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Abstract

Introduction: Symptomatic decrease in perfusion distal to the vascular access is a severe complication in patients with chronic kidney disease (CKD) in hemodialysis programs. This study aimed to identify the risk factors associated with vascular access steal syndrome (VASS) in patients with CKD undergoing renal replacement therapy in hemodialysis units.

Methods: This case-control study was carried out in Santo Domingo and Portoviejo (Ecuador) hemodialysis units from January to December 2015. Patients with CKD 5-d with arteriovenous fistulae, with VASS (Cases) and without VASS (controls). The variables were demographic, type of arteriovenous fistula, the severity of the steal syndrome, comorbidities, size of the anastomosis, place of implantation of the vascular access, and etiology of kidney disease. The sample was probabilistic of 42 patients in each group. The association with the Odds ratio and 95% confidence interval is presented.

Results: The average age was 56 ±15 years. In patients with VASS, 33 cases (78.57%) were in the elbow forearm, 6 cases (14.29%) were in the arm, and 3 cases (7.14%) were in the wrist. The severity of VASS was Grade I, 10 cases (23.81%); grade II, 19 cases (45.24%); grade III, 6 cases (14.29%); grade IV, 7 cases (16.67%). Overweight/obese had an OR 3.1 (95% CI 1.24-7.75) P=0.01. The implantation of the fistula was different from the wrist OR 11.81 (95% CI 1.24-7.75) P=0.01. Type 2 diabetes and high blood pressure were not factors associated with the presence of VASS. The anastomosis size > 5 mm OR 0.20 (95% CI 0.07-0.52) was established as a protective factor.

Conclusions: In the present study, overweight or obesity are established as risk factors for the presence of VASS at the implantation site other than the wrist.

Keywords: MESH: Vascular Fistula; Arteriovenous Fistula; Risk Factors; Theft, Arteriovenous Fistula; Case-Control Studies; Kidney Failure, Chronic.
The construction and maintenance of vascular access represent an essential component of treating patients with stage 5d chronic kidney disease. Vascular access steal syndrome (VASS) for hemodialysis, first described in 1969 by Busell et al., is a clinical situation derived from arterial insufficiency distal to an arteriovenous fistula and the existence of an inadequate collateral network. Ischemia appears when the flow is insufficient [1].

VASS is a potentially severe complication: approximately 10% of patients with arteriovenous fistulas present mild symptoms related to stealing syndrome, and between 4% and 28% of patients with brachiocephalic AVF may present with ischemic symptoms that require diagnosis and early treatment to avoid irreversible ischemic damage that is expressed in limb amputation or death [1]. The probability of showing a VASS picture secondary to the creation of vascular access, whether autologous or prosthetic in the upper limbs, has been related in 62 to 100% with stenosis or proximal occlusions or distal arterial disease [2].

Other factors strongly associated with the appearance of the ischemic process are diabetes mellitus, high-flow fistulas, the location of the access in the arm, affection of the ulnararterial axis, giant anastomotic mouths, placement of prosthetic vascular accesses, and the female sex [2, 3]. VASS type I (early) can manifest 30 days after performing vascular access [4–6]. Regarding intensity, the scale proposed by Tordoir is used, which establishes four grades depending on the severity of the symptoms: (a) grade 1 cyanosis, pallor, coldness without pain, (b) pain at the time of exercise or during dialysis, (c) rest pain, and (d) digital gangrene [8]. The objective of the present study was to determine the risk factors associated with VASS scores in 2 hemodialysis centers in Santo Domingo and Portoviejo (Ecuador).

Materials and methods

Study design

This multicenter study was observational and case–control.

Scenery

The study was carried out in the hemodialysis units of the city of Santo Domingo located on Zamora Street s/n and Avenida de Los Tsáchilas and in the unit of the city of Portoviejo located on the Manabí Guillén Highway and the Metrodial Group. The study period was from January 01, 2015, to December 31, 2015.

Participants

For the study, patients diagnosed with chronic kidney disease stage 5d were referred through the public health network of Ecuador and in whom arteriovenous fistulas were made in one of the upper extremities and had been diagnosed with VASS. The control group comprised patients without a diagnosis of VASS.

Variables

The variables studied were age, weight, sex, body mass index, type of arteriovenous fistula, severity of the steal syndrome, comorbidities, size of the anastomosis, place of implantation of the vascular access, and etiology of kidney disease.

