



ARE THERE ANY RECOMMENDATION GUIDELINES FOR PREVENTING DEVELOPMENT OF FUTURES STAGES OF VEIN INSUFFENCY AND AVOIDING ENDOVENOUS LASER ABLATION (EVLA) IN YOUNG RECREATIVE SPORTSMEN AGE 20-30 WITH SUPPORT OF SPORTS COMPRESSION SOCKS DURING EXERCISE TRAINING?

Sid Solakovic^{[a]*}, Nina Solakovic^[b], Amina Godinjak^[c], Emir Solaković^[d], Mensur Vrcic^[e], Ratko Pavlović^[f], Iryna Skrypchenko^[g], Olena Dorofieieva^[h], Kseniya Yarymbash^[e]

Article History: Received: 05.09.2022

Revised: 10.10.2022

Accepted: 20.11.2022

Abstract: Background: Varicose veins and vein insufficiency as is mostly aesthetic problem disease with hidden etiology witch is treated endovenous Laser Ablation (EVLA) method in most cases. The progression of Venous abnormalities in lower extremities with sport connection or exercise training among athletes aged 20-30 is relatively unknown. But is still in scientific eye the excesses recommendation in varicose patients witch is better; Stationary Bike Exercise Training with Sports Compression Socks or Jogging on Treadmill and witch sport can or even have the potential to reduce the pathological process preventing the futures stage of vein insufficiency with the development of pathological reflux of saphenofemoral junction and leg ulcers.

Aim: study Focused Clinical Question. Is any sport exercise limitation in young varicose vein patients and with recommendation is better for young adults (treadmill jogging or stationary cycling including weights lifting)?

Patients and methods: This study was conducted from the beginning of July, 2018 till end of July, 2021 at the Clinic of Cardiovascular department of Vascular Surgery, Clinical Center University of Sarajevo and Faculty of Sport and Physical Education, University of Sarajevo, included 142 patients in young age 20-30 with varicose vein (72 nonsurgical patients were observed during one year on standard weight lifting and Treadmill sport excise with and without Sports Compression Socks and control group consisting of 70 nonsurgical were observed during one year patients on Stationary Bike and weight lifting and with and without Sports Compression Socks), male and female patients, in Stage 1: Spider Veins and Stage 2: Varicose Veins / Ropey Veins without pathologic reflux of saphenofemoral junction.

Results: Analysis shows the no statistically significant difference between Stationary Bike Exercise Training with Sports Compression Socks or Jogging on Treadmill Sports Compression after one year study ($p > 0.005$).

Conclusion: Stationary Bike Training with Sports Compression Socks provide better protection as an alternative of Treadmill jogging with Sports Compression Socks for progression of futures stage of vein insufficiency and can be potentially recommended, but still need more evidence and large number of subjects to acknowledge this science clamed.

Keywords: Varicose veins, Vein insufficiency, Compression Socks, Jogging, Stationary Cycling, Weights lifting.

[a]. Special Hospital dr.Solakovic Department for Vascular Surgery Sarajevo, BIH

[b]. The International University of Gorazde (IUG) Medical Faculty, BIH

[c]. Cardiovascular Surgery Clinic and Vascular Surgery Department, Clinical Center of the University in Sarajevo, BIH

[d]. Faculty of Sport and Physical Education, University of Sarajevo, BIH

[e]. Faculty of Physical Education and Sport, University of East Sarajevo, BIH

[f]. Dnipropetrovsk State University of Internal Affairs, Dnipro, Ukraine

[g]. Bogomolets National Medical University Department of physical rehabilitation and sport medicine, Kyiv, Ukraine

[h]. Bogomolets National Medical University Department of physical rehabilitation and sport medicine, Kyiv, Ukraine

***Corresponding Author**

E-mail: sid.solakovic@gmail.com

DOI: 10.31838/ecb/2022.11.11.008

INTRODUCTION

Excessive dilatation, elongation and potential tortuosity are characteristics of varicose diseases especially at the level of the lower leg with progression and potential for spreading throughout anatomically affected venous segment that often accompanies the reflection of physical intensity activities with or without genetic predisposition to varicose disease with noticeable and imperceptible accompanying venous symptomatology of further development of insufficiency saphenofemoral and saphenopopliteal vein to the final surgical Endovenous Laser Ablation (EVLA) Interventions (1-2). The compression (elastic) socks is recognized and effective conservative and preventive method of treating venous insufficiency in patients with varicose veins as well as athletes (professionals, amateurs and recreationists) modified multi-purpose applications at high loads in the form of muscle improvement pumps and potential prevention of muscle damage during aerobic or anaerobic exercise, and the benefits themselves reflect on the quality of training and recovery (2). Symptomatology itself of pain and swelling in the legs at high stall loads, running a bike can be provoked or in direct relation to the genetics of venous insufficiency as well as partially masked clinical picture of unreliable symptoms of venous insufficiency and accelerate itself pathological process of disease development into further stage (2-3). In addition to the clinical examination of detection varicose veins, ultrasound diagnostic measurement is an important unavoidable factor as well as the role itself clinical picture in operatively conservative treatment with prediction and focus monitoring the further treatment process in the form of continued operative or conservative treatment (2-5). Despite the modernized development of indicative medical radiology technology ultrasound examination (Duplex scanning) saphenofemoral junction remains a key factor in setting indications for further treatment guidelines in addition to impaired functionality of weakened crural muscle pump which are of secondary importance in patients while in athletes it represents an additional and serious problem in the form of underutilization, unused and unusable stasis venous blood in the venous system and deficiencies as well as needs for vasomiotective alternative solutions such as compression sports socks covering a wide range of applications in sports (6-7). In addition to genetic risk factors, pregnancy, obesity of various concept exercises under the load of an individual are prone to vasodilators changes in the upper and lower extremities which, depending on the intensity of the load and as well as decades of the training process itself of certain sports activities consequences vasolytic damage as well as sudden oscillations in individual weight and severity in low body fat percentage below 8%. Tests have confirmed and improvements in technical performance and maximization of power in the technical performance of short application of compression stockings in scientifically tested versus without application of compression socks on a control group of football players (12). The question arises; Is a preventive therapeutic solution enough? A compression stocking with a stationary bicycle and whether it is safe and super-general training method over the treadmill in young recreational athletes with varicose veins (stage I) in the

