

Kidney Donor and Recipient Perioperative Evaluation

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INTRODUCTION

Kidney transplantation the best known renal replacement therapy for patients with end-stage renal disease, as it is associated with better survival and quality of life. The donated kidney is either from living or deceased donor. In order to have a successful transplantation, it is important to select recipient and donor accurately. The pre-transplantation clinical and laboratory assessment of both potential candidate and donor is intended to find suitable candidates and improve patient and graft survival and reduce perioperative complications.

With more than 200 transplantations per year, Shahid Labbafinejad Medical Center is one of the main transplantation centers in Iran. Transplant experts at this academic hospital developed this curriculum to systematically address preoperative considerations involving donors and recipients. This curriculum is based on the best available evidence around these issues after a comprehensive literature review. The collected evidence was reviewed and critically appraised by the members and was revised to meet the requirements and resources across the country. It is of note that in addition to the systematic evaluation, individual candidates must be assessed based on their specific conditions.

PART 1: EVALUATION AND PREPARATION OF KIDNEY TRANSPLANT CANDIDATES

I. Comprehensive History and Physical Examination

1. Determination of the cause of kidney failure and native kidney biopsy result
 2. Informing patients with primary focal and segmental glomerulosclerosis about the risk of recurrence
 3. Assessment of the history of kidney transplantation, the cause of previous graft failure, and the allograft biopsy result
 4. Documentation of dialysis history
 5. Documentation of the history of blood product transfusion
 6. Evaluation of pregnancy history
 7. Examination for lymphadenopathy, hepatomegaly, splenomegaly, skin lesions, diabetic ulcer, and evidence for peripheral vascular diseases
 8. Examination of dialysis access site for infection and function
- Avoid femoral catheter insertion especially on the supposed site of transplantation, if possible.

II. Laboratory Investigations

1. Blood group, Rh
 - a. No need for Rh compatibility
 - b. In female candidates with negative Rh and in reproductive age, Rh compatibility is preferred.
 - c. Only ABO compatible transplantation is allowed.
2. Complete blood count, differential
3. Fasting blood glucose and glycosylated hemoglobin in diabetic patients
4. Biochemical evaluation (blood urea nitrogen and serum creatinine, sodium, potassium, and uric acid)
5. Plasma calcium, phosphorus, and intact parathyroid hormone
 - a. Hyperphosphatemia should be treated.
 - b. In the presence of an intact parathyroid hormone level greater than 800 pg/mL and resistance to maximal conservative treatment (phosphate binders and vitamin D analogues), delaying transplantation and treatment with cinacalcet or parathyroidectomy should be considered based on the nephrologist opinion.
6. Lipid profile
7. Liver function tests

If there is more than 2-fold change in serum aminotransferase levels (reference alanine aminotransferase, < 17 IU/L; reference aspartate amino transferase, < 24 IU/L), liver ultrasonography and hepatitis B and C viral loads should be assessed.
8. Serum alkaline phosphatase

In case of elevated levels, bone or biliary source should be sought (gamma glutamyl transpeptidase or biliary system ultrasound evaluation).
9. Iron profile (serum iron, transferrin saturation, and ferritin)

If transferrin saturation is less than 30% or ferritin level is less than 500 ng/mL, intravenous iron supplementation should be administered.
10. 25-hydroxyvitamin D level

25-hydroxyvitamin D replacement is recommended in patients with deficiency.
11. Erythrocyte sedimentation rate and C-reactive protein
12. Prothrombin time, partial thromboplastin

- time, and international normalized ratio
13. Urine analysis and culture (in non-anuric patients)
14. 24-hour urine collection for protein, creatinine, volume (in non-anuric patients)
15. Stool examination for occult blood, ova, and parasite
16. Beta-human chorionic gonadotropin

All the female candidates at childbearing age should be tested at the time of evaluation and within a week before transplantation.
17. Other assessments

In those with history of deep venous thrombosis, spontaneous abortion, recurrent clotting of a dialysis fistula or graft, thrombotic events in the previous graft or bleeding tendencies the following assessments should performed: activated protein C, protein S, factor V Leiden, prothrombin gene mutation, antiphospholipid antibodies, and hematologist consultation.

