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Original scientific paper

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Case report

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Betimi i Hipokratit

Në çastin kur po hy në radhët e anëtarëve të profesionit mjekësor premtoj solemnisht se jetën time do ta vë në shërbim të humanitetit. Ndaj mësuesve do ta ruaj mirënjohjen dhe respektin e duhur. Profesionin tim do ta ushtroj me ndërgjegje e me dinjitet. Shëndeti i pacientit tim do të jetë brenga ime më e madhe. Do t'i respektoj e do t'i ruaj fshehtësitë e atij që do të më rrëfehet. Do ta ruaj me të gjitha forcat e mia nderin e traditës fisnike të profesionit të mjekësisë.

Kolegët e mi do t'i konsideroj si vëllezër të mi.

Në ushtrimin e profesionit ndaj të sëmurit tek unë nuk do të ndikojë përkatësia e besimit, e nacionalitetit, e racës, e politikës, apo përkatësia klasore. Që nga fillimi do ta ruaj jetën e njeriut në mënyrë apsolute. As në kushtet e kërcënimit nuk do të lejoj të keqpërdoren njohuritë e mia mjekësore që do të ishin në kundërshtim me ligjet e humanitetit. Këtë premtim po e jap në mënyrë solemne e të lirë, duke u mbështetur në nderin tim personal.

The Oath of Hippocrates

Upon having conferred on me the high calling of physician and entering medical practice, I do solemnly pledge myself to consecrate my life to the service of humanity. I will give my teachers the respect and gratitude which is their due. I will practice my profession with conscience and dignity. The health of my patient will be my first consideration. I will respect the secrets which are confided in me, even after the patient has died. I will maintain by all the means in my power, the honor and the noble traditions of the medical profession.

My colleagues will be my brothers.

I will not permit considerations of religion, nationality, race, party politics or social standing to intervene between my duty and my patient. I will maintain the utmost respect for human life from its beginning even under threat and I will not use my medical knowledge contrary to the laws of humanity. I make these promises solemnly, freely and upon my honor

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STATISTICAL ANALYSIS OF ABLATION OF SUPERFICIAL VENOUS INSUFFICIENTY IN PATIENTS WITH SYMPTOMATIC CHRONIC PERIPHERAL ARTERIAL DISEASE

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ABSTRACT

Introduction: Peripheral artery disease (PAD) is widespread globally, affecting 113 million people aged 40 and older. The prevalence of PAD increased by 72% from 1990 to 2019, considering a 45% growth rate in the world population. Preventing major amputations should always be a cornerstone in treatment.

Objective: To protect patients with PAD, we must evaluate the arterial and superficial venous system so we can prevent future adverse complications. We present a study in which patient with severe peripheral arterial disease and insufficient superficial venous system, has undergo for sclerosing the superficial veins that leads to improved peripheral arterial circulation through the formation of a completely new arterial collateral network for revascularization of the lower extremities, as evidenced by examining arterial flow before and after intervention.

Materials and Methods: We conducted a prospective study at the Department of Cardiology, Clinical Hospital Shtip, Republic of North Macedonia from January 2023 till December 2023 in which we included 90 patients aged between 40 and 90 years old with confirmed superficial venous insufficiency. Also each patient had primary arterial disease of the lower extremities that had primary occlusion of native arteries, occlusion of previously placed stents or occlusion of previously performed bypasses. All patients underwent arterial Doppler testing to determine flow velocities in these vessels before the intervention and Doppler for evaluation of superficial venous system. Following sclerosis of the great superficial vein (GSV) and small saphenous vein (SSV), flow velocity was again assessed in patients at one, three, six, and nine months post-intervention to monitor improvements in circulation and collateral development.

Results: According to the statistical analysis results, the flow velocity through the SFA significantly differed after intervention (p=0.00022), with a significantly higher percentage of patients with PS >45 cm/sec post-intervention (62.22% vs. 44.44%, p=0.017). The flow velocity through the PA one (1) month post-intervention significantly differed from pre-intervention flow velocity (p=0.000002), with a significantly higher percentage of patients with PS >45 cm/sec post-intervention (56.67% vs. 32.22%, p=0.001), as well as after three (3) months (57.78% vs. 32.22%, p=0.0006), six (6) months (61.11% vs. 32.22%, p=0.0001), and nine (9) months post-intervention (63.32% vs. 32.22%, p=0.0000). The flow velocity through the PTA one (1) month post-intervention also differed significantly from the pre-intervention flow velocity (p<0.0001), with PS >45 cm/sec post-intervention (45.56% vs. 22.22%, p=0.0009), as well as after three (3) months (46.67% vs. 22.22%, p=0.0006), 6 months (46.67% vs. 22.22%, p=0.0006), and nine (9) months post-intervention (57.78% vs. 22.22%, p=0.0006). The flow velocity through the ATA one (1) month post-intervention significantly differed from the pre-intervention flow velocity (p<0.0001), with a significantly higher percentage of patients with PS >45 cm/sec post-intervention (37.78% vs. 17.78%, p=0.0027), as well as after three (3) months (38.89% vs. 17.78%, p=0.0017), six (6) months (43.33% vs. 17.78%, p=0.0002), and nine (9) months post-intervention (48.89% vs. 17.78%, p=0.0000). A statistically significant difference was also confirmed in the percentage of collaterals before and one (1) month after the intervention on PA, PTA/ATA/A. INTEROSSEA (p=00021).

Conclusion: Based on the results, we concluded that arterial flow improved immediately after the intervention, with significant enhancement, and development of the native arterial system or collateral network over the following months. That contributes to reducing future adverse complications in patients with PAD, primarily those with chronic peripheral artery disease.

