Selective screening imaging of the aortoiliac arterial system in kidney transplant candidates with non-contrast pelvic computed tomography

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**Running head:** CT screening of the aortoiliac arterial system

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**Abbreviations:** CAD, coronary artery disease; CT, computed tomography; DM, diabetes mellitus

**Abstract**
Non-contrast pelvic computed tomography (CT) can detect severe iliac artery calcifications that present technical contraindications to kidney transplantation (TCT). We screened 454 asymptomatic patients with a history of any of the following: hemodialysis >10 years, diabetes mellitus >20 years, coronary artery disease (CAD) with percutaneous or surgical interventions, carotid disease, diabetes with below-/above-knee amputations, heart-kidney transplantation candidacy. Patients with normal dorsalis pedis and/or tibialis posterior pulses were not screened. A total of 8.4% had severe calcifications with TCT; CT determined laterality for implantation in 13.9%. No patients with the following characteristics were classified as TCT: age <40 years, hemodialysis >10 years, carotid arterial disease, prior lower extremity amputation, or heart-kidney transplantation candidacy. CAD was associated with TCT in univariate though not multivariate analysis. Limiting screening to patients >40 years, with DM >20 years, or with CAD, 9.8% had a TCT and CT determined transplant laterality in 14.2%. Screening for severe iliac artery calcifications is useful for selected kidney transplantation candidates over age 40. It can assist with laterality choice or surgeon determination of TCT. Cost and radiation exposure risks should be weighed against the morbidity risks from unnecessary surgery.

**Keywords:** Kidney transplantation; Pretransplant evaluation; Imaging
1. Introduction

Kidney transplantation is a well-established treatment that offers longer survival and better quality of life than dialysis in eligible patients with end-stage kidney disease. Over time, improved results from kidney transplantation have led to acceptance of patients with increased age and comorbidities (1). One barrier to transplantation is the technical ability to implant the graft, which can be limited by significant atherosclerotic involvement of the aortoiliac arterial system and can ultimately be a technical contraindication for transplantation. There is wide variation across transplant centers concerning the pretransplant approach to screening of the aortoiliac arterial system, from no screening at all to imaging for all candidates. The most recent recommendations regarding evaluation of kidney transplant candidates do not address imaging for patients without clinically apparent peripheral vascular disease (2). We devised and analyzed the results of a screening protocol consisting of non-contrast computed tomography (CT) scans of the pelvis for transplant candidates with specific conditions.

2. Methods

We performed a prospective study of selective aorto-iliac CT screening of high-risk patients in the process of evaluation or patients on the waiting list for kidney transplantation at Baylor University Medical Center in Dallas, TX and Baylor Scott and White All Saints Medical Center in Fort Worth, TX from September 2018 through June 2019. Criteria for screening were established by consensus of a panel of nephrologists and surgeons serving on the Kidney Transplant Selection Committee, with input from radiology, cardiology, and vascular surgery. Screening imaging included non-contrast pelvic CT, CT angiograms, and abdominal x-rays. Prior to ordering additional screening imaging, all attempts were made to obtain and review any prior images performed for diagnostic or therapeutic purposes.

Non-contrast CT scans of the pelvis were obtained for patients with a history of hemodialysis for >10 years, diabetes mellitus (DM) for >20 years, coronary artery disease (CAD) with percutaneous interventions or coronary bypass grafting, intermediate or severe internal carotid stenosis, carotid endarterectomy, DM with a below- or above-knee amputation, and candidacy for combined heart and kidney transplant. Asymptomatic patients with palpable, normal dorsalis pedis and/or posterior tibial pulses were excluded from screening. CT angiograms were
obtained in patients with abdominal aortic aneurysms (with or without prior intervention or repair), a history of aortic dissection, peripheral vascular disease with claudication, a history of percutaneous or surgical vascular procedures, and grossly diminished femoral pulses and/or dorsalis pedis/posterior tibial pulses. Abdominal x-rays were obtained to assess aortic or iliac arterial stenting. This screening protocol was implemented for new kidney transplant applicants meeting criteria, as well as for those already waitlisted during their annual pretransplant follow-up visit within the study period (Table 1). Screening was performed only if there were no major contraindications for transplant at the original intake evaluation. Patients on the waiting list were not screened if they were inactive due to an issue that precluded transplantation.