form of expansion of varicose disease and the emergence of crucial pathology saphenofemoral reflux to indicate a potential surgical treatment? (15)

The purpose of this study is to obtain a reliable insight into the benefits of compression stockings in subjects with reflection on venous status with a positive effect on physiological preservation of saphenofemoral reflux and perforators who are active aerobic and anerobic recreational training process 4-6 times a week. The purpose of the study is to focus on the vasodilatory protection of the compression stockings at different types of intensity and exercise due to the exposure of training as well as records of potential and further development of the stage of venous disease. activities in a patient with varicose veins (stationary bicycle or treadmill), and whether there is a purpose for the application of compression stockings in subjects who are actively involved in sports or need invasive surgical treatment in the form of varicectomy with possible stripping of the saphenous vein or Endovenous Laser Ablation (EVLA) with combinations of sclerotizant therapy or phlebectomy by Klapp and Smetani or Va Ramlet hooks).

SUBJECTS AND METHODS

The study includes a randomized double-blind multicenter study in the period of 3 years from June 2018 to June 2021, which included a total of 235 recreational respondents with a positive history of varicose veins in the family (father / mother) in fitness clubs with BMI 20-30, (average) 25.12) Ages 20 to 30 years (mean age for female and male population 27.43) with stage I varicose veins who used compression stockings and those who did not use compression intensity therapy (20-30mmHg) during conception aerobic and anerobic training, which were conducted 4-6 times a week between 1.5-3.5 hours of different intensity and effort. The training concept included combinations of anaerobic and aerobic exercises with and without the inclusion of additional props (kettlebell, medicine ball, pilates weightlifting program as well as the use of fitness equipment). All respondents involved in the study had a positive family history (father / mother) and stage I varicose veins. The test group consists of 2 groups: the first subgroup that used compression stockings and aerobic treadmill selection. The second subgroup that did not use compression stockings and aerobic treadmill selection. The control group also consisted of 2 groups. the first subgroup that used compression socks and aerobic choice of stationary bicycle and the second subgroup that did not use compression socks and aerobic choice of stationary bicycle, dumbbells, props (heat, medical, balls)

Ethical Authorization

Since this is follow-up of patients without modifications of the ethical indicative medical treatment, no ethical principle of this study has been violated or added to.

Funding

The all international author (s) received no financial support for the research, authorship and / or publication of this article.

Table 1. Inclusion criteria before three years (36 months) of study (p <0.005)

Total patients	235
Average Age between 20 and 30	25± 0.7
total male subjects	109
total female subjects	53
group with and woutout elastic compression stockings (20 - 30 mmHg) underknee	162
BMI 20-30 (male / female)	27± 1.2
Average BMI (small)	23.15
Average BMI (female)	26.36
Caucasian blakan young population	142
between 2-4 mm perforator of diameter	2,4 ± 0.3mm
borderline perforator reflux 300-350 ms	105
under 4 mm perforator diametar in Middle third of thigh (Dodd's) 300-350 ms	65± 2
under 4 mm diameter perforator in Upper calf (Boyd's perforator) 300-350 ms	94
Upper under 4 mm diameter perforator in Lower calf (Crocket's perforator) 300-350 ms	99
Middle under 4 mm perforator diameter in Lower calf (Crocket's perforator) 300-350 ms	98± 4
Lower under 4 mm perforator diameter in Lower calf (Crocket's perforator) 300-350 ms	79
Saphenofemoral junction refluxs under (normal valve function) 500 ms	69± 5
Saphenofemoral junction diameter under 5.5 mm	235
positive family history of varicose vein (mother / father)	109
No DVT findings in deep illiac and femoral vein, also poplitel vein and cruralis veins.	0
No Secondary varicose findings	0
No subjects with active ulceration	0

Table 2.exclusion criteria before three years (36 months) of study (p <0.005)

varicose veins without pathology reflux over 500 ms	0
borderline perforator reflux over 350 ms	0
Age under 20 and over 30	0
elastic compression stockings (over 30 mmHg) overknee	0
elastic compression stockings (under 20 mmHg) overknee	0
Previous varicose vein surgery	0
Previous sclerotherapy	0
over 4 mm perforator diameter	0
over 4 mm perforator diametar in Middle third of thigh (Dodd's) over 350 ms	0
over 4 mm perforator diameter in Upper calf (Boyd's perforator) over 350 ms	0
Upper over 4 mm diameter perforator in Lower calf (Crocket's perforator) over 350 ms	0
Middle over 4 mm diameter perforator in Lower calf (Crocket's perforator) over 350 ms	0
Lower over 4 mm perforator diameter in Lower calf (Crocket's perforator) over 350 ms	0
DVT findings (low and upper extremitis)	0
valvular reflux findings over 500ms in the great saphenous vein	0
saphenofemoral junction diameter over 5.5 mm	0
negative family history of varicose vein (mother / father)	2±1
No subjects with active ulceration	0
No subjects are compare with the sid effects with locaction extreamly al aplay	0