Keywords: venous insufficiency, peripheral artery disease, sclerosis, collaterals, Doppler, velocity.

INTRODUCTION

Peripheral artery disease (PAD) is prevalent worldwide, affecting 113 million people aged 40 and older, with 42.6% of these individuals in countries with a low to medium sociodemographic index. The global prevalence is 1.52%, increasing with age (14.91% among those aged 80-84) and it is higher in women than in men (18.03% vs. 10.56% in the same age group). (1-4) The prevalence of PAD has risen by 72% from 1990 to 2019, considering the 45% growth rate of the global population.1,2,5 The overall global age-standardized prevalence is approximately 1,470 per 100,000 people. (5)

Peripheral artery disease is a complex condition. Preventing wounds and major amputations should always be a cornerstone in treatment. (6) PAD affects the peripheral vasculature and can lead to gangrene, intermittent claudication, ischemic rest pain, ischemic ulcers, and functional impairment. (7) Outcomes requiring amputation have a ≤50% mortality rate within one year. (8)

There is a thin boundary between the peripheral arterial system and the peripheral superficial venous system, and thus those two systems can be considered as one, especially in patients with proven superficial venous insufficiency.

The primary issue in the peripheral venous system lies within the superficial veins. The focal superficial veins of the lower extremities are the great saphenous vein (GSV) and the small saphenous vein (SSV). The normal venous system relies on a complex mechanism involving muscle pumps, valves, and pressure changes to counter gravitational pull, positional variations, and fluctuations in thoracic and abdominal pressure. Retrograde flow, also known as venous incompetence, occurs when the deep or superficial venous systems cannot function normally, with several theories explaining the development of venous incompetence. (9-11)

In healthy individuals, arterial blood circulates to the distal part of the limbs and then, via the arteriovenous capillary system (AVCS), moves through the superficial venous system rather than the deep venous system. From there, it flows through the inferior vena cava to the right heart, where it enters the pulmonary circulation for oxygenation and carbon dioxide removal and returns as oxygenated arterial blood from the left heart back into the arterial circulation.

When arterial blood reaches the arteriovenous capillary system in patients with superficial venous insufficiency, there is increased pressure due to venous insufficiency. This retrograde pressure is transmitted back to the arteries, particularly below the knee, creating “wall stress” on the intima-media layers of the arteries, which initiates an atherosclerotic process that eventually leads to arterial stenosis and complete arterial occlusion. Therefore, arterial flow can be improved with the development of collaterals by reducing retrograde pressure that held in AVCS that originate from insufficient superficial venous system.

OBJECTIVE

The objective of this study is to assess whether there is an improvement in the circulation of native blood vessels or collaterals in patients with confirmed venous insufficiency and primarily diagnosed peripheral arterial disease before and after performing sclerosis of the superficial veins (greater saphenous vein and small saphenous vein). This assessment is done by measuring arterial flow rates in 1, 3, 6, and 9 months after the sclerosis procedure.

MATERIALS AND METHODS

To verify if there is an improvement in the circulation of native blood vessels or collaterals, this study included 90 patients from the Cardiology Department at the Clinical Hospital in Shtip. Using color Doppler imaging of the venous and arterial beds, patients were selected who had venous insufficiency along with a primary problem with arterial disease (femoral artery, popliteal artery, anterior tibial artery, posterior tibial artery, interosseous artery) in the legs, with primary occlusion of native arteries,

occlusion of previously placed stents, or occlusion of previously created bypasses.

All selected patients with PAD and superficial venous insufficiency (greater and small saphenous veins) underwent for arterial Doppler examination of the lower extremity arteries (femoral, popliteal, anterior/posterior tibial, and interosseous arteries), where flow rates were recorded in these vessels prior to the intervention and underwent for CT angiography of the lower extremities, where the state of the arterial bed was noted before the intervention.

Subsequently, the patients underwent sclerosis of the superficial veins (greater or small saphenous veins), where for this study we used non-thermal, non-invasive system for immediate occlusion and result.

The patients were monitored at one (1) month, three (3) months, six (6) months, and nine (9) months post-intervention, with another arterial Doppler was performed, noting the flow rates in the femoral, popliteal, and anterior/posterior tibial, and interosseous arteries, with a comparison made between pre- and post-intervention measurements.

RESULTS

The study included participants with peripheral arterial disease (PAD) and superficial venous insufficiency in the greater and small saphenous veins, the majority of whom were male (68 participants, or 75.56%) (Table 1, Figure 1). Regarding age distribution, most patients were in the 70-79 and 60-69 age groups, with 42 (46.67%) and 32 (35.56%) patients, respectively, followed by those aged 50-59, 40-49, and 80-89, with 9 (10%), 4 (4.44%), and 3 (3.33%) patients, respectively. (Table 1)

Table 1. Characteristics of the Participants

Variable	n (%)
Gender (Sex)	
Female	22 (24.44)
Male	68 (75.56)
Age/Years	
40 – 49	4 (4.44)
50 – 59	9 (10)
60 – 69	32 (35.56)
70 – 79	42 (46.67)
80 – 89	3 (3.33)

Table 2 presents comparative results from the arterial Doppler of the superficial femoral artery (SFA) before and after the intervention. Statistical analysis confirmed a significant difference in flow velocity through the SFA following the intervention (p=0.00022).

