles of tenofovir alafenamide, tenofovir disoproxil fumarate, and entecavir for chronic hepatitis B. *Alimentary Pharmacology & Therapeutics*. 2026;63(7):945–954.

17. Rinaldi L, Giorgione C, Mormone A, Esposito F, Rinaldi M, Berretta M, et al. Non-invasive measurement of hepatic fibrosis by transient elastography: a narrative review. *Viruses*. 2023;15(8):1730.
18. Zheng L, Ye ZY, Ma JJ. Effect of cholesterol metabolism on hepatolithiasis. *World Journal of Gastroenterology*. 2025;31(1):99960.
19. Chauhan K, Khan A, Chowdhury S, Ross HM, Parra NS, Halegoua-DeMarzio D. Risk of metabolic syndrome and cardiovascular disease after liver transplantation. *Livers*. 2022;2(2):85–96.
20. Colaci C, Gambardella ML, Scarlata GGM, Boccuto L, Colica C, Luzza F, et al. Dysmetabolic comorbidities and NAFLD: a stairway to MASLD. *Hepatoma Research*. 2024;10.
21. Biciusca T, Stan SI, Balteanu MA, Cioboata R, Ghenea AE, Danoiu S, et al. Role of the fatty liver index in NAFLD management: a systematic review. *Diagnostics*. 2023;13(21):3316.
22. Alluhayyan OB, Almutawa FM, Alghamdi YI, Alyousef KA, Altaleb KA, AlGhamdi HA, et al. Use of semaglutide in diabetes care post renal transplantation. *Current Transplantation Reports*. 2025;12(1):9.
23. Tincopa MA, Loomba R. Non-invasive diagnosis and monitoring of NAFLD and NASH. *The Lancet Gastroenterology & Hepatology*. 2023;8(7):660–670.
24. Gadour E. Lessons from 60 years of liver transplantation: advancements, challenges, and future directions. *World Journal of Transplantation*. 2025;15(1):93253.
25. Al-Worafi YM. Liver diseases. In: *Handbook of Complementary, Alternative, and Integrative Medicine*. CRC Press; 2025. p. 367–388.

Chapter 12

IMMUNOSUPPRESSIVE DRUGS AND OCULAR COMPLICATIONS AFTER KIDNEY TRANSPLANTATION

Burak ULAS[1]

Abstract

Kidney transplantation is the treatment of choice for patients with end-stage renal disease and has substantially improved long-term survival and quality of life. The success of transplantation, however, relies on lifelong immunosuppressive therapy, which is associated with a wide range of systemic adverse effects, including potentially vision-threatening ocular complications. As the life expectancy of transplant recipients continues to increase, recognition and prevention of drug-related ocular morbidity have become increasingly important components of comprehensive post-transplant care.

Ocular complications in kidney transplant recipients arise through multiple mechanisms, including direct pharmacologic toxicity, microvascular dysregulation, neurotoxicity, impaired tissue repair, and increased susceptibility to opportunistic infections. This chapter provides a comprehensive and clinically oriented overview of ocular complications associated with the major classes of immunosuppressive agents used in renal transplantation, including corticosteroids, calcineurin inhibitors, mammalian target of rapamycin (mTOR) inhibitors, and antimetabolites. Corticosteroids remain the most common cause of ocular morbidity, frequently leading to posterior subcapsular cataract, steroid-induced glaucoma, and central serous chorioretinopathy. Calcineurin inhibitors, particularly tacrolimus and cyclosporine, may produce neuro-ophthalmic complications such as toxic optic neuropathy and posterior reversible encephalopathy syndrome. In contrast, mTOR inhibitors primarily affect ocular surface integrity and wound healing, whereas antimetabolites contribute mainly

[1] Dr. Assoc. Prof., Ophthalmology Department, Faculty of Medicine, Cukurova University, drburakulas@gmail.com, ORCID iD: 0000-0003-4828-8843

DOI: 10.37609/akya.4215.c12421

ophthalmic adverse effects, and clinically important pharmacokinetic interactions with immunosuppressive drugs.

Immunosuppressive drug–related ocular complications represent a significant and clinically consequential component of long-term morbidity after kidney transplantation. Their impact extends beyond visual symptoms alone, influencing functional independence, quality of life, perioperative recovery, and the broader safety profile of chronic transplant therapy. Greater awareness, systematic ophthalmologic surveillance, and integrated multidisciplinary care are essential to minimizing preventable visual loss while maintaining durable graft survival. As post-transplant care continues to evolve toward more personalized and outcome-oriented models, ophthalmologic monitoring should be increasingly recognized as a necessary pillar of high-quality kidney transplant medicine.

REFERENCES

1. Jawdeh BGA, Me HM. Immunosuppression in kidney transplant recipients: an update for the general nephrologist. Adv Kidney Dis Health. 2024;31(5):408–415.
2. Khan MA, Hanna A, Sridhara S, et al. Maintenance immunosuppression in kidney transplantation: a review of the current status and future directions. J Clin Med. 2025;14(6):1821.
3. Multani EK, Bajwa D, Multani PK, et al. Eye disease in kidney transplantation: clinical challenges in a unique patient population. Surv Ophthalmol. 2022;67(4):1252–1269.
4. Yaprak AÇ, Avanaz A, Pota CE, et al. Long-term ocular complications after kidney transplantation. Sci Rep. 2025;15(1):15222.
5. Berindán K, Nemes B, Szabó RP, et al. Ophthalmic findings in patients after renal transplantation. Transplant Proc. 2017;49(7):1526–1529.
6. Kersey JP, Broadway DC. Corticosteroid-induced glaucoma: a review of the literature. Eye (Lond). 2006;20(4):407–416.
7. Jobling AI, Augusteyn RC. What causes steroid cataracts? A review of steroid-induced posterior subcapsular cataracts. Clin Exp Optom. 2002;85(2):61–75.
8. Ge G, Zhang Y, Zhang Y, et al. Corticosteroid usage and central serous chorioretinopathy: a meta-analysis. Graefes Arch Clin Exp Ophthalmol. 2020;258(1):71–77.
9. Lanternier F, Sun HY, Ribaud P, et al. Mucormycosis in organ and stem cell transplant recipients. Clin Infect Dis. 2012;54(11):1629–1636.
10. Ginu PM, Sati A, Murari T, et al. Ocular manifestations in renal allograft recipients: an Indian perspective. Indian J Ophthalmol. 2021;69(4):900–905.
11. Pruitt AA. Neurologic complications of transplantation. Continuum (Minneap Minn). 2017;23(3):802–821.
12. Rasool N, Boudreault K, Lessell S, et al. Tacrolimus optic neuropathy. J Neuroophthalmol. 2018;38(2):160–166.
13. Song T, Rao Z, Tan Q, et al. Calcineurin inhibitors-associated posterior reversible encephalopathy syndrome in solid organ transplantation: report of 2 cases and literature review. Medicine (Baltimore). 2016;95(14):e3173.
14. Kommana SS, Bains U, Fasula V, et al. Tacrolimus-induced posterior reversible encephalopathy syndrome initially presenting as bilateral optic neuropathy: a case report. Case Rep Ophthalmol. 2019;10(1):140–144.

15. Khalil MAM, Al-Ghamdi SMG, Dawood US, et al. Mammalian target of rapamycin inhibitors and wound healing complications in kidney transplantation: old myths and new realities. J Transplant. 2022;2022:6255339.
16. Schear MJ, Rodgers R. Everolimus-induced eyelid edema: a case report. Ophthalmic Plast Reconstr Surg. 2018;34(1):e21–e22.
17. Milani BY, Milani FY, Park DW, et al. Rapamycin inhibits the production of myofibroblasts and reduces corneal scarring after photorefractive keratectomy. Invest Ophthalmol Vis Sci. 2013;54(12):7424–7430.
18. Daniel E, Thorne JE, Newcomb CW, et al. Mycophenolate mofetil for ocular inflammation. Am J Ophthalmol. 2010;149(3):423–432.e1–2.
19. Khosroshahi HT, Asghari A, Estakhr R, et al. Effects of azathioprine and mycophenolate mofetil immunosuppressive regimens on the erythropoietic system of renal transplant recipients. Transplant Proc. 2006;38(7):2077–2079.
20. Bernabeu-Wittel M, Naranjo M, Cisneros JM, et al. Infections in renal transplant recipients receiving mycophenolate versus azathioprine-based immunosuppression. Eur J Clin Microbiol Infect Dis. 2002;21(3):173–180.
21. Kotton CN, Kamar N, et al. New insights on CMV management in solid organ transplant patients: prevention, treatment, and management of resistant/refractory disease. Infect Dis Ther. 2023;12(2):333–342.
22. Limaye AP, Budde K, Humar A, et al. Letermovir vs valganciclovir for prophylaxis of cytomegalovirus in high-risk kidney transplant recipients: a randomized clinical trial. JAMA. 2023;330(1):33–42.
23. Rashad R, Shanbhag SS, Kwan J, et al. Chronic ocular complications in lamotrigine vs trimethoprim-sulfamethoxazole-induced Stevens-Johnson syndrome/toxic epidermal necrolysis. Ocul Surf. 2021;21:16–18.
24. Zhao YC, Xiao CL, Hou JJ, et al. The effect of voriconazole on tacrolimus in kidney transplantation recipients: a real-world study. Pharmaceutics. 2022;14(12):2739.
25. Le Trung N, Toan PQ, Trung NK, et al. Eye lesions in patients after one year of kidney transplantation. Clin Ophthalmol. 2023;17:2887–2896.
26. Sezenoz AS, Gokgoz G, Dogan IK, et al. Ocular symptoms in kidney, liver, and heart transplant recipients. Exp Clin Transplant. 2024;22:141–147.
27. Raczyńska D, Slizien M, Bzoma B, et al. A 10-year monitoring of eyesight in patients after kidney transplantation. Medicine (Baltimore). 2018;97(6):e9822.
28. Wang J, Wang YX, Zeng D, et al. Artificial intelligence-enhanced retinal imaging as a biomarker for systemic disease. Theranostics. 2025;15(8):3223–3233.
29. Ringel MJ, Tang EM, Tao YK. Advances in multimodal imaging in ophthalmology. Ther Adv Ophthalmol. 2021;13:25158414211002400.
30. Tran L, Kandel H, Sari D, et al. Artificial intelligence and ophthalmic clinical registries. Am J Ophthalmol. 2024;268:263–274.

Chapter 13

INFECTIOUS, NON-INFECTIOUS AND VASCULAR COMPLICATIONS OF THE EYE AFTER KIDNEY TRANSPLANTATION

Ibrahim Inan HARBIYELI[1]

Abstract

Although kidney transplantation is the gold standard treatment for patients with end-stage renal failure, the lifelong immunosuppressive therapy required for graft survival makes patients susceptible to serious ocular complications. This study examines post-transplant ocular conditions under three main headings: infectious, non-infectious, and vascular. Within the infectious complications, herpes viruses are the most common viral pathogens causing serious post-transplant ocular infections. The most important clinical conditions include cytomegalovirus retinitis, herpes simplex virus keratitis, herpes zoster ophthalmicus, herpetic acute retinal necrosis, and Epstein-Barr virus retinitis, and the diagnostic and treatment strategies for these important pathologies are highlighted. Toxoplasma chorioretinitis, caused by the obligate intracellular protozoan parasite Toxoplasma gondii, is a destructive ocular infection and its important aspects are discussed in this section. Ocular bacterial infections in renal transplant recipients are serious complications caused by opportunistic pathogens due to the effects of immunosuppression. In this group, ocular syphilis, cat scratch disease, and tuberculosis are primarily examined. On the other hand, when fungal infections are considered, Aspergillus is one of the most common causes of systemic fungal diseases in kidney transplant recipients. In the section on non-infectious and vascular complications, tubulointerstitial nephritis and uveitis syndrome, hypertensive retinopathy, diabetic retinopathy, and retinal vein occlusion are covered. Because immunosuppressive drugs can mask typical signs of ocular inflammation, early diagnosis of vision-threatening conditions in kidney transplant recipients is difficult. To prevent diagnostic delays and permanent

[1] Assoc. Prof. Dr., Ophthalmology Department, Faculty of Medicine, Adana , Cukurova University, inanharbiyeli[at]hotmail.com, ORCID iD: 0000-0003-2586-1096

DOI: 10.37609/akya.4215.c12422

this type of retinal vascular occlusion. Fundus fluorescein angiography is used to confirm the diagnosis and identify ischemic areas. Optical coherence tomography is critically important, especially for the quantitative assessment of retinal thickness and edema. In the treatment plan, laser photocoagulation is applied for ischemic cases, while vitrectomy surgery may be necessary in complicated cases. To minimize the risk of vision loss, regular ophthalmological check-ups are vital for high-risk transplant patients.

CONCLUSION

Kidney transplantation is the definitive treatment for end-stage renal failure, but the lifelong immunosuppressive therapy required to preserve graft function exposes the eye to a wide range of infectious, non-infectious, and vascular complications. This section summarizes the major viral, parasitic, bacterial, and fungal opportunistic infections, autoimmune pathologies, and vascular occlusive events that can develop after transplantation. Since immunosuppression can mask the classic signs of ocular inflammation, timely diagnosis requires repeated ophthalmological examinations and structured multidisciplinary follow-up. Therefore, routine ophthalmological screening should be considered an integral component of post-transplant patient care.