Of note, the panel considered including smoking history as a potential screening criterion, but decided not to include it in the absence of the factors listed above. Data regarding smoking history was collected retrospectively from patient charts.

This study focused only on non-contrast pelvis CT scans. Images were reviewed by six surgeons on a rotational basis. The original reviewing surgeon requested the opinion of a second reviewing surgeon as needed and for all cases where contraindications were identified secondary to severe vascular calcifications. CT scans may have been obtained for other indications, such as previous surgeries, previous transplants, or other intraabdominal pathology. For the purpose of this study, data were only collected for patients meeting the inclusion criteria. CT scans were graded for calcifications in the common and/or external iliac arteries in four nonparametric categories: no calcifications; mild calcifications; moderate calcifications with relative sparing of the external iliac arteries; and severe calcifications that presented a technical contraindication for transplantation (Figure 1). To be considered a contraindication, calcifications needed to be severe and concentric throughout the common and external iliac arteries bilaterally, sparing no arterial segment (Figure 1d). In addition to determining contraindications, transplant laterality (right or left side only) was determined based on imaging (Figure 1c). Significant incidental findings were recorded as well. Imaging findings were discussed in a combined Kidney Transplant Selection Committee between both facilities prior to reaching formal decisions regarding candidacy for kidney transplantation. Patients with severe atherosclerosis were not approved for transplant. The candidacy of patients with nonsevere atherosclerosis was evaluated in the context of their existing comorbidities or lack thereof.
Three endpoints were examined in the study: 1) the determination of technical contraindications for transplant secondary to severe calcific atherosclerosis; 2) the determination of laterality for implantation of the kidney transplant; and 3) the combination of contraindications and laterality as aggregate practical relevance, assisting with decision making. We chose to add aggregate relevance as an additional measure of the effectiveness of the screening method.

Patients’ age, gender, and indication for CT scan per the screening protocol were compared between patients with and without findings on imaging. The Kruskal-Wallis test was used to compare continuous variables. A chi-square test or Fisher’s exact test was used to compare categorical variables. Significance was defined as a \( P \) value < 0.05. The Cox proportional-hazards model was used to analyze the association of covariates and event of radiological findings of interest. A multivariate approach was used to adjust the potential confounding effects. The effect of each factor on the occurrence of radiological findings was presented as an adjusted odds ratio with a 95% confidence interval. All statistical analyses were performed in R (version 3.5.2). This study was approved by the Baylor Scott and White Institutional Review Board.

3. Results

A total of 454 patients met criteria for the screening protocol and had a non-contrast CT scan reviewed; 302 (66.5%) were men and 147 (33.5%) were women. Ages ranged from 22 to 78 years, with a mean of 57 ± 10.8. New scans were obtained in 368 (81%) of cases, while in 86 cases (19%) existing scans were reviewed. Based on the findings of the protocol scans, 38 patients were excluded from transplantation secondary to contraindications (8.4%), and laterality was determined in another 63 patients (13.9%). The overall practical aggregate relevance was 22.3% (Table 2).

Screening results for both contraindications and determination of laterality varied across subcategories of patients (Table 2). No contraindication was seen on the protocol CT scans for patients on hemodialysis >10 years (n = 27), patients with carotid stenosis/endarterectomy (n = 5), and candidates for combined heart-kidney transplant (n = 10) (Table 3); laterality for implantation was determined in 7, 1, and 0 of these patients, respectively. In contrast, for patients with DM >20 years (n = 348), a contraindication was determined in 26 (7.5%) and laterality in 45 (12.9%), for an aggregate relevance of 20.4%. Out of 110 patients with CAD with previous
bypass or percutaneous intervention, contraindications occurred in 16 (14.5%) and laterality determinations in 17 (15.4%), for an aggregate relevance of 30%. Aggregate relevance was higher in CAD patients without DM or DM < 20 years (n = 68, contraindications 12 [17.6%], laterality 11 [16.1%], aggregate relevance 33.8%) than in CAD patients with DM >20 years (n = 42, contraindications 4 [9.5%], laterality 6 [14.3%], aggregate relevance 23.8%). There were 2 patients with 20 or more pack years of smoking in patients with CAD and DM > 20 years and 8 in patients with no DM or DM < 20 years. Of the 7 patients screened secondary to amputations in the setting of DM, one had a contraindication (and would have also been screened for DM >20 years) and one had a determination of laterality (based on an existing scan).

