ORIGINAL ARTICLE

EFFECT OF TRANSCUTANEOUS ELECTRICAL NERVE STIMULATION IN PAIN REDUCTION AND VENOUS BLOOD FLOW AUGMENTATION IN PATIENTS DIAGNOSED WITH VARICOSE VEINS

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Background: Patients with varicose veins experience pain in affected leg which is due to venous blood stasis in the lower limb therefore it is essential to determine the severity of pain along with venous blood flow in the affected area. For this purpose the study was conducted to observe the effect of Transcutaneous Electrical Nerve Stimulation for pain reduction and venous blood flow augmentation. **Methods:** In this study, 80 subjects were included which were divided into Group A (Healthy controls) n=40 and Group B (Varicose vein patients) n=40 which was further subdivided into Group 1 (Varicose vein controls) and Group 2 (Transcutaneous Electrical Nerve Stimulation application). Numeric Rating Scale was used to measure pain score and Duplex Ultrasound was done to measure popliteal vein peak flow velocity (Cm/Sec) and blood flow (mL/min) in both Group A, Group 1 and Group 2 (before and after experiment). **Results:** The Mean±SD of Numeric Rating Scale (NRS) in Group 2 (5.56±0.651) was statistically significantly reduced (p=0.004) as compared to Mean±SD in Group 1 (7.36±0.757). Similarly the Mean±SD of popliteal vein peak flow velocity (15.20±1.42) and popliteal vein blood flow (93.08±5.049) was statistically significantly raised (p=0.001) as compared to mean±SD of popliteal vein peak flow velocity (10.06±1.31) and popliteal vein blood flow (71.04±2.894) in Group 1. **Conclusion:** TENS can be used as an effective adjunctive treatment modality in patients suffering from varicose veins.

Keywords: Varicose veins, Transcutaneous Electrical Nerve Stimulation

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INTRODUCTION

Varicose veins are present in the sub-cutaneous tissue of lower limbs.[1] The prevalence of varicose veins worldwide ranges from 25–55% in women and 10–30% in men while in Pakistan its prevalence is 15%.[2] There are various predisposing factors that contribute to the development of Varicose veins which include advancing age, prolonged standing, family history, sedentary lifestyle, smoking, obesity, lower extremity trauma, increased estrogen levels, pregnancy, history of venous thrombosis in the past.[1,3] The major challenge which prevents the development of chronic venous disease is pumping of blood upward against gravity (CVD).[4] The competent one way valves located in the veins and the calf muscle pump (CMP) in the lower legs are recognized as the main mechanism for pumping blood upward.[5] The development of weakness in venous walls and calf muscles leads to the incompetence of one-way venous valves and calf pump failure which results in the reflux and stasis of blood in the lower extremity veins.[6,7] Varicose vein patients present with throbbing pain, night cramps, swelling, itching, cosmetic disfigurement and heaviness in the lower limbs.[8,9]

The most pragmatic diagnostic technique for Varicose veins is Duplex ultrasound which determines valvular incompetence in the sephanopopliteal and sephanofemoral junction, vein diameter, venous blood velocity and blood flow in lower limb veins.[10] As the patients of Varicose veins often present with pain in the legs therefore to appraise and evaluate the intensity of pain, a Numeric Rating Scale (NRS) is used. NRS is a horizontal line on which numbers from 0–10 are arranged which serve as the pain score of the patients.[11] Treatment options for Varicose veins is conservative and surgical treatment. Conservative treatment includes leg elevation, weight reduction, quitting cigarette smoking, performing regular exercise and use of Compression stockings.[5] Surgical treatment includes Stripping and ligation, Sclerotherapy, Endovascular heat ablation and Sub-fascial Endoscopic Perforator Surgery.[12]

