Arab Journal of Nephrology and Transplantation. 2014 Jan;7(1):45-47

AJNT

Country Data

Prevalence and Risk Factors of Central Venous Stenosis among Prevalent Hemodialysis Patients, a Single Center Experience

Osama O. Osman*[1], Abdul-Rahman A. El-Magzoub[2] and Sarra Elamin[2]

1. Research fellow, Seven Corners Medical and Research Center, Arlington VA, USA.
2. Ahmed Gasim Cardiac Surgery and Renal Transplant Center, Khartoum, Sudan.

Abstract

Introduction: Central vein stenosis (CVS) is a common complication of central venous catheter (CVC) insertion. In this study we evaluated the prevalence and risk factors of CVS among hemodialysis (HD) patients in a single center in Sudan, using Doppler ultrasound as a screening tool.

Methods: The study included 106 prevalent HD patients. For every patient, we performed Duplex Doppler for the right and left jugular, subclavian and femoral veins. A patient was considered to have hemodynamically significant stenosis if the pre-stenosis to the post-stenosis velocities ratio was ≥ 2.5 or they had complete vein occlusion.

Results: Overall, 28.3% of patients had Doppler detected CVS, including 25.5% with hemodynamically significant stenosis and 2.8% with compromised flow. The prevalence of CVS was 68.4% among symptomatic patients compared to 19.5% in asymptomatic patients. The prevalence of CVS among patients with history of 0-1, 2-3 and ≥4 central venous catheters was 3.4%, 29.4% and 53.8% respectively (p=0.00). CVS was not more common in patients with history of previous/current jugular or femoral vein catheterization compared to no catheter placement in these veins (28.3% vs 28.6% and 35% vs 26.7% respectively; p >0.1). However, CVS was significantly more common in patients with previous/ current subclavian vein catheterization compared to no catheter placement in this vein (47.8% vs 22.9%, p = 0.02).

Conclusion: CVS is highly prevalent among studied HD patients, particularly in the presence of suggestive clinical signs. The number of HD catheter placements and subclavian vein utilization for dialysis access impose a significantly higher risk of CVS.

* Corresponding Author; D245 Rio Dr #711, Falls Church, VA 22041, USA; E mail: Osammyoa@yahoo.com.

Keywords: Central Venous Stenosis; Hemodialysis; Central Venous Catheter; Doppler.

Introduction

Central vein stenosis (CVS) is a common complication of central venous catheter (CVC) insertion. Besides indwelling catheters, other devices like indwelling cardiac wires and upper extremity peripherally inserted central lines (PICCs) may also cause CVS [1]. CVS may also occur without an identifiable cause or with extrinsic compression of the brachiocephalic vein [2]. Different imaging modalities can be used to visualize the central veins with variable sensitivity and specificity in detecting CVS, and each method has its own limitations. Fluoroscopy or X-ray venography is considered to be the gold standard for the diagnosis of CVS, but the procedure carries the risks associated with the injection of contrast medium and extrinsic venous compression is not directly visualized. Computed Tomography angiography (CTA) is superior to venography in detecting extrinsic venous compression; however, large doses of contrast (up to 150 cc) are needed in order to ensure adequate venous opacification. Magnetic Resonance Venography (MRV) has the advantage evaluating the proximal parts of the central venous tree, as some parts of the central veins cannot be visualized directly by US, but studies comparing MRV to venography have yielded controversial results. Radionuclide Flow Imaging typically cannot differentiate between intrinsic and extrinsic venous compromise. Ultrasound imaging is the least invasive method to screen for CVS, and is relatively inexpensive. The patency of the vein is evaluated in gray scale imaging by demonstrating compressibility of the vein. Loss of compressibility is consistent with acute thrombosis but can also occur in the presence of chronic venous thrombosis. A full examination also includes evaluation of the spectral Doppler wave form that reflects the velocity profiles obtained from blood in the major veins [3]. Blood hemodynamics change when

it passes a stenotic segment, leading to a corresponding change in blood velocity that can be detected during Doppler examination.

A change in the peak velocity across any venous segment by more than 2.5 times is a valid and reproducible criterion for significant venous stenosis [4]. This ratio corresponds to >50% stenosis in that particular vein segment. The transmission of normal polyphasic atrial waveform from the right atrium into the central veins can rule out the possibility of a more central venous occlusion or stenosis with a sensitivity that is greater than 80% [5]. In addition, by comparing the waveform obtained from the right and left central veins, it is possible to draw valuable conclusions about the patency of the innominate and superior vena cava veins [6].

