UNIVERSITY OF MEDICINE AND PHARMACY CRAIOVA
FACULTY OF GENERAL MEDICINE

Ph.D. THESIS

THE IMPACT OF VASCULAR ACCESS ON MORBIDITY AT HEMODIALYSIS PATIENTS

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VASCULAR ACCESS FOR HEMODIALYSIS

**KEY WORDS:** vascular access, hemodialysis patients, central venous catheter, arteriovenous fistula, complications, risk mortality, morbidity.

Adequate care of hemodialysis (HD) patients is inseparable from the problems of creating and maintaining the patency of vascular access. An ideal permanent vascular access should: deliver an adequate blood flow rate, provide longevity of use, and have low complication rates for stenosis, thrombosis, and infection. Delivery of optimal HD requires a well functioning vascular access with a nominal blood flow rate of 400 mL/minute without access recirculation. Failure of access function limits the delivered dose of dialysis which in turn is one of the major determinants of survival on dialysis.

The need for vascular access in patients with renal failure can be either temporary or permanent. Need for temporary access may vary from several hours (single dialysis) to months (if used to bridge maturation of a primary autologous AV fistula).

Temporary access is usually established by the percutaneous insertion of a catheter into a large vein (preferably femoral or internal jugular; subclavian is less desirable).

The autologous arteriovenous (AV) fistula introduced by Brescia and Cimino in 1966 comes closest to satisfying the requirements for delivering adequate blood flow while minimizing complications. Although the autologous AV fistula is the desired access for patients initiating HD, there is disproportionate use of prosthetic access (AV grafts) in the United States compared to AV fistulas and an increasing dependence on permanent indwelling silastic central catheters Although cuffed venous catheters have evolved into an alternative form of long-term vascular access for patients in whom a permanent AV access cannot be readily created.

The National Kidney Foundation-Dialysis Outcomes Quality Initiative (NKF-DOQI) recommends the increased construction of AV fistulas as the access of choice for HD as well as earlier referral of chronic renal failure (CRF) patients to nephrologists to permit access evaluation and early construction of an AV fistula or graft, thereby minimizing the use of venous catheters. Early protection of potential sites for native AV fistula construction is also of utmost importance. After the access is constructed, the major issues relate to: detection of access dysfunction prior to access thrombosis; maintenance of vascular access patency; and prevention of infectious, ischemic, and aneurysmal complications. Dialysis centers thus
need to detect vascular accesses at risk, track access complication rates and implement procedures that maximize access longevity. Achieving these goals requires the concerted efforts of nephrologists, nephrology nurses, access surgeons, vascular interventionists, patients and other members of the health care team.

Vascular access complications are reported to be the largest single cause of morbidity among HD patients and a major contributor to HD cost. In USA, the total number of vascular access related hospitalization as a percentage of all cause of hospitalization has increased from approximately 17% in 1986 to > 20% in 1991.

Vascular access complications can account for up to 30% of hospital admissions in some chronic HD programs.

One of the most important causes for increased morbidity from vascular access is the progressive decrease in the fraction of native AV fistulas constructed relative to those of polytetrafluoroethylene (PTFE) grafts and indwelling permanent catheters. In the US, it is presently estimated that < 25% of ESRD patients undergo construction of the native AV fistula.

Correction of inordinate delay in access placement is simply achieved by earlier referral of patients with CRF to nephrologists. However, such early participation can significantly reduce the need for temporary catheters, reducing not only the direct procedural costs but also indirect hospitalization costs associated with catheter complications (pneumothorax, hemothorax, and sepsis). The other major source of costs attributable to vascular access arises from non-mechanical complications; infectious complications are a source of substantial morbidity and a common cause of death among HD patients, accounting for about 20 – 25% of all vascular access complications. AV fistulas have a much lower rate of infection than PTFE grafts.

Low dose of dialysis is associated with a number of the major causes of death in the ESRD population. Low doses of dialysis may promote atherogenesis, infection, malnutrition and failure to thrive through a variety of pathophysiologic mechanisms. HD vascular access dysfunction is an important cause for inadequate dose of dialysis.