None of the 34 patients under the age of 40 had scans suggesting contraindications, and only one of them had imaging that determined laterality (2.9%). With a single exception, the proportion of CT findings indicated by aggregate relevance increased with every decade of age: the aggregate practical relevance was 23.6%, 19.6%, 25.1%, and 32% for those in their 40s, 50s, 60s, and 70s, respectively. Of note, in patients in their 40s, most of the relevant scans provided information on laterality of implantation (15.3%). There was no difference in the proportion of contraindications or determinations of laterality by gender.

Excluding categories that did not yield findings on CT scans, there were 386 patients >40 years old who had DM >20 years and/or CAD with interventions. In this subgroup, contraindications occurred in 38 (9.8%) and laterality was determined in 55 (14.2%), for an aggregate relevance of 24%. Restricting age to >40 for nondiabetic CAD patients (n = 68) increased the aggregate relevance to 33.7%. Review of existing CT scans yielded fewer patients with contraindications compared with those requested by protocol (4/86 [4.7%] vs 34/368 [9.2%]); a similar proportion of laterality determinations was observed with new and existing scans (13.9% vs 14%) (P = 0.16).

Data on smoking history were available for 430 of the 454 patients (94.7%), with 278 never smokers (64.7%), 29 with smoking less than 10 pack years (6.7%), and 64 (14.9%), 29 (6.7%), and 30 patients (7%) with 10-19, 20-29, and 30 pack years and above, respectively. Data were missing on two patients with CT based contraindications for transplant (5.3%), which was identical to the proportion of missing smoking data in the entire patient group (also 5.3%).

Univariate analysis demonstrated that a history of CAD with intervention (percutaneous coronary intervention or coronary artery bypass grafting) was associated with a statistically higher
incidence of contraindications ($P = 0.013$) (Table 3). However, in the multivariate analysis, which
included smoking history of more than 20 pack years (Table 4), none of the variables taken into
consideration were associated with significant risk of contraindication for transplant. When the
endpoint was contraindications or determination of laterality of implantation, the odds ratio
increased by age only ($P = 0.013$). Findings were similar when the threshold for smoking was set
at 10 pack years, and 30 pack years (data not shown).

Incidental findings were observed in 44 patients, 10 of which were significant: renal
masses subsequently found to be renal cell carcinomas by pathology exam ($n = 2$); large
polycystic kidneys requiring native nephrectomy ($n = 2$); asymptomatic colovesical fistula
requiring surgical treatment prior to transplant; mesenteric lymphadenopathy and thickening of
the pancreas requiring further workup; mesenteric cyst that was biopsied; right adrenal adenoma;
asymptomatic 4.2 cm abdominal aortic aneurysm; and the anatomic site of a reservoir for a
penile implant.

4. Discussion

Atherosclerotic vascular calcifications are common in patients with chronic kidney
disease (3). As kidney transplantation for patients with an increased number and severity of
comorbidities becomes more common, appropriate screening for calcified atherosclerotic disease
is increasingly important (1). Some patients deemed eligible for transplantation could be
explored surgically, only to find that their arteries are not appropriate for implantation, or be
subject to more high-risk procedures that may lead to vascular complications and potential early
renal graft loss. We built a screening protocol after surgical exploration showed that transplant
was not feasible in three of our patients. While the number of patients is small, all had a long
hospital stay, and some needed physical rehabilitation due to rapid decline or faced
psychological issues.

We found that screening CT was useful in determining technical contraindications and
laterality of implantation in patients with certain characteristics. Our findings suggest that
screening for severe atherosclerotic disease as a contraindications or in order to determine
laterality using non-contrast CT scans of the pelvis may be beneficial in selected patients with a
high risk of atherosclerotic disease. The patients we found to be most likely to have lesions on
CT scan that affected surgical decision-making and transplant candidacy were those over the age
of 40, with DM >20 years, and/or with CAD requiring percutaneous or surgical intervention.
contrast, screening with CT scans was not useful in patients with significant cerebrovascular
disease, in patients with DM with amputations in the absence of the above criteria, and in heart-
kidney transplant candidates. However, we need to caution that the number of patients with
carotid disease was very low, and no conclusion can be drawn about the effectiveness of their
screening at this time. Also, heart-kidney transplant candidates typically have less atherosclerotic
disease burden than the average kidney transplant candidate. Of note, none of the inclusion
criteria were associated with technical contraindications or determination of laterality of
implantation in the multivariate analysis.