RESULTS

The results contained in tables (3-7) and graphs (1-4) show that no pathological safefemoral reflux with perforator insufficiency was observed in subjects who used a stationary bicycle as well as a treadmill. It is evident that compression stockings (sports compression stockings) are beneficial against

the progression of varicose veins. Also, the use of permanent compression stockings on the stationary bike and treadmill (treadmill) can have a positive protective and therapeutic benefit for preventing the further spread of varicose diseases and improving muscle pumps and potential protection for the further development of venous insufficiency of the superficial venous system and the very quality of physical benefits activities.

Table 3. Results after one year (12 months) of study in subjects with compression socks on stationary bike

Toatal subjects		41
Total male subjects	22	
Total female subjects		19
Average Crocket's perforator diameter for woman		2.31 ± 0.09mm
Average Crocket's perforator diameter for men		3.13 ± 0.12mm
over 4 mm perforator diameter		0
under 4 mm perforator diameter		41
Upper over 4 mm diameter perforator in Lower calf (Crocket's perforator) over 350 ms		1
Middle over 4 mm diameter perforator in Lower calf (Crocket's perforator) over 350 ms	2	
Lower over 4 mm perforator diameter in Lower calf (Crocket's perforator) over 350 ms		0
over 4 mm perforator diametar in Middle third of thigh (Dodd's) over 350 ms		0
over 4 mm perforator diameter in Upper calf (Boyd's perforator) over 350 ms		0
Saphenofemoral junction diameter over 5.5 mm		0
valvular reflux findings over 500ms in the great saphenous vein		1
valvular reflux findings over 500ms in the small saphenous vein		0
lost to follow up		0

Table 4. Results after one year (12 months) of study in subjects without compression socks on stationary bike

Toatal subjects		39
Total male subjects		23
Total female subjects		16
Average Crocket's perforator diameter for woman		2.31 mm
Average Crocket's perforator diameter for men		3.13 mm
over 4 mm perforator diameter		4
under 4 mm perforator diameter		35
Upper over 4 mm diameter perforator in Lower calf (Crocket's perforator) over 350 ms		2
Middle over 4 mm diameter perforator in Lower calf (Crocket's perforator) over 350 ms		3
Lower over 4 mm perforator diameter in Lower calf (Crocket's perforator) over 350 ms		2
over 4 mm perforator diametar in Middle third of thigh (Dodd's) over 350 ms		0
over 4 mm perforator diameter in Upper calf (Boyd's perforator) over 350 ms		0
Saphenofemoral junction diameter over 5.5 mm		1
valvular reflux findings over 500ms in the great saphenous vein		0
valvular reflux findings over 500ms in the small saphenous vein		1
lost to follow up		0

Table 5. Results after two years (24 months) of study in subjects with compression socks on treadmill

Total subjects		38
Total male subjects		18
Totalfemale subjects		20
Average Crocket's perforator diameter for woman		2.31 mm
Average Crocket's perforator diameter for men		3.13 mm
over 4 mm perforator diameter		3 ± 1
under 4 mm perforator diameter		37
Upper over 4 mm diameter perforator in Lower calf (Crocket's perforator) over 350 ms		3
Middle over 4 mm diameter perforator in Lower calf (Crocket's perforator) over 350 ms		2
Lower over 4 mm perforator diameter in Lower calf (Crocket's perforator) over 350 ms		2
over 4 mm perforator diametar in Middle third of thigh (Dodd's) over 350 ms		4
over 4 mm perforator diameter in Upper calf (Boyd's perforator) over 350 ms		2
Saphenofemoral junction diameter over 5.5 mm		0
valvular reflux findings over 500ms in the great saphenous vein		0
valvular reflux findings over 500ms in the small saphenous vein		0
lost to follow up		

Table 6. Results after two years (24 months) of study in subjects without compression socks on treadmill

Total subjects	39
Total male subjects	21
Totalfemale subjects	18
Average Crocket's perforator diameter for woman	2.31 mm
Average Crocket's perforator diameter for men	3.13 mm
over 4 mm perforator diameter	1
under 4 mm perforator diameter	38
Upper over 4 mm diameter perforator in Lower calf (Crocket's perforator) over 350 ms	1
Middle over 4 mm diameter perforator in Lower calf (Crocket's perforator) over 350 ms	2
Lower over 4 mm diameter perforator in Lower calf (Crocket's perforator) over 350 ms	3 ± 1
over 4 mm perforator diametar in Middle third of thigh (Dodd's) over 350 ms	1
over 4 mm perforator diameter in Upper calf (Boyd's perforator) over 350 ms	2
Saphenofemoral junction diameter over 5.5 mm	0
valvular reflux findings over 500ms in the great saphenous vein	0
valvular reflux findings over 500ms in the small saphenous vein	0
lost to follow up	0