REFERENCES

1. Thapa M, Shrestha GB, Gautam P, et al. Ocular Findings among the Patients of Renal Transplantation. Nepal J Ophthalmol. 2023;15:234-241. https://doi.org/10.3126/nepjoph.v15i1.52446
2. Yaprak AÇY, Avanaz A, Pota ÇE, Arabacı Tur KT, Yaprak M. Long-term ocular complications after kidney transplantation. Sci Rep. 2025;15:15222. https://doi.org/10.1038/s41598-025-99847-3
3. Sarıgül Sezenöz A, Gökgöz G, Doğan İK, et al. Ocular Symptoms in Kidney, Liver, and Heart Transplant Patients. Exp Clin Transplant. 2024;22:141-147. https://doi.org/10.6002/ect.mesot2023.o34
4. Sidiropoulou M, Arant EC, Arya S, et al. Herpetic ocular infections in solid organ transplantation: A narrative review. Transplant Rev. 2026;40:101005. https://doi.org/10.1016/j.trre.2026.101005
5. Hwang DK, Ng DSC, Qian Z, et al. International consensuses and guidelines on diagnosing and managing cytomegalovirus retinitis by the Asia-Pacific Vitreo-retina Society, the Asia-Pacific Professors of Ophthalmology and the Asia-Pacific Society of Ocular Inflammation and Infection. Asia Pac J Ophthalmol. 2025;14(5):100248. https://doi.org/10.1016/j.apjo.2025.100248
6. Litt J, Cunningham AL, Arnalich-Montiel F, et al. Herpes Zoster Ophthalmicus: Presentation, Complications, Treatment, and Prevention. Infect Dis Ther. 2024;13:1439-1459. https://doi.org/10.1007/s40121-024-00990-7
7. Romão EA, Bolella VR, Nardin MEP, et al. Ocular syphilis in a kidney transplant recipient. Rev Inst Med Trop Sao Paulo. 2016;58:46. https://doi.org/10.1590/s1678-9946201658046

8. Mehta S, Suratkal L. Ophthalmoscopy in the early diagnosis of opportunistic tuberculosis following renal transplant. Indian J Ophthalmol. 2007;55:389-391. https://doi.org/10.4103/0301-4738.33832
9. Ghabi H, Belaid R, Tlili S, et al. Orbital cellulitis unmasking disseminated TB in a kidney transplant recipient. IJTLD open. 2026;3(3):185. https://doi.org/10.5588/ijtldopen.25.0315
10. Akova YA, Altan-Yaycıoğlu R, Yılmaz G, et al. Opportunistic Posterior Uveal Infections in Renal Transplant Patients. Transplant Proc. 2006;38:602-605. https://doi.org/10.1016/j.transproceed.2006.02.132
11. Mota MC. Fulminant Bilateral Streptococcus pneumoniae Endophthalmitis in a Kidney Transplant Patient With Prior Herpetic Keratopathy. Cureus. 2026;18:e100898. https://doi.org/10.7759/cureus.100898
12. Cheng HH, Ding Y, Wu M, et al. Endogenous aspergillus endophthalmitis after kidney transplantation. Int J Ophthalmol. 2011;4:567-571. https://doi.org/10.3980/j.issn.2222-3959.2011.05.10
13. López V, Solà E, Gutiérrez C, et al. Anterior Uveitis Associated With Treatment With Intravenous Cidofovir in Kidney Transplant Patients With BK Virus Nephropathy. Transplant Proc. 2006;38:2562-2565. https://doi.org/10.1016/j.transproceed.2006.08.067
14. Berindán K, Nemes B, Szabó RP, et al. Ophthalmic Findings in Patients After Renal Transplantation. Transplant Proc. 2017;49:1532-1534. https://doi.org/10.1016/j.transproceed.2017.06.016
15. Lee J, Choe HR, Park SH, et al. Impact of kidney transplantation on the risk of retinal vein occlusion in end-stage renal disease. Sci Rep. 2021;11:15370. https://doi.org/10.1038/s41598-021-90765-8

Chapter 14

BONE AND JOINT PROBLEMS AFTER KIDNEY TRANSPLANTATION

Melih BAGİR[1]

Abstract

Kidney transplantation is a treatment method for terminal renal insufficiency. Bone and joint issues commonly occur after kidney transplantation. Osteoporosis, osteopenia, fractures, renal osteodystrophy and osteomalacia are the most relevant problems subsequent to transplantation. Sarcopenia, a decrease in muscle mass, can also be observed. All these problems result in a deterioration in patients' quality of life, which is closely related to morbidity and mortality rates. Immunosuppressive drugs after transplantation were identified as the main etiology of these musculoskeletal problems. Recent studies support reducing corticosteroid dosages and using alternative immunosuppressive drugs to prevent graft-versus-host disease, thereby reducing bone and joint complications. As a result, customized treatment selection has been shown to be the key factor for minimizing these problems. In this section, we explained the bone and joint problems, their diagnosis, and the up-to-date treatment methods after renal transplantation.

Keywords: Renal transplant, musculoskeletal, metabolic

INTRODUCTION

Renal transplantation is an effective treatment for terminal renal insufficiency. After transplantation, the patient's clinical condition is strongly correlated with quality of life. Bone and joint problems are frequently encountered after renal transplantation. These pathologies could be either problems prior to transplantation, related to renal insufficiency, or to immunosuppressive treatment

[1] Assoc. Prof. Dr., Department of Orthopedics and Traumatology, Faculty of Medicine, Çukurova University, melihbagir@yahoo.com, ORCID iD: 0000-0002-3761-8774

DOI: 10.37609/akya.4215.c12423

REFERENCES

1. Drüeke TB, Evenepoel P. The Bone after Kidney Transplantation. Clin J Am Soc Nephrol. 2019 Jun 7;14(6):795-797. doi: 10.2215/CJN.04940419. Epub 2019 May 14. PMID: 31088852; PMCID: PMC6556733.
2. Pichette V, Bonnardeaux A, Prudhomme L, Gagné M, Cardinal J, Ouimet D. Long-term bone loss in kidney transplant recipients: a cross-sectional and longitudinal study. Am J Kidney Dis. 1996 Jul;28(1):105-14. doi: 10.1016/s0272-6386(96)90138-9. PMID: 8712204.
3. Kart-Köseoglu H, Yücel AE, Isiklar I, Türker I, Akçali Z, Haberal M. Joint pain and arthritis in renal transplant recipients and correlation with cyclosporine therapy. Rheumatol Int. 2003 Jul;23(4):159-62. doi: 10.1007/s00296-002-0283-y. Epub 2003 Feb 12. PMID: 12856139.
4. Aguanno F, Passaseo A, Barbuto S, Vetrano D, Zavatta G, Marzocchi G, Giannini S, Comai G, La Manna G, Cianciolo G. Bone disease in kidney transplant: don't forget about osteomalacia: a case report and literature review. Int Urol Nephrol. 2026 Apr;58(4):1381-1391. doi: 10.1007/s11255-025-04781-y. Epub 2025 Sep 25. PMID: 40996610; PMCID: PMC12999700.
5. Khairallah P, Nickolas TL. Bone and Mineral Disease in Kidney Transplant Recipients. Clin J Am Soc Nephrol. 2022 Jan;17(1):121-130. doi: 10.2215/CJN.03410321. Epub 2021 Jun 14. PMID: 34127484; PMCID: PMC8763144.
6. Segaud N, Legroux I, Hazzan M, Noel C, Cortet B. Changes in bone mineral density after kidney transplantation: 2-year assessment of a French cohort. Osteoporos Int. 2018 May;29(5):1165-1175. doi: 10.1007/s00198-018-4383-2. Epub 2018 Mar 2. PMID: 29500526.
7. Park WY, Han S, Choi BS, Park CW, Yang CW, Kim YS, Kim JI, Moon IS, Chung BH. Progression of Osteoporosis After Kidney Transplantation in Patients With End-Stage Renal Disease. Transplant Proc. 2017 Jun;49(5):1033-1037. doi: 10.1016/j.transproceed.2017.03.038. PMID: 28583521.
8. Patel S, Kwan JT, McCloskey E, McGee G, Thomas G, Johnson D, Wills R, Ogunremi L, Barron J. Prevalence and causes of low bone density and fractures in kidney transplant patients. J Bone Miner Res. 2001 Oct;16(10):1863-70. doi: 10.1359/jbmr.2001.16.10.1863. PMID: 11585351.
9. Velioglu A, Kaya B, Aykent B, Ozkan B, Karapinar MS, Arikan H, Asicioglu E, Bugdaycı O, Yavuz DG, Tuglular S. Low bone density, vertebral fracture and FRAX score in kidney transplant recipients: A cross-sectional cohort study. PLoS One. 2021 Apr 30;16(4):e0251035. doi: 10.1371/journal.pone.0251035. PMID: 33930070; PMCID: PMC8087085.
10. Canalis E. Mechanisms of glucocorticoid-induced osteoporosis. Curr Opin Rheumatol. 2003 Jul;15(4):454-7. doi: 10.1097/00002281-200307000-00013. PMID: 12819474.
11. Horber FF, Casez JP, Steiger U, Czerniak A, Montandon A, Jaeger P. Changes in bone mass early after kidney transplantation. J Bone Miner Res. 1994 Jan;9(1):1-9. doi: 10.1002/jbmr.5650090102. PMID: 8154303.
12. Monier-Faugere MC, Mawad H, Qi Q, Friedler RM, Malluche HH. High prevalence of low bone turnover and occurrence of osteomalacia after kidney transplantation. J Am Soc Nephrol. 2000 Jun;11(6):1093-1099. doi: 10.1681/ASN.V1161093. PMID: 10820173.
13. Farmer CK, Hampson G, Abbs IC, Hilton RM, Koffman CG, Fogelman I, Sacks SH. Late low-dose steroid withdrawal in renal transplant recipients increases bone formation and bone mineral density. Am J Transplant. 2006 Dec;6(12):2929-36. doi: 10.1111/j.1600-6143.2006.01557.x. PMID: 17061994.
14. Kalantar-Zadeh K, Molnar MZ, Kovesdy CP, Mucsi I, Bunnapradist S. Management of mineral and bone disorder after kidney transplantation. Curr Opin Nephrol Hypertens. 2012 Jul;21(4):389-403. doi: 10.1097/MNH.0b013e3283546ee0. PMID: 22614626; PMCID: PMC3532932.
15. Alshayeb HM, Josephson MA, Sprague SM. CKD-mineral and bone disorder management in kidney transplant recipients. Am J Kidney Dis. 2013 Feb;61(2):310-25. doi: 10.1053/j.ajkd.2012.07.022. Epub 2012 Oct 26. PMID: 23102732.

16. Chauhan V, Ranganna KM, Chauhan N, Vaid M, Kelepouris E. Bone disease in organ transplant patients: pathogenesis and management. Postgrad Med. 2012 May;124(3):80-90. doi: 10.3810/pgm.2012.05.2551. PMID: 22691902.
17. Wong J, Tan MZW, Chandran M. Fifty shades of gray: Bone disease in renal transplantation. Proc Singapore Healthc. 2015;24(4):225–32.
18. Kidney Disease: Improving Global Outcomes (KDIGO) CKD Work Group. KDIGO 2024 Clinical Practice Guideline for the Evaluation and Management of Chronic Kidney Disease. Kidney Int. 2024 Apr;105(4S):S117-S314. doi: 10.1016/j.kint.2023.10.018. PMID: 38490803.
19. Liu X, Li X, Zhao Y, Gao Q, Xue Y, Wu Z, Shi X, Wu X. Comparative efficacy and safety of anti-osteoporotic therapies for kidney transplant recipients: a systematic review and network meta-analysis. Front Endocrinol (Lausanne). 2025 Nov 3;16:1689233. doi: 10.3389/fendo.2025.1689233. PMID: 41255525; PMCID: PMC12620273.
20. Nikkel LE, Hollenbeak CS, Fox EJ, Uemura T, Ghahramani N. Risk of fractures after renal transplantation in the United States. Transplantation. 2009 Jun 27;87(12):1846-51. doi: 10.1097/TP.0b013e3181a6bbda. PMID: 19543063.
21. Iseri K, Carrero JJ, Evans M, Felländer-Tsai L, Berg HE, Runesson B, Stenvinkel P, Lindholm B, Qureshi AR. Fractures after kidney transplantation: Incidence, predictors, and association with mortality. Bone. 2020 Nov;140:115554. doi: 10.1016/j.bone.2020.115554. Epub 2020 Jul 28. PMID: 32730931.
22. Bouquegneau A, Salam S, Delanaye P, Eastell R, Khwaja A. Bone Disease after Kidney Transplantation. Clin J Am Soc Nephrol. 2016 Jul 7;11(7):1282-1296. doi: 10.2215/CJN.11371015. Epub 2016 Feb 15. PMID: 26912549; PMCID: PMC4934848.
23. Zhang JZ, Shi W, Zou M, Zeng QS, Feng Y, Luo ZY, Gan HT. Diagnosis, prevalence, and outcomes of sarcopenia in kidney transplantation recipients: A systematic review and meta-analysis. J Cachexia Sarcopenia Muscle. 2023 Feb;14(1):17-29. doi: 10.1002/jcsm.13130. Epub 2022 Nov 20. PMID: 36403578; PMCID: PMC9891953.
24. Vangala C, Pan J, Cotton RT, Ramanathan V. Mineral and Bone Disorders After Kidney Transplantation. Front Med (Lausanne). 2018 Jul 31;5:211. doi: 10.3389/fmed.2018.00211. PMID: 30109232; PMCID: PMC6079303.
25. Kumru G, Mutlu ŞŞ, Başarır EN, Ateş K, Ertürk Ş, Nergizoğlu G, Kutlay S, Şengül Ş, Keven K. Avascular necrosis in kidney transplant recipients: Incidence and risk factors in the modern immunosuppression era. Jt Dis Relat Surg. 2025 Jul 21;36(3):732-740. doi: 10.52312/jdrs.2025.2423. Epub 2025 Jul 21. PMID: 40784006; PMCID: PMC12456333.