Data sources/measurements

The source was direct. An electronic form was used with the study variables. Age was calculated based on the date of birth of the patient’s identity card. Weight, sex, comorbidities, etiology, and presence and severity of VASS were taken directly from the institutional file. The principal investigator collected the clinical data on the type of access and place of implantation. The size of the anastomosis was assessed with vascular ultrasound.

Biases

The results were validated by the medical directors of the participating centers. An imaging specialist in vascular access performed the ultrasound.

Studio size

The sample was probabilistic, the confidence interval was 95%, the power was 80%, the ratio in the group of cases was 1, the percentage of those exposed in the control group was 10%, the odds ratio was 5, and the percentage of cases with exposure was 35.7%. The sample calculation was 42 patients for the case group and 42 patients for the control group.

Quantitative variables

Scaled variables such as age, body mass index, and anastomosis size are presented as the mean and standard deviation. Categorial variables such as sex, type of fistula, severity of VASS, comorbidities, implantation site, and etiology of kidney disease are presented as proportions.

Statistical analysis

The statistical program used was SPSS 17 (Chicago: SPSS Inc.). Comparisons of means and proportions between groups were performed using Student’s t test and the chisquare test, respectively. The risk factors were obtained with the cross-product factor of the contingency table. Significant values were less than P < 0.05 with a 95% confidence interval greater than unity.
Results

Participants
Eighty-four patients entered the study. The participant diagram is presented in Figure 1.

Characteristics of the study population
Eighty-four patients with arteriovenous fistula (AVF) entered the study, with a mean age of 56 ± 15 years. Patients from 17 to 83 years old. The distribution by sex was homogeneous, with a male:female ratio of 1:1. In patients with VASS, 33 cases (78.57%) were in the elbow forearm, 6 cases (14.29%) were in the arm, and 3 cases (7.14%) were in the wrist. The severity of VASS was grade I, 10 cases (23.81%); grade II, 19 cases (45.24%); grade III, 6 cases (14.29%); and grade IV, 7 cases (16.67%).

Risk factors
Table 1 presents the risk factors for VASS.

Table 1. Risk factors for vascular access steal syndrome.

<table>
<thead>
<tr>
<th>Variable</th>
<th>Group 1 (VASS n=42)</th>
<th>Group 2 without VASS n=42</th>
<th>Odds Ratio</th>
<th>CI-95%</th>
<th>P</th>
</tr>
</thead>
<tbody>
<tr>
<td>Overweight/Obesity</td>
<td>22 (52.38%)</td>
<td>11 (26.19%)</td>
<td>3.10</td>
<td>1.24-7.75</td>
<td>0.0124</td>
</tr>
<tr>
<td>Diabetes</td>
<td>26 (61.90%)</td>
<td>21 (50.0%)</td>
<td>1.62</td>
<td>0.68-3.87</td>
<td>0.772</td>
</tr>
<tr>
<td>HBP</td>
<td>15 (35.71%)</td>
<td>21 (50.0%)</td>
<td>0.56</td>
<td>0.23-1.33</td>
<td>0.270</td>
</tr>
<tr>
<td>Size &gt;5 mm</td>
<td>10 (23.81%)</td>
<td>25 (60.90%)</td>
<td>0.20</td>
<td>0.07-0.52</td>
<td>0.001</td>
</tr>
<tr>
<td>Implantation other than the wrist</td>
<td>39 (92.86%)</td>
<td>22 (52.38%)</td>
<td>11.81</td>
<td>3.15-44.29</td>
<td>&lt;0.0001*</td>
</tr>
</tbody>
</table>

HBP: high blood pressure. VASS: Vascular access steal syndrome.

Discussion

The construction of an arteriovenous fistula (AVF) can reduce the perfusion of the most distal extremity due to stealing arterial blood flow in the fistula; the magnitude of this problem is essential since symptomatic steal occurs in up to 20% of cases. Patients were receiving access to the upper extremities and even more so with severe manifestations requiring intervention in 4% [8-10]; this factor also influences the patient’s preferences to opt for a hemodialysis catheter compared to the subsequent refusal to rebuild a new arteriovenous fistula [9, 11].

There are risks reported in the literature to establish or suspect the exposure or manifestation of the Robbery Syndrome. Huber suggests that there should be special care for patients at risk; he suggests that the female sex and arteries with a diameter of less than 3 mm are associated factors; on the other hand, diabetes does not generate risk [3]. Davidson, on the other hand, reports that diabetes, as a moderately important factor, ethnicity and age, are also associated risk factors [3]. Tordoi further proposed the presence of arteriosclerotic disease [2]. In the present study, ethnicity was not included, and no relationship was found with age since it was the relationship factor between the groups. There was no relationship with sex.