The comparison of patients concerning individual categories of flow velocity through the SFA before and after the intervention showed a nonsignificant lower percentage of patients with no flow after the intervention (22.22% vs. 33.33%, p=0.096). An identical percentage before and after the intervention had a PS of 15-25 cm/sec (1.11%). A nonsignificantly higher percentage after the intervention had a PS of 26-35 cm/sec (10% vs. 4.44%, p=0.15), a similar percentage with a PS of 36-45 cm/sec (11.11% vs. 10%, p=0.815), and a significantly higher percentage of patients with a PS >45 cm/sec after the intervention (62.22% vs. 44.44%, p=0.017). (Table 2)

Table 2. Comparison of flow velocity through superficial femoral artery (SFA) before/after intervention

SFA				
Flow velocity PS (cm/sec)	Intervention		p-value	difference test
	before	after 1, 3, 6, 9 months		
0	30 (33.33)	20 (22.22)	Z=3.7 ***p=0.00022	p=0.096
15 – 25	1 (1.11)	1 (1.11)		
26 – 35	9 (10)	4 (4.44)		p=0.15
36 – 45	10 (11.11)	9 (10)		p=0.81
>45	40 (44.44)	56 (62.22)		*p=0.017

Z (Wilcoxon Matched Pairs Test)

*sig<0.05, ***sig<0.0001

Table 3 presents the comparative results from the arterial Doppler of the popliteal artery (PA) before and one (1) month after the intervention. According to the results of the statistical analysis, the flow velocity through the PA one (1) month after the intervention significantly differed from the velocity before the intervention (p=0.000002).

The comparison of patients regarding individual categories of flow velocity through the PA before and 1 month after the intervention showed an insignificantly lower percentage of patients with no flow after the intervention (11.11% vs 20%, p=0.1), a similar percentage before and after the intervention with PS of 1-14 cm/sec (1.11% vs 0%, p=0.32), an insignificantly lower percentage after the intervention with PS of 15-25 cm/sec (4.44% vs 10%, p=0.15), a significantly lower percentage after the intervention with PS of 26-35 cm/sec (8.89% vs 23.33%,

p=0.008), an insignificantly higher percentage after the intervention with PS of 36-45 cm/sec (17.78% vs 14.44%, p=0.54), and a significantly higher percentage of patients with PS >45 cm/sec after the intervention (56.67% vs 32.22%, p=0.001). (Table 3)

Table 3. Comparison of flow velocity through the PA before/1 month after the intervention

PA				
Flow velocity PS (cm/sec)	Intervention		p-value	difference test
	before n (%)	after 1 month n (%)		
0	18 (20)	10 (11.11)	Z=4.76 ***p=0.000002	p=0.1
1 – 1		1 (1.11)		p=0.32
15 – 25	9 (10)	4 (4.44)		p=0.15
26 – 35	21 (23.33)	8 (8.89)		**p=0.008
36 – 45	13 (14.44)	16 (17.78)		p=0.54
>45	29 (32.22)	51 (56.67)		**p=0.001

Z (Wilcoxon Matched Pairs Test)

*sig<0.05, ***sig<0.0001

Table 4 interprets the comparative results from the arterial Doppler of the popliteal artery before the intervention and 3 months after. According to the results of the statistical analysis, the flow velocity through the PA three (3) months after the intervention significantly differed from the velocity before the intervention (p=0.000001).

The comparison of patients concerning individual categories of flow velocity through the popliteal artery before and three (3) months after the intervention showed an insignificantly lower percentage of patients without flow after the intervention (10% vs. 20%, p=0.06), a similar percentage of patients before and after the intervention with a PS of 1–14 cm/sec (1.11% vs. 0, p=0.32), an insignificantly lower percentage of patients with a PS of 15-25 cm/sec after the intervention (4.44% vs. 10%, p=0.15), a significantly lower percentage of patients with a PS of 26-35 cm/sec after the intervention (7.78% vs. 23.33%, p=0.004), an insignificantly higher percentage of patients with a PS of 36-45 cm/sec after the intervention (18.89% vs. 14.44%, p=0.42), and a significantly higher percentage of patients with a PS >45 cm/sec after the intervention (57.78% vs. 32.22%, p=0.0006). (Table 4)

Table 4. Comparison of flow velocity in the popliteal artery before and three (3) months after the intervention

PA				
Flow velocity PS (cm/sec)	intervention		p-value	difference test
	before n (%)	after 3 months n (%)		
0	18 (20)	9 (10)	Z=4.94 ***p=0.000001	p=0.06
1 – 1		1 (1.11)		p=0.32
15 – 25	9 (10)	4 (4.44)		p=0.15
26 – 35	21 (23.33)	7 (7.78)		**p=0.004
36 – 45	13 (14.44)	17 (18.89)		p=0.42
>45	29 (32.22)	52 (57.78)		***p=0.0006

Z (Wilcoxon Matched Pairs Test)

**sig<0.01, ***sig<0.0001

Table 5 shows the comparative results from arterial Doppler of the popliteal artery, before the intervention and six (6) months after. Statistical analysis confirmed a significant difference in the flow velocity through the popliteal artery six (6) months post-intervention, compared to the pre-intervention flow velocity (p<0.0001).