Chapter 15

POST-TRANSPLANT BONE MINERAL DISEASE

Aylin SARİYİLDİZ[1]
Aysegul YETİSİR[2]

Abstract

Kidney transplantation is associated with mineral and bone disorders that contribute to an increased risk of fractures and, consequently, to higher morbidity and mortality. Post-transplant mineral and bone disorders encompass not only the persistent effects of chronic kidney disease–mineral and bone disorder present before transplantation, but also new pathophysiological processes driven by persistent hyperparathyroidism, elevated fibroblast growth factor-23 levels, vitamin D deficiency, calcium–phosphate imbalance, immunosuppressive therapies, and changes in graft function. The assessment of bone disorder in kidney transplant recipients includes the identification of clinical risk factors, monitoring of biochemical parameters, evaluation of bone mineral density by dual-energy X-ray absorptiometry, and, in selected cases, bone biopsy. However, currently available diagnostic tools have certain limitations in precisely determining fracture risk and characterizing the type of bone turnover. Primary management strategies include non-pharmacological measures, such as reducing fall risk, promoting exercise, and modifying lifestyle- alongside adequate calcium and vitamin D supplementation. Individualized treatment options may include bisphosphonates, denosumab, calcimimetics, osteoanabolic agents, and parathyroidectomy. Evidence remains limited regarding the long-term effects of these interventions on fracture outcomes, graft safety, and their efficacy across different patterns of bone turnover. This review aims to provide a comprehensive overview of the current literature on the pathophysiology, epidemiology, risk

1 Assoc. Prof. MD., Department of Physical Medicine and Rehabilitation, Faculty of Medicine, Cukurova University, aylingoksen@hotmail.com, ORCID iD: 0000-0002-8835-4203

2 Assist. Prof. MD., Department of Physical Medicine and Rehabilitation, Faculty of Medicine, Cukurova University, ayetisir@cu.edu.tr, ORCID iD: 0000-0001-7070-3076

DOI: 10.37609/akya.4215.c12424

Future research in this field should focus on evaluating current therapeutic strategies, with particular emphasis on long-term outcomes beyond the first year after KT. High-quality studies are required to generate stronger evidence based on clinical outcomes and to better define the efficacy and safety of bisphosphonates and other therapeutic options in the management of both skeletal and extraskeletal complications associated with PTBD.

REFERENCES

1. Teh JW, Mac Gearailt C, Lappin DWP. Post-Transplant Bone Disease in Kidney Transplant Recipients: Diagnosis and Management. *International Journal of Molecular Sciences.* 2024;25(3):1859. doi:https://doi.org/10.3390/ijms25031859
2. Afsar B, Afsar RE, Caliskan Y, et al. The Relationship between Sclerostin and Kidney Transplantation Mineral Bone Disorders: A Molecule of Controversies. *Calcified Tissue International.* 2024;115(4):339-361. doi:https://doi.org/10.1007/s00223-024-01261-w
3. Kidney Disease: Improving Global Outcomes (KDIGO) CKD Work Group. KDIGO 2024 Clinical Practice Guideline for the Evaluation and Management of Chronic Kidney Disease. *Kidney International.* 2024;105(4S):S117-S314. doi:https://doi.org/10.1016/j.kint.2023.10.018
4. Kidney Disease: Improving Global Outcomes (KDIGO) CKD-MBD Update Work Group. KDIGO 2017 Clinical Practice Guideline Update for the Diagnosis, Evaluation, Prevention, and Treatment of Chronic Kidney Disease-Mineral and Bone Disorder (CKD-MBD). *Kidney International Supplements (2011).* 2017;7(1):1-59. doi:https://doi.org/10.1016/j.kisu.2017.04.001
5. Torregrosa JV, Ferreira AC, Cucchiari D, et al. Bone Mineral Disease After Kidney Transplantation. *Calcified Tissue International.* 2021;108(4):551-560. doi:https://doi.org/10.1007/s00223-021-00837-0
6. Kurnool S, Shah N, Ekanayake P. Treatment of osteoporosis in the solid organ transplant recipient: an organ-based approach. *Therapeutic Advances in Endocrinology Metabolism.* 2025;16:20420188251347351. doi: https:// 10.1177/20420188251347351
7. Wolf M, Weir MR, Kopyt N, et al. A Prospective Cohort Study of Mineral Metabolism After Kidney Transplantation. *Transplantation.* 2016;100:184–193. doi:https://10.1097/TP.0000000000000823.
8. Kovvuru K, Kanduri SR, Vaitla P, et al. Risk Factors and Management of Osteoporosis Post-Transplant. *Medicina (Kaunas).* 2020;56(6):302. doi: https:// 10.3390/medicina56060302
9. Kim KJ, Ha J, Kim SW, et al. Bone Loss after Solid Organ Transplantation: A Review of Organ-Specific Considerations. *Endocrinology and Metabolism (Seoul).* 2024;39(2):267-282. doi: https:// 10.3803/EnM.2024.1939
10. Amiri FS, Khatami MR. Fibroblast Growth Factor 23 in Postrenal Transplant: An Often Forgotten Hormone. *Experimental and Clinical Transplantation.* 2016;14(6):606-616. doi: https:// 10.6002/ect.2016.0025
11. Bellorin-Font E, Rojas E, Martin KJ. Bone Disease in Chronic Kidney Disease and Kidney Transplant. *Nutrients.* 2022;15(1):167. doi: https:// 10.3390/nu15010167.
12. Khairallah P, Nickolas TL. Bone and Mineral Disease in Kidney Transplant Recipients. *Clinical Journal of the American Society of Nephrology.* 2022;17(1):121-130. doi: https:// 10.2215/CJN.03410321
13. Palmer SC, Chung EY, McGregor DO, et al. Interventions for preventing bone disease in kidney transplant recipients. *Cochrane Database of Systematic Reviews.* 2019;10(10):CD005015. doi: https:// 10.1002/14651858.CD005015.pub4

14. Cowan AC, Solo K, Lebedeva V, et al. Incidence, Prediction, and Prevention of Fractures After Kidney Transplantation: A Systematic Review Protocol. *Canadian Journal of Kidney Health and Disease.* 2024;11:20543581241306799. doi: https:// 10.1177/20543581241306799
15. Kuppachi S, Cheungpasitporn W, Li R, et al. Kidney transplantation, immunosuppression and the risk of fracture: clinical and economic implications. *Kidney Medicine.* 2022;4(6):100474. doi: https:// 10.1016/j.xkme.2022.100474.
16. Jia L, Chao S, Yang Q, et al. The comprehensive incidence and risk factors of fracture in kidney transplant recipients: a meta-analysis. *Nephrology (Carlton).* 2024;29(9):588-599. doi: https:// 10.1111/nep.14301.
17. Ketteler M, Evenepoel P, Holden RM, et al. Chronic kidney disease-mineral and bone disorder: conclusions from a Kidney Disease: Improving Global Outcomes (KDIGO) Controversies Conference. *Kidney international.* 2025;107(3):405-423. doi: https:// 10.1016/j.kint.2024.11.013
18. Georgopoulou GA, Papasotiriou M, Ntrinias T, et al. Impact of bisphosphonate treatment on bone mineral density after kidney transplant. *World Journal of Transplantation.* 2024;14(3):92335. doi: https:// 10.5500/wjt.v14.i3.92335
19. Leng Y, Yu X, Yang Y, et al. Efficacy and safety of medications for osteoporosis in kidney transplant recipients or patients with chronic kidney disease: A meta-analysis. *Journal of Investigative Medicine.* 2023;71:760–772. doi: https:// 10.1177/10815589231184215.
20. Toth-Manikowski SM, Francis JM, Gautam A, et al. Outcomes of bisphosphonate therapy in kidney transplant recipients: a systematic review and meta-analysis. *Clinical Transplantation.* 2016;30(9):1090-1096. doi: https:// 10.1111/ctr.12792.
21. Lip A, Warias A, Shamseddin MK, et al. Effect of bisphosphonates on bone health in adult renal transplant patients: beyond the first year posttransplant—a systematic review and meta-analysis. *Canadian Journal of Kidney Health and Disease.* 2019;6: 2054358119858014. doi: https:// 10.1177/2054358119858014.
22. Kahwaji JM, Yang SJ, Sim JJ, et al. Bisphosphonate Use after Kidney Transplantation Is Associated with Lower Fracture Risk. *Clinical Journal of the American Society of Nephrology.* Published online November 5, 2024. doi: https:// 10.2215/CJN.0000000591
23. Song SH, Choi HY, Kim HY, et al. Effects of bisphosphonates on long-term kidney transplantation outcomes. *Nephrology Dialysis Transplantation.* 2021;36(4):722-729. doi: https:// 10.1093/ndt/gfaa371
24. Zhu P, Yang T, Le J, et al. Efficacy of denosumab on bone metabolism and bone mineral density in renal transplant recipients: a systematic review and meta-analysis. *Transplantation Reviews (Orlando).* 2023;37(4):100793. doi: https:// 10.1016/j.trre.2023.100793.
25. Vetrano D, Aguanno F, Passaseo A, et al. Efficacy and safety of teriparatide in kidney transplant recipients with osteoporosis and low bone turnover: a real-world experience. *International Urology and Nephrology.* 2025;57(6):1965-1975. doi: https:// 10.1007/s11255-025-04383-8
26. Cejka D, Benesch T, Krestan C, et al. Effect of teriparatide on early bone loss after kidney transplantation. *American Journal of Transplantation.* 2008;8(9):1864-1870. doi: https:// 10.1111/j.1600-6143.2008.02327.x
27. Tominaga A, Wada K, Kato Y, et al. Romosozumab for managing severe osteoporosis in patients undergoing kidney transplantation: a retrospective case series. *JBMR Plus.* 2025;9(6):ziaf049. doi: https:// 10.1093/jbmrpl/ziaf049

Chapter 16

IMMUNOSUPPRESSION-RELATED EARLY NEUROLOGICAL COMPLICATIONS AFTER KIDNEY TRANSPLANTATION

Mehmet Taylan PEKÖZ[1]

Abstract

Neurological complications after kidney transplantation may appear early in the postoperative period and are frequently related to immunosuppressive treatment, metabolic vulnerability, infection, vascular instability, or drug interactions. Among immunosuppression-related disorders, calcineurin inhibitor (CNI) neurotoxicity is the most clinically relevant entity. Tacrolimus and cyclosporine may cause a broad neurological spectrum ranging from tremor, headache, insomnia, paresthesia, and mild cognitive symptoms to encephalopathy, seizures, posterior reversible encephalopathy syndrome (PRES), and, rarely, coma or focal neurological deficits. The presentation may be subtle because fever, leukocytosis, and inflammatory responses can be blunted in immunosuppressed recipients. Early recognition is essential because neurological toxicity may be reversible when precipitating factors are corrected and immunosuppressive therapy is appropriately adjusted. Mechanistic target of rapamycin (mTOR) inhibitors and corticosteroids may also contribute to neurological and psychiatric symptoms, either directly or through metabolic, vascular, and pharmacokinetic mechanisms. Acute delirium and metabolic encephalopathy require a structured differential diagnosis including hypoxia, dysglycemia, electrolyte disturbances, renal or hepatic dysfunction, infection, hypertensive emergency, and medication toxicity. Seizures and status epilepticus in kidney transplant recipients demand rapid standard treatment while considering renal function, dialysis, interactions with immunosuppressants, and avoidance of enzyme-inducing antiseizure medications whenever possible. This chapter summarizes the clinical spectrum,

[1] Assoc. Prof. Dr., Department of Neurology, Faculty of Medicine, Cukurova University, taylanpekoz@gmail.com, ORCID iD: 0000-0001-9126-9192

DOI: 10.37609/akya.4215.c12425

according to standard emergency principles while considering renal function and drug interactions. The distinction between refractory and super-refractory status epilepticus must be preserved: super-refractory status epilepticus is defined by persistence or recurrence after at least 24 hours of anesthetic therapy, not by persistence beyond 60 minutes.

Optimal care requires collaboration among transplant surgeons, nephrologists, neurologists, intensivists, infectious disease specialists, pharmacists, and radiologists. As transplant recipients become older and medically more complex, careful monitoring, medication reconciliation, individualized immunosuppression, and early neurological consultation will remain central to preventing avoidable morbidity.

