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The Effect of Saphenous Vein Closure on Myocardial Ischemia

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Abstract

Chronic venous insufficiency (CVI) affects approximately 40% of the United States and is prevalent worldwide. Modern percutaneous treatment options, including radiofrequency ablation of the great and small saphenous veins, are highly effective. While the efficacy of these procedures for symptomatic relief is well established in the literature, their effects on cardiac hemodynamics and myocardial ischemia remain unknown.

35 patients with chronic venous insufficiency and known cardiovascular disease who underwent radiofrequency ablation of the small and great saphenous veins were retrospectively analyzed to determine the impact of venous closure on myocardial ischemia. All 35 patients had SPECT myocardial perfusion imaging pre- and post-venous closure.

Prior to venous closure, 9 of the 35 (25.7%) patients were found to have abnormal SPECT myocardial perfusion studies with evidence of myocardial ischemia. 2 patients were excluded from analysis due to non-invasive treatment of ischemia with enhanced external counter pulsation (EECP) therapy for refractory chronic, stable angina. Of the 7 remaining patients, post venous closure SPECT imaging revealed resolution of ischemia in 3 of these patients (abnormal to normal). This represents a 42.9% improvement in myocardial ischemia status post saphenous venous closure.

Anatomical and technical factors did not appear to play a role in the success of reperfusion, however, factors that may influence the success of reperfusion include younger age, lower ischemic burden, higher BMI (obesity paradox), and shorter time to myocardial perfusion imaging.

In light of our findings, we conclude that saphenous vein closure may increase myocardial oxygen perfusion and treat myocardial ischemia as evidenced by the high percentage of normal SPECT myocardial perfusion studies post saphenous vein closure. Further research is needed to determine the effect of saphenous vein closure on cardiac hemodynamics and myocardial ischemia.

Keywords: Ablation; Ischemia; Saphenous Vein; Stress Test; Chronic Venous Insufficiency

Introduction

Chronic venous insufficiency (CVI) affects approximately 40% of the United States and is prevalent worldwide. Known risk factors for CVI are female gender, family history, tobacco use, advanced age, obesity, and inactivity. Symptoms of CVI include edema, cramping, restless legs, fatigue, venous stasis changes, and ulceration. Venous closure using radiofrequency ablation, or cyanoacrylate closure is indicated for the therapeutic treatment of symptomatic chronic venous insufficiency after a failure of conservative therapy [1]. Modern percutaneous treatment options are highly effective. One such treatment, radiofrequency ablation (Closure Fast), has a closure rate of 91.9% at five years [2]. While the efficacy of these procedures for symptomatic relief is well established in the literature, their effects on cardiac hemodynamics and myocardial ischemia remain unknown.

CVI is a disease of the vascular system and is often concomitantly found in patients with known cardiovascular disease, such as a history of myocardial infarction, congestive heart failure, and myocardial ischemia. Here we report a series of 35 patients with both CVI and known cardiovascular disease who underwent radiofrequency ablation of the saphenous veins and examine its impact on myocardial ischemia using single-photon emission computed tomography (SPECT) myocardial perfusion imaging.

Materials and Methods

35 patients with chronic venous insufficiency and known cardiovascular disease who underwent radiofrequency ablation of the small and great saphenous veins were retrospectively analyzed to determine the impact of venous closure on myocardial ischemia. All 35 patients had SPECT myocardial perfusion imaging pre- and post-venous closure.

Patient eligibility included chronic venous insufficiency documented by a bilateral lower extremity duplex ultrasound venous insufficiency study that identified vein diameter greater than 4 mm and reflux greater than 500 milliseconds. Patients had a documented failure of conservative therapy including use of compression stockings for greater than 3 months, weight loss, rest, and elevation.

Myocardial ischemia was assessed by SPECT myocardial perfusion imaging pre- and post-vein closure. Supply-demand mismatch was quantified as a percentage of reversible ischemia identified on SPECT myocardial perfusion imaging. A lack of reversible ischemia, or normal SPECT myocardial perfusion imaging, was the benchmark used to quantify adequate myocardial oxygen perfusion. A one-day protocol was used. Patients received between 10 and 12 mCi of Tc99m Myoview intravenously at rest. This was followed by rest myocardial SPECT images with a gamma camera 30 minutes afterwards. Patients then exercised and at peak exercise received between 30 and 35 mCi of Tc99m of Myoview. Gated Stress SPECT image acquisition was done 30 minutes afterwards. Processing was performed using a workstation to obtain 3D images, polar mapping, and quantitative analysis. A final interpretation of the stress test was performed, noting if there was either normal or abnormal (reversible ischemia) exercise myocardial perfusion.

Results

Prior to venous closure, 9 of the 35 (25.7%) patients were found to have abnormal SPECT myocardial perfusion studies with evidence of myocardial ischemia. 2 patients were excluded from analysis due to non-invasive treatment of ischemia with enhanced external counterpulsation (EECP) therapy for refractory chronic, stable angina. Of the 7 remaining patients, post venous closure SPECT imaging revealed resolution of ischemia in 3 of these patients (abnormal to normal). This represents a 42.9% improvement in myocardial ischemia status post saphenous venous closure. This population had an average age of 76. 22% were female, and 78% were male. The average length of the right and left great saphenous veins and small saphenous veins were 31.5 cm, 36.0 cm, 16.1 cm and 17.3 cm respectively (Table 1). The average Watts to treat were 10.0, 9.9, 5.3, and 5.0 respectively (Table 2).