Transcutaneous electrical nerve stimulation (TENS) is used to curtail pain and revamp muscle performance.[13] American Physical Therapy Association has described Transcutaneous electrical nerve stimulation (TENS) as a noninvasive and safe method used for alleviating acute and chronic pain.[13] The application of Transcutaneous electrical nerve stimulation (TENS) to the skin aids in mitigating post-operative, migraine, labor, musculoskeletal, neuropathic and osteoarthritic pain.[14] In addition to curtailing pain, it also enhances muscle performance and improves the blood flow.[15,16] Limited data is

available on the use of TENS in decreasing pain and augmenting blood flow in Varicose vein patients. Therefore, the current study is carried out to determine the effects of TENS in mitigating pain and enhancing blood flow in Varicose vein patients.

MATERIAL AND METHOD

Current study was carried out in the Department of Physiology of Islamic International Medical College, Rawalpindi in collaboration with the Department of Surgery, Physiotherapy and Radiology of the District Head Quarter and Railway General Hospital, Rawalpindi. This study was conducted from 1st October 2018 to 30th September 2019 which was a Quasi Experimental study and it was approved by the Ethical Review Committee of Islamic International Medical College, Riphah International University.

Non-probability convenience sampling was used for data collection during the study. A total of 80 subjects were included in the study The inclusion criteria included both males and females (25–60 years of age) who were diagnosed patients of Varicose veins Grade II (only varicosities in veins) and Grade III (varicosities in veins with oedema) according to Clinical, Etiological, Anatomical and Pathological (CEAP) classification[10] and normal healthy individuals with no physical disability or any other chronic disease.

Written informed consent was taken from all subjects and they were divided into Group A and Group B. Group A included 40 healthy subjects (Controls) on which no intervention was done and Group B included 40 subjects who were diagnosed cases of varicose veins Grade II and Grade III. Group B was further subdivided into Group 1 (Varicose vein controls) n=20 in which no treatment modality was used and Group 2 (n=20) which included subjects of varicose veins on which application of Transcutaneous Electrical Nerve Stimulation (TENS) was done. Detailed medical history was taken by asking the subjects to fill out a proforma which included their name, age, sex, occupation, disease symptoms, duration of disease, aggravating and relieving factors, past history, family history and any previous treatment.

Physical examination was performed by exposing lower limb till the middle of thigh. The location of the varicosities was noted and palpation was done for any skin induration or pitting oedema. The subjects of Group A and Group B were assessed through Numeric Rating Scale (NRS) for measurement of pain score which is an eleven point scale (0–10) with end points showing the extremes of pain.[11] Subjects were asked to rate their pain score by pointing the number on the NRS scale from 0–10 which represented their pain score.

The Duplex scan (Sonoscape-S11 4D Ultrasound Machine, Guangzhou Medical Equipment China) of lower extremity veins was performed to measure the popliteal vein peak flow velocity (Cm/Sec) and popliteal vein blood flow (ml/min).[10] The subjects were placed in the lying left lateral position on the couch. In case of Group A, any of the two lower limbs was exposed up to the knee joint while in case of Group B the affected leg with varicose veins was exposed up to the knee joint. Gel was applied on the probe of Duplex ultrasound machine and the probe was placed on the popliteal fossa of the exposed leg. The position of popliteal vein was located and the values of the popliteal vein peak flow velocity (Cm/Sec) and popliteal vein blood flow (mL/min) were recorded.

After performing this, the subjects of Group 2 (n=20) were exposed to Transcutaneous Electrical Nerve Stimulation (Classic TENS of Body clock company, Germany) intervention. After explaining the procedure, the pre-gelled two channel electrodes of TENS device were placed on the affected leg exposed till the knee joint in prone position. One electrode was placed below the proximal end of calf muscle heads, and second electrode was placed above the Achilles tendon. The patients were then placed in the supine position. The stimulator was set on a frequency of 4–5 Hz, pulse width of 100–200 microseconds with continuous mode of stimulation set for 30 minutes duration. The intensity was set according to patient's comfort which was 3–4 mA.[17] Calf muscle twitching was observed during this 30 minutes time.