REFERENCES

1. Kasiske BL, Zeier MG, Chapman JR, et al. KDIGO clinical practice guideline for the care of kidney transplant recipients: a summary. Kidney Int. 2010;77(4):299-311. DOI: https://doi.org/10.1038/ki.2009.377
2. Shoskes A, Wilson R. Neurologic complications of kidney transplantation. Transl Androl Urol. 2019;8(2):164-172. DOI: https://doi.org/10.21037/tau.2018.08.11
3. Faravelli I, Velardo D, Podesta MA, Ponticelli C. Immunosuppression-related neurological disorders in kidney transplantation. J Nephrol. 2021;34(2):539-555. DOI: https://doi.org/10.1007/s40620-020-00956-1
4. Bechstein WO. Neurotoxicity of calcineurin inhibitors: impact and clinical management. Transpl Int. 2000;13(5):313-326. DOI: https://doi.org/10.1007/s001470050708
5. Bajon A, Sikora J, Siwek M, et al. Neurotoxicity of calcineurin inhibitors. Ann Indian Acad Neurol. 2025;28(4):505-511. DOI: https://doi.org/10.4103/aian.aian_614_24
6. Lee HJ, Myoung H, Kim SM. Review of two immunosuppressants: tacrolimus and cyclosporine. J Korean Assoc Oral Maxillofac Surg. 2023;49(6):311-323. DOI: https://doi.org/10.5125/jkaoms.2023.49.6.311
7. Kaye AD, Shah SS, Johnson CD, et al. Tacrolimus- and mycophenolate-mediated toxicity: clinical considerations and options in management of post-transplant patients. Curr Issues Mol Biol. 2024;47(1):2. DOI: https://doi.org/10.3390/cimb47010002
8. Wagle Shukla A, Lunny C, Mahboob O, et al. Tremor induced by cyclosporine, tacrolimus, sirolimus, or everolimus: a review of the literature. Drugs R D. 2023;23(4):301-329. DOI: https://doi.org/10.1007/s40268-023-00428-4
9. Fugate JE, Rabinstein AA. Posterior reversible encephalopathy syndrome: clinical and radiological manifestations, pathophysiology, and outstanding questions. Lancet Neurol. 2015;14(9):914-925. DOI: https://doi.org/10.1016/S1474-4422(15)00111-8
10. Webster AC, Nagler EV, Morton RL, Masson P. Chronic kidney disease. Lancet. 2017;389(10075):1238-1252. DOI: https://doi.org/10.1016/S0140-6736(16)32064-5
11. Sawhney H, Gill SS. Renal transplant recipient seizure practical management. World J Nephrol. 2020;9(1):1-8. DOI: https://doi.org/10.5527/wjn.v9.i1.1
12. Shepard PW, St Louis EK. Seizure treatment in transplant patients. Curr Treat Options Neurol. 2012;14(4):332-347. DOI: https://doi.org/10.1007/s11940-012-0180-y
13. Mutluay R, Gurcu S. Evaluation of drug-drug interactions in renal transplant patients. Eskisehir Med J. 2023;4(3):292-295. DOI: https://doi.org/10.48176/esmj.2023.149

14. Vignatelli L, Tontini V, Meletti S, et al. Clinical practice guidelines on the management of status epilepticus in adults: a systematic review. Epilepsia. 2024;65(6):1512-1530. DOI: https://doi.org/10.1111/epi.17982
15. Mullhi R, Hayton T, Midgley-Hunt A, et al. Guidance for: the acute management of status epilepticus in adult patients. J Intensive Care Soc. 2025;26(2):249-262. DOI: https://doi.org/10.1177/17511437251321338 DOI: https://doi.org/10.1177/17511437251321338

Chapter 17

MEDIUM AND LONG-TERM NEUROLOGICAL COMPLICATIONS AFTER KIDNEY TRANSPLANTATION

Ahmet Yusuf ERTÜRK[1]

Abstract

Neurological complications after renal transplantation represent an important source of morbidity and may substantially affect long-term functional status, treatment adherence, quality of life, and graft outcomes. Although these complications may occur at any time after transplantation, medium- and long-term neurological manifestations require particular attention because they are often related to chronic immunosuppression, opportunistic infections, vascular risk factors, metabolic disturbances, and drug-related neurotoxicity. This chapter reviews the major neurological complications encountered after the first month following renal transplantation, including central nervous system infections, posttransplant lymphoproliferative disease with CNS involvement, cerebrovascular disease, chronic cognitive impairment, peripheral neuropathy, and myopathy. A practical time-based framework is used, defining the medium term as 1 to 6 months and the long term as the period beyond 6 months after transplantation. Opportunistic and reactivation infections such as cryptococcal meningitis, progressive multifocal leukoencephalopathy, cytomegalovirus infection, cerebral aspergillosis, and toxoplasmosis are discussed with emphasis on clinical presentation, diagnostic workup, neuroimaging findings, antimicrobial therapy, and immunosuppression management. Central nervous system posttransplant lymphoproliferative disease is addressed as a rare but serious late complication that requires EBV assessment, systemic staging, and histopathological confirmation. The chapter also highlights the increased burden of cerebrovascular disease and cognitive impairment in renal transplant recipients, together

[1] Department of Neurology, University of Health Sciences Adana City Training and Research Hospital, mail:ahmetyusuf1990@gmail.com, ORCID iD: 0000-0002-1025-0519

DOI: 10.37609/akya.4215.c12426

REFERENCES

1. Shoskes A, Wilson R. Neurologic complications of kidney transplantation. Transl Androl Urol. 2019;8(2):164-172. doi:10.21037/tau.2018.08.11.
2. Faravelli I, Velardo D, Podestà MA, Ponticelli C. Immunosuppression-related neurological disorders in kidney transplantation. J Nephrol. 2021;34(2):539-555. doi:10.1007/s40620-020-00956-1.
3. Fishman JA. Infection in solid-organ transplant recipients. N Engl J Med. 2007;357(25):2601-2614. doi:10.1056/NEJMra064928.
4. Jurgensen A, Qannus AA, Gupta A. Cognitive function in kidney transplantation. Curr Transplant Rep. 2020;7:145-153. doi:10.1007/s40472-020-00284-0.
5. Alviz LF, Jones BA, Agnihotri SP, Thakur KT. Identifying CNS infections in transplantation and immunomodulatory therapy. Ther Adv Infect Dis. 2024;11:20499361241298456. doi:10.1177/20499361241298456.
6. Tardieu L, Divard G, Lortholary O, et al. Cryptococcal meningitis in kidney transplant recipients: A two-decade cohort study in France. Pathogens. 2022;11(6):699. doi:10.3390/pathogens11060699.
7. Mori K, Kurokawa M, Harada M, et al. Overview of MRI findings in progressive multifocal leukoencephalopathy. Jpn J Radiol. 2025;43(12):1908-1925. doi:10.1007/s11604-025-01837-y.
8. Baldassari LE, Wattjes MP, Cortese ICM, et al. The neuroradiology of progressive multifocal leukoencephalopathy: A clinical trial perspective. Brain. 2022;145(2):426-440. doi:10.1093/brain/awab419.
9. Jeemon G, Ganesh K, Madavana VV, Abraham MA. A rare cause of encephalopathy post renal transplant: BK polyoma virus encephalitis. Indian J Nephrol. 2023;33(6):464-467. doi:10.4103/ijn.ijn_150_22.
10. Anjum SH, Bennett JE, Dean O, et al. Neuroimaging of cryptococcal meningitis in patients without human immunodeficiency virus: Data from a multi-center cohort study. J Fungi (Basel). 2023;9(5):594. doi:10.3390/jof9050594.
11. Chandler S, Isbel N. Progressive multifocal leukoencephalopathy 10 years following transplant: 5HT receptor antagonism as an adjunct to immune reconstitution. BMJ Case Rep. 2022;15(12):e252284. doi:10.1136/bcr-2022-252284.
12. van den Bogaart L, Lang BM, Rossi S, et al. Central nervous system infections in solid organ transplant recipients: Results from the Swiss Transplant Cohort Study. J Infect. 2022;85(1):1-7. doi:10.1016/j.jinf.2022.05.019.
13. Serris A, Benzakoun J, Danion F, et al. Cerebral aspergillosis in the era of new antifungals: The CEREALS national cohort study. J Infect. 2022;84(2):227-236. doi:10.1016/j.jinf.2021.11.014.
14. La Hoz RM, Morris MI. Tissue and blood protozoa including toxoplasmosis, Chagas disease, leishmaniasis, Babesia, Acanthamoeba, Balamuthia, and Naegleria in solid organ transplant recipients: Guidelines from the American Society of Transplantation Infectious Diseases Community of Practice. Clin Transplant. 2019;33(9):e13546. doi:10.1111/ctr.13546.
15. Jin L, Lu D, Yan F, et al. A disease warranting attention from neurosurgeons: Primary central nervous system post-transplant lymphoproliferative disorder. Front Neurol. 2024;15:1392691. doi:10.3389/fneur.2024.1392691.
16. Ludvigsen LUP, Åsberg A, Spetalen S, et al. Risk and prognosis of posttransplant lymphoproliferative disease in Epstein-Barr virus-seronegative kidney transplant recipients: An observational cohort study from Norway and western Denmark. Am J Transplant. 2025;25(7):1547-1560. doi:10.1016/j.ajt.2025.01.035.
17. El-Mallawany NK, Rouce RH. EBV and post-transplant lymphoproliferative disorder: A complex relationship. Hematology Am Soc Hematol Educ Program. 2024;2024(1):728-735. doi:10.1182/hematology.2024000583.

18. Atallah-Yunes SA, Salman O, Robertson MJ. Post-transplant lymphoproliferative disorder: Update on treatment and novel therapies. Br J Haematol. 2023;201(3):383-395. doi:10.1111/bjh.18763.
19. Tsai TH, Huang KH, Chen H, et al. Risks of cardiovascular disease and cerebrovascular disease following kidney transplantation: A nationwide, population-based cohort study. Int J Med Sci. 2025;22(9):2237-2246. doi:10.7150/ijms.108744.
20. De La Mata NL, Kelly PJ, Wyld M, et al. Excess stroke deaths in kidney transplant recipients: A retrospective population-based cohort study using data linkage. Transplantation. 2020;104(10):2129-2138. doi:10.1097/TP.0000000000003091.
21. Gupta A, Mahnken JD, Bernal J, et al. Changes in cognitive function after kidney transplantation: A longitudinal cohort study. Am J Kidney Dis. 2024;84(1):28-37.e1. doi:10.1053/j.ajkd.2023.12.022.
22. Ziengs AL, Buunk AM, van Sonderen L, et al. Long-term cognitive impairments in kidney transplant recipients: Impact on participation and quality of life. Nephrol Dial Transplant. 2023;38(2):491-498. doi:10.1093/ndt/gfac035.
23. Schietzel S, Kressig RW, Huynh-Do U. Screening of cognitive performance in kidney transplant recipients: A mini review. Front Nephrol. 2023;3:1238501. doi:10.3389/fneph.2023.1238501.
24. Bajon A, Sikora J, Siwek M, et al. Neurotoxicity of calcineurin inhibitors. Ann Indian Acad Neurol. 2025;28(4):505-511. doi:10.4103/aian.aian_614_24.
25. Evans MC, Bellanti R, Dahdaleh S, et al. Chronic inflammatory demyelinating polyradiculoneuropathy developing during tacrolimus treatment: A case series. Muscle Nerve. 2025;72(6):1289-1293. doi:10.1002/mus.70025.
26. Wu M, Liu C, Sun D. Glucocorticoid-Induced Myopathy: Typology, Pathogenesis, Diagnosis, and Treatment. Horm Metab Res. 2024;56(5):341-349. doi:10.1055/a-2246-2900.
27. Ferdousi M, Azmi S, Kalteniece A, et al. No evidence of improvement in neuropathy after renal transplantation in patients with end stage kidney disease. J Peripher Nerv Syst. 2021;26(3):269-275. doi:10.1111/jns.12456.
28. Baker LA, March DS, Wilkinson TJ, et al. Clinical practice guideline exercise and lifestyle in chronic kidney disease. BMC Nephrol. 2022;23(1):75. doi:10.1186/s12882-021-02618-1.
29. Billany RE, Bishop NC, Castle EM, et al. Physical activity interventions in adult kidney transplant recipients: An updated systematic review and meta-analysis of randomized controlled trials. Ren Fail. 2025;47(1):2480246. doi:10.1080/0886022X.2025.2480246.

Bölüm 18

RECURRENT DISEASES AFTER KIDNEY TRANSPLANTATION

Mutlu DEGER[1]

Abstract

Recurrent disease after kidney transplantation remains an important cause of proteinuria, graft dysfunction, and allograft loss. This review summarizes the epidemiology, pathogenesis, clinical presentation, diagnosis, risk factors, and treatment of the most relevant recurrent diseases, including membranous nephropathy, primary focal segmental glomerulosclerosis, IgA nephropathy, lupus nephritis, C3 glomerulopathy, and amyloidosis. Recurrence is driven by persistent recipient-specific mechanisms such as autoantibodies, circulating permeability factors, galactose-deficient IgA1 immune complexes, complement dysregulation, or ongoing systemic inflammatory or clonal plasma cell disorders. Clinical manifestations range from isolated proteinuria and microscopic hematuria to nephrotic syndrome and progressive graft dysfunction, although recurrence may also be subclinical.

Kidney allograft biopsy remains the diagnostic cornerstone and is essential for distinguishing recurrence from rejection, calcineurin inhibitor toxicity, and chronic allograft injury. Serologic and biomarker-based tools, including anti-PLA2R, anti-nephrin, complement markers, and disease-specific hematologic parameters, may support risk stratification and follow-up but do not replace histologic confirmation. Pretransplant disease quiescence, assessment of antibody burden, and identification of genetic or monoclonal causes are critical for recurrence prevention.