The comparison of patients based on individual flow velocity categories through the popliteal artery before and six (6) months after the intervention showed an insignificantly lower percentage of patients without flow post-intervention (10% vs. 20%, p=0.06), a similar percentage of patients before and after the intervention with a PS of 1-14 cm/sec (1.11% vs. 0%, p=0.32), a significantly lower percentage of patients with a PS of 15-25 cm/sec post-intervention (0% vs. 10%, p=0.0021), a significantly lower percentage of patients with a PS of 26-35 cm/sec post-intervention (7.78% vs. 23.33%, p=0.004), an insignificantly higher percentage of patients with a PS of 36-45 cm/sec post-intervention (20% vs. 14.44%, p=0.32), and a significantly higher percentage of patients with a PS >45 cm/sec post-intervention (61.11% vs. 32.22%, p=0.0001). (Table 5)

Table 5. Comparison of flow velocity through the popliteal artery before and 6 months after the intervention

PA				
Flow velocity PS (cm/sec)	Intervention		p-value	difference test
	before n (%)	after 6 months n (%)		
0	18 (20)	9 (10)	Z=5.55 ***p=0.000000	p=0.06
1 – 1	0	1 (1.11)		p=0.32
15 – 25	9 (10)	0		**p=0.0021
26 – 35	21 (23.33)	7 (7.78)		**p=0.004
36 – 45	13 (14.44)	18 (20)		p=0.32
>45	29 (32.22)	55 (61.11)		***p=0.0001

Z (Wilcoxon Matched Pairs Test)

**sig<0.01, ***sig<0.0001

Table 6. Comparison of flow velocity through the popliteal artery before/9 months after the intervention

PA				
Flow velocity PS (cm/sec)	Intervention		p-value	difference test
	before n (%)	after 9 months n (%)		
0	18 (20)	8 (8.89)	Z=5.65 ***p=0.000000	*p=0.034
1 – 1		1 (1.11)		p=0.32
15 – 25	9 (10)	1 (1.11)		**p=0.009
26 – 35	21 (23.33)	6 (6.67)		**p=0.0017
36 – 45	13 (14.44)	17 (18.89)		p=0.42
>45	29 (32.22)	57 (63.33)		***p=0.0000

Z (Wilcoxon Matched Pairs Test)

**sig<0.01, ***sig<0.0001

Table 6 presents the comparative results of the arterial Doppler of the popliteal artery before and nine (9) months after the intervention. The statistical analysis confirmed a significant difference in the flow velocity through the popliteal artery (PA) nine (9) months after the intervention, compared to the flow velocity before the intervention (p<0.0001).

The comparison of patients regarding the individual categories of flow velocity through the popliteal artery before and nine (9) months after the intervention showed a significantly lower percentage of patients without flow after the intervention (8.89% vs. 20%, p=0.034), a similar percentage of patients before and after the intervention with a PS of 1-14 cm/sec (1.11% vs. 0%, p=0.32), a significantly lower percentage of patients with a PS of 15-25 cm/sec after the intervention (1.11% vs. 10%, p=0.0017), a significantly lower percentage of patients with a PS of 26-35 cm/sec after the intervention (6.67% vs. 23.33%, p=0.0017), an insignificant higher percentage of patients with a PS of 36-45 cm/sec after the intervention (18.89% vs. 14.44%, p=0.42), and a significantly higher percentage of patients with a PS >45 cm/sec after the intervention (63.32% vs. 32.22%, p=0.0000). (Table 6)

Table 7 shows the comparative results from arterial Doppler of the posterior tibial artery, before and one (1) month after the intervention. According to the results of the statistical analysis, the flow velocity through the posterior tibial artery (PTA) one (1) month after the intervention significantly differed compared to the flow velocity before the intervention (p<0.0001).

The comparison of patients regarding the individual categories of flow velocity through the posterior tibial artery before and one (1) month after the intervention showed a significantly lower percentage of patients with no flow after the intervention (13.33% vs. 25.56%, p=0.038), a nonsignificantly lower percentage of patients with a PS of 1-14 cm/sec after the intervention (2.22% vs. 6.67%, p=0.15), a nonsignificantly lower percentage of patients with a PS of 15-25 cm/sec after the intervention (6.67% vs. 13.33%, p=0.14), a nonsignificantly lower percentage of patients with a PS of 26-35 cm/sec after the intervention (15.56% vs. 23.33%, p=0.19), a nonsignificantly higher percentage of patients with a PS of 36-45 cm/sec after the intervention (16.67% vs. 8.89%, p=0.118), and a significantly higher percentage of patients with a PS >45 cm/sec after the intervention (45.56% vs. 22.22%, p=0.0009).

Table 7. Comparison of flow velocity in the posterior tibial artery (PTA) before and 1 month after the intervention

PTA				
Flow velocity (PS) (cm/sec)	Intervention		p-value	difference test
	before n (%)	after 1 month n (%)		
0 0 cm/sec	23 (25.56)	12 (13.33)	Z=5,15 ***p=0.000000	*p=0.038
1 1 – 14 cm/sec	6 (6.67)	2 (2.22)		p=0.15
2 15 – 25 cm/sec	12 (13.33)	6 (6.67)		p=0.14
3 26 – 35 cm/sec	21 (23.33)	14 (15.56)		p=0.19
4 36 – 45 cm/sec	8 (8.89)	15 (16.67)		p=0.118
5 >45 cm/sec	20 (22.22)	41 (45.56)		***p=0.0009

Z (Wilcoxon Matched Pairs Test)

**sig<0.01, ***sig<0.0001

Table 8 shows the comparative results of the posterior tibial artery Doppler before and three (3) months after the intervention. The difference in flow velocity across the posterior tibial artery (PTA) three (3) months after the intervention, compared to the velocity before the intervention, was statistically significant (p<0.0001).