Close attention to vascular access management has great potential for improving quality of life and overall outcomes for HD patients. The high overall costs and the large fraction of costs that still accrue from inpatient settings clearly indicate that opportunity for savings exist from optimizing vascular access care.
Study objectives

1. Evaluation of early and late complications of central venous catheter in chronic hemodialysis patients
2. Local and general complications of permanent vascular access at hemodialysis patients
3. Risk factors for arterio-venous fistula dysfunction in hemodialysis patients
4. Vascular access monitoring methods to improve its service life

Patients and methods

This research was conducted in the Emergency County Hospital Craiova, medical facility with 1800 beds, in center hemodialysis. The study was conducted between 2006-2010 on patients with chronic kidney disease that were in the replacement therapy of renal function by hemodialysis. All patients that performed hemodialysis in this period were monitored in terms of vascular access, except those who met the following exclusion criteria:
1) patients requiring hemodialysis therapy for less than three months, then treatment was discontinued due to the partial resumption of renal function;
2) patients who died within the first three months of hemodialysis treatment;
3) patients that belonged to other hemodialysis centers, but being in transit in Dolj County have made for a limited time in our center hemodialysis sessions;
4) patients were performed during this period of time a kidney transplant from living donor graft or cadaveric.

Results. Conclusions.

In the first part we tried to identify complications of central venous catheter for each location: jugular, femoral and subclavian, their incidence in chronic hemodialysis patients and their impact on mortality and morbidity on these patients. The results were dramatic as the high incidence of complications occurring in patients with central venous catheter, but also through effects on relative risk of mortality in
this group of patients, which exceeded that of patients who made hemodialysis on a arterio-venous fistula.(2.28 vs.1).

In Part-II we tried to analyze several classes of local and general complications caused by the presence of arterio-venous fistula in a hemodialysis patient.

Aneurysm was the most common local complication, followed by thrombosis and infection. Arterio-venous fistula thrombosis hadn’t the highest incidence, but caused the greatest mortality rate.

We found that, if first reduced blood flow fistula indicates a vascular access dysfunction, on the other hand, its high flow rate increases cardiopulmonary flow and can cause heart failure with increased cardiac output, even pulmonary hypertension mediated by increasing cardiac output. ROC analysis curves show that the amount of vascular access flow \( Q \geq 2 \text{ L / min} \) is an accurate predictor of 99\% for developing heart failure.

Reversal of blood flow in the periphery after an arterio-venous shunt of creation was a common phenomenon, but did not correlate with symptoms. There was no statistically significant correlation between the presence of diabetes mellitus and symptoms caused by ischemia of the hand; however, the likelihood that a patient with diabetic to develop hand complications in a short time of the shunt creation are higher than a patient without diabetes. We suggest that the 20 cm / sec for maximum systolic velocity is a limit below which symptoms of ischemia may occur.

In Part-III of the research we tried through a retrospective clinical study to identify risk factors for vascular access dysfunction, because arterio-venous fistula can lead to life-threatening complication for uremic patients undergoing dialysis. We evaluated the influence on the functionality of arterio-venous fistula on many factors: the presence of comorbidities (myocardial infarction, stroke, cancer), smoking (duration, number of cigarettes per day or packs / year), some drugs (insulin, oral antidiabetic agents, dipyridamole, salicylates, ticlopidine, coumarin anticoagulant), type of vascular access at dialysis initiation, localization and development of fistula / fistulas performed throughout treatment by hemodialysis, the time located for fistula maturation, the number of dialysis sessions (<3, ≥ 3) per week, number of hours of dialysis (<12, ≥ 12) per week, BP values. Logistic regression analysis showed that only the number of hours of dialysis per week had a significant influence on the lifetime of the fistula, so the overall analysis of all fistulas, as well as the analysis after excluding those who had early failure.

The last part of the research, Part IV, we tried to achieve a well organized rigorous
monitoring of vascular access functionality, by implementing a protocol for clinical monitoring of vascular access, while comparing the efficacy of clinical assessment method with the assessment of its access with the Doppler ultrasound. The two prospective subgroups were similar in all aspects except the monitoring methodology applied to each sublot. Although the subgroup clinical prevalence of older patients and those with diabetes was higher than the Doppler subgroup, analysis of variants showed no significant differences of vascular access survival between the 2 subgroups. Data can help increase attention for the purpose of creating an early FAV or synthetic prosthesis in patients with chronic kidney disease, because patients who had initiation made in hemodialysis with central venous catheter had a higher mortality than those who had their initiation made with arterio-venous fistula - survival at 24 months was 68% vs. 86%.
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