Management is disease-specific and combines optimized supportive care with tailored immunosuppression or targeted therapy. Rituximab, plasmapheresis, corticosteroids, calcineurin inhibitors, complement-directed agents, and

[1] Assoc. Prof. Dr., Department of Urology, Faculty of Medicine, Cukurova University, drmutludeger@gmail.com, ORCID iD: 0000-0002-8357-5744

DOI: 10.37609/akya.4215.c12427

REFERENCES

1. Phumthian T, Wattanasatja V, Wipattanakitcharoen A, et al. Recurrent, Nonrecurrent, and De Novo Membranous Nephropathy After Kidney Transplantation: A Systematic Review and Meta-Analysis. Kidney Med. 2026 Feb 6;8(4):101284. doi: 10.1016/j.xkme.2026.101284.
2. Koirala A, Singh A, Geetha D. Recurrence of Glomerular Diseases (GN) After Kidney Transplantation: A Narrative Review. J Clin Med. 2025 Sep 22;14(18):6686. doi: 10.3390/jcm14186686.
3. Gaggar P, Nair RR, Thakur AP, et al. Post Transplant Membranous Nephropathy: A 10-year Single-Centre Experience. Indian J Nephrol. 2025 Jul-Aug;35(4):552-554. doi: 10.25259/IJN_150_2025.
4. Bai J, Zheng Z, Cao J, et al. Incidence and risk factors for recurrent membranous nephropathy after kidney transplantation: a systematic review and meta-analysis. Ann Med. 2025 Dec;57(1):2522971. doi: 10.1080/07853890.2025.2522971.
5. Bensouna I, Delafosse M, Cartery C, et al. Recurrence of Phospholipase A2 Receptor-Associated Membranous Nephropathy in the Absence of Serum Anti-Phospholipase A2 Receptor Antibodies Reappearance. Kidney Int Rep. 2024 Dec 10;10(3):952-955. doi: 10.1016/j.ekir.2024.12.009.
6. Rodrigo E, Belmar L, Pérez-Canga JL. Recurrence of Glomerular Diseases after Kidney Transplantation: What Do We Know New? Nephron. 2025 Jan 8:1-12. doi: 10.1159/000543268.
7. Kenan A, Kurien AA, Gonzalez M, et al. Neural epidermal growth factor-like 1 protein-positive membranous nephropathy in renal allografts: A series of 6 patients. Am J Transplant. 2025 Apr;25(4):860-866. doi: 10.1016/j.ajt.2024.11.026.
8. Cremoni M, Teisseyre M, Thaunat O, et al. Anti-Phospholipase A2 Receptor 1 Antibodies and Membranous Nephropathy Recurrence After Kidney Transplantation. Kidney Int Rep. 2024 Sep 23;9(12):3427-3438. doi: 10.1016/j.ekir.2024.09.012.
9. Beck LH, Salant DJ. The podocyte slit diaphragm: target of anti-nephrin antibodies. Curr Opin Nephrol Hypertens. 2026 May 1;35(3):279-286. doi: 10.1097/MNH.0000000000001167.
10. Oatley Z, Jaber D, Rayarakula N, et al. Recurrence of focal segmental glomerulosclerosis: An updated review of pathophysiology, biomarkers, and therapeutic strategies. Cell Transplant. 2026 Jan-Dec;35:9636897261417049. doi: 10.1177/09636897261417049.
11. Nuccitelli R, Toutoungis A, Martinelli E, et al. Opportunities and challenges in recurrent diffuse podocytopathy post-transplantation: the critical value of the definition. Front Immunol. 2026 Jan 22;17:1735978. doi: 10.3389/fimmu.2026.1735978.
12. Liaukouskaya N, Hengel FE, Mühlig A, et al. A New Hope for Treating Podocytopathies: Emerging Role of Anti-Nephrin Antibody. Clin J Am Soc Nephrol. 2026 Jan 21. doi: 10.2215/CJN.0000001008.
13. Romagnani P, Tang SCW, Weins A, et al. Podocytopathies. Nat Rev Dis Primers. 2025 Dec 11;11(1):87. doi: 10.1038/s41572-025-00671-w.
14. Filippone EJ, Farber JL. Serum Factors in Primary Podocytopathies. Antibodies (Basel). 2025 Sep 28;14(4):82. doi: 10.3390/antib14040082.
15. Shan S, Li X, Zhang Y, Luo Z, et al. Post-Transplant Recurrence of Focal Segmental Glomerulosclerosis: Circulating Factors, Molecular Biomarkers, and Treatments. Kidney Dis (Basel). 2025 Jul 29;11(1):560-583. doi: 10.1159/000547336.
16. Moroni G, Longhi S, Quaglini S, et al. The long-term outcome of renal transplantation of IgA nephropathy and the impact of recurrence on graft survival. Nephrol Dial Transplant. 2013 May;28(5):1305-14. doi: 10.1093/ndt/gfs472.
17. Leeaphorn N, Garg N, Khankin EV, Cardarelli F, Pavlakis M. Recurrence of IgA nephropathy after kidney transplantation in steroid continuation versus early steroid-withdrawal regimens: a retrospective analysis of the UNOS/OPTN database. Transpl Int. 2018 Feb;31(2):175-186. doi: 10.1111/tri.13075.

18. Allen PJ, Chadban SJ, Craig JC, Lim WH, Allen RDM, Clayton PA, Teixeira-Pinto A, Wong G. Recurrent glomerulonephritis after kidney transplantation: risk factors and allograft outcomes. Kidney Int. 2017 Aug;92(2):461-469. doi: 10.1016/j.kint.2017.03.015.
19. Berthoux F, Suzuki H, Mohey H, et al. Prognostic Value of Serum Biomarkers of Autoimmunity for Recurrence of IgA Nephropathy after Kidney Transplantation. J Am Soc Nephrol. 2017 Jun;28(6):1943-1950. doi: 10.1681/ASN.2016060670.
20. Matarneh A, Salameh O, Koirala M, Karasinski A, Kaur G, Trivedi N, Ghahramani N, Shah V. Treatment of Recurrent IgA Nephropathy After Kidney Transplantation: Case Report and Comprehensive Literature Review. Clin Case Rep. 2025 Nov 21;13(11):e71474. doi: 10.1002/ccr3.71474.
21. Alnaimat F, AbuHelal A, Elmusa R, et al. Immune rehabilitation after renal transplantation in autoimmune diseases: Balancing immunosuppression and risk of complications. Autoimmun Rev. 2026 Apr;25(4):104031. doi: 10.1016/j.autrev.2026.104031.
22. Morytko M, Dziedzic R, Pociej-Marciak W, et al. Recurrence and Outcomes of Lupus Nephritis After Renal Transplantation: Analysis of Nine Cases and Review of the Literature. J Clin Med. 2026 Feb 24;15(5):1682. doi: 10.3390/jcm15051682.
23. Gonzalez Suarez ML, Jiqiu W, Kattah AG, et al. The Clinicopathologic Characteristics of Recurrent Lupus Nephritis Post-Transplant Using Surveillance and Indication Biopsies. Kidney Int Rep. 2025 Apr 3;10(6):1829-1842. doi: 10.1016/j.ekir.2025.03.044.
24. Moroni G, Calatroni M, Ponticelli C. The Recurrence of Systemic Diseases in Kidney Transplantation. J Clin Med. 2025 Apr 9;14(8):2592. doi: 10.3390/jcm14082592.
25. Jiang K, Pan Y, Pu D, et al. Kidney transplantation in Lupus Nephritis: a comprehensive review of challenges and strategies. BMC Surg. 2025 Mar 22;25(1):112. doi: 10.1186/s12893-025-02832-w.
26. Kim YE, Kim JM, Ahn SM, et al. Lupus flare and recurrent lupus nephritis following kidney transplantation in patients with lupus nephritis. Int J Rheum Dis. 2024 Sep;27(9):e15349. doi: 10.1111/1756-185X.15349.
27. Kopel T, Salant DJ. C3 glomerulopathies: Dense deposit disease and C3 glomerulonephritis. In: Glassock RJ, Fervenza FC, Lam AQ, eds. UpToDate. Literature review current through March 2026. Topic last updated December 19, 2025. Accessed April 21, 2026
28. Bartoli G, Dello Strologo A, Grandaliano G, et al. Updates on C3 Glomerulopathy in Kidney Transplantation: Pathogenesis and Treatment Options. Int J Mol Sci. 2024 Jun 13;25(12):6508. doi: 10.3390/ijms25126508.
29. Zuckerman J, Pham PT, Parakkal M, et al. C3 glomerulopathy post kidney transplantation: A single center experience. World J Transplant. 2025 Jun 18;15(2):101517. doi: 10.5500/wjt.v15.i2.101517.
30. Schwarz C, Georgin-Lavialle S, Lombardi Y, et al. Kidney Transplantation in Patients With AA Amyloidosis: Outcomes in a French Multicenter Cohort. Am J Kidney Dis. 2024 Mar;83(3):329-339. doi: 10.1053/j.ajkd.2023.07.020.
31. Yamauchi J, Raghavan D, Jweehan D, et al. Kidney Transplant Outcomes in Amyloidosis: US National Database Study. Transplantation. 2025 Mar 1;109(3):536-548. doi: 10.1097/TP.0000000000005191.
32. Anand SK, Sanchorawala V, Verma A. Systemic Amyloidosis and Kidney Transplantation: An Update. Semin Nephrol. 2024 Jan;44(1):151496. doi: 10.1016/j.semnephrol.2024.151496.
33. Stern L, Havasi A. Renal transplantation in amyloidosis and MIDD. Front Biosci (Elite Ed). 2015 Jan 1;7(1):149-57. doi: 10.2741/724.
34. Angel-Korman A, Havasi A. Kidney Transplantation in Systemic Amyloidosis. Transplantation. 2020 Oct;104(10):2035-2047. doi: 10.1097/TP.0000000000003170.

Chapter 19

MALIGNANCIES AFTER KIDNEY TRANSPLANTATION

Yasemin Aydinalp CAMADAN[1]
Tolga KOSECİ[2]

Abstract

The risk of malignancy after kidney transplantation is significantly higher than in the general population and is among the most critical complications affecting long-term survival and quality of life in transplant recipients. In the pretransplant period, disease-free waiting periods, determined by the cancer's biological behavior and stage, are fundamental to ensuring oncological safety. In the posttransplant period, cumulative immunosuppressive burden is the most important modifiable risk factor. T-cell-depleting induction therapies and calcineurin inhibitors (CNIs), in particular, increase the risk of cancer. Furthermore, Torque Teno Virus (TTV) burden is a notable functional biomarker that reflects the patient's immune competence and predicts the risk of malignancy that may develop due to excessive immunosuppression. Among de novo malignancies frequently seen in kidney transplant recipients, cutaneous squamous cell carcinoma tends to be more aggressive, multifocal, and to present at an earlier age than in the general population. Lymphoproliferative diseases, which are a significant risk in the early post-transplant phase, are among the most aggressive cancers linked to viral reactivation. In the urogenital system, native kidney renal cell carcinoma is notably prominent. The basic principles of malignancy management are based on establishing a delicate balance between oncological efficacy and the preservation of graft function, and on a multidisciplinary decision-making process. In this context, individualizing therapy and reducing the cumulative immunosuppressive burden, the most important modifiable risk factor, is the fundamental treatment strategy. The strategic switch from CNIs to mTOR inhibitors (sirolimus/

[1] M.D., University of Health Sciences, Sanlıurfa Mehmet Akif İnan Education and Research Hospital, Departmant of Medical Oncology, ORCID iD: 0000-0003-2435-368X

[2] Assoc. Prof. Dr., Department of Medical Oncology, Çukurova University Faculty of Medicine, drtolgakoseci@gmail.com, ORCID iD: 0000-0003-2993-1960

DOI: 10.37609/akya.4215.c12428

combination of low-dose calcineurin inhibitors (CNIs) (e.g., tacrolimus target level 3-5 ng/mL) and steroids, while others advocate switching to mTOR inhibitors for antitumor synergy. However, low-dose CNIs do not always prevent rejection.

Nephrotoxicity: In addition to directly triggering rejection, ICIs can cause acute renal injury (AKI) due to acute tubulointerstitial nephritis in transplant kidneys.

Drug Interactions: Pharmacokinetic interactions and the cumulative nephrotoxicity potential of immunosuppressants (CNIs, mTOR inhibitors) and ICIs should be carefully managed in the treatment pl**an.**

- **Risk of Graft Loss and Planning for Conversion to Dialysis**
- Planning should be initiated in cases of advanced cancer or when aggressive treatments threaten the graft.
- Dialysis Guarantee: Unlike other organ transplants, graft loss is not fatal for kidney transplant recipients; dialysis is available as a backup option.
- End-of-Life Decisions: Completely discontinuing immunosuppression in patients with advanced malignancy is a difficult decision. Gradual discontinuation of medications and switching to high-dose steroids may be considered to prevent rejection symptoms. An integrated approach, including the palliative care team, is necessary in this process.

REFERENCES

1. Brennan DC, Lentine KL. Kidney transplantation in adults: Evaluation of the potential kidney transplant recipient. In: UpToDate, Post TW (Ed), UpToDate, Waltham, MA. (Accessed on April 23, 2026)
2. Wong G, Lim WH. Prior cancer history and suitability for kidney transplantation. Clinical Kidney Journal. 2023;16(11):1908-16. https://doi.org/10.1093/ckj/sfad141
3. Al-Adra DP, Hammel L, Roberts J, Woodle ES, Levine D, Mandelbrot D, et al. Preexisting melanoma and hematological malignancies, prognosis, and timing to solid organ transplantation: a consensus expert opinion statement. American Journal of Transplantation. 2021;21(2):475-83. https://doi.org/10.1111/ajt.16324
4. Al-Adra DP, Hammel L, Roberts J, Woodle ES, Levine D, Mandelbrot D, et al. Pretransplant solid organ malignancy and organ transplant candidacy: a consensus expert opinion statement. American Journal of Transplantation. 2021;21(2):460-74. https://doi.org/10.1111/ajt.16318
5. Al-Adra D, Al-Qaoud T, Fowler K, Wong G. De novo malignancies after kidney transplantation. Clinical Journal of the American Society of Nephrology. 2022;17(3):434-43. https://doi.org/10.2215/cjn.14570920
6. Brennan DC, Rodeheffer RJ, Ambinder RF. Malignancy after solid organ transplantation. Vella J, Sawinski D, eds. UpToDate. Waltham, MA: UpToDate Inc. uptodate.com (Accessed on April 25, 2026).
7. Hellemans R, Pengel LH, Choquet S, Maggiore U, project EWotT. Managing immunosuppressive therapy in potentially cured post-kidney transplant cancer (excluding non-melanoma

skin cancer): an overview of the available evidence and guidance for shared decision-making. Transplant International. 2021;34(10):1789-800. https://doi.org/10.1111/tri.13952