Patients with CAD and without DM or with DM of lesser duration had a higher practical
aggregate relevance from screening than patients with CAD and DM >20 years, which is
surprising. Smoking habits, with more heavy smokers in the first group compared to the latter,
can account for some of the difference (11.8% versus 4.7%). Our candidates with longstanding
diabetes who were otherwise eligible for transplant might have had better long-term diabetes
control than those who were not candidates for transplant, a form of selection bias. Also, some of
the patients had occlusive iliac disease, for which they were sent for CT angiograms instead of
non-contrast CT scans.

The most important message is that we found absolutely no lesions leading to
contraindications in patients <40 years old, suggesting that screening is not warranted in this
group. Age was not used as an initial parameter for screening. While we do not have the data to
show, we can extrapolate that patients under the age of 40 without the comorbidities included in
our screening criteria should have negative screening CT scans as well. Based on this, we can
spare younger patients of radiation exposure, knowing that they might require imaging later in
life and face cumulative risks of radiation over time. Screening was also not useful for patients
on hemodialysis for >10 years in the absence of other comorbidities. This could be due to
selection bias, as those who survived >10 years of hemodialysis with no major comorbidities
might have different biological factors than the average.

Screening with imaging is an addition to history and physical examination, not a
substitute. We decided not to screen with CT scans if patients had normal dorsalis pedis/
posterior tibial pulses. Symptomatic patients with claudication or rest pain of an ischemic nature
or with absent or diminished femoral pulses required vascular workup and treatment before
kidney transplantation was considered. If there is suspicion of flow-limiting lesions in the
aortoiliac system, screening with non-contrast CT scans only is not sufficient, and therefore should not apply. The quality of the femoral pulse can give indications regarding the rigidity of the iliac arteries. While pulse volume recording is an excellent tool used to recognize arterial rigidity, it cannot differentiate between a segmental arterial problem or an entirely involved calcified arterial system.

Designing a screening protocol for severe calcific atherosclerosis in potential kidney transplant candidates is a complex task. The latest guidelines on evaluation of kidney transplant candidates do not specify the need for imaging in patients without clinical arterial disease (2). Anecdotally, practice varies greatly among transplant centers, from no screening at all to screening all patients. We were unable to find surveys of centers regarding this topic. Screening with CT scans adds significant cost, more appointments for patients, and exposure to radiation. Imaging can bring up incidental findings, leading to other tests and procedures that would otherwise not be required, causing further inconvenience for patients. Screening imaging can deem some patients ineligible for transplant when in fact a transplant could be performed, with or without vascular intervention. Broad or universal screening might not be effective if the yield of significant findings is low. Screening can become very broad when inclusion criteria are too wide. Defining which populations do not require screening is as important as defining those that do.

Beyond the evaluation of patients from the technical standpoint, there is the question of overall prognosis of patients with iliac arterial disease. While there are data to formulate life prognosis for patients with heart disease or femoropopliteal disease, specific survival data in patients with iliac disease are scarce. There is some evidence that severe calcifications in the infrarenal aorta and the iliac arteries are associated with higher mortality with a functioning graft, major vascular events after kidney transplantation (4), and cardiovascular morbidity and mortality in the dialysis patient population (5-11).

Conventional arteriograms have not had a significant role as a screening tool in kidney transplant evaluation. CT angiograms have replaced conventional angiograms, as they are less invasive, but they still require intravenous contrast administration and deliver significant radiation exposure. Modified magnetic resonance angiography can be used with comparable results (12, 13). Plain x-ray films of the abdomen fail to recognize calcifications that are not diffuse or very severe (14). When calcifications are present on plain x-rays, however, they are
associated with a higher mortality rate after transplant (15). Non-contrast CT scans of the pelvis require less radiation exposure (though still significant), while avoiding the use of intravenous contrast material, which is relevant in patients with kidney disease not yet on dialysis.

