Upper Extremity Steal Syndrome Is Associated with Atherosclerotic Burden and Access Configuration

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Background: Clinically significant steal syndrome occurs in a subset of dialysis patients with arteriovenous (AV) access. Factors associated with steal are poorly understood. Severe symptoms require access revision or sacrifice, potentially jeopardizing access options. Our objective was to review our dialysis access experience to identify factors associated with significant steal syndrome.

Methods: We reviewed all adult patients undergoing their first permanent upper extremity access, AV fistula (AVF) or AV graft (AVG), between January 2008 and July 2011 at a single center. Medical, demographic, and access characteristics were collected from our electronic medical record and a local dialysis center's database. Patients who required correction of steal syndrome were compared with the larger access cohort. Statistical analysis included Fisher's exact test and χ^2 for noncontinuous variables and unpaired *t*-test for continuous variables.

Results: Of the 303 patients, 15 required correction for steal syndrome (8 of 232 AVF and 7 of 71 AVG). Eight were ligated; 2 were initially banded, then ligated; and 5 underwent distal revascularization with interval ligation. Coronary artery disease was more prevalent in steal syndrome patients (66.7% vs. 25%, $P = 0.001$); the same was found with peripheral arterial disease (40% vs. 13.8%, $P = 0.02$). Furthermore, more patients with steal syndrome were on clopidogrel for cardiovascular reasons (40% vs. 9%, $P = 0.002$). Steal syndrome only developed with AVF and AVG using brachial artery inflow. No cases of steal syndrome arose from radial/ulnar inflow ($P = 0.03$). All AVG with steal syndrome had a straight configuration; no looped AVG developed steal ($P = 0.02$). Other patient characteristics such as age, sex, race, hypertension, diabetes mellitus, congestive heart failure, cerebrovascular accident, cause of end-stage renal disease, and other medication history were not different between groups.

Conclusions: Clinically significant steal syndrome is associated with disease in coronary and peripheral arterial beds. In addition, the use of brachial artery inflow and straight AVG configuration is associated with steal syndrome. Consideration should be given to construction of access using smaller forearm arteries and looped AVG configuration in patients with high risk for steal. In addition, such patients may require more vigilant monitoring for development of steal after access construction.

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INTRODUCTION

End-stage renal disease (ESRD) affects over 500,000 Americans, with over 100,000 new cases reported each year.[1] One of the main challenges for ESRD patients is the creation and maintenance of permanent hemodialysis access. The development of steal syndrome following construction of an arteriovenous fistula (AVF) or arteriovenous graft (AVG) greatly impacts management. Although uncommon, clinically significant steal requires either major access revision or abandonment in patients who are ill-equipped to lose an access option.

The introduction of a low resistance arteriovenous (AV) circuit, whether fistula or graft, leads to physiologic steal from the distal extremity. The majority of patients remain asymptomatic, adjusting via local vasodilatory and compensatory flow mechanisms. However, a subset of patients are unable to adequately compensate, leading to manifestations of ischemia, prompting intervention. Previous observations indicate that clinically significant steal is seen in 1−10% of all AV accesses.[2] Associated symptoms include ischemic rest pain, neuropathy, digital ulceration, and gangrene.[3] Diagnosis of steal is usually made from patient history and clinical examination, along with supporting noninvasive studies and/or angiography. Depending on severity, intervention may be necessary to prevent further ischemic tissue damage. Surgical revision for relief of steal can include access banding, distal revascularization with interval ligation (DRIL), revascularization using distal inflow, or proximalization of arterial inflow procedures. These procedures can partially or completely reverse ischemia associated with steal and allow retention of the access for dialysis. However, such procedures may not be sufficient or appropriate for all patients. For some high risk patients, or for those with insufficient relief of symptoms after access revision, ligation and sacrifice of the access becomes necessary. Because best management of ESRD patients relies on identifying and creating the most appropriate and durable permanent access, sacrifice of an access can mean increasingly complicated patient management, increased catheter use, and loss of ipsilateral limb sites for future access. Accurate identification of patients at the highest risk for developing steal and implementing strategies for avoiding this complication remain a challenge in hemodialysis access construction and management.

Much of the previous work with steal syndrome has focused on management and surgical revision, once the problem has been identified.[4−6] Through these studies, several risk factors have been proposed for the development of steal syndrome. Female gender, diabetes mellitus (DM), previous ipsilateral access, age greater than 60, and access location were identified as contributing to the development of steal.[5,7−14] However, much of this work was conducted decades ago, and little has been published recently focusing on the identification of risk factors and strategies to avoid development of steal. Additionally, many of these studies include heterogeneous populations who may have had prior and complicated access construction. The objective of this study was to examine our institution's experience with a contemporary population of patients undergoing construction of their first upper extremity access and identify factors associated with clinically significant steal syndrome.

METHODS

A retrospective review was conducted of all AVF and AVG constructed at the University Hospitals Case Medical Center between January 2008 and July 2011. The study was approved by the University Hospitals Institutional Review Board. Patients were identified by querying Current Procedural Terminology billing codes for the study period. Data were obtained from the hospital's electronic medical record system and from the major dialysis outpatient treatment group in northeast Ohio. From this initial review, adult patients undergoing construction of their first permanent upper extremity hemodialysis access were selected. Those who subsequently underwent a procedure for correction of steal syndrome were compared with the larger first-time AV access cohort to identify factors associated with the development of significant steal leading to corrective measures. The need for intervention to salvage the access or protect the hand was determined by the operating surgeon on the basis of clinical examination and patient consultation. Management of subclinical steal or symptoms not sufficient to warrant intervention was not examined in this study. We defined clinically significant steal as the condition where surgical intervention or revision was undertaken for the correction of steal symptoms. The follow-up period concluded on May 17, 2012. If a patient underwent correction of steal syndrome during the follow-up period, the clinical course was followed further to determine the final access outcome.

Demographic variables collected included age, race, hypertension (HTN), coronary artery disease (CAD), congestive heart failure (CHF), cerebrovascular accident (CVA), diabetes, peripheral arterial