8. Herz C, Haupenthal F, Doberer K, Kapps S, Görzer I, Bond G. # 2402 Torque teno virus is associated with an increased risk for malignancies after kidney transplantation. Nephrology Dialysis Transplantation. 2025;40(Supplement_3):gfaf116. 2. https://doi.org/10.1093/ndt/gfaf116.112
9. Herz CT, Haupenthal F, Herkner F, Doberer K, Kapps S, Eder M, et al. Torque teno virus is predictive for malignancies after kidney transplantation. Nephrology Dialysis Transplantation. 2026:gfag078. https://doi.org/10.1093/ndt/gfag078
10. Kulbat A, Richter K, Stefura T, Kołodziej-Rzepa M, Kisielewski M, Wojewoda T, et al. Systematic review of calcineurin inhibitors and incidence of skin malignancies after kidney transplantation in adult patients: a study of 309,551 cases. Current Oncology. 2023;30(6):5727-37. https://doi.org/10.3390/curroncol30060430
11. Fuhrmann JD, Valkova K, von Moos S, Wüthrich RP, Müller TF, Schachtner T. Cancer among kidney transplant recipients> 20 years after transplantation: post-transplant lymphoproliferative disorder remains the most common cancer type in the ultra long-term. Clinical Kidney Journal. 2022;15(6):1152-9. https://doi.org/10.1093/ckj/sfac013
12. Negrin RS, Brennan DC. Treatment and prevention of post-transplant lymphoproliferative disorders. Chao NJ, ed. UpToDate. Waltham, MA: UpToDate Inc. uptodate.com (Accessed on April 25, 2026). Updated January 02, 2025.
13. Małyszko SJ, Rog L, Sprangers B, Renaghan AD, Rosner MH, Stec R, et al. Malignancy of Urinary Tract in Kidney Transplant Recipients—A Narrative Review. Cancers. 2026;18(4):695. https://doi.org/10.3390/cancers18040695
14. Murakami N, Mulvaney P, Danesh M, Abudayyeh A, Diab A, Abdel-Wahab N, et al. A multi-center study on safety and efficacy of immune checkpoint inhibitors in cancer patients with kidney transplant. Kidney international. 2021;100(1):196-205 https://doi.org/10.1016/j.kint.2020.12.015

Chapter 20

PREGNANCY AFTER KIDNEY TRANSPLANTATION

Mete SUCU[1]

Abstract

Kidney transplantation is the kidney replacement therapy method with the highest probability of restoring reproductive potential in women with advanced chronic kidney disease. Following a successful transplant, ovulatory cycles and spontaneous fertility often return within the first few months, frequently within the first six months; this makes pregnancy a realistic possibility for many women who were subfertile during dialysis or in the course of advanced renal failure. However, pregnancy should never be considered a routine occurrence in kidney transplant recipients. Pregnancy is a high-risk clinical situation, carrying not only the physiological burden of pregnancy itself but also the combined effects of chronic kidney disease, a single functioning graft, the need for lifelong immunosuppression, and the associated disease burden of hypertension, proteinuria, and the risk of infection.

Despite all these challenges, current data are generally encouraging with careful planning. Data from registry systems and meta-analyses show that live births are possible in the majority of pregnancies following kidney transplantation, with live birth rates often ranging from approximately 73–79%. These findings demonstrate that successful motherhood is possible in this patient group. However, despite acceptable live birth rates, rates of hypertensive pregnancy disorders, preterm birth, cesarean section, and fetal growth restriction are significantly higher compared to the general obstetric population. Therefore, the primary goal of care is not only to allow pregnancy but also to ensure conception occurs at the safest possible time and under the most appropriate clinical conditions.

Keywords: Kidney transplantation; pregnancy; fertility; chronic kidney disease; immunosuppressive therapy; high-risk pregnancy; live birth; preterm birth; hypertensive disorders of pregnancy; graft function.

[1] Assoc. Prof. Dr., Department of Obstetrics and Gynecology, Faculty of Medicine, Cukurova University, metesucu[@yahoo.com, ORCID iD: 0000-0002-6889-7147

DOI: 10.37609/akya.4215.c12429

recipient-specific risk factors. Therefore, prevention and management require individualized immunosuppressive strategies, regular oncological screening, early detection of high-risk lesions, and careful monitoring of viral and immune biomarkers such as Torque Teno Virus. When malignancy develops, treatment should balance effective cancer control with preservation of graft function, and decisions regarding immunosuppression reduction, conversion to mTOR inhibitors, surgery, systemic therapy, or immune checkpoint inhibitors must be made through a multidisciplinary approach. Overall, personalized risk assessment and close collaboration between oncology, nephrology, and transplant teams are essential to improve long-term outcomes in kidney transplant recipients.

REFERENCES

1. Agarwal, K. A., & Pavlakis, M. Sexuality, Contraception, and Pregnancy in Kidney Transplantation. Kidney Med, 2021, 3(5), 837-847. https://doi.org/10.1016/j.xkme.2021.05.009
2. Boulay, H., Mazaud-Guittot, S., Supervielle, J., et al. Maternal, foetal and child consequences of immunosuppressive drugs during pregnancy in women with organ transplant: a review. Clin Kidney J, 2021,14(8), 1871-1878. https://doi.org/10.1093/ckj/sfab049
3. Coscia, L., Cohen, D., Dube, G. K., et al. Outcomes With Belatacept Exposure During Pregnancy in Kidney Transplant Recipients: A Case Series. Transplantation, 2023,107(9), 2047-2054. https://doi.org/10.1097/tp.0000000000004634
4. Eke, A. C., Gebreyohannes, R. D., Fernandes, M. F. S., et al. Physiologic Changes During Pregnancy and Impact on Small-Molecule Drugs, Biologic (Monoclonal Antibody) Disposition, and Response. J Clin Pharmacol, 63 Suppl 1(Suppl 1), 2023, S34-S50. https://doi.org/10.1002/jcph.2227
5. Katz-Greenberg, G., Afshar, Y., Bonn, J., et al. Pregnancy After Solid Organ Transplantation: Review of the Evidence and Recommendations. Transplantation, 2025, 109(9), 1483-1494. https://doi.org/10.1097/tp.0000000000005341
6. Mustafa, M. S., Noorani, A., Abdul Rasool, A., et al. Pregnancy outcomes in renal transplant recipients: A systematic review and meta-analysis. Womens Health (Lond), 2024, 20, 17455057241277520. https://doi.org/10.1177/17455057241277520
7. Ponticelli, C., Zaina, B., & Moroni, G. Planned Pregnancy in Kidney Transplantation. A Calculated Risk. J Pers Med, 2021, 11(10). https://doi.org/10.3390/jpm11100956
8. Schagen, M. R., Ulu, A. N., Francke, M. I., et al. Modelling changes in the pharmacokinetics of tacrolimus during pregnancy after kidney transplantation: A retrospective cohort study. Br J Clin Pharmacol, 2024, 90(1), 176-188. https://doi.org/10.1111/bcp.15886
9. Irani, R. A., Coscia, L. A., Chang, E., et al. Society for Maternal-Fetal Medicine Consult Series #66: Prepregnancy evaluation and pregnancy management of patients with solid organ transplants. Am J Obstet Gynecol, 2023, 229(2), B10-B32. https://doi.org/10.1016/j.ajog.2023.04.022
10. Torres, V. E., Ahn, C., Barten, T. R. M., et al. KDIGO 2025 clinical practice guideline for the evaluation, management, and treatment of autosomal dominant polycystic kidney disease (ADPKD): executive summary. Kidney Int, 2025, 107(2), 234-254. https://doi.org/10.22141/2307-1257.14.1.2025.494

Chapter 21

BLADDER DISORDERS AND VOIDING DYSFUNCTION AFTER KIDNEY TRANSPLANTATION

M.Gurkan ARIKAN[1]

Abstract

Kidney transplantation is the most effective treatment for end-stage renal disease; however, long-term graft survival largely depends on the functional integrity of the lower urinary tract. Bladder disorders and voiding dysfunction after transplantation are common, particularly in patients with a history of prolonged anuria or oliguria. These conditions are associated with reduced bladder capacity, impaired compliance, and detrusor dysfunction. Comprehensive evaluation, including clinical assessment, uroflowmetry, post-void residual measurement, and selective urodynamic studies, is essential for identifying high-risk patients. Common dysfunction patterns include low-capacity bladder, overactive bladder, hypocontractile bladder, and neurogenic bladder. If untreated, these conditions may lead to complications such as urinary tract infections, vesicoureteral reflux, and obstructive uropathy, ultimately compromising graft function. A stepwise management approach, incorporating pharmacological therapy, clean intermittent catheterization, and surgical interventions, is crucial for optimizing outcomes and preserving long-term graft function.

INTRODUCTION

Kidney transplantation represents the treatment method with the best survival and quality of life rates for end-stage renal disease (ESRD). However, the healty function of the graft after transplantation largely depends on the ability of the lower urinary tract (LUT) to safely store and empty the urine load from the new graft. Bladder disorders and voiding dysfunctions due to prolonged anuric or oliguric periods in transplant patients emerge after transplantation.

[1] Dr. Assist. Prof., Department of Urology, Faculty of Medicine, Çukurova University, mgarikan26@gmail.com, ORCID iD: 0000-0002-9707-596X

DOI: 10.37609/akya.4215.c12430

determinants of transplant success and long-term graft survival. Functional monitoring initiated in the preoperative period and continued in the postoperative process;especially in patients whose clinical symptoms have become subtle due to prolonged anuria or who have a history of complex urological pathology, it allows for the early detection of underlying dysfunctions. It has been shown that timely and targeted treatment approaches (such as early surgical interventions, clean intermittent catheterization, or the creation of catheterizable channels), applied based on data obtained from urodynamic examinations, uroflowmetry, and PVR monitoring, protect the graft from mechanical damage caused by high intravesical pressure and obstructive uropathy. Consequently, the effective management of bladder disorders and voiding dysfunction is not merely a supportive approach; it is a fundamental component that directly protects graft function and optimizes long-term survival by providing a low-pressure and safe reservoir.

REFERENCES

1. Neves Neto JF, Palomino Z, Mizuno Watanabe IK, et al. Pretransplant defunctionalized bladder—overrated condition? Neurourol Urodyn. 2018. DOI: 10.1002/nau.23495
2. Asakura H, Nakamura K, Tachibana M, et al. Evaluation of lower urinary tract function in renal transplant recipients by urodynamic study. Transplant Proc. 1998.
3. Zachoval R, Krhut J, Slatinska J, et al. The relationship between lower urinary tract dysfunctions and urinary leakage from ureterocystoneoanastomosis in male patients after kidney transplantation. Bratisl Med J. 2021. DOI: 10.4149/BLL_2021_057
4. De Wall LL, Oomen L, Glaap-Roeven F, et al. Outcome of a thorough screening of lower urinary tract function in all pediatric kidney recipients. Pediatr Transplant. 2020. DOI: 10.1111/petr.13929
5. Amesty MV, García-Vaz C, Espinosa L, et al. Long-term renal transplant outcome in patients with posterior urethral valves. Front Pediatr. 2021. DOI: 10.3389/fped.2021.646923
6. Wicaksono I, Rahardjo HE. Factors associated with postoperative voiding dysfunction post renal transplantation. Transplant Proc. 2020. DOI: 10.1016/j.transproceed.2020.04.1817
7. Rude T, Nassiri N, Naser-Tavakolian A, et al. The role of urodynamics in the pre-transplant evaluation of renal transplant. Curr Urol Rep. 2019. DOI: 10.1007/s11934-019-0887-3
8. Kamiya KA, Jose Benito AA, Ernesto LG Jr. Evaluation of cystography/voiding cystourethrography prior to renal transplantation: a systematic review and meta-analysis. Int Urol Nephrol. 2025. DOI: 10.1007/s11255-025-04583-2
9. European Association of Urology. Renal transplantation. In: EAU Guidelines. 2026 edition. Arnhem, The Netherlands: EAU; 2026. Available at: https://uroweb.org/guidelines
10. Aikawa A, Muramatsu M, Takahashi Y, et al. Surgical challenge in pediatric kidney transplant: lower urinary tract abnormality. Exp Clin Transplant. 2018. DOI: 10.6002/ect.TOND-TDTD2017.L42
11. Errando C, Batista JE, Caparros J, et al. Is bladder cycling useful in the urodynamic evaluation previous to renal transplantation? Urol Int. 2005. DOI: 10.1159/000084435
12. Righetto M, Mancini M, Modonutti D, et al. Patients with renal transplant and moderate-to-severe LUTS benefit from urodynamic evaluation and early transurethral resection of the prostate. World J Urol. 2021. DOI: 10.1007/s00345-021-03631-4

13. Herthelius M, Öborn H. Urinary tract infections and bladder dysfunction after renal transplantation in children. J Urol. 2007. DOI: 10.1016/j.juro.2007.01.054
14. Sabnis RB, Singh AG, Ganpule AP, et al. The development and current status of minimally invasive surgery to manage urological complications after renal transplantation. Indian J Urol. 2016. DOI: 10.4103/0970-1591.185100
15. Orecchia L, Rosato E, Siragusa L, et al. Percutaneous tibial nerve stimulation improves lower urinary tract dysfunction and infection rate in a kidney transplant recipient with augmentation cystoplasty: a case report and literature review. Transplant Proc. 2022. DOI: 10.1016/j.transproceed.2022.03.032
16. Salman B, Hassan A, Sultan S, et al. Renal transplant in the abnormal bladder: long-term follow-up. Exp Clin Transplant. 2018. DOI: 10.6002/ect.2016.0193

Chapter 22

UPPER AIRWAY AND OTORHINOLARYNGOLOGIC COMPLICATIONS IN RENAL TRANSPLANT RECIPIENTS

Muhammed DAGKIRAN[1]
Ilda TANRISEVER PEHLİVAN[2]

Abstract

Renal transplantation significantly improves survival and quality of life in patients with end-stage renal disease. However, lifelong immunosuppressive therapy predisposes transplant recipients to a broad spectrum of infectious, inflammatory, and neoplastic complications involving the upper airway and otorhinolaryngologic system. Impairment of cellular immunity, disruption of mucosal barriers, and alterations in the sinonasal microbiome contribute to increased susceptibility to opportunistic infections and chronic inflammatory disorders. Chronic rhinosinusitis represents the most frequently encountered sinonasal complication, whereas invasive fungal rhinosinusitis, although less common, remains a life-threatening condition requiring urgent diagnosis and management. Oropharyngeal complications such as chronic pharyngitis, oral candidiasis, aphthous ulcers, and herpes simplex infections are frequently observed and may significantly impair nutritional status and quality of life. Otologic manifestations, including otitis externa, otitis media, and drug-related ototoxicity, may also occur during the post-transplant period. In addition, prolonged immunosuppression increases the risk of head and neck malignancies and post-transplant lymphoproliferative disorders. Early recognition of symptoms, prompt endoscopic evaluation, radiologic imaging, and microbiological or histopathological confirmation are essential for accurate diagnosis. Management requires a multidisciplinary approach

[1] Assoc. Prof. Dr., Cukurova University Faculty of Medicine, Department of Otolaryngology and Head and Neck Surgery, muhammeddagkiran@gmail.com, ORCID iD: :0000-0002-1923-3731

[2] Lecturer, Cukurova University Faculty of Medicine, Department of Otolaryngology and Head and Neck Surgery, ildatanrisever@gmail.com, ORCID iD: 0000-0002-9134-3070

DOI: 10.37609/akya.4215.c12431

are indispensable tools in this process. Early biopsy is recommended for suspicious lesions. Management includes antimicrobial therapy, optimization of immunosuppression, and surgical intervention when necessary. Collaboration between nephrologists, ENT specialists, urologists and infectious disease experts is critical. Drug toxicity, interactions (e.g., calcineurin inhibitors with antifungals), and recurrence of infections are common challenges. Regular monitoring is required. Emerging approaches include personalized immunosuppression, microbiome-based therapies, and biomarker-driven diagnostics.