Table 7. Results after three years (36 months) of study in subjects with compression socks on treadmill

Total subjects	42
Total male subjects	25
Totalfemale subjects	17
Average Crocket's perforator diameter for woman	2.31 mm
Average Crocket's perforator diameter for men	3.13 mm
over 4 mm perforator diameter	0
under 4 mm perforator diameter	41
Upper over 4 mm diameter perforator in Lower calf (Crocket's perforator) over 350 ms	1
Middle over 4 mm diameter perforator in Lower calf (Crocket's perforator) over 350 ms	2
Lower over 4 mm perforator diameter in Lower calf (Crocket's perforator) over 350 ms	3
over 4 mm perforator diametar in Middle third of thigh (Dodd's) over 350 ms	3
over 4 mm perforator diameter in Upper calf (Boyd's perforator) over 350 ms	1
Saphenofemoral junction diameter over 5.5 mm	0
valvular reflux findings over 500ms in the great saphenous vein	1
valvular reflux findings over 500ms in the small saphenous vein	0
lost to follow up	0

Table 8: Results after three years (36 months) of study in subjects without compression socks on treadmill

Total Subjects	36
Total male subjects	26
Total female subjects	10
Average Crocket's perforator diameter for woman	2.31 mm
Average Crocket's perforator diameter for men	3.13 mm
over 4 mm perforator diameter	1
under 4 mm perforator diameter	35
Upper over 4 mm diameter perforator in Lower calf (Crocket's perforator) over 350 ms	2
Middle over 4 mm diameter perforator in Lower calf (Crocket's perforator) over 350 ms	2
Lower over 4 mm perforator diameter in Lower calf (Crocket's perforator) over 350 ms	1
over 4 mm perforator diametar in Middle third of thigh (Dodd's) over 350 ms	0
over 4 mm perforator diameter in Upper calf (Boyd's perforator) over 350 ms	1
Saphenofemoral junction diameter over 5.5 mm	1
valvular reflux findings over 500ms in the great saphenous vein	2
valvular reflux findings over 500ms in the small saphenous vein	1
lots to folow up	0

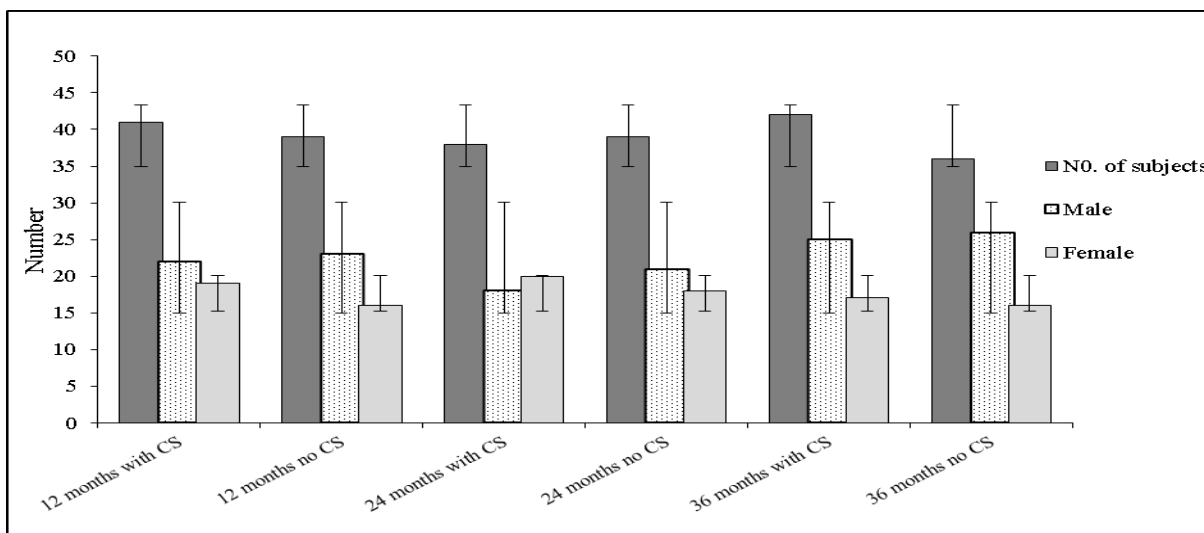


Figure 1. Results of study in subjects and with and without compression socks on stationary bike