These patients were given five sessions of 30 minutes duration a week for three weeks. After three weeks of the sessions, the Numeric Rating Scale (NRS) and Duplex ultrasound was done again to assess the pain score, the popliteal vein peak flow velocity (Cm/Sec) and popliteal vein blood flow (mL/min) to see any improvement in the pain score and popliteal vein blood flow of Group 2 subjects after the TENS application.

Data was analysed using SPSS-22. Results were expressed as Mean±SD. Independent *t*-test for comparison between the groups was applied and $p<0.05$ was regarded as statistically significant.

RESULTS

The Mean±SD of NRS, Popliteal vein peak velocity (Cm/Sec) and popliteal vein blood flow (mL/min) between Group A and Group B were compared by using independent sample *t*-test and is shown in Table-1. The Mean±SD of NRS in Group 1 (7.36±0.757) and Group 2 (5.56±0.651) were compared by using independent sample *t*-test and is shown in the Figure-1. The Mean±SD of Popliteal vein peak velocity (Cm/sec) in Group 1 (10.06±1.31) and Group 2 (15.20±1.42) were compared by using independent sample *t*-test and is shown in the Figure-2. The Mean±SD of Popliteal vein blood flow (ml/min) in Group 1 (71.04±2.894) and Group 2 (93.08±5.049) were compared by using independent sample *t*-test and is shown in the Figure-3.

Table-1: Comparison of Mean±SD of NRS, popliteal vein peak velocity (Cm/Sec) and popliteal vein blood flow (mL/min) between Group A and Group B

Study Parameters	Group A Control group (n=40)	Group B Experimental group (n=40)
NRS	0.00	7.60±0.22**[a]
Popliteal Vein Peak Velocity (Cm/Sec)	17.70±0.47	10.65±0.39**[b]
Popliteal Vein Blood Flow (mL/min)	117.0±1.47	73.40±.077**[c]

**p=0.001, statistically significant, **[a]=Comparison of NRS of Group A *vs* Group B, **[b]=Comparison of popliteal vein peak velocity (Cm/Sec) GroupA *vs* B, **[c]=Comparison of popliteal vein blood flow (mL/min) Group A *vs* B

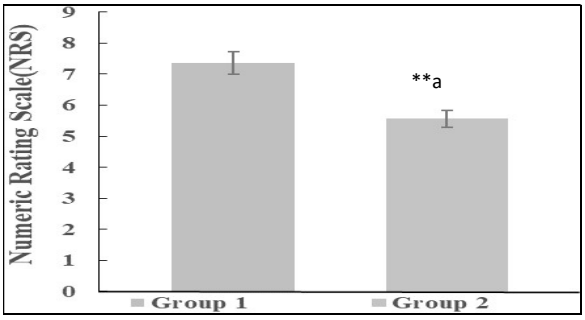

Figure-1: Comparison of Mean±SD of NRS in Group 1 and Group 2 of varicose vein patients

**p=0.004 is considered statistically significant
**a= Comparison of Mean±SD of NRS in Group 1 and Group 2

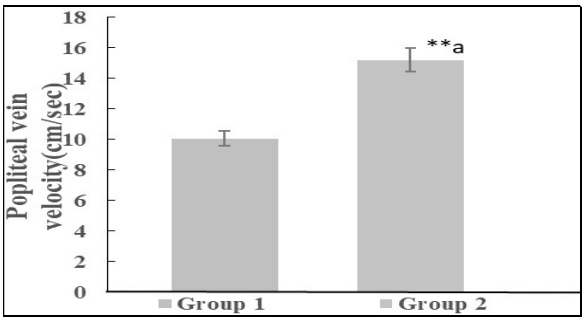

Figure-2: Comparison of Mean±SD of popliteal vein peak velocity in Group 1 and Group 2 of varicose vein patients