III. Assessment for Latent and Active Infections

1. Testing for venereal disease research laboratory or rapid plasma reagin
2. Screening for brucellosis with Wright test
3. Assessment for mycobacterium tuberculosis with tuberculosis skin test and quantiferon

Patients with positive results should be treated with isoniazid for 9 months.
4. Testing for human immunodeficiency virus (HIV) antibody
5. Testing for hepatitis B surface antigen (HBsAg), HBsAg antibody titer, and hepatitis B core antibody (HBcAb)
 - a. If HBsAg is positive, it is recommended to check hepatitis B virus (HBV) DNA, hepatitis B e antigen (HBeAg), and HBeAg antibody, and refer to a hepatologist for fibroscan or liver biopsy.
 - b. If HBsAg antibody titer is less than 10 mIU/mL, pretransplantation vaccination should be suggested (at least one 0.4-mL intradermal before transplantation).
 - c. If HBcAb is positive and HBsAg antibody level is less than 10 mUI/mL, HBV DNA qualitative polymerase chain reaction (PCR) should be checked.
 - d. If HBcAb is positive and HBsAg antibody level is greater than 10 mUI/mL, with

- abnormal liver function test results, HBV DNA qualitative PCR should be checked.
- e. A positive HBV DNA PCR should be consulted with a hepatologist and lamivudin prophylaxis should be started.
 - f. Patients with a negative PCR result will proceed to transplantation.
 - g. In case of a positive HBcAb, an HBsAg antibody level greater than 10 mIU/mL, and normal liver function, close follow-up with HBsAg, HBV DNA, and liver function tests is recommended every 1 to 3 month after transplantation.
6. Testing for Anti-hepatitis C virus (HCV) antibody
 - a. Those with positive Anti HCV antibodies or abnormal liver function should be tested by HCV RNA qualitative PCR.
 - b. Patients with positive PCR results should be referred to a hepatologist for liver biopsy and treatment before transplantation.
 7. Screening for hepatocellular carcinoma

Patients with chronic HBV or HCV infection should be screened using abdominal computed tomography (CT) or ultrasonography and alpha-fetoprotein testing.
 8. Testing for cytomegalovirus immunoglobulin (Ig) M and IgG antibodies

Patients with elevated cytomegalovirus IgM antibodies and a history of immunosuppression:

 - i. Should be reassessed in 2 to 4 weeks, or
 - ii. Should be evaluated by cytomegalovirus qualitative PCR. Those with positive PCR results should be treated with a 21-day course of ganciclovir and can proceed to transplantation after proven eradication.
 9. Screening for Epstein-Barr virus IgM and IgG antibodies
 - a. Epstein-Barr virus IgM should be rechecked in 2 weeks.
 - b. Candidates with a positive Epstein-Barr virus IgM can proceed to transplantation with prophylactic ganciclovir.
 10. Screening for varicella-zoster virus IgG antibody

Those with negative varicella-zoster virus IgG:

 - i. Should be vaccinated before transplantation, or
 - ii. Closely followed after transplantation for prompt initiation of postexposure prophylaxis with acyclovir for a period of 7 to 21 days.
 11. Screening for human T-lymphotropic virus types 1 and 2 antibodies

Candidates from northeast of Iran should be screened.
 12. Testing for plasma BK virus PCR

In patients with a history of previous graft loss and BK virus-associated nephropathy plasma BK virus PCR should be evaluated.
 13. Repeating all abovementioned tests in 3-month intervals
 14. Immunizations against influenza, pneumococcal infection, and hepatitis B (if HBsAg antibody < 10 mIU/mL)

All potential transplant candidates should complete all recommended immunizations at least 4 to 6 weeks before transplantation to achieve optimal immune response and to minimize the possibility of live vaccine-derived infection in the posttransplant period.
 15. Dental consultation and ear, nose, and throat specialist consultation for occult infection

IV. Assessment for Immunologic Risk

1. Assessment for panel reactive antibodies (cell cytotoxicity)
2. Tissue typing for human leukocyte antigen (HLA) antibody, panel reactive antibodies, and leukocyte cross-match with donor
 - a. All these should be done for all the candidates on admission again.
 - b. All the candidates should have a negative leukocyte cross-match with the donor
3. Donor-specific anti-HLA antibodies and flowcytometric cross-match with donor

Those with a history of previous graft loss and highly sensitized candidates (panel reactive antibodies, > 30%) should also be evaluated for donor-specific anti-HLA antibodies and flowcytometric cross-match.
4. Checking anti-HLA antibodies for those with history of transfusion or pregnancies
5. Desensitization of highly sensitized candidates

Desensitization would be done according to hospital protocols.

