Role of Venous Pressure Monitoring as Predictor of High Flow Access in Prevalent Hemodialysis Patients

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By

Hend Reda Mohammed
Master degree – Ain Shams University

Under Supervision of

Prof. Dr. Gamal El Sayed Mady
Professor of Internal Medicine and Nephrology
Faculty of Medicine, Ain Shams University

Dr. Tamer Wahid El Said
Assistant Professor of Internal Medicine and Nephrology
Faculty of Medicine, Ain Shams University

Dr. Ashraf Hassan Abd El Mobdy
Lecturer of Internal Medicine and Nephrology
Faculty of Medicine, Ain Shams University

Faculty of Medicine
Ain Shams University
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بسم الله الرحمن الرحيم

قالوا

سبحانك لا علم لنا إلا ما علمتنا إنك أنت العليم الحكيم

صدق الله العظيم

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Hend Reda Mohammed

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List of Abbreviations

Abbr.	Full-term
Qa	: Access blood flow
AVF	: Arterio-venous fistula
AVG	: Arterio-venous graft
BUN	: Blood urea nitrogen
CF	: Cardiac failure
CI	: Cardiac index
CO	: Cardiac output
CPR	: Cardio-pulmonary recirculation
CVCs	: Central venous catheters
CAS	: Cephalic arch stenosis
CKD	: Chronic kidney disease
CDU	: Color Doppler Ultrasound
CDI	: Color duplex imaging
DASS	: Dialysis Associated Steal Syndrome
DASS	: Dialysis Associated Steal Syndrome
DHIS	: Distal Hypo-perfusion Ischemic Syndrome
DRIL	: Distal revascularization interval ligation
EF	: Ejection fraction
ESRD	: End stage renal disease
ET-1	: Endothelin-1
HD	: Hemodialysis

HFM	: Hemodialysis Fistula Maturation
HOCF	: High Output Cardiac Failure
HFA	: High-flow access
JVP	: Jugular venous pressure
K/DOQI	: Kidney Dialysis Outcomes Quality Initiative
LVH	: Left ventricular hypertrophy
LVMi	: LV mass index
MRA	: Magnetic resonance angiography
mPAP	: Mean pulmonary artery pressure
NKF	: National Kidney Foundation
NSF	: Nephrogenic systemic fibrosis
NO	: Nitric oxide
PTA	: Percutaneous balloon angioplasty
PD	: Peritoneal dialysis
PDE5i	: Phospho-diesterase 5 inhibitors
PTFE	: Poly-tetra-fluoroethylene
PH	: Pulmonary hypertension
PVR	: Pulmonary vascular resistance
Qa/CO	: Cardio-pulmonary ratio
RUDI	: Revision using distal inflow
sDVP	: Standardized dynamic venous pressure
SVP	: Static venous pressure
SPSS	: Statistical software package
SVR	: Systemic vascular resistance

URR **:** Urea reduction ratio

VA **:** Vascular access

WSS **:** Wall shear stress

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Abstract:

Background: Kidney Disease Outcomes Quality Initiative (K/DOQI) guidelines suggest that high intra access pressure may be regarded as a surrogate for arteriovenous fistula (AVF) outflow stenosis. It can be measured using static venous pressure (sVP) or standardized dynamic venous pressure (dVP). Access blood flow (Qa) measurement is also recommended by (K/DOQI) as the preferred method for access surveillance, but it is not readily available at all dialysis facilities. We hypothesized that in absence of clinical signs of stenosis, venous pressure(both dynamic &static) can be used as predictor of AVF Qa: a simple and useful screening technique that can be used to detect fistulae with inappropriately high Qa (>1500ml/min). High Qa fistulae may compromise cardiac function, and may require an endovascular or surgical intervention to guard against heart failure.

Methods: A prospective cohort study conducted on 59 chronic hemodialysis patients at Ain Shams University hospital. Inclusion criteria: patients with autogenous AVF. Exclusion criteria: clinical signs of AVF outflow stenosis (physical evaluation was done for localized edema/collaterals, jerky pulsations and hand elevation tests); and/or ultrasonic evidence of AVF stenosis or thrombosis. *Measurements:* standardized dVP (fistula needle gauge 16", and dialysis machine pump speed set at 200ml/min for 5 minutes) ,while static measurement (P) will be from arterial needle exactly 30 seconds after stopping blood flow. All measures of AVF Qa were obtained by means of Color Doppler Ultrasound using Mindray-M5 ultrasound system. All the investigations were performed for all patients at baseline and were repeated after six months for follow up.

Results: This study included 59 chronic hemodialysis patients with 35 males (59.3 %) and 24 females (40.7%) with mean age 54.41±13.057 years. Twenty six subjects (44.1 %) had distal AV fistula while thirty three subjects (55.9%) had proximal AVFs. Mean value of baseline AVF Flow (Qa,) was 1.327 ± 0.847, while baseline DVP, SVP & adjusted SVP were 95.10 ± 35.807, 13.10 ± 21.7 & 0.015 ± 0.0496 respectively.

