Effects of Surgery on Microvascular Function in Venous Insufficiency

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Background: The aim of our study was to assess the effects of venous stripping on microvascular functions in isolated great saphenous vein insufficiency.

Methods: Two groups of participants were prospectively evaluated. The first group included 15 healthy participants without any evidence of venous insufficiency. The second group included 20 patients with varicose veins because of great saphenous vein insufficiency. The demographics, venous clinical severity scores, and CEAP classifications of the patients were recorded. Next, all individuals underwent evaluations for microvascular vasoreactivity using an iontophoretic laser Doppler imager, and the outcomes were recorded. Patients with varicose veins underwent stripping surgeries, and microvascular vasoreactivity evaluations were repeated 6 weeks postoperatively.

Results: There was a statistically significant decrease in the patients with varicose veins compared with the control group in response to nitroprusside (SNP) applied at 4 mC in the supine position. Furthermore, there was also a significant difference in the response to acetylcholine (ACh) in patient group in the sitting position ($P < 0.05$). We also observed a statistically significant decrease in the responses to SNP applied for 1, 2, and 4 mC ($P < 0.05$) in the patients in the sitting position. The relief of pain and edema after surgery was found to be significant ($P < 0,001$). In the subgroup in which ACh was applied for 1 and 4 mC in the supine position, postoperative microvascular flow was significantly increased ($P < 0.005$). Moreover, based on the measurements taken in the supine position, the patients in the subgroup in which SNP was applied for 1, 2, or 4 mC exhibited significantly increased postoperative microvascular dilatation ($P < 0.005$).

Conclusions: Saphenous vein insufficiency impairs the endothelium-dependent vasodilatation response in the perimalleolar region, and partial recoveries in microvascular function were observed after surgical treatment.

INTRODUCTION

Varicose veins are because of the permanent expansion, curving, and elongation of veins of different diameters that causes those veins to become more clearly visible under the skin. Venous valvular reflux plays a role in the pathophysiology of varicose veins.[1] The occurrence of venous hypertension because of incompetent valves impairs dermal microcirculation. Early microvascular responses result in infiltration of serum into the tissue and visible edema. White blood cells are activated as the inflammatory process proceeds. The white blood cells become captured in the dermal microcirculation and cause an increase in capillary permeability. Plasma proteins leak into the interstitium and exacerbate the edema.[2] Previous studies have shown that, in the upright position, the cutaneous microvascular vasodilatory responses in the perimalleolar region are impaired in patients with isolated great saphenous

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vein (GSV) incompetence compared with healthy controls.[3] Surgical treatment of isolated saphenous vein insufficiency reduces the risk of ulcer development, alleviates symptoms, and reduces the risk of recurrence.[4] However, there is limited information about the effects of surgical treatment on microvascular perfusion and reactivity. Therefore, the aims of our study were to assess microvascular function in isolated saphenous vein insufficiency and to investigate the effects of surgical treatment on microvascular function.

PATIENTS AND METHODS

Study Design

The institutional ethics committee approved the procedures of this study, and informed consent was obtained from all participants. Two groups of participants were prospectively evaluated. The first group included 15 healthy participants without any evidence of venous insufficiency. The second group included 20 patients with varicose veins because of GSV insufficiency. Patients with peripheral artery diseases, histories of previous varicose vein surgeries, deep venous thrombosis, diabetes, hypertension, hypercholesterolemia, active infections, or heart failure were excluded from the study. The demographics, venous clinical severity scores, and CEAP classifications of the patients were recorded. The lower extremities of individuals were evaluated via duplex Doppler ultrasound examination of the superficial and deep venous systems to document the presence or absence of deep vein thrombosis, venous reflux in the main trunks and dilated tributaries. Duplex ultrasound examinations were performed on a Philips HDI 5000 (Philips Medical Systems, Bothell, WA) device with a 12 MHz linear array transducer. GSV insufficiency was defined as the presence of >0.5 sec of reflux in the saphenofemoral junction and proximal GSV. Next, all individuals underwent an iontophoretic laser Doppler imaging evaluation for microvascular vasoreactivity. Iontophoretic laser Doppler assessment of microvascular vasoreactivity was performed once in the control group. The patients who underwent saphenous vein stripping were assessed for microvascular vasoreactivity 1 day before surgery and 3 weeks after surgery.

Varicose Vein Surgery

The indications of varicose vein were cosmetic complaints and symptomatic varicosities (e.g., pain, edema, heaviness, night cramps, recurrent superficial thrombophlebitis, and bleeding) or the need for treatment of venous hypertension after skin or subcutaneous tissue changes (e.g., lipodermatosclerosis, atrophy, ulceration, or hyperpigmentation) had developed.[5]

Spinal or general anesthesia was given depending on the patients' general conditions and preferences. Surgeries were initiated with a 2- to 3-cm incision made parallel to the inguinal fold at the fossa ovalis. The GSV and the saphenofemoral junction were exposed via dissection of the region of femoral triangle, and the GSV and its tributaries were ligated, while the femoral vein was maintained. Another small skin incision was made on the leg between the knee and the ankle depending on the reflux exhibited by the patient. The GSV was identified and ligated distally. After ligation and division of the junction, the stripper was passed into the GSV at the distal incision and proximally through the incompetent vein, and the stripper was removed through the proximal incision. The GSV was inverted into itself and torn away from each tributary and perforator as the stripper was pulled downward through the leg and out through the incision below the knee. Several 1- to 2-mm incisions were made over the varicose veins with a tiny blade, phlebectomy hooks were introduced into these incisions, and the veins were removed through the incisions.

Assessment of Microvascular Vasoreactivity

To assess microvascular vasoreactivity, the endothelium-dependent vasodilator acetylcholine (ACh) and the endothelium-independent vasodilator nitroprusside (SNP) were both iontophoretically applied to collect measurements with a laser scanner. Iontophoresis is increasingly being used for the transdermal delivery of vasodilating agents such as ACh and SNP for the assessment of endothelial vasomotion. This technique is based on the fact that charged molecules migrate across the skin under the influence of an applied electrical field; thus, the delivery of ionized drugs is dependent on the magnitude and duration of the applied current (current $\times$ time charge, in coulombs). Laser Doppler imaging measures the dose-dependent changes in perfusion because of the iontophoresis. This methodology has been widely used to investigate microvascular function in various disease states, most commonly diabetes mellitus in which endothelial dysfunction is implied by decreased responses to ACh iontophoresis.[3,6–9]