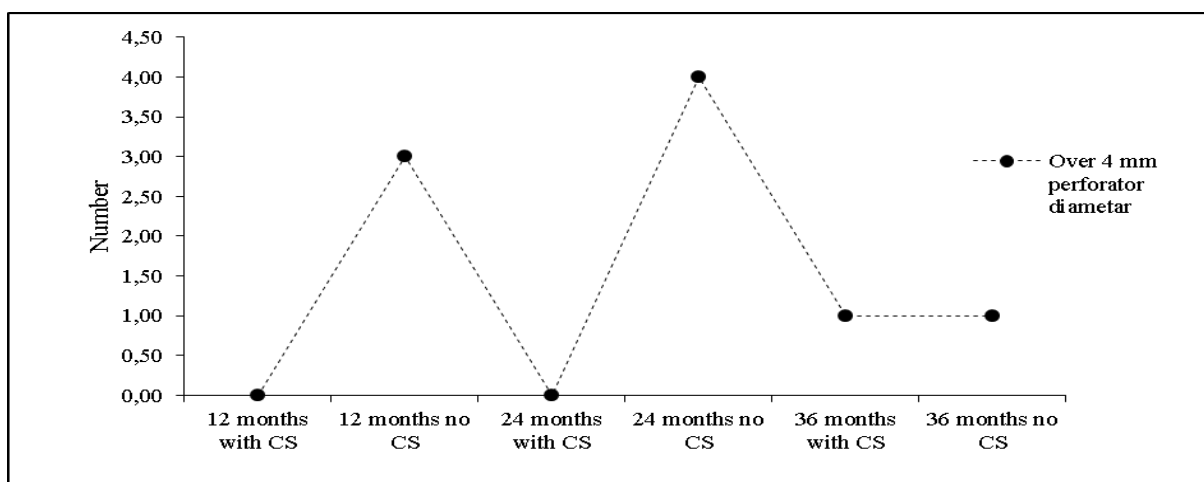


Figure 2. Results of study in subjects over 4mm perforator diameter

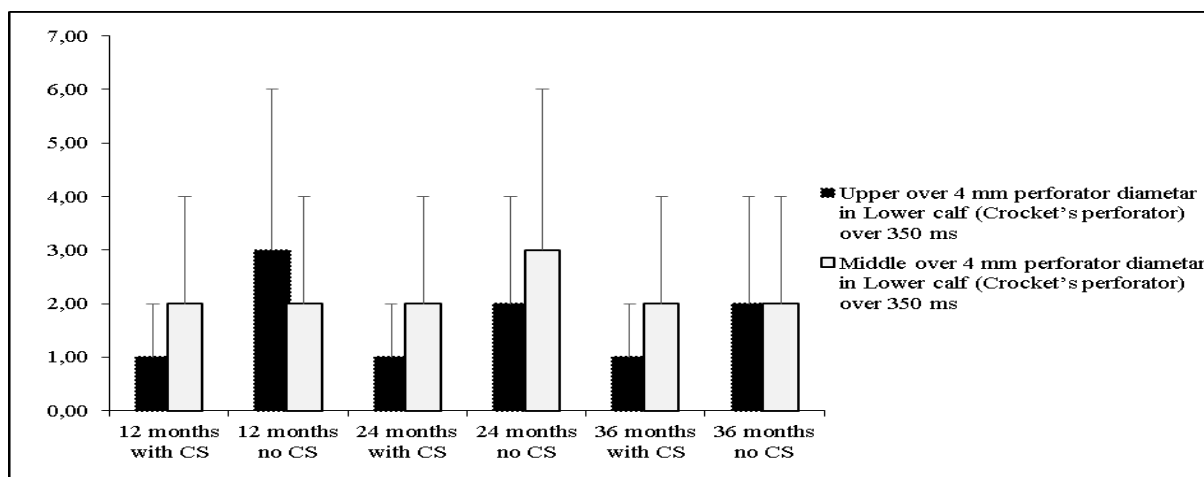


Figure 3. Results of study upper and middle over 4mm (Crocket's perforator) in lower calf over 350ms

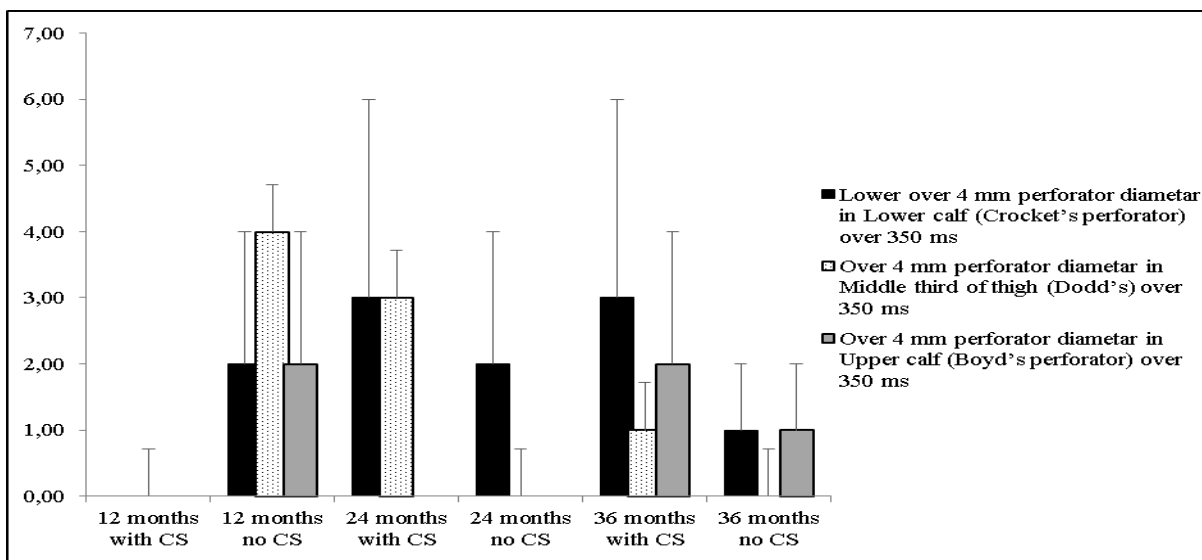


Figure 4. Results of study (Crocket's, Dodd's, Boyd's) of thigh and upper calf perforator over 350ms