Methods

This study was conducted in the year 2012 and included 106 end-stage renal disease (ESRD) patients who had been maintained on regular HD at Ahmed Gasim Dialysis Center, Khartoum-North, for a minimum duration of three months. Doppler ultrasound was done using high resolution b-mode (gray scale) as well as color and pulsed-wave Doppler (Mindiray® V6D) for the six central veins, using a high frequency ultrasound transducer (7-10 MHZ). Measurements of the blood velocities were taken from the proximal, mid and distal parts of the right and left jugular, subclavian and femoral veins. If stenosis was detected, the pre and post stenosis velocities were recorded. Patients were classified as having significant CVS (≥ 50%) if a peak vein velocity ratio >2.5 was found at any point along the course of one of the six central veins or if the vein was totally occluded with no detected blood flow. Compromised flow (<50%) was defined as abnormal flow with velocities ratio <2.5. Normal flow was defined as the lack of velocity gradient throughout the vein. We also examined the possible association between CVS and HD duration, number of previous catheter insertions and history of documented deep venous thrombosis (DVT) episodes.

Results

The mean age of the study participants was 43.6 years (range 18-78) and 61% were males. Their mean duration on dialysis was 3.9 years. Eighty-two percent of patients had functioning arterio-venous fistulas (AVF) while 13.2% were being dialyzed through tunneled HD catheters and 2.8% were being dialyzed through non-tunneled HD catheters.

Overall, 28.3% of patients had Doppler detected CVS, including 25.5% with hemodynamically significant stenosis and 2.8% with compromised flow. Nineteen patients had clinical signs suggestive of CVS and this was confirmed by Doppler in 68.4% of the patients. Screening of the remaining asymptomatic patients detected CVS in only 19.5% of cases. No significant relationship existed between CVS and patients' age, gender or duration of dialysis. However, history of DVT was associated with a higher incidence of detected CVS (77.8% versus 22.1%, p=0.00).

Ninety-seven percent of studied patients had history of at least one HD catheter placement in a central vein. These included the right or left jugular vein in 93.3%, the right or left subclavian vein in 21.7% and the right or left femoral vein in 18.9%. The median number of previously inserted central venous catheters was two. The prevalence of CVS among patients with history of 0-1, 2-3 and ≥4 central venous catheters was 3.4%, 29.4% and 53.8% respectively (p=0.00). CVS was not more common in patients with history of previous/current jugular or femoral vein catheterization compared to no catheter placement in these veins (28.3% vs 28.6% and 35% vs 26.7% respectively; p >0.1). However, CVS was significantly more common in patients with previous/current subclavian vein catheterization compared to no catheter placement in this vein (47.8% vs 22.9%, p = 0.02).

Discussion

The dialysis access is the lifeline for the ESRD patient. The majority of studied patients (82%) had functioning AVF, in agreement with current best practice guidelines [7]. However, almost all patients had history of at least one HD catheter placement in a central vein. This is caused by late referral and the frequent need for urgent HD initiation in our setting. The jugular vein was the most commonly utilized vein, again in concordance with the guidelines [7]. However, one fifth of patients still had been exposed to HD catheter placement in the subclavian or femoral veins. Forauer et al [8] stated that although CVS can develop without an identifiable antecedent, CVS is related primarily to the use of catheters. The utilization of the subclavian vein was reported to carry the highest risk of CVS [9, 10], and this was evident in the current study. The introduction of catheters into veins usually causes endothelial trauma and inflammation that tends to cause thrombosis [11]. This thrombosis can be clinical or subclinical, and if not treated can become chronic and lead to vein narrowing or complete lumen obliteration. In a retrospective study that included 238 patients [10], catheter-related venous thrombosis was found in 13% of patients with subclavian vein catheters compared to 3% in patients with internal jugular vein catheters. We also found strong correlation between the number of HD catheters used and CVS. The placement of only two HD catheters was associated with a dramatic increase in the incidence of CVS. Similar findings were reported by Rae et al [9].

CVS can remain asymptomatic unless there is an ipsilateral functioning dialysis access [12]. In the presence of an ipsilateral dialysis access that drains into the affected central veins, the patient may develop rapidly increasing massive edema of the access arm, with pain and discomfort which are commonly aggravated by the dialysis session [12]. Superior vena cava syndrome can occur with superior vena cava lesions [13]. Additional signs of CVS include pleural effusion, dilated venous collaterals over the patient's chest, breast edema, recurrent infections, difficult cannulation or thrombosis of dialysis access [14]. In this study, CVS was detected in 80.5% of patients with suggestive clinical findings. Aujla et al recommended screening dialysis patients who present with any of the symptoms and/or signs suggestive of CVS. They also added that the presence of massive arm edema in the access arm is virtually pathognomonic of central vein stenosis [13]. They stated that the clinical behavior of lesions in the subclavian and innominate veins are similar and that superior vena cava syndrome can occur with superior vena cava lesions [13].

Confirmed CVS was prevalent among our study population. However, higher prevalence was reported by other researchers. In one study of 133 HD patients, 41% were found to have evidence of significant central vein stenosis [9]. In another study of 69 patients, the prevalence of the CVS was 42% [2]. Both studies included symptomatic HD patients while in the current study we screened all patients undergoing regular HD at our center, whether symptomatic or not.

Conclusion

CVS is highly prevalent among the studied HD patients particularly in the presence of suggestive clinical signs. The number of HD catheter placements and subclavian vein utilization for dialysis access impose a higher risk of CVS.

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