The comparison of patients regarding individual categories of flow velocity across the posterior tibial artery before and three (3) months after the intervention showed a significantly lower percentage of patients with no flow post-intervention (12.22% vs. 25.56%, p=0.022), an insignificantly lower percentage of patients with flow velocities of 1–14 cm/sec post-intervention (3.33% vs. 6.67%, p=0.3), an insignificantly lower percentage of patients with flow velocities of 15–25 cm/sec post-intervention (5.56% vs. 13.33%, p=0.75), an insignificantly lower percentage of patients with flow velocities of 26–35 cm/sec post-intervention (15.56% vs. 23.33%, p=0.19), an insignificantly higher percentage of patients with flow velocities of 36–45 cm/sec post-intervention (16.67% vs. 8.89%, p=0.118), and a significantly higher percentage of patients with flow velocities >45 cm/sec post-intervention (46.67% vs. 22.22%, p=0.0006). (Table 8)

Table 8. Comparison of flow velocity of the posterior tibial artery (PTA) before and three (3) months after the intervention

PTA				
Flow velocity (PS) (cm/sec)	Intervention		p-value	difference test
	before n (%)	after 3 months n (%)		
0 0 cm/sec	23 (25.56)	11 (12.22)	Z=5.38 ***p=0.000000	*p=0.022
1 1 – 14 cm/sec	6 (6.67)	3 (3.33)		p=0.3
2 15 – 25 cm/sec	12 (13.33)	5 (5.56)		p=0.75
3 26 – 35 cm/sec	21 (23.33)	14 (15.56)		p=0.19
4 36 – 45 cm/sec	8 (8.89)	15 (16.67)		p=0.118
5 >45 cm/sec	20 (22.22)	42 (46.67)		***p=0.0006

Z (Wilcoxon Matched Pairs Test)

*sig<0.05, ***sig<0.0001

Table 9 presents the comparative results of the arterial Doppler of the posterior tibial artery, both before and six (6) months after the intervention. A statistically significant difference in the flow velocity through the posterior tibial artery (p<0.0001) was confirmed six (6) months after the intervention, compared to the pre-intervention flow velocity.

The comparison of patients according to the individual flow velocity categories through the posterior tibial artery before and six (6) months after the intervention showed a significantly lower percentage of patients without flow post-intervention (6.67% vs. 25.56%, p=0.0006), a similar percentage of patients with flow velocities of 1–14 cm/sec before and after the intervention (6.67% vs. 7.78%, p=0.77), an insignificantly lower percentage of patients with flow velocities of 15-25 cm/sec post-intervention (5.56% vs. 13.33%, p=0.75), an insignificantly lower percentage of patients with flow velocities of 26-35 cm/sec post-intervention (15.56% vs. 23.33%, p=0.19), an insignificantly higher percentage of patients with flow velocities of 36-45 cm/sec post-intervention (17.78% vs. 8.89%, p=0.079), and a significantly higher percentage of patients with flow velocities greater than 45 cm/sec post-intervention (46.67% vs. 22.22%, p=0.0006). (Table 9)

Table 9. Comparison of flow velocity in the posterior tibial artery (PTA) before and six (6) months after the intervention

PTA				
Flow velocity PS (cm/sec)	Intervention		p-value	difference test
	before n (%)	after 6 months n (%)		
0 0 cm/sec	23 (25.56)	6 (6.67)	Z=5.73 ***p=0.000000	***p=0.0006
1 1 – 14 cm/sec	6 (6.67)	7 (7.78)		p=0.77
2 15 – 25 cm/sec	12 (13.33)	5 (5.56)		p=0.075
3 26 – 35 cm/sec	21 (23.33)	14 (15.56)		p=0.19
4 36 – 45 cm/sec	8 (8.89)	16 (17.78)		p=0.079
5 >45 cm/sec	20 (22.22)	42 (46.67)		***p=0.0006

Z (Wilcoxon Matched Pairs Test)

***sig<0.0001

Table 10 presents the comparative results from the arterial Doppler of the posterior tibial artery before and nine (9) months after the intervention. The difference in flow velocity through the PTA nine (9) months after the intervention compared to before the intervention was statistically significant (p<0.0001).

Comparison of patients with individual flow velocity categories through the posterior tibial artery before and nine (9) months after the intervention showed a significantly lower percentage of patients without flow after the intervention (5.56% vs. 25.56%, p=0.0002), an insignificantly lower percentage of patients with PS from 1-14 cm/sec after the intervention (4.44% vs. 6.67%, p=0.51), an insignificantly lower percentage of patients with PS from 15-25 cm/sec after the intervention (5.56% vs. 13.33%, p=0.75), borderline statistical significance with a lower percentage of patients with PS from 26-35 cm/sec after the intervention (12.22% vs. 23.33%, p=0.05), an insignificantly higher percentage of patients with PS from 36-45 cm/sec after the intervention (14.44% vs. 8.89%, p=0.25), and a significantly higher percentage of patients with PS >45 cm/sec after the intervention (57.78% vs. 22.22%, p=0.0006). (Table 10)

Table 10. Comparison of flow velocity through PTA before and nine (9) months after the intervention

PTA				
Flow velocity (PS) (cm/sec)	Intervention		p-value	difference test
	before n (%)	after 9 months n (%)		
0 0 cm/sec	23 (25.56)	5 (5.56)	Z=6.6 ***p=0.000000	***p=0.0002
1 1 – 14 cm/sec	6 (6.67)	4 (4.44)		p=0.51
2 15 – 25 cm/sec	12 (13.33)	5 (5.56)		p=0.75
3 26 – 35 cm/sec	21 (23.33)	11 (12.22)		p=0.05
4 36 – 45 cm/sec	8 (8.89)	13 (14.44)		p=0.25
5 >45 cm/sec	20 (22.22)	52 (57.78)		***p=0.0000

Z (Wilcoxon Matched Pairs Test)

***sig<0.0001

Table 11 shows the comparative results of the arterial Doppler of the anterior tibial artery before the intervention and one (1) month afterward. According to the results of the statistical analysis, the flow velocity through the ATA one (1) month after the intervention significantly differed compared to the flow velocity before the intervention (p<0.0001).