DISSCUSION

Limitation of scientifically based indications for recommendations of sports activity in young recreational patients with stage I varicose diseases, especially by the vascular surgeon guidelines by detecting ultrasound without any operative significance except the application of sclerotizing therapy, which is not the domain of surgical treatment but mostly cosmetic (2,6). Although from the spectrum of vascular surgery the primary indication for operative solution of varicose veins is high-stage varicose disease with pathological reflux. Picture of the first stage of varicose veins for aesthetic reasons, as well as guidelines for further guidance of recreational athletes who are already exhibiting stages of varicose veins limit further and conventional aesthetic solutions as well as the solution of swelling of the legs during the manifestation of different concepts of aerobic activities of high intensity and duration. Although conservative treatment of varicose disease of the first degree through sclerosing and preventive compression therapy with the manifestation of sports activities is more in the recommendation of guidelines than an indication for appropriate physical activity of the consideration than only indicative applications treatment of varicose veins. Many studies have shown that compression stockings (18-22 mmHg) have no effect on preventing muscle damage by combining bikes and running long distances 70.3, while up to 10 km running elastic (compression) socks show improved endurance improvements with the benefit of facilitating individual regeneration of the muscle itself. Without adequate data on the progression of the stage of varicose veins as well as the importance of stretching before and after physical activity (15-20). Some studies have suggested atrophic changes following the application of sock compressions at the gastrocnemius level in conventional protocols (21-26). anthropomotor mechanization of lower extremity movements. In his study, Magnusson proved the benefits of compression stockings even

in cycling, where 15% improvement in oxygen was observed with elimination of up to 13% of toxins from muscle tissue at different types of intensity without subjective symptoms of swelling of the legs, inflammation with soreness and sensory, lateral and posterior compartment after prolonged bicycle training. 15 minutes after knee sock compression stockings improves strength and endurance as well as muscle oxygenation by minimizing venous pathway that cannot be used for reoxidation of blood with which recreational or amateur athletes would further exploit this potential to prevent muscle degeneration by improving muscle function in the form of potential muscle prevention and potential prevention of further expansion of venous insufficiency and perforator insufficiency as well as prevention of further development of varicose veins after surgical treatment in ordinary recreational athletes. (27-30). Possible development of deep vein thrombosis (DVT) without potential development of saphenofemoral pathological reflux, and by this conclusion recreational cycling without strong interval units in connection with compression stocking as a forced form of additional compression could be classified as avoiding the possibility of surgical or Endovenous Laser Ablation (EVLA). (31-38) We believe that the recommended application of compression stockings in grade I venous insufficiency and sports aerobic training on a treadmill or stationary bike is extremely important, and definitely leaves a preventive therapeutic effect after a year with the potential prevention of further expansion of varicose veins of grade I and II to the next stage. regardless of gender, although the female population group develops pathological changes faster than the male population group, with the subjectivity of the significance of the lighter recovery as well as reduction of lower leg swelling and better comfort and quality of training after applications of the sports socks themselves (39-45). It is scientifically proven efficacy and positive benefit of preventing the progression of venous disease symptomatology 3rd stage as well as prevention of ulceration in the application of compression stockings variable compression strength classes of

elasticity of application material with variation of application according to individual weight (13-14) The benefits of a stationary bicycle are known to prevent progression excessive dilatation and varicose vein disease due to muscle pump activity without strain on the joints, bones and ligaments caused mainly by the treadmill and therefore it is not suitable for obese patients and patients suffering from obesity due to loads on the osteochondral structures of the spine as well as individual parities of the lower body extremities. Due to its anaerobic and non-potential anaerobic properties as well as according to attitude In this opinion, a stationary bicycle would have an advantage over the treadmill in young people with varicose veins with the added application of compression stockings during exercise. The advantage of a treadmill is that it burns most of the calories and mobilizes most of the muscle in contrast from a stationary bicycle. Although the effectiveness of compression stockings in healthy athletes is scientifically recognized with a wide application, the effect is poorly known compression sports socks in young active patients with the progression of venous diseases that are directly related to the reduction of muscle pump and venous function stagnation and as with the selection of recommended sports aerobic activity in the patient first stage of venous insufficiency without pathological saphenofemoral reflux and weakness venous perforators of the lower leg (Dodd's. Crocket's perforator) (2-6). Sports medicine studies showed multi beneficial effects of compression (elastic) socks in the form of external manifestations effects on the very preservation of the functionality of pre-existing venous insufficiency with effect except more only with a preventive vasoprotective effect. Compressive effects themselves during physical aero-anaerobic stress as well as benefits after aero-anaerobic stress below knees have also been reported in improving muscle pump performance and preventively acting only on myodestruction and improving the regenerative recovery phase in runners different metabolic lactate phases as opposed to where they do not provide protection to muscle damage in triathletes at the Ironman 70.3 distance, the scientific question also arises between the benefits of the application and the potential benefits of the Marathons or better benefits in applications on short or medium lines (8-11).

CONCLUSION

After the end of the active recreational training process of three years, no pathological saphenofemoral reflux with perforator insufficiency was significantly observed in subjects who used a stationary bicycle as well as a treadmill. Competitive application alone would achieve and improve protective and antiedematous benefits. Although the compression stocking (sports compression stocking) was limited to the lower leg, it emphasized the benefit of varicose disease progression. Also with the application of constant compression stockings on stationary bike and treadmill (treadmill) we can achieve a positive protective and therapeutic benefit to prevent further spread of varicose disease and improvement muscle pumps as well as potential protections for further development of venous

insufficiency superficial venous system and the very quality of the benefits of physical activity.