Against this background, Suding mentions that the prediction of Robo syndrome is complex; some characteristics are not as well defined in the patient, and others are related to the surgical technique. This author proposes factors that were not included in this study, such as multiple previously created vascular accesses. In the present study, it was determined that the presence of an arteriovenous fistula at the level of the wrist and hand almost completely frees the patient from presenting limb ischemia related to the vascular access OR of 11.81 (95% CI 3.15-44.29) P <0.0001, and the few patients who presented it are related to the presence of more than one distal vascular access, which determines exhaustion of the distal arterial network due to the use of both the radial artery and the ulnar artery. The use of proximal arteries in this study was indirectly studied by determining the place of implantation of the vascular access, which in patients affected by steal syndrome occurs in 78.57% at the level of the forearm-elbow compared to 14.29% at the level of the arm. It also shows that diabetes behaves as a risk factor, the latter being the one that has had the most significant discrepancy between the results presented in several studies [4]. In the present study, diabetes mellitus was not categorized related to the expression of Robbery syndrome, with an OR of 1.67 (95% CI 0.68-3.87) P = 0.772; however, overweight and obesity were risk factors, with an OR = 3.1 (95% CI 1.24-7.75) P = 0.012 for VASS.

End-stage kidney disease in recent decades has been identified as a public health problem for all countries, compromising the response capacity of any health system in the short term. In Ecuador in 2015, it was considered that there were 11,460 patients with terminal chronic renal failure who required renal replacement therapy; of this figure, 92.8% were assigned to a hemodialysis program. With this premise, the patient needs to create an arteriovenous fistula free of complications.

With the history and high numbers of patients in hemodialysis programs, there are no country reports on the characterization of arteriovenous fistulas.

The most common causes of IRT are arterial hypertension, that is, nephroangiosclerosis, and diabetes mellitus with diabetic nephropathy; however, arterial hypertension cannot be identified as a risk factor associated with steal syndrome, and the implication of diabetes mellitus is not significant; however, the study shows a high probability of presenting limb ischemia in a patient with diabetes mellitus and first-intention proximal AVF.

The characterization of surgery in the first world determines that an arteriotomy for an anastomosis of vascular access must be 1.5 mm more than the caliber of the arterial vessel; patients who presented anastomoses greater than 5 mm had a lower risk of developing steal syndrome as a protective factor (OR 0.20, 95% CI 0.07-0.52). It is probable from the hemodynamic point of view that the generosity of the anastomosis allows a more
rapid compensatory dilation and therefore favors the nonappearance of the steal syndrome.

When an AVF is established in the healthy vascular territory, the dilation of the proximal and distal arteries as well as the collaterals around the anastomosis, compensates for the increased systolic flow of the vascular access and the diastolic reflux of the distal artery. Any pathology that affects any of the aforementioned adaptive mechanisms can cause distal ischemia associated with steal syndrome. The steal phenomenon will depend on the size of the vascular access anastomosis and the integrity of the rest of the limb’s vascular tree. Future prospective studies should explore this association.

Conclusions

In the present study, the presence of VASS at the implantation site other than the wrist and the presence of overweight or obesity were established as risk factors.

Abbreviations

AVF: arteriovenous fistula.
CKD: chronic kidney disease.
CI: confidence interval.
BMI: Body mass index.
OR: odds ratio.
VASS: Vascular access steal syndrome.

Supplementary information

Supplementary materials have not been declared.

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References


Author contributions

Ana Theresa Waibel Guadarnud: Conceptualization, Data Curation, Formal Analysis, Fundraising, Research Methodology, Project Management, Resources, Software, Writing – original draft.
Jaime Raúl Iturralde Panchi: Conceptualization, supervision, validation, visualization, writing: revision and editing.
All authors read and approved the final version of the manuscript.

Financing

The authors provided research expenses.

Availability of data or materials

The data sets generated and analyzed during the current study are not publicly available due to participant confidentiality but are available from the corresponding author upon reasonable academic request.

Statements

Ethics committee approval and consent to participate

The bioethics committee approved the study of the Central University of Ecuador Faculty of Medicine.

Consent to publication

This does not apply when images or photographs of the physical examination or radiography/tomography/MRI of patients are not published.

Conflicts of interest

The authors report having no conflicts of interest.

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