V. Malignancy Screening

1. Testing for total prostate-specific antigen in male candidates older than 45 years
 - a. Men with a total prostate-specific antigen level greater than 7 ng/mL should be referred for urologic consultation and prostate biopsy.
 - b. Men with a total prostate-specific antigen level of 3 ng/mL to 7 ng/mL should undergo repeat testing several weeks later. Those with a repeat prostate-specific antigen level above 3 ng/mL should be referred for urologic consultation and prostate biopsy.
2. Obstetric-gynecologic consultation in female candidates
3. Pap smear in all sexually active female candidates
4. Mammography in female candidates older than 40 years or female candidates with a family history of breast cancer
5. Tested for occult blood in stool or colonoscopy in candidates older than 50 years
6. Ultrasonography for acquired cystic disease in patients on dialysis for more than 3 years
7. Serum protein electrophoresis in patients older than 60 years and those with unexplained kidney failure and anemia

VI. Cardiovascular Evaluations

1. Cardiac history
 - a. Transplantation is not recommended within 3 months of bare metal stent placement and within 12 months of drug-eluted stent placement, particularly if the anticipated time of poststent dual antiplatelet therapy will be shortened.
 - b. Transplantation is not recommended within 4 weeks of coronary revascularization with balloon angioplasty.
 - c. Kidney transplantation is contraindicated in patients with progressive symptoms of angina and those with a myocardial infarction within 6 months.
2. Evaluation for ischemic heart disease and left ventricle dysfunction

Cardiac assessment should be done in all patients by means of physical examination, echocardiography, chest radiography, and echocardiography.
3. Noninvasive testing

Noninvasive tests must be done in:

- i. Symptomatic patients, or
- ii. High-risk asymptomatic candidates with 3 or more risk factors: age > 50 years, diabetes mellitus, prolonged duration of chronic kidney disease (> 4 years), being on dialysis > 1 year, positive family history in first-degree relatives, history of smoking, hypertension, dyslipidemia, and history of ischemic heart disease, cerebral vascular accidents, and severe peripheral vascular disease.
4. Cardiology consultation

Cardiologist must do further evaluation and clear the patient for transplantation surgery.
5. Revascularization of critical coronary lesions prior to transplantation
6. Measurement of serum cardiac troponin T

Troponin T at the time of evaluation may be measured as an additional prognostic marker.
7. Low-dose aspirin therapy

Low-dose aspirin is not a contraindication to transplantation and can be continued perioperatively.
8. Lipid control
 - a. It may be reasonable to administer statins to kidney transplantation candidates to reduce the risk of vascular disease events.
 - b. It is reasonable to pursue a low-density lipoprotein cholesterol goal of less than 100 mg/dL in kidney transplant recipients without known coronary artery disease.
9. Beta-blockers administration
 - a. Among patients already taking beta-adrenergic blockers before renal transplantation, continuing the medication perioperatively and postoperatively is recommended to prevent rebound hypertension and tachycardia.
 - b. Initiating beta-blocker therapy in beta-blocker-naïve patients the night before and/or the morning of non-cardiac surgery is not recommended.
10. Cardiology re-evaluation
 - a. The cardiologist should re-evaluate the patient if more than 90 days has past the initial visit.
 - b. High risk patients that must be re-evaluated in 1 month are those with an age greater than

50 years; history of myocardial infarction, coronary artery bypass graft, percutaneous coronary intervention, or proven cardiac disease; an ejection fraction less than 45%; mild pericardial effusion; and new cardiac symptoms and signs (based on clinical assessment, chest radiography, or echocardiography).