As shown in Table 3, patients whose ischemia resolved post radiofrequency ablation tended to have lower ischemic burden on myocardial perfusion imaging (6% vs. 15.5%), were younger (71.4 vs. 80.1), had myocardial perfusion imaging performed sooner post ablation (234.7 vs. 258.8 days), and had a higher body mass index (40.6 vs 33.5).

Table 1: Venous Anatomy

	Right GSV	Left GSV	Right SSV	Left SSV
Average Length (cm)	31.5 ± 9.3	36.0 ± 9.1	16.1 ± 5.1	17.25 ± 7.3
Vein Diameter Proximal (mm)	9.1 ± 1.6	7.9 ± 1.5	5.0 ± 1.3	5.6 ± 1.2
Vein Diameter Mid (mm)	6.0 ± 1.0	6.1 ± 1.3	4.0 ± 0.7	5.3 ± 1.7
Vein Diameter Distal (mm)	5.4 ± 1.6	6.0 ± 1.3	4.4 ± 0.8	4.1 ± 0.8

*GSV, great saphenous vein. SSV, small saphenous vein.

Table 2: Radiofrequency Ablation Technical Factors

	Right GSV	Left GSV	Right SSV	Left SSV
Average Watts	10 ± 2.9	9.9 ± 2.1	5.3 ± 0.8	5.0 ± 2.2
Average Time (min/sec)	2:25 ± 0:35	2:47 ± 0:41	2:37 ± 0:37	2:10 ± 0:26
Average Cycles (Hz)	7.3 ± 1.8	8.4 ± 2.1	7.3 ± 1.9	6.5 ± 1.3.

Table 3: Characteristics of Resolution vs. Non-Resolution Groups post RFA

Resolution of Ischemia Post RFA	Yes	No
Average Ischemic Burden (%)	6	15.5
Average Age	71.4	80.1
Time to MPI (days)	234.7	258.8
BMI	40.6	33.5

Discussion

The left ventricle is a pump. Its primary function is to eject oxygenated blood into the aorta where it is then distributed to the body. This pump can only eject the amount of blood that it receives from the pulmonary veins via the left atrium (preload). The Frank-Starling law asserts that as blood volume increases in the left ventricle so does left ventricular contractile function. This enhanced contractile function thus augments cardiac output (heart rate * stroke volume) [3]. Even minimal volume changes have a large impact. Crossman asserts that, "Within the myocardium the pre-contraction tension (myocardial wall tension) has a clear relation with the pre-contraction ventricular volume, where even relatively small changes in volume will be associated with quite large changes in wall tension [4].

The heart itself requires adequate blood supply that it receives from its microcirculation (arterioles and capillaries), and epicardial coronary arteries. During diastole, when the left ventricle is at rest, coronary arterial inflow increases with a transmural gradient that favors perfusion to the microcirculation. At this time, coronary venous outflow falls [3]. Oxygen delivery to the myocardium depends upon oxygen carriage by the blood and coronary blood flow [4].

Ischemia results from a lack of adequate blood supply to the myocardium and causes symptoms including shortness of breath, fatigue, and angina. Ischemia is detected by SPECT myocardial perfusion imaging and is corrected by increasing delivery of oxygen rich blood to the myocardium, either percutaneously with coronary artery stenting, or non-invasively with antianginal medical management.

Closure of the superficial saphenous veins reroutes deoxygenated blood from the diseased, refluxing vein into the perforating veins, and then into the deep venous system. There, non-refluxing, healthy veins transport blood back to the heart. We hypothesize that this increase in venous return (preload) increases cardiac output, and optimizes cardiac hemodynamics. This in turn improves epicardial and microvascular myocardial oxygen perfusion as seen on SPECT myocardial perfusion imaging.

Anatomical and technical factors (Tables 1 and 2) do not appear to play a role in the success of reperfusion. Factors that may influence the success of reperfusion include younger age, lower ischemic burden, higher BMI (obesity paradox), and shorter time to myocardial perfusion imaging (Table 3). Further research is needed to examine the individual effects of these factors.

Conclusion

In light of our findings, we conclude that saphenous vein closure may increase myocardial oxygen perfusion and treat myocardial ischemia as evidenced by the high percentage of normal SPECT myocardial perfusion studies post saphenous vein closure. In concert with guideline goal-directed medical therapy, and appropriate intervention, saphenous vein closure may be an important component in the treatment of myocardial ischemia.

Limitations of this study include sample size, the exclusion of patients who underwent enhanced external counterpulsation (EECP) to treat refractory CCS III angina, and the analysis of only one treatment modality, namely radiofrequency ablation. A larger, prospective trial is required to further evaluate the effects of saphenous vein closure on myocardial ischemia. Additionally, a robust comparison of treatment modalities including radiofrequency ablation and cyanoacrylate saphenous venous closure may add further value.

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