There are several limitations to this study. First, our grading system for arterial calcifications was based on qualitative and not quantitative assessment of imaging. Similar grading systems and scores have been described (16, 17). In our evaluation, moderate calcification of the iliac arteries or less was not deemed a contraindication in itself. Severe calcifications seen as a contraindication required review of the imaging by a second surgeon, and the ultimate decision was made by the selection committee. The degree of calcification of the aorta and the iliac arteries can be assessed using various scores (8, 18, 19). However, the aim of the scores is to predict cardiovascular complications or mortality. These scores are not useful for decision making regarding transplant feasibility.

The endpoint of our study was the utility of imaging for determination of transplant candidacy and laterality of implantation. We defined a technical contraindication for transplantation as the presence of severe, concentric calcifications in the common and external iliac arteries bilaterally. The limitation of this methodology is that the patients determined to have contraindications were not listed for transplantation, so we were not able to determine if the imaging correlated with a true technical contraindication. Therefore, patients denied transplant listing based on imaging may have had acceptable intraoperative findings. Moreover, these patients may have been technically acceptable in other programs with a higher tolerance for vascular intervention and reconstruction at the time of transplantation. Also, screening with CT scans may be remote from the time of transplantation with a deceased donor, and atherosclerotic disease may progress over years of waiting time, leading to an unrecognized contraindication for transplantation. Finally, we have not used patient smoking habits as an independent reason for screening. This is a limitation of the study since smoking is a recognized risk factor for atherosclerotic disease. Smoking data were included in the univariate multivariate analysis. A history of heavy smoking did not correlate with adverse findings on CT. However, smoking data were collected retrospectively, and we are missing the data in a few patients. In a future study, we might consider screening in candidates with significant smoking history.

In conclusion, screening of the iliac arterial system with non-contrast CT scans of the pelvis is a useful tool in the evaluation of specific groups of kidney transplant candidates. We
found that patients with long-standing DM and patients with CAD stand to benefit from CT screening for significant aorto-iliac atherosclerosis, to determine laterality of implantation and technical contraindications for transplantation. Asymptomatic candidates younger than 40 years with no clinical findings do not require vascular screening.

**Data availability:** The data that support the findings of this study are available on request from the corresponding author. The data are not publicly available due to privacy or ethical restrictions.

**Table Legends**
Table 1. Vascular screening protocol for kidney transplant candidates
Table 2. Descriptive yield of non-contrast pelvic computed tomography scans in subgroups of kidney transplant candidates
Table 3. Univariate analysis for patients with and without Technical contraindications for Transplantation (TCT) for severe iliac calcifications
Table 4. Descriptive statistics for patients with and without Technical contraindications for Transplantation (TCT) for severe iliac calcifications

**References**


14. NasrAllah MM, Nassef A, Elshaboni TH, Morise F, Osman NA, Sharaf El Din UA. Comparing different calcification scores to detect outcomes in chronic kidney disease...


<table>
<thead>
<tr>
<th>Imaging type</th>
<th>Candidates</th>
</tr>
</thead>
</table>
| CT scan of pelvis without oral or intravenous contrast | • Hemodialysis for >10 years  
• Diabetes mellitus for >20 years  
• Coronary artery disease with PCI or CABG (try to obtain runoffs if available)  
• Known intermediate or severe internal carotid stenosis or history of carotid endarterectomy  
• History of below- or above-knee amputation in diabetics  
A palpable dorsalis pedis/tibialis posterior pulse invalidates all of the above. |
| CT angiogram (recommended—decision by surgeon/committee) | • Abdominal aortic aneurysm (with or without prior intervention)  
• History of aortic dissection  
• PVD with claudication (rest pain should be addressed by vascular before considering transplant)  
• PVD with history of vascular procedures (previous imaging might suffice)  
• Grossly diminished femoral and/or DP-TP pulses (good femoral with diminished DP-TP pulses are okay in patients who do not have claudication) |
| Abdominal x-ray                                  | • History of iliac artery stenting  
• History of inferior vena cava filter placement |