VII. Cerebrovascular Evaluations

1. Cerebrovascular history
Kidney transplantation is contraindicated within 6 months of cerebrovascular accident or transient ischemic attacks.
2. Carotid artery Doppler study
Candidates with history of cerebrovascular accident or transient ischemic attacks or asymptomatic patients with carotid bruits should be evaluated by Doppler study.
3. Neurology consultation
A neurologist should evaluate candidates with a history of seizure and assess possible interactions of anticonvulsant drug with immunosuppressive drugs.

VIII. Peripheral Vascular Evaluations

1. Lower extremity arterial Doppler study
Candidates with history of claudication, nonhealing ischemic ulcer, clinical signs of lower extremity ischemia, and recurrent diabetic ulcers should be evaluated with lower extremity arterial Doppler study.
2. Angiography
Any abnormality in Doppler study should be further evaluated by angiography.
3. Assessment for infection
Actively infected diabetic or ischemic ulcers preclude transplantation. Diabetic foot ulcers must be healed before transplantation.
4. Checking eligibility for transplantation
Those with normal femoral pulses, no claudication, and no history of vascular surgery could proceed to transplantation.

IX. Pulmonary Evaluations

1. Screening with history, physical examination, and chest radiography to identify lung disease that may increase the risk for major postoperative pulmonary complications.
2. Considerations for smokers

- a. All the candidates should be strongly encouraged to stop smoking.
- b. Pulmonary function tests and pulmonary consultation should be considered in all the smokers (significant history of smoking), symptomatic patients and those with a history of lung disease.

X. Gastrointestinal Evaluations

1. Total abdomen and pelvis ultrasonography
2. Gastrointestinal consultation
3. Upper gastrointestinal endoscopy
4. Surgical evaluation
 - a. Surgical evaluation is recommended in patients with a history of cholecystitis or diabetes and gallstone or with symptoms related to gallbladder.
 - b. Patients with a history of diverticulitis should be evaluated and considered for partial colectomy before transplant.

XI. Urologic Evaluations

1. Voiding cystourethrography
 - a. Patients with a history of reflux, neurogenic bladder, previous bladder surgery, spina bifida, and a history of recurrent urinary tract infections should undergo voiding cystourethrography.
 - b. Candidates younger than 20 years old with unexplained renal failure should undergo voiding cystourethrography.
2. Evaluation of Prostate
 - a. Male candidates with symptoms of bladder outlet obstruction and sufficient urine volume should be evaluated for benign prostatic hyperplasia and undergo prostatectomy before transplantation.
 - b. In anuric male candidates, prostatectomy is postponed till after transplantation.
3. Cystoscopy
Patients with persistent hematuria or sterile pyuria should be assessed by cystoscopy.
4. Evaluation for dysfunctional bladder
Patients with dysfunctional bladder could safely go on transplantation with clean intermittent catheterization.

XII. Hematologic Evaluation

1. Hematologic Consultation
Candidates with abnormal leukocyte or

platelet count should be referred to a hematologist.

2. Treatment of anemia

- a. Anemic candidates should be treated with erythropoiesis-stimulating agents with the target hemoglobin of 11 g/dL.
- b. Candidates resistant to erythropoiesis-stimulating agents should be evaluated for the cause of resistance (iron deficiency, malignancy, etc).
- c. Perioperative hematocrit levels greater than 30% appear safe and may reduce cardiovascular events in the early posttransplant period.
- d. It is best that pretransplantation hemoglobin concentration be more than 7 g/dL, and in patients older than 50 years or those with cardiovascular disease the per-transplantation hemoglobin should be maintained at about 10 g/dL.
- e. Pretransplant blood transfusion is better to not be used in female or previously transplanted or sensitized transplant candidates.
- f. When transfusions are necessary, filtered blood products are preferable to leukocyte-reduced products. Irradiation of blood products is probably unnecessary.

XIII. Systemic Evaluations

1. Bone mineral densitometry

In postmenopausal candidates and those with a history of steroid treatment, bone mineral densitometry is recommended.

2. Oxalate concentration and genetic study

In candidates with a history of recurrent nephrolithiasis started at young age, serum and urine oxalate concentration and genetic study should be done.