Further Research

Although the progression of varicose veins depends on multietiological factors as well as hereditary factors, different variability of weight redistribution as well as large and sudden oscillations in body weight. From a scientific point of view, it would be difficult to focus on combinations, types of exercises and the degree of load with which the exercise is performed, and whether there is a direct or indirect connection supplements by recreational athletes, such as type (pre work outs), however, numerous participants are needed in the study with a detailed description of the intake of supplements and others supportive permitted pharmacological supplements with progression of muscle mass to be able to derive the scientific benefit of further prevention of young recreationalists.

Conflict Of Interest

The authors declare no conflict of interest

REFERENCES

- i. Holzheimer RG1, Stautner-Brückmann C et al Calf pain in runners may be caused by venous insufficiency *Eur J Med Res.* 2008 May 26; 13 (5): 218-20.
- ii. Zwiebel WJ. Introduction to vascular ultrasonography. In: Galt SW, Lawrence PF, editors. Rationale for duplex ultrasonography assessment of extremity veins. 4th ed. Philadelphia: WB Saunders; 2000. pp. 287-96.
- iii. Costas T, Ioannou CV, Touloupakis E, Daskalaki E, Giannoukas AD, Tsetis D, Katsamouris AN. Recurrent varicose veins after surgery: a new appraisal of a common and complex problem in vascular surgery. *Eur J Vasc Endovasc Surg* 2004; 27: 275–282.
- iv. Wright DD, Rose KG, Young E, Mc Collum CN. Recurrence following varicose vein surgery. *Phlebology* 2002; 16: 101–105.
- v. Benabou JE, Molnar LJ, Cerri GG. Duplex sonographic evaluation of the sapheno-femoral venous junction in patients with recurrent varicose veins after surgical treatment. *J Clin Ultrasound* 1998; 26: 401–404.
- vi. MG De Maeseneer, CP Vandebroek, JM Hendriks et al Accuracy of Duplex Evaluation One Year after Varicose Vein Surgery to Predict Recurrence at the Sapheno – Femoral Junction after Five Years *Eur J Vasc Endovasc Surg* (2005); 29; 308–312.
- vii. Englund R et al Duplex scanning for recurrent varicose veins *Aust NZJ Surg.* 1996 Sep; 66 (9): 618-20.
- viii. Stanek JM. et al. The Effectiveness of Compression Socks for Athletic Performance and Recovery. *J Sport Rehabil.* 2017 Jan; 26 (1): 109-114.
- ix. Wolfgang Kemmler; Simon von Stengel; Christina Köckritz et al. Effect of Compression Stockings on Running Performance in Men Runners *Journal of Strength and Conditioning Research.* 23 (1): 101-10.
- x. Del Coso J, Areces F, et al Compression stockings do not improve muscular performance during a half-ironman triathlon race. *Eur J Appl Physiol.* 2014 Mar; 114 (3): 587-95.