The comparison of patients concerning the individual flow velocity categories through the anterior tibial artery before and one (1) month after the intervention showed a significantly lower percentage of patients with no flow after the intervention (10% vs. 32.22%, p=0.0003), an insignificantly lower percentage of patients with PS between 1 – 14 cm/sec after the intervention (2.22% vs. 5.56%, p=0.25), an insignificantly lower percentage of patients with PS between 15-25 cm/sec after the intervention (12.22% vs. 15.58%, p=0.51), an insignificantly lower percentage of patients with PS between 26-35 cm/sec after the intervention (14.44% vs. 17.78%, p=0.54), a significantly higher percentage of patients with PS between 36-45 cm/sec after the intervention (21.11% vs. 7.78%, p=0.011), and a significantly higher percentage of patients with PS >45 cm/sec after the intervention (37.78% vs. 17.78%, p=0.0027). (Table 11)

Table 11. Comparison of flow velocity of ATA before and one (1) month after the intervention

ATA				
Flow velocity (PS) (cm/sec)	intervention		p-value	difference test
	before n (%)	after 1 month n (%)		
0 0 cm/sec	29 (32.22)	9 (10)	Z=5.61 ***p=0.000000	***p=0.0003
1 1 – 14 cm/sec	5 (5.56)	2 (2.22)		p=0.25
2 15 – 25 cm/sec	14 (15.58)	11 (12.22)		p=0.51
3 26 – 35 cm/sec	16 (17.78)	13 (14.44)		p=0.54
4 36 – 45 cm/sec	7 (7.78)	19 (21.11)		*p=0.011
5 >45 cm/sec	16 (17.78)	34 (37.78)		**p=0.0027
missing	3 (3.33)	2 (2.22)		

Z (Wilcoxon Matched Pairs Test)

*sig<0.05, **sig<0.01, ***sig<0.0001

Table 12 shows the comparative results of the arterial Doppler on the anterior tibial artery, before the intervention and three (3) months after. The difference in flow velocity through the ATA, three (3) months after the intervention compared to before the intervention, was statistically significant (p<0.0001).

The comparison of patients concerning individual categories of flow velocity through the anterior tibial artery before and three (3) months after the intervention showed a significantly lower percentage of patients without flow after the intervention (8.89% vs. 32.22%, p=0.0001), an insignificant lower percentage of patients with PS of 1-14 cm/sec after the intervention (3.33% vs. 5.56%, p=0.47), an insignificant lower percentage of patients with PS of 15-25 cm/sec after the intervention (10% vs. 15.58%, p=0.26), an insignificant lower percentage of patients with PS of 26-35 cm/sec after the intervention (14.44% vs. 17.78%, p=0.54), a significantly higher percentage of patients with PS of 36-45 cm/sec after the intervention (22.22% vs. 7.78%, p=0.0067), and a significantly higher percentage of patients with PS>45 cm/sec after the intervention (38.89% vs. 17.78%, p=0.0017). (Table 12)

Table 12. Comparison of flow velocity in the ATA before and three (3) months after the intervention

ATA				
Flow velocity (PS) (cm/sec)	Intervention		p-value	difference test
	before n (%)	after 3 months n (%)		
0 0 cm/sec	29 (32.22)	8 (8.89)	Z=5.74 ***p=0.000000	***p=0.0001
1 1 – 14 cm/sec	5 (5.56)	3 (3.33)		p=0.47
2 15 – 25 cm/sec	14 (15.58)	9 (10)		p=0.26
3 26 – 35 cm/sec	16 (17.78)	13 (14.44)		p=0.54
4 36 – 45 cm/sec	7 (7.78)	20 (22.22)		**p=0.0067
5 >45 cm/sec	16 (17.78)	35 (38.89)		**p=0.0017
missing	3 (3.33)	2 (2.22)		

Z (Wilcoxon Matched Pairs Test)

**sig<0.01, ***sig<0.0001

Table 13 shows the comparative results from the Arterial Doppler of the anterior tibial artery before and six (6) months after the intervention. A statistically significant difference in the flow velocity through the ATA was confirmed six (6) months post-intervention compared to pre-intervention (p<0.0001).

The comparison of patients according to the individual categories of flow velocity through the anterior tibial artery before and six (6) months after the intervention showed a significantly lower percentage of patients with no flow post-intervention (6.67% vs. 32.22%, p<0.0001), an insignificantly lower percentage of patients with a PS of 1-14 cm/sec post-intervention (3.33% vs. 5.56%, p=0.47), an insignificantly lower percentage of patients with a PS of 15-25 cm/sec post-intervention (10% vs. 15.58%, p=0.26), an insignificantly lower percentage of patients with a PS of 26-35 cm/sec post-intervention (14.44% vs. 17.78%, p=0.54), a significantly higher percentage of patients with a PS of 36-45 cm/sec post-intervention (20% vs. 7.78%, p=0.018), and a notably higher percentage of patients with a PS >45 cm/sec post-intervention (43.33% vs. 17.78%, p=0.0002). (Table 13)

Table 13. Comparison of flow velocity of the ATA before and six (6) months after the intervention

ATA				
Flow velocity PS (cm/sec)	Intervention		p-value	difference test
	before n (%)	after 6 months n (%)		
0 0 cm/sec	29 (32.22)	6 (6.67)	Z=6.15 ***p=0.000000	***p=0.0000
1 1 – 14 cm/sec	5 (5.56)	3 (3.33)		p=0.47
2 15 – 25 cm/sec	14 (15.58)	9 (10)		p=0.26
3 26 – 35 cm/sec	16 (17.78)	13 (14.44)		p=0.54
4 36 – 45 cm/sec	7 (7.78)	18 (20)		*p=0.018
5 >45 cm/sec	16 (17.78)	39 (43.33)		***p=0.0002
missing	3 (3.33)	2 (2.22)		

Z (Wilcoxon Matched Pairs Test)

**sig<0.01, ***sig<0.0001

Table 14 shows the comparative results from the arterial Doppler of the anterior tibial artery before and nine (9) months after the intervention. A statistically significant difference in the flow velocity through the ATA was confirmed nine (9) months after the intervention compared to the flow velocity before the intervention, with p<0.0001.