3. Assessment for other diseases

- a. Candidates with anti-glomerular basement membrane disease could be referred for kidney transplantation if the circulating anti-glomerular basement membrane antibody is undetectable and they have quiescent disease (off cytotoxic agents) for at least 6 months posttreatment.
- b. Candidates with a history of lupus nephritis could be referred for transplantation if their disease is clinically quiescent for at least 6

months (positive serologic tests per se do not preclude transplantation). They should also be evaluated for antiphospholipid antibodies.

- c. Patients with vasculitis could be referred for transplantation after at least 12 months off cytotoxic drugs and clinically quiescent. Pretransplant antineutrophil cytoplasmic antibodies does not appear to predict recurrence.
- d. Patients with amyloidosis and no cardiac involvement, no evidence for myeloma or systemic inflammation could be considered for transplantation. Patients with familial Mediterranean fever should receive colchicine to prevent recurrent disease in the allograft.

PART 2. EVALUATION OF ADULT LIVE KIDNEY DONORS

I. Comprehensive History and Physical Examination

1. Medical history

- a. History of hypertension, diabetes mellitus, urinary tract infection, nephrolithiasis, gestational diabetes, low birth weight (if possible), birth weight of offsprings, history of blood transfusion, and any significant medical conditions should be taken.
- b. Female candidates with a history of gestational diabetes in the past 10 years should be excluded from donation program.
- c. History of alcohol abuse, smoking, substance abuse, and use of non-steroidal anti-inflammatory drugs should be taken.
- d. A family history of diabetes mellitus and kidney disease (nephrolithiasis, autosomal dominant polycystic kidney disease, IgA nephropathy, and systemic lupus erythematosus) should be considered.
- e. History of pregnancy or planning for pregnancy should be considered.

2. Calculation of body mass index

3. Evaluation of blood pressure

- a. Blood pressure should be measured after sitting for 5 minutes, twice at the same visit, as 2 different assessments of blood pressure on different days.
- b. It should be preferably measured by ambulatory blood pressure monitoring,

particularly among older donors (> 50 years) and those with a high office blood pressure readings.

4. Examination for signs of heart disease, lung disease, lymphadenopathy, hepatomegaly, and splenomegaly
5. Vascular evaluation (abdominal, femoral, and carotid bruits, etc.)

II. Laboratory Investigations

1. Blood group, Rh
 - a. No need for Rh compatibility
 - b. Only ABO compatible transplantation is allowed
2. Complete blood count, differential

Potential donor with anemia must be evaluated for the etiology.
3. Fasting blood glucose
 - a. A fasting blood glucose level of 126 mg/dL or higher, a 2-hour glucose with oral glucose tolerance test result of 200 mg/dL or higher, or a glycosylated hemoglobin of 6.5% or higher precludes donation.
 - b. A fasting blood glucose level of 100 mg/dL or lower should be tested with 2-hour glucose with oral glucose tolerance test and glycosylated hemoglobin if one of the following risk factors are documented: body mass index of 30 kg/m² and higher, history of diabetes in first-degree relatives, and history of gestational diabetes over 10 years ago.
 - c. Impaired glucose tolerance (> 140 mg/dL) precludes donation.
 - d. Potential donors with a glycosylated hemoglobin level between 5.7% and 6.4% should be excluded.
 - e. Donation in potential donors with a fasting blood glucose level between 100 mg/dL and 126 mg/dL (impaired fasting glucose) is not recommended except in related donors with normal oral glucose tolerance test.
4. Blood urea nitrogen and serum creatinine

Serum creatinine level should be used to estimate glomerular filtration rate (GFR) based on the CKD-EPI equation.
5. Comprehensive panel (electrolytes and lipid profile)
6. Uric acid

High uric acid levels are associated with

the metabolic syndrome and independently with reduced kidney function.

7. Liver function tests

Up to 2-fold increase in transaminase level is acceptable in the presence of negative virologic studies and normal liver ultrasonography.
8. Prothrombin time, partial thromboplastin time, and international normalized ratio
9. Erythrocyte sedimentation rate and C-reactive protein
10. Urine analysis and culture
11. Beta-human chorionic gonadotropin

All the female candidates at childbearing age should be tested.
12. Leukocyte cross-match

All the candidates should have a negative leukocyte cross-match with recipient.