**p=0.001, statistically significant, **a=Comparison of Mean±SD of Popliteal vein peak velocity (Cm/Sec) in Group 1 and Group 2

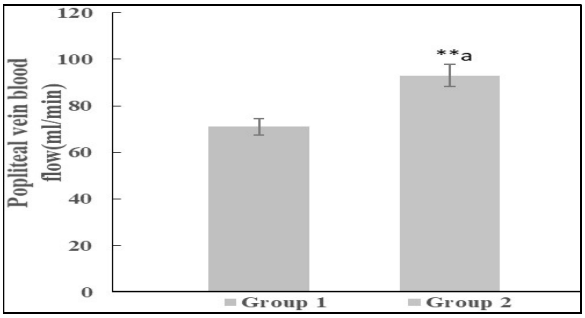

Figure-3: Comparison of Mean±SD of popliteal vein blood flow (mL/min) in Group 1 and Group 2 of varicose vein patients

**p=0.003, statistically significant, **a=Comparison of Mean±SD of Popliteal vein blood flow (mL/min) in Group 1 and Group 2

DISCUSSION

In the current study it was observed that when TENS is used on the Calf muscle of Varicose vein patients (C2 and C3 Varicosities with oedema) for half an hour for a period of 3 weeks, it reduced the pain score of the patients measured with the help of NRS, and augmented the popliteal vein peak flow velocity, and blood flow easured by Duplex scan. This observation is supported by the findings in a study by Shimoura *et al*[18] who carried out a randomized control trial on patients with knee osteoarthritis (n=50) and randomly divided them into TENS group (25) and sham-TENS group (n=25). They measured the pain score of the patients with the help of Visual Analogue Scale (VAS) after the application of TENS under the patella for 30 minutes in both groups and concluded that use of TENS can improve the pain score of the patients. But in contrast to our study they did not measure the peak flow velocity and blood flow in popliteal veins of knee osteoarthritis patients.

Another study was carried out by Santana *et al*, in which they recruited forty-six, primigravida patients with a gestational age of more than 37 weeks and a cervical dilation of 4 Cm.[19] TENS was applied to the primigravida patients at the beginning of the active phase of labor for 30 minutes and pain intensity was assessed by Visual Analogue Scale (VAS) after the intervention period. It was concluded that the use of TENS produces a momentous decrease in pain and adjourns the use of pharmacological analgesia. But in contrast to our study they did not measure the blood flow in popliteal veins in these patients.

Another study was carried out by Choi, and Lee[20], who recruited 11 patients with lower extremity lymphedema and randomly divided them into experimental group (TENS group n=6) and a control group (n=5) who received drug treatment prescribed by the doctor. TENS application was performed on the experimental group on the site of oedema, 3 times per week for a period of 3 weeks. Surface tape measurement of the lower extremity was used to measure the reduction in oedema in the lower extremity. They concluded that TENS is very effective in reducing oedema by augmenting venous blood flow in lower extremity.

Another study was carried out by Broderick BJ *et al*[21], in which they studied the effect of electrical stimulation on calf muscle by comparing the blood flow changes in lower limb while the subjects are at bed rest with the changes when the calf muscles have been electrically stimulated. They concluded that electrical stimulation can increase the blood flow in lower limbs and can alleviate the debilitating effects of venous stasis.

CONCLUSION

Application of TENS has proven to be a beneficial treatment modality for varicose veins. The use of TENS has not only reduced the pain score of patients but also improved the venous blood flow which leads to a reduction in the venous stasis, oedema formation and other complications.

FUTURE RECOMMENDATIONS

- In future a large sample size should be taken to observe the effects of TENS in Varicose vein patients.
- Longer duration follow-up studies should be conducted to observe the effects of TENS in Varicose vein patients.
- Studies should be carried out to see the combined effect of TENS with Compression stockings in varicose vein patients.

STUDY LIMITATIONS

The study limitations include a small sample size due to financial position. The follow-up time was also short due to time constraint.

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