CONCLUSION

Renal transplant patients are prone to serious ENT conditions that can be life-threatening. Therefore, a routine ENT evaluation should be performed prior to transplantation. Sinonasal symptoms that develop in the post-transplant period should be evaluated promptly. Particular vigilance is required for acute complications such as epistaxis, especially during the first month. A multidisciplinary approach and early endoscopic evaluation are key to reducing morbidity and mortality.

REFERENCES

1. Valencia-Sanchez BA, Daniel H, Wilson P, et al. Incidence and Risk Factors for De Novo Chronic Rhinosinusitis in Kidney and Liver Transplant Recipients. OTO Open. 2026;10(1):e70200. doi:10.1002/oto2.70200.
2. Lee AY, Jeong J, Heo KN, et al. Complications Associated with Immunosuppressive Agents in Solid Organ Transplant Recipients: A Nationwide Analysis. J Clin Med. 2025;14(10):3602. doi:10.3390/jcm14103602.
3. Husain S, Singh N. The Impact of Novel Immunosuppressive Agents on Infections in Organ Transplant Recipients and the Interactions of These Agents with Antimicrobials. Clin Infect Dis. 2002;35(1):53-61. doi:10.1086/340867.
4. Chak E, Saab S. Risk Factors and Incidence of De Novo Malignancy in Liver Transplant Recipients: A Systematic Review. Liver Int. 2010;30(9):1247-1258. doi:10.1111/j.1478-3231.2010.02290.x.
5. Moroni G, et al. Kidney Transplantation: Shifting the Focus from Graft Survival to Patient Health. Front Immunol. 2026;17:1738675. doi:10.3389/fimmu.2026.1738675.
6. Hizal E, Ozcan M, Sennaroglu L, et al. Otorhinolaryngologic Problems in Liver and Kidney Transplant Recipients. Exp Clin Transplant. 2018;16(Suppl 1):706-710.
7. Romano FR, Voegels RL, Butugan O. Chronic Rhinosinusitis: Current Concepts in Pathophysiology and Management. Braz J Otorhinolaryngol. 2025;91(2):101-110.
8. Andrade-Bonilla CM, et al. Chronic Rhinosinusitis and Quality of Life in Immunocompromised Patients. Rev Fac Med Hum. 2024;24(2):20-28.
9. Costantini E, Natale F, Carbone A, et al. Pelvic Organ Prolapse. In: Heesakkers J, Chapple C, De Ridder D, Farag F, eds. Practical Functional Urology. Springer International Publishing Switzerland; 2016. p.153-238.
10. Aull MJ, Trofe-Clark J. Infections in Transplant Recipients. In: Organ Transplantation: New Perspectives and Therapeutic Strategies. IntechOpen; 2013.

Chapter 23

THORACIC COMPLICATIONS AFTER KIDNEY TRANSPLANTATION

İsmail Can KARACAOĞLU[1]

Abstract

Thoracic complications after kidney transplantation constitute a heterogeneous clinical spectrum ranging from early postoperative respiratory impairment to late infectious, thromboembolic, pleural, malignant, and ventilation-related disorders. Their evaluation requires more than routine postoperative respiratory assessment because immunosuppression, graft function, renal-adjusted therapies, altered inflammatory responses, and competing diagnoses frequently obscure the clinical picture. This chapter reviews thoracic complications from a thoracic surgery-oriented perspective, emphasizing practical diagnostic pathways, indications for invasive evaluation, and situations in which surgical intervention becomes necessary. Particular attention is given to postoperative atelectasis and pneumonia, pleural effusion and pleural infection, pulmonary embolism, thoracic malignancies, pulmonary nodules, post-transplant lymphoproliferative disorder, diaphragmatic dysfunction, and complex pleural or pulmonary conditions requiring video-assisted thoracoscopic surgery. The chapter highlights the importance of differentiating reversible postoperative changes from complications requiring microbiologic diagnosis, pleural drainage, bronchoscopy, tissue biopsy, oncologic staging, or operative management. Because evidence specific to kidney transplant recipients remains limited for several thoracic conditions, general thoracic, pulmonary, and thromboembolic principles should be applied with transplant-specific caution. Early recognition, structured assessment, individualized risk evaluation, and coordinated multidisciplinary care are central to improving outcomes in this vulnerable patient population.

[1] Dr. Assist.Prof., Department of Thoracic Surgery, Faculty of Medicine, Çukurova University, ikaracaoglu@cu.edu.tr, ORCID iD: 0000-0002-2273-5097

DOI: 10.37609/akya.4215.c12974

REFERENCES

1. Miskovic A, Lumb AB. Postoperative pulmonary complications. British Journal of Anaesthesia. 2017;118(3):317–334. DOI: 10.1093/bja/aex002. PMID: 28186222.
2. Wu X, Zhang H, Cai M, Zhang Y, Xu A. Predicting the risk of pulmonary infection after kidney transplantation using machine learning methods: a retrospective cohort study. International Urology and Nephrology. 2025;57:947–955. DOI: 10.1007/s11255-024-04264-6. PMID: 39488661.
3. Dulek DE, Mueller NJ. Pneumonia in solid organ transplantation: Guidelines from the American Society of Transplantation Infectious Diseases Community of Practice. Clinical Transplantation. 2019;33(9):e13545. DOI: 10.1111/ctr.13545. PMID: 30900275.
4. Bhargava V, Meena P, Bhalla AK, et al. Prevalence, risk, and outcomes of venous thromboembolic events in kidney transplant recipients: a nested case-control study. Renal Failure. 2023;45(1):2161395. DOI: 10.1080/0886022X.2022.2161395. PMID: 36688793.
5. Massicotte-Azarniouch D, Noel JA, Knoll GA. Epidemiology of cancer in kidney transplant recipients. Seminars in Nephrology. 2024;44(1):151494. DOI: 10.1016/j.semnephrol.2024.151494. PMID: 38538455.
6. Nimmo A, Elyan B, Lakey J, et al. Increased cancer risk in kidney transplant patients in Scotland: a national registry linkage study. British Journal of Cancer. 2025;133:555–563. DOI: 10.1038/s41416-025-03086-2. PMID: 40517146.
7. Poddighe D, Van Hollebeke M, Rodrigues A, et al. Respiratory muscle dysfunction in acute and chronic respiratory failure: how to diagnose and how to treat? European Respiratory Review. 2024;33(174):240150. DOI: 10.1183/16000617.0150-2024. PMID: 39631928.
8. BTS Pleural Guideline Development Group. British Thoracic Society Guideline for pleural disease. Thorax. 2023;78(Suppl 3):s1–s42. DOI: 10.1136/thorax-2022-219784. PMID: 37433578.
9. Bedawi EO, Ricciardi S, Hassan M, et al. ERS/ESTS statement on the management of pleural infection in adults. European Respiratory Journal. 2023;61(2):2201062. DOI: 10.1183/13993003.01062-2022. PMID: 36229045.
10. Konstantinides SV, Meyer G, Becattini C, et al. 2019 ESC Guidelines for the diagnosis and management of acute pulmonary embolism developed in collaboration with the ERS. European Heart Journal. 2020;41(4):543–603. DOI: 10.1093/eurheartj/ehz405. PMID: 31504429.
11. Stevens SM, Woller SC, Baumann Kreuziger L, et al. Antithrombotic therapy for VTE disease: second update of the CHEST Guideline and Expert Panel Report. Chest. 2021;160(6):e545–e608. DOI: 10.1016/j.chest.2021.07.055. PMID: 34352278.
12. Mansell H, Shoker A, Alcorn J, et al. Pharmacokinetics of apixaban and tacrolimus or cyclosporine in kidney and lung transplant recipients. Clinical and Translational Science. 2022;15(7):1687–1697. DOI: 10.1111/cts.13284. PMID: 35439353.
13. Watanabe H, Kadomatsu Y, Hakiri S, et al. Lung cancer after kidney transplantation: a 50-year experience at a single institution. Surgery Today. 2024;54(10):1124–1130. DOI: 10.1007/s00595-024-02819-9. PMID: 38546862.
14. Krist AH, Davidson KW, Mangione CM, et al. Screening for lung cancer: US Preventive Services Task Force recommendation statement. JAMA. 2021;325(10):962–970. DOI: 10.1001/jama.2021.1117. PMID: 33687470.
15. Dharnidharka VR, Ruzinova MB, Marks LJ. Post-transplant lymphoproliferative disorders. Seminars in Nephrology. 2024;44(1):151503. DOI: 10.1016/j.semnephrol.2024.151503. PMID: 38519279.

Chapter 24

METABOLIC COMPLICATIONS AFTER KIDNEY TRANSPLANTATION

Kaniye AYDIN[1]

Abstract

Various metabolic complications are common in the post-kidney transplant period and can negatively impact patient and graft survival. The most important complications include post-transplant diabetes mellitus (PTDM), dyslipidemia, metabolic syndrome, and electrolyte imbalances. PTDM is defined as diabetes that develops after transplantation and is evaluated regardless of the time of onset. The presence of PTDM is associated with an increased frequency of infections, increased cardiovascular morbidity and mortality, and an increased risk of graft loss. Dyslipidemia is characterized by elevated levels of low-density lipoprotein cholesterol and triglycerides, particularly in response to immunosuppressive therapies. This contributes to the development of atherosclerotic cardiovascular disease and facilitates the development of metabolic syndrome. Metabolic syndrome is a complex clinical condition characterized by abdominal obesity, hypertension, hyperglycemia, and dyslipidemia, and is a significant risk factor for cardiovascular mortality in kidney transplant recipients. Electrolyte imbalances are also commonly observed in the post-kidney transplant period. Hyperkalemia, particularly due to calcineurin inhibitors reducing distal tubular potassium secretion, can lead to serious cardiac arrhythmias. Hypomagnesemia, on the other hand, results from multifactorial mechanisms such as renal magnesium loss, gastrointestinal malabsorption, and immunosuppressive drug use. Low magnesium levels increase the risk of developing PTDM through decreased insulin secretion and increased insulin resistance, and can also potentiate the diabetogenic effects of calcineurin inhibitors. Hypophosphatemia is frequently

[1] Assoc. Prof. Dr. Department of Internal Medicine, Division of Medical Intensive Care Unit, School of Medicine, Çukurova University, ORCID iD: 0000-0001-5538-3692

DOI: 10.37609/akya.4215.c12975

graft function. Early detection of metabolic complications, regular metabolic monitoring, and the implementation of individualized treatment strategies are critically important both in reducing cardiovascular events and in extending graft survival. The current approach aims not only to preserve graft function but also to improve long-term patient and graft survival through early and effective management of metabolic risk factors.