III. Assessment for Latent and Active Infections

1. Testing for venereal disease research laboratory or rapid plasma reagin
 - a. Positive results of venereal disease research laboratory and rapid plasma reagin should be confirmed by a more specific test for syphilis such as a fluorescent treponemal antibody absorption test.
 - b. Donors with a positive fluorescent treponemal antibody should be treated according to stage, and donation must be delayed till confirmation of successful treatment.
2. Screening for brucellosis with Wright test

A donor with successfully treated brucellosis infection may still be suitable for live kidney donation.
3. Assessment for mycobacterium tuberculosis with tuberculosis skin test with control and chest radiography
 - a. In case of a positive result (> 10 mm) and in the absence of active disease, recipient should be treated with isoniazid for 9 to 12 months.
 - b. A potential donor with a past history of pulmonary tuberculosis who has received adequate treatment may still be an acceptable donor if there is no renal infection.
4. Testing for HIV antibody by HIV-1 and HIV-2 antibody
 - a. Detection of a positive HIV-1 and HIV-

- 2 by an enzyme-linked immunosorbent assay in a potential kidney donor should be confirmed by a neutralization test and a Western blot analysis.
- b. Positive results are contraindications for donation.
5. Testing for HBsAg, HBsAg antibody titer , and HBcAb (IgM and IgG)
 - a. A positive HBsAg is a contraindication of donation.
 - b. In donors with a positive HBcAb IgM, transplantation should be delayed to determine whether the infection is progressing.
 - c. In potential donors with positive results for either HBcAb IgG or HBsAg antibody, HBV DNA quantitative PCR should be performed; those with negative results may donate to recipients with positive protective levels of HBsAg antibody.
6. Evaluation for anti-HCV antibody (enzyme-linked immunosorbent assay)

HCV-infected donors preclude from donation, except for donation to HCV-positive recipients of the same genotype, if the donor is treated and HCV viral load is negative.
7. Screening for cytomegalovirus IgM and IgG antibodies

If cytomegalovirus IgM is positive, either cytomegalovirus qualitative PCR or repeat anticytomegalovirus IgM should be performed in 2 to 4 weeks.

 - i. In case of positive PCR, donation should be postponed until it became negative.
 - ii. If IgM titer is declining transplantation can be done.
 - iii. If IgM titer is not changed or increased, cytomegalovirus qualitative PCR should be performed.
 - iv. Those with negative IgM and PCR can undergo donation.
8. Screening for Epstein-Barr virus IgM and IgG antibodies
 - a. In case of positive anti-Epstein-Barr virus IgM, the test should be repeated in 2 to 4 weeks.
 - i. If IgM titer is declining transplantation can be done.
 - ii. If IgM titer is not changed or increased, Epstein-Barr virus qualitative PCR should be performed.
 - b. A past history of the infection is not a contraindication for donation.
9. Screening for anti-herpes simplex virus IgM and IgG antibodies
 - a. In case of a positive anti-herpes simplex virus IgM, the test should be repeated in 2 to 4 weeks.
 - i. If IgM titer is declining, transplantation can be done.
 - ii. If IgM titer is not changed or increased, herpes simplex virus qualitative PCR should be performed.
 - b. A past history of the infection is not a contraindication for donation.
10. Screening for human T-lymphotropic virus types 1 and 2 antibodies.
11. Screening for antitoxoplasma IgM and IgG antibodies

IV. Hypertension

1. Examination of blood pressure
 - a. Donors should have at least 2 office measurements documenting systolic blood pressure less than 140 mm Hg and diastolic pressure less than 90 mm Hg.
 - b. For ambulatory blood pressure monitoring, donors should have a mean awake blood pressure less than 135/85 mm Hg and sleep blood pressure less than 120/75 mm Hg.
 - c. A blood pressure higher than 140/90 mm Hg is an absolute contraindication of donation.
 - d. Caucasian donors with easily controlled blood pressure and the following features might be accepted for donation: age > 50 years, GFR > 80 cc/min and urine albumin < 30 mg/d.
2. Further evaluations

Prospective donors with mild hypertension should be evaluated for evidence of end-organ damage (echocardiography, chest radiography, echocardiography for left ventricular hypertrophy and cardiomegaly, and assessment for retinopathy).