CABG indicates coronary artery bypass grafting; CT, computed tomography; DP-TP, dorsalis pedis and tibialis; PCI, percutaneous coronary intervention; PVD, peripheral vascular disease.
<table>
<thead>
<tr>
<th>Group</th>
<th>n</th>
<th>TCT&lt;sup&gt;b&lt;/sup&gt;</th>
<th>LFI&lt;sup&gt;c&lt;/sup&gt;</th>
<th>PAR&lt;sup&gt;d&lt;/sup&gt;</th>
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<tbody>
<tr>
<td>All</td>
<td>454</td>
<td>38 (8.4%)</td>
<td>63 (13.9%)</td>
<td>101 (22.3%)</td>
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<td>New scans</td>
<td>368</td>
<td>34 (9.2%)</td>
<td>51 (13.9%)</td>
<td>85 (23.1%)</td>
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<td>Existing scans</td>
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<td>12 (14%)</td>
<td>16 (18.6%)</td>
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<td>348</td>
<td>26 (7.5%)</td>
<td>45 (12.9%)</td>
<td>71 (20.4%)</td>
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<td>CAD with previous PCI or CABG</td>
<td>110</td>
<td>16 (14.5%)</td>
<td>17 (15.4%)</td>
<td>33 (30%)</td>
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<tr>
<td>CAD&lt;sup&gt;a&lt;/sup&gt; No DM &gt;20 years</td>
<td>68</td>
<td>12 (17.6%)</td>
<td>11 (16.1%)</td>
<td>23 (33.8%)</td>
</tr>
<tr>
<td>CAD&lt;sup&gt;a&lt;/sup&gt; with DM &gt;20 years</td>
<td>42</td>
<td>4 (9.5%)</td>
<td>6 (14.3%)</td>
<td>10 (23.8%)</td>
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<td>Hemodialysis &gt; 10 years</td>
<td>27</td>
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<td>0</td>
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<td>Age 40–49 years</td>
<td>72</td>
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<td>Age 50–59 years</td>
<td>143</td>
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<td>Age 60–69 years</td>
<td>155</td>
<td>14 (9%)</td>
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<td>Age ≥70 years</td>
<td>50</td>
<td>7 (14%)</td>
<td>9 (18%)</td>
<td>16 (32%)</td>
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<td>Age 40+, DM &gt;20 years, and/or CAD&lt;sup&gt;a&lt;/sup&gt;</td>
<td>386</td>
<td>38 (9.8%)</td>
<td>55 (14.2%)</td>
<td>94 (24%)</td>
</tr>
</tbody>
</table>

<sup>a</sup> CAD with previous PCI or CABG.

<sup>b</sup> Technical Contraindication to Transplant (TCT) - Transplant contraindicated from vascular standpoint, based on imaging.

<sup>c</sup> Laterality For Implantation (LFI) – Determination of whether a kidney transplant should be placed on the right- or left-side based on CT scan findings.

<sup>d</sup> Practical Aggregate Relevance (PAR) - Determination of technical contraindication to transplant (TCT) and/or laterality for implantation (LFI) based on screening CT scan. CABG indicates coronary artery bypass grafting, CAD, coronary artery disease; DM, diabetes mellitus; PCI, percutaneous coronary intervention.
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<tr>
<td>Male</td>
<td>277 (66.6%)</td>
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</tr>
<tr>
<td>Female</td>
<td>139 (33.4%)</td>
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<td>27 (6.49%)</td>
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<td>Diabetes mellitus &gt;20 years</td>
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<td>12 (31.6%)</td>
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<td>322 (77.4%)</td>
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<tr>
<td>CAD with PCI or CABG</td>
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<td>22 (57.9%)</td>
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<tr>
<td>Yes</td>
<td>94 (22.6%)</td>
<td>16 (42.1%)</td>
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<td>Carotid stenosis^a or history of CEA</td>
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<td>No</td>
<td>411 (98.8%)</td>
<td>38 (100%)</td>
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<td>5 (1.20%)</td>
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<tr>
<td>No</td>
<td>410 (98.6%)</td>
<td>37 (97.4%)</td>
<td></td>
</tr>
<tr>
<td>Yes</td>
<td>6 (1.44%)</td>
<td>1 (2.63%)</td>
<td></td>
</tr>
<tr>
<td>Candidacy for combined heart/kidney transplant</td>
<td></td>
<td></td>
<td>1.000</td>
</tr>
<tr>
<td>No</td>
<td>406 (97.6%)</td>
<td>38 (100%)</td>
<td></td>
</tr>
<tr>
<td>Yes</td>
<td>10 (2.40%)</td>
<td>0 (0.00%)</td>
<td></td>
</tr>
<tr>
<td>Smoking history^b</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>10 or more pack years</td>
<td>110 (27.9%)</td>
<td>13 (36.1%)</td>
<td>0.396</td>
</tr>
<tr>
<td>20 or more pack years</td>
<td>52 (13.2%)</td>
<td>7 (19.4%)</td>
<td>0.31</td>
</tr>
<tr>
<td>30 or more pack years</td>
<td>26 (6.6%)</td>
<td>4 (11.1%)</td>
<td>0.301</td>
</tr>
</tbody>
</table>