- xi. Areces F1, Salinero JJ, Abian-Vicen J et al .The use of compression stockings during a marathon competition to reduce exercise-induced muscle damage: are they really useful? *J Orthop Sports Phys Ther.* 2015 Jun; 45 (6): 462-70.
- xii. Hasan H, Davids K, Chow JY, Kerr G et al. Compression and texture in socks enhance football kicking performance. *Hum Mov Sci.* 2016 Aug; 48: 102-11.
- xiii. Senet P, Monfort JB, Debure C et al Compression therapy: Choosing the right option for leg ulcers in 2016 *J Mal Vasc.* 2016 Sep; 41 (5): 347-50.
- xiv. Nelson EA, Bell-Syer SE et al Compression for preventing recurrence of venous ulcers *Cochrane Database Syst Rev.* 2012 Aug 15; (8): CD002303. doi: 10.1002 / 14651858.CD002303.pub2.
- xv. Ali A, Caine MP, Snow BG (2007) Graduated compression stockings: physiological and perceptual responses during and after exercise. *J Sports Sci* 25: 413-419.
- xvi. Stephen B Thacker et al The impact of stretching on sports injury risk: a systematic review of the literature *Medicine and Science in Sports and Exercise.* 2004; 36 (3): 371-8.
- xvii. Juan Del Coso et al Compression stockings do not improve muscular performance during a half-ironman triathlon race *Eur J Appl Physiol.* 2014; 114: 587.
- xviii. K. Ye et al Post-operative Benefit of Compression Therapy after Endovenous Laser Ablation for Uncomplicated Varicose Veins: A Randomized Clinical Trial *Eur J Vasc Endovasc Surg* 2016 (52) 847-853.
- xix. S. Biswas, A. Clark and DA Shields Randomized Clinical Trial of the Duration of Compression Therapy after Varicose Vein Surgery *Eur J Vasc Endovasc Surg* 2007 (33), 631-637.
- xx. Raraty Gt, greeny G, et al There is no benefit from 6 weeks postoperative compression after varicose vein surgery: a prospective randomized trial. *Phlebology* 1999; (14): 21-2.
- xxi. OESCH A. 'Pin stripping': a novel method of atraumatic stripping. *Phlebology* 1993; 8: 171-173.
- xxii. Justin M. Stanek et al The Effectiveness of Compression Socks for Athletic Performance and Recovery *Journal of Sport Rehabilitation*, 2017, 26, 109 -114.
- xxiii. Scanlan AT, Dascombe BJ, Reaburn PRJ, Osborne M. The effects of wearing lower-body compression garments during endurance cycling. *Int J Sports Physiol Perform.* 2008; 3 (4): 424-438.
- xxiv. Kraemer WJ, Bush JA, Newton RU, Duncan ND, Volek JS, Denegar CR. Influence of a compression garment on repetitive power output production before and after different types of muscle fatigue. *Sports Med Train Rehabil.* 1998; 8 (2): 163-184.
- xxv. Miyamoto N, Hirata K, Mitsukawa N, Yanai T, Kawakami Y. Effect of pressure intensity of graduated elastic compression stocking on muscle fatigue following calf-raise exercise. *J Electromyogr Kinesiol.* 2011; 21 (2): 249-254.
- xxvi. Magnusson M, Kålebo P, Lukse P, Sivertsson R, Risberg B. Colors Doppler ultrasound in diagnosing venous insufficiency: a comparison to descending phlebography. *Eur J Vasc Endovasc Surg* 1995; 9: 437e43.
- xxvii. Ali A, Caine MP, Snow BG (2007) Graduated compression stockings: physiological and perceptual responses during and after exercise. *J Sports Sci* 25: 413-419.
- xxviii. Ali A, Creasy RH, Edge JA (2010) Physiological effects of wearing graduated compression stockings during running. *Eur J Appl Physiol* 109: 1017-1025
- xxix. Ali A, Creasy RH, Edge JA (2011) The effect of graduated compression stockings on running performance. *J Strength Cond Res* 25: 1385-1392.
- xxx. Faulkner JA et al Effect of lower-limb compression clothing on 400-m sprint performance. *J Strength Cond Res.* 2013 Mar; 27 (3): 669-76.
- xxxi. Chauveau, M. et al Effects of compression on venous haemodynamics. in: C. Gardon-Mollard, AA Ramlet (Eds.) *Compression therapy.* Masson, Paris; 1999: 23-28.
- xxxii. Kan YM, Delis KT: Hemodynamic effects of supervised calf muscle exercise in patients with venous Leg ulceration a prospective controlled study. *Arch Dermatol* 2001, 136 (12): 1364-1369.
- xxxiii. Yang D, Vandongen YK, Stacey MC: Effect of exercise on calf muscle pump function in patients with chronic venous disease. *Br J Surg* 1999,86 (3): 338-3
- xxxiv. Whiteley MS and O'Donnell TF. Debate: whether venous perforator surgery reduces recurrences. *J Vasc Surg* 2014; 60 (3): 796-803.
- xxxv. Sarin S, Scurr JH and Smith PD. Medial calf perforators in venous disease: the significance of outward flow. *J Vasc Surg* 1992; (16): 40-46.
- xxxvi. Rutherford EE, Kianifard B, Cook SJ, et al. Incompetent perforating veins are associated with recurrent varicose veins. *Eur J Vasc Endovasc Surg* 2001; 21 (5): 458-460.
- xxxvii. Salam A, Chung J and Milner R. External iliac vein stenosis owing to prolonged cycling. *Vascular* 2010; 18 (2): 111-115.
- xxxviii. Nakamura KM, Skeik N, Shepherd RF, et al. External iliac vein thrombosis in an athletic cyclist with a history of external iliac artery endofibrosis and thrombosis. *Vasc Endovascular Surg* 2011; 45 (8): 761-764.
- xi. Norman S. Williams, Christopher JK Bulstrode, P. Ronan O'Connell. *Bailey and Love's Short Practice of Surgery: Venous disorders.* 26th ed. Boca Raton, London, New York: CRC Press; 2013.p 927-940.
- xii. Courtney M. Townsend Jr., R. Daniel Beauchamp, B. Mark Evers, Kenneth L. Mattox. *Sabiston Textbook of Surgery The Biological Basis of Modern Surgical Practice: venous disease.* 19th ed, Philadelphia: Saunders Elseiver; 2012. p 1801-1816.
- xiii. Cavezzi A., Labropoulos N., Partsch H., Ricci S., Caggiati A., Myers K., Nicolaidis A. and Smith PC. Duplex ultrasound investigation of veins in chronic venous disease of the lower limbs- UIP consensus document. part II, Anatomy. *Eur J.Vasc Endovasc surg.* 2006 Mar; 31 (3): p 288-99.

- xliii. Kent PJ and Weston MJ. Duplex scanning may be used selectively in patients with primary varicose veins. *Ann R. Coll Surg Engl.* 1998 Nov; 80 (6): p 388-393.
- xliv. Nicloaides AN, Zukowski AJ. The value of dynamic venous pressure measurements. *World J Surg.* 1986 Dec; 10 (6): p 919-924.
- xliv. Cornu Thenard A., Boivin P., Baud JM., De Vincenzi I., and Carpentier PH. Importance of the familial factor in varicose disease clinical study of 134 families. *J. Dermatol surg oncol.* 1994 May; 20 (5): p 318-326.
- xlvi. Yang D, Vandongon YK and Stacey MC. Variability and reliability of air plethysmographic measurements for the evaluation of chronic venous disease. *J.Vasc Surg.* 1997 Oct; 26 (4): p 638-642.