V. Obesity

1. Measurement of waist circumference and body mass index
 - a. Potential donors who are obese should

- be very carefully assessed for risk factors associated with chronic kidney disease.
- b. Obesity (body mass index $> 30 \text{ kg/m}^2$) should be considered a relative contraindication to donation.
- c. A body mass index greater than 35 kg/m^2 is a contraindication to donation.
- d. Potential obese donors with a risk factor for chronic kidney disease preclude donation.
- e. Potential obese donors should be encouraged to lose weight before donation.

VI. Diabetes Mellitus

1. Fasting blood glucose
 - a. A fasting blood glucose level of 126 mg/dL or higher, a 2-hour glucose with oral glucose tolerance test result of 200 mg/dL or higher, or a glycosylated hemoglobin of 6.5% or higher precludes donation.
 - b. A fasting blood glucose level of 100 mg/dL or lower should be tested with 2-hour glucose with oral glucose tolerance test and glycosylated hemoglobin if one of the following risk factors are documented: body mass index of 30 kg/m^2 and higher, history of diabetes in first-degree relatives, and history of gestational diabetes over 10 years ago.
 - c. Donation in potential donors with a fasting blood glucose between 100 mg/dL and 126 mg/dL (impaired fasting glucose) is not recommended except in related donors with normal oral glucose tolerance test.

VII. Dyslipidemia

1. Lipid profile

Dyslipidemia should be included along with other risk factors in donor risk assessment, but dyslipidemia alone does not exclude kidney donation.

VIII. Cardiovascular Evaluation

1. Assessments with electrocardiography and chest radiography

Individuals with a significant cardiac risk factor should be excluded from donation.

IX. Pulmonary Evaluation

1. Pulmonary function test and pulmonary evaluation

Pulmonary assessments should be done in candidates with a history of chronic lung disease or pulmonary symptoms.

2. Considerations for smokers

Smoking cessation at least 4 weeks prior to donation is advised.

X. Malignancy Screening

1. General and specific screenings
 - a. Age related malignancy screening should be done for prospective donors.
 - b. Serum total prostate-specific antigen test should be tested for male donors older than 45 years.
 - c. All the sexually active female donors should have a Pap smear.

XI. Kidney Function

1. Estimating GFR
 - a. GFR in potential donor should be estimated by:
 - i. Creatinine clearance from 24-hour urine collection (adequacy of collection should be confirmed by containing 20 mg to 25 mg creatinine per kilogram body weight for men and 15 mg/kg to 20 mg/kg for women).
 - ii. CKD-EPI equation for creatinine
 - b. An estimated GFR greater than $90 \text{ mL/min/1.73 m}^2$ is acceptable for donation.
 - c. An estimated GFR less than $80 \text{ mL/min/1.73 m}^2$ is a contraindication for donation in donors younger than 50 years old.
 - d. Prospective donors with an estimated GFR between $80 \text{ mL/min/1.73 m}^2$ and $90 \text{ mL/min/1.73 m}^2$ should be evaluated by radioisotope renography (ie, diethylenetriamine pentaacetic acid scan).
2. Evaluation for proteinuria
 - a. Proteinuria should be measured by 24-hour urine collection (adequacy of collection should be confirmed by containing 20 mg to 25 mg creatinine per kilogram body weight for men and 15 mg/kg to 20 mg/kg for women).
 - b. Proteinuria greater than 150 mg/d would usually be an exclusion of donation.
 - c. Measuring protein-creatinine or albumin-creatinine ratios is not recommended as

- the only evaluation for proteinuria.
- d. The presence of microalbuminuria (urinary albumin excretion > 30 mg/d) should preclude live donation.
3. Evaluations for presence of asymptomatic hematuria

In case of persistent isolated microscopic hematuria (> 3 to 5 urinary sediment erythrocytes per high-power field), if urinary tract infection has been ruled out, urine should be evaluated for dysmorphic erythrocytes.