The comparison of patients regarding the individual categories of flow velocity through the anterior tibial artery before and nine (9) months after the intervention showed a significantly lower percentage of patients without flow after the intervention (5.56% vs. 32.22%, p<0.0001), an insignificantly lower percentage of patients with PS from 1–14 cm/sec (3.33% vs. 5.56%, p=0.47), an insignificantly lower percentage of patients with PS from 15–25 cm/sec (7.78% vs. 15.58%, p=0.1), a significantly lower percentage of patients with PS from 26–35 cm/sec after the intervention (7.78% vs. 17.78%, p=0.0445), a notably higher percentage of patients with PS from 36–45 cm/sec after the intervention (24.44% vs. 17.78%, p=0.0024), and a particularly higher percentage of patients with PS >45 cm/sec (48.89% vs. 17.78%, p=0.0000). (Table 14)

Table 14. Comparison of flow velocity of the ATA before and nine (9) months after the intervention

ATA				
Flow velocity PS (cm/sec)	intervention		p-value	difference test
	before n (%)	after 9 months n (%)		
0 0 cm/sec	29 (32.22)	5 (5.56)	Z=6.52 ***p=0.000000	***p=0.0000
1 1 – 14 cm/sec	5 (5.56)	3 (3.33)		p=0.47
2 15 – 25 cm/sec	14 (15.58)	7 (7.78)		p=0.1
3 26 – 35 cm/sec	16 (17.78)	7 (7.78)		*p=0.0445
4 36 – 45 cm/sec	7 (7.78)	22 (24.44)		**p=0.0024
5 >45 cm/sec	16 (17.78)	44 (48.89)		***p=0.0000
missing	3 (3.33)	2 (2.22)		

Z (Wilcoxon Matched Pairs Test)

*sig<0.05, **sig<0.01***sig<0.0001

One month after the intervention, a smaller percentage of patients had collaterals in the SFA (1.11% vs. 4.44%), in the PA (8.89% vs. 17.78%), and a smaller percentage of patients had improved circulation in the native arteries without collaterals (30% vs. 38.89%). One month after the intervention, a higher percentage of patients had collaterals in the SFA, PA (6.67% vs. 1.11%), in the PA, PTA/ATA/A.INTEROSSEA (10% vs. 0), in the PTA/ATA/A. INTEROSSEA (14.44% vs. 12.22%), and in the SFA, PA, PTA/ ATA/A.INTEROSSEA (1.11% vs. 0). The difference in the percentage of collaterals before and one month after the intervention in the PA, PTA/ATA/A.INTEROSSEA was statistically significant (p=0.0021). (Table 15)

Table 15. Presence of collaterals before and one (1) month after the intervention

Collaterals	Intervention		difference test
	before n (%)	after 1 month n (%)	
0 none	17 (18.89)	6 (6.67)	
1 SFA	4 (4.44)	1 (1.11)	p=0.17
1.2 SFA, PA	1 (1.11)	6 (6.67)	p=0.054
2 PA	16 (17.78)	8 (8.89)	p=0.08
2.3 PA, PTA/ATA/A. INTEROSSEA		9 (10)	**p=0.0021
2.4 PA, Improved circulation in native arteries without collaterals	5 (5.56)	6 (6.67)	p=0.76
3 PTA/ATA/A. INTEROSSEA	11 (12.22)	13 (14.44)	p=0.66
3.4 PTA/ATA/A. INTEROSSEA Improved circulation in native arteries without collaterals	1 (1.11)	8 (8.89)	*p=0.017
4 Improved circulation in native arteries without collaterals	35 (38.89)	27 (30)	p=0.21
1.2.3 SFA, PA, PTA/ATA/A. INTEROSSEA		1 (1.11)	p=0.32
2.3.4 PA, PTA/ATA/A. INTEROSSEA, Improved circulation in native arteries without collaterals		4 (4.44)	*p=0.043
1.2.3.4 SFA, PA, PTA/ATA/A. INTEROSSEA, Improved circulation in native arteries without collaterals		1 (1.11)	p=0.32

*sig p<0.05, **sig p<0.01

Six (6) months after the intervention, there was a nonsignificantly lower percentage of patients with collaterals on the SFA (2.22% vs. 4.44%, p=0.41), a significantly lower percentage of patients with collaterals on the PA (6.67% vs. 1.11%, p=0.023), a nonsignificantly higher percentage of patients with collaterals on the SFA, PA (6.67% vs. 1.11%, p=0.054), a significantly higher percentage of patients with collaterals on the PA, PTA/ATA/A.INTEROSSEA (12.22% vs. 0, p=0.0006), while the percentage of patients with collaterals on the PTA/ATA/A.INTEROSSEA (12.22% vs. 11.11%, p=0.82) and on the SFA, PA, PTA/ATA/A.INTEROSSEA (0 vs. 1.11%, p=0.32) remained similar before and six (6) months after the intervention. (Table 16)

Table 16. Presence of collaterals before and six (6) months after the intervention