Patients with high access flow (>1.5 L/m) were 16 patients. Baseline results show that, their mean blood flow was 2.179 ± 0.681, with mean duration 53.75 months, and mean DVP, adjusted SVP to blood pressure& SVP were 103.13, 0.022 &17.19 respectively. Their mean URR was 0.701. Although there was a significant correlation between AVF flow & SVP with P value 0.027, but the evaluation of the test (the svp) using roc curve demonstrated Weak sensitivity and specificity making the test not suitable for screening.

Conclusion: our study demonstrated that surveillance of venous pressure readings obtained from hemodialysis machine detectors do not help to diagnose patients with high flow AVF (Qa ≥1500ml/min).

Key words: Venous Pressure, High Flow Access Prevalent Hemodialysis

Introduction

The patient's vascular access is often referred to as their "lifeline," and without it, the life- sustaining treatment of hemodialysis would not be possible **(Vachharajani, 2010).**

To maintain the access, patency depends on diagnostic accuracy and active and timely interventions. Complications related to the vascular access are the leading cause of hospitalization for the hemodialysis patient. Preventing the development of complications can reduce morbidity, improve quality of life, and reduce the costs of health care in the dialysis population **(Lee et al., 2002).**

Many of the problems that occur in association with the patient's vascular access can be detected by physical examination and clinical evaluation **(Besarab et al., 1995).**

The Kidney Disease Outcomes Quality Initiative work group stated that "physical examination and clinical evaluation are skills that can be as valuable as any surveillance method. A brief physical examination of the patient's access should always be performed prior to each dialysis treatment. The physical exam should include, but is not limited to:

- Visual inspection of the access (for signs of infection)
- Palpa6tion to assess for evidence of stenosis or thrombosis

- Auscultation with a stethoscope to identify any changes in the bruit.

The patient should also be asked about any abnormal or unusual occurrences specifically involving the access that may have been experienced between dialysis treatments—bleeding, swelling, bruising, redness, drainage, pain, a change in the thrill **(Workgroup, NKF-KDOQI Vascular Access,2006) .**

The hemodialysis access has made it possible for chronic kidney failure patients to receive long term outpatient treatment **(Amerling et al., 2011).** Although complications of clotted catheters and infected expanded polytetrafluoroethylene grafts overshadow the day-to-day workings of the hemodialysis unit, a high-flow access likely will go unnoticed. It is not until complaints of Dialysis Associated Steal Syndrome (DASS), or an aneurysm has enlarged to the point of eventual rupture, that notice is taken. Too often, repeat episodes of congestive heart failure are considered to be cardiac and go unrecognized as a problem related to a hyper-functioning access **(Goel et al., 2006).**

The Kidney Dialysis Outcomes Quality Initiative (K/DOQI) recommend native arteriovenous fistula (AVF) to be the vascular access of choice for hemodialysis due to its longevity, lower complications, low mortality rate than catheters **(Allon & Robbin, 2002).** However, a hyper-functioning AVF; with flows exceeding 2000 ml/min in most cases may actively promote cardiac overload resulting in increased cardiovascular morbidity **(Vaes et al., 2014).** Once recognized by Doppler ultrasound, flow should be reduced to prevent impending cardiovascular complications **(Miller & Hwang, 2012).** Cardiac failure resulting from high-flow vascular access can be treated successfully with surgery **(Tellioglu et al., 2008).**

The ideal hemodialysis access functions with just enough flow to prevent thrombosis while maximizing dialysis efficiency. A useful, although arbitrary, guideline for ranges of blood flow within a typical dialysis access are the following: low (600 mL/min), normal (600-1500mL/min), and high (1500-4000 mL/min) categories **(Bourquelot et al., 2001).**

Flow-related problems are patient specific and mostly are unrecognized because there is very little correlation with symptoms. A low-flow access can cause both DASS and cardiac overload, depending on the degree of pre-existing systemic vascular disease and cardiac dysfunction. Conversely, a high-flow access causes neither DASS nor cardiac overload symptoms **(Goel et al., 2006).**

Thus far, proposed treatments are based entirely on clinical symptoms rather than attempts to normalize access flow. A lack of prospective data to support flow reduction and the fear of access loss resulting from intervening on an otherwise, well-functioning access, compounds the resistance to address high-flow accesses.

Retrospective data and numerous anecdotes suggest a significant benefit in proactive management.

Currently, K/DOQI guidelines suggest that high intra access pressure may be regarded as a surrogate for arteriovenous fistula (AVF) outflow stenosis. It can be measured using static venous pressure (SVP) or standardized dynamic venous pressure (dVP). Though measurement of vascular access blood flow (Qa) is recommended as the preferred method of surveillance for AVF; however, this method is not readily available at all dialysis facilities **(National Kidney Foundation, 2000).**

AVF outflow stenosis is thought to increase intra-access venous pressure and will eventually result in progressive decline in blood flow, hence the rationale behind KDOKI recommendations for venous pressure measurements. However, presence of venous outflow stenosis may eventually interfere with AVF hemodynamics and blood flow. Thus, we hypothesized that in absence of clinical signs or ultrasonic