 - i. Presence of dysmorphic erythrocytes indicates glomerular hematuria and kidney biopsy must be performed to rule out IgA nephropathy.
 - ii. Urine cytology and complete urologic workup (including spiral CT scan and cystoscopy) should be done if glomerular hematuria has been excluded.
 - iii. Unexplained hematuria necessitates evaluation for adenovirus.
 4. Evaluations for presence of pyuria
 - a. Urine culture should be checked to rule out infection.
 - b. Potential male donors should be evaluated for prostatitis.
 - c. Three consecutive early morning urine cultures should be done to rule out urinary tract tuberculosis.
 - d. If all the above evaluation are negative, a kidney biopsy should be performed to rule out chronic interstitial nephritis or pyelonephritis.
 5. Treatment of bacteriuria
 - a. The urinary tract must be sterile for donation (negative urine culture is mandatory).
 - b. Asymptomatic bacteriuria should be treated before donation.
 6. Evaluation of nephrolithiasis
 - a. Recurrent stone formers are excluded from donation.
 - b. Metabolic derangement precludes donation.
 - c. Prospective donors with a distant history of a single calculus (> 10 years) without recurrence and without metabolic abnormality would be acceptable.
 - d. Asymptomatic potential donors with a history of or current single calculus could be accepted as donor if:
 - i. The size of calculus is less than 1 cm.
 - ii. The calculus is potentially removable during transplantation.
 - iii. The metabolic evaluation of donor is not significant (no hypercalcuria, hyperuricemia, or metabolic acidosis; no cystinuria or hyperoxaluria; and normal serum intact parathyroid hormone, calcium, and phosphorus levels).
 - iv. No evidence of multiple calculi or nephrocalcinosis is documented on spiral CT scan.
 - v. The calculus-containing kidney is selected for donation.
 - e. Calculi with a high risk of recurrence (cystine, struvite, or those due to systemic diseases) preclude donation.
 - f. The younger the donor age (age 25 to 35 years), the longer the exposure to the possibility of a recurrence. Donation is not recommended in young candidates.
 - g. Lifelong annual evaluation for new calculi in the remnant kidney is recommended.
 7. Other assessments
 - a. All the prospective donors should undergo ultrasonography of kidneys and urinary tract, to rule out the kidneys size difference, masses, cysts, or calculi.
 - b. Computed tomographic angiography and urography should be done to evaluate the kidneys, kidney vasculature, and urinary tract anatomy.
 - c. Evidence of mass, cyst, horseshoe kidney, and cortical scarring precludes donation.
 8. Abnormal vasculature, evidence of fibromuscular dysplasia or atherosclerosis, and bilateral multiple vascular system preclude donation.
 9. Left kidney with single vascular system is preferred for donation.

XII. Hereditary Renal Disease

1. Assessment for autosomal dominant polycystic disease
 - a. Prospective donors older than 30 years old and no cyst on ultrasonography or CT scan can safely proceed to donation.
 - b. Since cysts cannot be ruled out by imaging in potential donors aged between 20 and 30 years old, donation is not recommended

- unless genetic studies are normal.
- 2. Assessment for Alport disease
 - a. Potential donors without hematuria and older than 20 years can be accepted for donation.
- 3. Assessment for systemic lupus erythematosus
 - a. Potential donors with a family history of lupus should be evaluated for familial systemic lupus erythematosus by:
 - i. antinuclear antibodies
 - ii. Complement level
 - iii. anti-double-stranded DNA antibody
 - b. Positive antinuclear antibodies preclude donation.

XIII. Postdonation Follow-up

- 1. Annual follow-up
 - a. Medical advice should be provided to avoid nephrotoxic drugs (nonsteroidal anti-inflammatory drugs and antibiotics)
 - b. Healthy lifestyle should be encouraged.
 - c. High-protein and high-salt diet should be discouraged.
 - d. Blood pressure should be assessed and targeted to less than 130/80 mm Hg.
 - e. Laboratory evaluation
 - i. Serum creatinine
 - ii. Blood urea nitrogen
 - iii. Urinalysis
 - iv. Fasting blood glucose
 - v. Lipid profile

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