Collaterals	Intervention		difference test
	before n (%)	after 6 months n (%)	
0 none	17 (18.89)	5 (5.56)	
1 SFA	4 (4.44)	2 (2.22)	p=0.41
1.2 SFA, PA	1 (1.11)	6 (6.67)	p=0.054
2 PA	16 (17.78)	6 (6.67)	*p=0.023
2.3 PA, PTA/ATA/A. INTEROSSEA		11 (12.22)	***p=0.0006
2.4 PA, Improved circulation in native arteries without collaterals	5 (5.56)	1 (1.11)	p=0.096
3 PTA/ATA/A. INTEROSSEA	11 (12.22)	10 (11.11)	p=0.82
3.4 PTA/ATA/A. INTEROSSEA Improved circulation in native arteries without collaterals	1 (1.11)	11 (12.22)	**p=0.0028
4 Improved circulation in native arteries without collaterals	35 (38.89)	23 (25.56)	p=0.056
1.2.3 SFA, PA, PTA/ATA/A. INTEROSSEA		1 (1.11)	p=0.32
2.3.4 PA, PTA/ATA/A. INTEROSSEA, Improved circulation in native arteries without collaterals		13 (14.44)	***p=0.0002
1.2.3.4 SFA, PA, PTA/ATA/A. INTEROSSEA, Improved circulation in native arteries without collaterals		1 (1.11)	p=0.32

Nine (9) months after the intervention, there were no patients with collaterals on the SFA (0 vs. 4.44%, p=0.043) and with collaterals on the PA (0 vs 17.78%, p=0.0000). Collaterals on the SFA, PA had a nonsignificantly higher percentage of patients (5.56% vs. 1.11%, p=0.096). Collaterals on the SFA, PTA/ATA/A.INTEROSSEA had a nonsignificantly higher percentage of patients (2.22% vs. 0, p=0.15). Collaterals on the PA, PTA/ATA/A.INTEROSSEA had a significantly higher percentage of patients (26.27% vs. 0, p=0.0000). Collaterals on the PTA/ATA/A.INTEROSSEA had a significantly lower percentage of patients (3.33% vs. 12.22%, p=0.026). Collaterals on the PA, PTA/ATA/A.INTEROSSEA had a significantly higher percentage of patients (12.22% vs. 1.11%, p=0.0028). (Table 17)

Table 17. Presence of collaterals before and nine (9) months after the intervention

Collaterals	Intervention		difference test
	before n (%)	after 9 months n (%)	
0 none	17 (18.89)	4 (4.44)	
1 SFA	4 (4.44)		*p=0.043
1.2 SFA, PA	1 (1.11)	5 (5.56)	p=0.096
1.3 SFA, PTA/ATA/A. INTEROSSEA		2 (2.22)	p=0.15
2 PA	16 (17.78)		***p=0.0000
2.3 PA, PTA/ATA/A. INTEROSSEA		24 (26.67)	***p=0.0000
2.4 PA, Improved circulation of native arteries without collaterals	5 (5.56)	2 (2.22)	p=0.25
3 PTA, ATA, A. INTEROSSEA	11 (12.22)	3 (3.33)	*p=0.026
2.3 PA, PTA/ATA/A. INTEROSSEA	1 (1.11)	11 (12.22)	**p=0.0028
2.4 PA, Improved circulation of native arteries without collaterals	35 (38.89)	22 (24.44)	*p=0.037
3 PTA, ATA, A. INTEROSSEA		2 (2.22)	p=0.15
2.3 PA, PTA/ATA/A. INTEROSSEA		14 (15.56)	***p=0.0001
2.4 PA, Improved circulation in native arteries without collaterals		1 (1.11)	p=0.32

DISCUSSION

Searching through the avaliable literature, we discovered that there were very few studies discussing the link between arterial vascular disease and vein insufficiency.

According to a study published by Matic, (12) where the aim of this study was to identify some common risk factors for both chronic venous insufficiency (CVI) and PAD, as well as to determine whether there is a higher incidence of PAD among CVI patients compared to the control group. The study showed that PAD occurs more often in patients with severe venous insufficiency

In another study published by Ammermann (13), main points were the frequency, traits and clinical importance of co-occurring venous insufficiency in individuals with suspected or confirmed PAD who were evaluated by run-off MRA. About one-fifth of individuals with known or suspected PAD who are evaluated with run-off MRA show signs of potential concurrent CVI. These results should be reported if they are found since CVI might mimic or exacerbate symptoms associated with PAD.

In our study we proceed the link between PAD and venous insufficiency to a level of sclerosis of insufficient superficial vein system and follow up the peripheral arterial system in a patients with PAD. We have evaluate the differences before and after the sclerosis of insufficient superficial veins, by arterial Doppler and CT scan of peripheral angiography and we proved that the patients had better arterial flow evaluated by PSV by Doppler of native arteries and collaterals and enlargement of old collaterals or showing a new collaterals after the sclerosis especially of the arterial vascular region of bellow the knee and femoral region on CT scan, and the patients increase the walking distance after the sclerosis, pain relief symptoms and recovery the sensatory and motorial functions of the feet of the patients with symptomatic PAD after sclerosis of insufficient superficial vein system.

CONCLUSION

Based on the results obtained, we concluded that the blood flow in the arterial bed improved immediately after the sclerosis of superficial insufficient veins, with significant improvement and development of collateral networks or improving the present collateral network over the following months. That contributes to the deficiency of symptoms of peripheral arterial disease by decreasing

calf pain, thereby increasing the walking distance and consequently, promoting the development of new and old collateral arterial networks, which ultimately represents a long-term solution for patients with symptomatic peripheral arterial disease.

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