REFERENCES

1. American Diabetes Association Professional Practice Committee for Diabetes*. 2. Diagnosis and Classification of Diabetes: Standards of Care in Diabetes-2026. *Diabetes Care*. 2026 1;49:S27-S49. https://doi.org/10.2337/dc26-S002
2. Long J, Zhao J, Gu X, Huang C. Post-transplant diabetes mellitus after kidney transplantation: pathogenesis, risk factors, and management strategies. *Front Endocrinol (Lausanne)*. 2026;17:1829579. https://doi.org/10.3389/fendo.2026.1829579
3. Barbachowska-Kubik AM, Gozdowska J, Kosieradzki M, Durlik M. Risk Factors for Development of Post-Transplant Diabetes Mellitus After Kidney Transplantation and Comparison Between Older and Younger Recipients in the Early Post-Transplantation Period: A Single-Center Study. *Ann Transplant*. 2025;30:e949855. https://doi.org/10.12659/AOT.949855
4. Kanbay M, Copur S, Topçu AU, et al. An update review of post-transplant diabetes mellitus: concept, risk factors, clinical implications and management. *Diabetes Obes Metab*. 2024;26(7):2531–2545. https://doi.org/10.1111/dom.15575
5. Alajous S, Budhiraja P. New-onset diabetes mellitus after kidney transplantation. *J Clin Med*. 2024;13(7):1928. https://doi.org/10.3390/jcm13071928
6. Sharif A, Chakkera H, de Vries APJ, et al. International consensus on post-transplantation diabetes mellitus. *Nephrol Dial Transplant*. 2024;39(3):531–549. https://doi.org/10.1093/ndt/gfad258
7. American Diabetes Association Professional Practice Committee for Diabetes*. 9. Pharmacologic Approaches to Glycemic Treatment: Standards of Care in Diabetes-2026. *Diabetes Care*. 2026;49:S183-S215. https://doi.org/10.2337/dc26-S009
8. Çelik Kavaklılar B, Aybı Özdemir Ö, Yıldırım T, et al. Evaluation of microvascular complications in kidney recipients with posttransplant diabetes mellitus. *J Clin Endocrinol Metab*. 2024;109(8):e1623–e1633. https://doi.org/10.1210/clinem/dgad738
9. Jeon JY, Han-Bit S, Park BH, et al. Impact of post-transplant diabetes mellitus on survival and cardiovascular events in kidney transplant recipients. *Endocrinol Metab (Seoul)*. 2023;38(1):139–145. https://doi.org/10.3803/EnM.2022.1594
10. Agarwal A, Prasad GVR. Post-transplant dyslipidemia: Mechanisms, diagnosis and management. *World Journal of Transplantation*. 2016;6(1):125–134 https://doi.org/10.5500/wjt.v6.i1.125
11. Chmielnicka K, Heleniak Z, Dębska-Ślizień A. Dyslipidemia in renal transplant recipients. *Transplantology*. 2022;3(2):188–199. https://doi.org/10.3390/transplantology3020020
12. Lentine KL, Brennan DC. Lipid abnormalities after kidney transplantation. *UpToDate*. Updated Jan 28, 2026. Accessed May 2026. https://www.uptodate.com/contents/lipid-abnormalities-after-kidney-transplantation?search=Lipid%20abnormalities%20after%20kidney%20transplantation&source=search_result&selectedTitle=1~150&usage_type=default&display_rank=1&searchCorrelationId=387e504c-bfce-4242-a87c-e0a12e64f510&searchCorrelationTerm=Lipid%20abnormalities%20after%20kidney%20transplantation

13. Pedrollo EF, Correa C, Nicoletto BB, et al. Effects of metabolic syndrome on kidney transplantation outcomes: a systematic review and meta-analysis. *Transpl Int.* 2016;29:1059–1066. https://doi.org/10.1111/tri.12805
14. Graˇnák K, Vnuˇcák M, Belianˇcinová M, et al. Adiponectin/leptin ratio as an index to determine metabolic risk in patients after kidney transplantation. *Medicina (Kaunas).* 2022;58(11):1656. https://doi.org/10.3390/medicina58111656
15. Lee YH, Song SH, Song SH, et al. Clinical implications of changes in metabolic syndrome status after kidney transplantation: a nationwide prospective cohort study. *Nephrol Dial Transplant.* 2023;38:2743–2753. https://doi.org/10.1093/ndt/gfad115
16. Yan J, Yang X, Wang J, et al. Metabolic risk profile and graft function deterioration 2 years after kidney transplant. *JAMA Netw Open.* 2023;6(12):e2349538. https://doi.org/10.1001/jamanetworkopen.2023.49538
17. Zhu K, Jin Y, Liu W, et al. Clinical investigations and therapeutic perspectives on metabolic syndrome following kidney transplantation. *Kidney Blood Press Res.* 2025;50:232–239. https://doi.org/10.1159/000545032
18. Naganuma T, Iwai T, Kabata D, et al. Impact of metabolic syndrome on renal and cardiovascular outcomes in renal transplant recipients: a single-center study in Japan. *J Clin Med.* 2025;14:5303. https://doi.org/10.3390/jcm14155303
19. Hamooya BM, Siame L, Muchaili L, et al. Metabolic syndrome: epidemiology, mechanisms, and current therapeutic approaches. *Front Nutr.* 2025;12:1661603. https://doi.org/10.3389/fnut.2025.1661603
20. Rizk JG, Lazo JG Jr, Quan D, et al. Mechanisms and management of drug-induced hyperkalemia in kidney transplant patients. *Rev Endocr Metab Disord*. 2021;22(4):1157–1170. https://doi.org/10.1007/s11154-021-09677-7
21. Garnier AS, Duveau A, Planchais M, et al. Serum magnesium after kidney transplantation: a systematic review. *Nutrients.* 2018;10(6):729. https://doi.org/10.3390/nu10060729
22. Elshehawy M, Abdelgawad AA, Baig MY, et al. Hypomagnesaemia in renal transplant recipients: a review of mechanistic complexity, diagnostic gaps, and emerging therapeutic strategies. *Kidney Dial.* 2025;5(3):45. https://doi.org/10.3390/kidneydial5030045
23. Chen S, Bowen DG, Liu K, et al. Hypomagnesaemia, an independent risk factor for the development of post-transplant diabetes mellitus in liver and renal transplant recipients? A systematic review. *J Hum Nutr Diet.* 2024;37(6):1407–1419. https://doi.org/10.1111/jhn.13354
24. Vangala C, Pan J, Cotton RT, et al. Mineral and bone disorders after kidney transplantation. *Front Med (Lausanne).* 2018;5:211. https://doi.org/10.3389/fmed.2018.00211
25. Teh JW, Mac Gearailt C, Lappin DWP. Post-transplant bone disease in kidney transplant recipients: diagnosis and management. *Int J Mol Sci.* 2024;25(3):1859. https://doi.org/10.3390/ijms25031859
26. Charoenngam N, Rittiphairoj T, Yingchoncharoen P, et al. Prognostic significance of hypophosphatemia in kidney transplant patients: a systematic review and meta-analysis. *J Evid Based Med.* 2025;18(1):e70000. https://doi.org/10.1111/jebm.70000
27. Ralston MR, Stevenson KS, Mark PB, et al. Clinical factors associated with severe hypophosphataemia after kidney transplant. BMC Nephrol. 2021;22(1):407. https://doi.org/10.1186/s12882-021-02624-3

Chapter 25

COMPLICATIONS IN PEDIATRICS AFTER RENAL TRANSPLANTATION

Önder ÖZDEN[1]

Abstract

This chapter examines the concept of childhood from social, legal, developmental, and ethical perspectives. It first discusses what it means to be a child and emphasizes that childhood should not be understood merely as a temporary stage before adulthood, but as a unique and valuable period of human life. The chapter highlights that children are rights-bearing individuals whose existence, development, and sense of self are shaped by the attitudes of families, society, and institutions. It explains how childhood has been defined in legal frameworks such as the Convention on the Rights of the Child, the Child Protection Law, the Turkish Penal Code, and the Turkish Civil Code. The chapter also addresses the importance of seeing the world through the eyes of children and draws attention to poverty, inequality, neglect, abuse, child labor, war, migration, and other social problems that threaten children's well-being. Furthermore, it compares the worlds of children and adults, underlining that children should not be treated as miniature adults or forced into adult responsibilities. Overall, the chapter argues that protecting childhood means protecting human dignity, children's rights, and the future of society.

Keywords: Childhood, child rights, child protection, child development, child welfare, childhood studies, social responsibility, neglect and abuse, child-centered approach

INTRODUCTION

Kidney transplantation is unquestionably the most appropriate treatment modality for many children with end-stage renal disease or those approaching this stage.

[1] Assoc. Prof. Dr., Cukurrova University, Faculty of Medicine, Department of Pediatric Surgery, onder24@hotmail.com, ORCID iD: 0000-0001-5683-204X

DOI: 10.37609/akya.4215.c12976

Lymphocele, defined as an encapsulated collection of lymphatic fluid arising secondary to the surgical division of lymphatic vessels overlying the iliac vasculature, represents a well-recognized urological complication in the post-transplant period. By exerting extrinsic compression upon the urinary tract, lymphocele may precipitate post-obstructive uropathy, thereby jeopardizing allograft function and long-term graft survival. In a retrospective study examining the incidence and clinical implications of this complication, lymphocele was identified in approximately 3% of pediatric renal transplant recipients, underscoring its relevance even within this relatively low-prevalence surgical context. Risk factors independently associated with lymphocele development include age greater than 11 years, male sex, body mass index exceeding the 95th percentile, and a history of multiple transplantations, suggesting that older children with higher adiposity and complex surgical histories may constitute a particularly vulnerable subgroup. Notably, in the aforementioned series, the presence of lymphocele was associated with a clinically meaningful 10% reduction in one-year graft survival, highlighting the potential downstream consequences of this complication on allograft longevity and emphasizing the importance of early detection and timely intervention in the post-transplant surveillance protocol[27].

REFERENCES

1. Hart, A., et al., *OPTN/SRTR 2019 Annual Data Report: Kidney.* Am J Transplant, 2021. **21 Suppl 2**: p. 21-137.
2. Harambat, J. and D. Morin, *[Epidemiology of childhood chronic kidney diseases].* Med Sci (Paris), 2023. **39**(3): p. 209-218.
3. Goebel, J., *New Nephrological Frontiers: Opportunities and Challenges Created by Fetal Care Centers.* Adv Pediatr, 2017. **64**(1): p. 73-86.
4. *National Kidney Foundation. K/DOQI clinical practice guidelines for chronic kidney disease: evaluation, classification, and stratification. Am J Kidney Dis 2002; 39:S1.*
5. Coche, S., et al., *Recurrence and Outcome of Anti-Glomerular Basement Membrane Glomerulonephritis After Kidney Transplantation.* Kidney Int Rep, 2021. **6**(7): p. 1888-1894.
6. Singh, T., et al., *Long-term outcomes in kidney transplant recipients with end-stage kidney disease due to anti-glomerular basement membrane disease.* Clin Transplant, 2021. **35**(2): p. e14179.
7. Salmela, K.T., et al., *Acute vascular rejection in renal transplantation--diagnosis and outcome.* Transplantation, 1992. **54**(5): p. 858-62.
8. Grandtnerova, B., et al., *Hyperacute rejection of living related kidney grafts caused by endothelial cell-specific antibodies: case reports.* Transplant Proc, 2008. **40**(7): p. 2422-4.
9. Matas, A.J., et al., *OPTN/SRTR 2013 Annual Data Report: kidney.* Am J Transplant, 2015. **15 Suppl 2**: p. 1-34.
10. Chaudhuri, A., et al., *The clinical impact of humoral immunity in pediatric renal transplantation.* J Am Soc Nephrol, 2013. **24**(4): p. 655-64.
11. Peruzzi, L., A. Amore, and R. Coppo, *Challenges in pediatric renal transplantation.* World J Transplant, 2014. **4**(4): p. 222-8.

12. Dello Strologo, L., et al., *Renal transplantation in sensitized children and young adults: a nationwide approach.* Nephrol Dial Transplant, 2017. **32**(1): p. 191-195.
13. Mengel, M., et al., *Banff 2011 Meeting report: new concepts in antibody-mediated rejection.* Am J Transplant, 2012. **12**(3): p. 563-70.
14. Loupy, A., et al., *The Banff 2019 Kidney Meeting Report (I): Updates on and clarification of criteria for T cell- and antibody-mediated rejection.* Am J Transplant, 2020. **20**(9): p. 2318-2331.
15. McDonald, R.A., et al., *Pretransplant peritoneal dialysis and graft thrombosis following pediatric kidney transplantation: a NAPRTCS report.* Pediatr Transplant, 2003. **7**(3): p. 204-8.
16. Smith, J.M., et al., *Decreased risk of renal allograft thrombosis associated with interleukin-2 receptor antagonists: a report of the NAPRTCS.* Am J Transplant, 2006. **6**(3): p. 585-8.
17. Kranz, B., et al., *Outcome after kidney transplantation in children with thrombotic risk factors.* Pediatr Transplant, 2006. **10**(7): p. 788-93.
18. Broyer, M., et al., *Preventive treatment of vascular thrombosis after kidney transplantation in children with low molecular weight heparin.* Transplant Proc, 1991. **23**(1 Pt 2): p. 1384-5.
19. Salvatierra, O., Jr., M. Millan, and W. Concepcion, *Pediatric renal transplantation with considerations for successful outcomes.* Semin Pediatr Surg, 2006. **15**(3): p. 208-17.
20. Routh, J.C., et al., *Urological complications and vesicoureteral reflux following pediatric kidney transplantation.* J Urol, 2013. **189**(3): p. 1071-6.
21. Tavakoli, A., et al., *Impact of stents on urological complications and health care expenditure in renal transplant recipients: results of a prospective, randomized clinical trial.* J Urol, 2007. **177**(6): p. 2260-4; discussion 2264.
22. Dharnidharka, V.R., et al., *Assessing the value of ureteral stent placement in pediatric kidney transplant recipients.* Transplantation, 2008. **85**(7): p. 986-91.
23. Englesbe, M.J., et al., *Early urologic complications after pediatric renal transplant: a single-center experience.* Transplantation, 2008. **86**(11): p. 1560-4.
24. Smith, K.M., et al., *Risk factors and treatment success for ureteral obstruction after pediatric renal transplantation.* J Urol, 2010. **183**(1): p. 317-22.
25. Patel, P., et al., *Prophylactic Ureteric Stents in Renal Transplant Recipients: A Multicenter Randomized Controlled Trial of Early Versus Late Removal.* Am J Transplant, 2017. **17**(8): p. 2129-2138.
26. Hewitt, I.K., G. Montini, and S.D. Marks, *Vesico-ureteric reflux in children and young people undergoing kidney transplantation.* Pediatr Nephrol, 2023. **38**(9): p. 2987-2993.
27. Giuliani, S., et al., *Lymphocele after pediatric kidney transplantation: incidence and risk factors.* Pediatr Transplant, 2014. **18**(7): p. 720-5.