^a Carotid stenosis refers to carotid artery stenosis.
^b Smoking history refers to smoking history of 10 or more pack years.
CABG, coronary artery bypass grafting; CAD, coronary artery disease; CEA, carotid endarterectomy; CT, computed tomography; PCI, percutaneous coronary intervention.

a Intermediate or severe internal carotid artery stenosis. b Smoking data available for 430 of 454 patients.
<table>
<thead>
<tr>
<th>Outcome</th>
<th>Variable</th>
<th>Adjusted odds ratio (95% CI)</th>
<th>P value</th>
</tr>
</thead>
<tbody>
<tr>
<td>1. Technical contraindication to transplant (TCT)</td>
<td>Age</td>
<td>1.03 (0.99, 1.07)</td>
<td>0.152</td>
</tr>
<tr>
<td></td>
<td>Sex (female vs male)</td>
<td>1.16 (0.55, 2.44)</td>
<td>0.703</td>
</tr>
<tr>
<td></td>
<td>Reason for scan: DM &gt;20 years</td>
<td>1.19 (0.47, 3.02)</td>
<td>0.708</td>
</tr>
<tr>
<td></td>
<td>Reason for scan: CAD with PCI or CABG</td>
<td>2.31 (0.97, 5.49)</td>
<td>0.064</td>
</tr>
<tr>
<td></td>
<td>Reason for scan: history of below- or above-knee amputation in DM</td>
<td>2.24 (0.24, 20.79)</td>
<td>0.513</td>
</tr>
<tr>
<td></td>
<td>Smoking history of ≥ 20 pack years</td>
<td>1.33 (0.54, 3.3)</td>
<td>0.544</td>
</tr>
<tr>
<td>2. Practical Aggregate Relevance (PAR)</td>
<td>Age</td>
<td><strong>1.03 (1, 1.05)</strong></td>
<td><strong>0.019</strong></td>
</tr>
<tr>
<td></td>
<td>Sex (female vs male)</td>
<td>1.05 (0.64, 1.73)</td>
<td>0.854</td>
</tr>
<tr>
<td></td>
<td>Reason for scan: Hemodialysis &gt;10 years</td>
<td>1.6 (0.5, 5.15)</td>
<td>0.438</td>
</tr>
<tr>
<td></td>
<td>Reason for scan: DM &gt;20 years</td>
<td>0.91 (0.44, 1.89)</td>
<td>0.799</td>
</tr>
<tr>
<td></td>
<td>Reason for scan: CAD with PCI or CABG</td>
<td>1.52 (0.78, 2.95)</td>
<td>0.223</td>
</tr>
<tr>
<td></td>
<td>Reason for scan: Intermediate or severe internal carotid stenosis or history of CEA</td>
<td>0.86 (0.08, 8.96)</td>
<td>0.9</td>
</tr>
<tr>
<td></td>
<td>Reason for scan: History of below- or above-knee amputation in DM</td>
<td>1.42 (0.26, 7.95)</td>
<td>0.693</td>
</tr>
<tr>
<td></td>
<td>Smoking history of ≥ 20 pack years</td>
<td>1.13 (0.59, 2.18)</td>
<td>0.709</td>
</tr>
</tbody>
</table>

CABG indicates coronary artery bypass grafting, CAD, coronary artery disease; CEA, carotid endarterectomy; CI, confidence interval; DM, diabetes mellitus; PCI, percutaneous coronary intervention. PAR, practical aggregate relevance = Technical contraindication to transplant (TCT) and/or determination of Laterality For Implantation (LFI)
Author/s:
Onaca, N; Martinez, E; Bayer, J; Wall, A; Fernandez, H; Ruiz, R; Ma, T-W; Gupta, A; McKenna, G; Testa, G

Title:
Selective screening imaging of the aortoiliac arterial system in kidney transplant candidates with non-contrast pelvic computed tomography.

Date:
2021-07

Citation:

Persistent Link:
http://hdl.handle.net/11343/298553