

## Effect of Ankle Resisted Exercises on Venous Leg Ulcers Healing

SAMAR NABIL, M.Sc.\*; MARWA M. EID, M.D.\*\*; ABD EL HALIM A. ABD EL MOHSEN, Ph.D.\* and  
HEBA M. MOHAMADY, Ph.D.\*

*The Department of Physical Therapy for Surgery, Faculty of Physical Therapy, Cairo University\* and  
The Department of Vascular Surgery, Faculty of Medicine, Al-Azhar University\*\**

### Abstract

**Background:** Venous leg ulcers are open chronic wounds that occur within the gaiter region of the leg (from below the ankle, up to mid-calf) and are a consequence of venous insufficiency. They typically present as repeated cycles of ulceration, healing, and recurrence. Such ulcers can take weeks or months to heal, and 12-month recurrence rates are between 18% and 28%. They are painful, malodorous, prone to infection, and severely affect patients' mobility and quality of life, therefore resisted ankle exercises is improving calf muscle pump action by increasing ankle (plantar flexion) range of motion which improving venous system function in the lower leg and so improving 2<sup>nd</sup> and 3<sup>rd</sup> degrees of venous leg ulcers healing.

**Aim of Study:** The aim of this study was to determine the efficacy of resisted ankle exercises on healing of venous leg ulcers.

**Subjects and Method:** Thirty patients suffering from 2<sup>nd</sup> and 3<sup>rd</sup> chronic venous leg ulcers were recruited from Vascular Surgical Outpatient Clinic of Al-Hussien University Hospital. Their ages ranged from 45 to 60 years old: They distributed into two Groups (A & B). Group (A) "study group": Fifteen patients who received ankle resistance training exercise in addition to the traditional medical treatment. Group (B) "control group": Fifteen patients who received only the traditional medical treatment. Resistance training exercise was applied in the form 20 or 25 repetitions maximum at the end of the twelve week, three sessions per week, every other day, for three months.

**Results:** Results showed that ankle resistance training exercise program was effective in improving healing of venous leg ulcers by decreasing ulcers' volume measured by sterilized saline solution by improving calf muscle pump function.

**Conclusion:** Application of 12 weeks ankle resisted exercises in patient with 2<sup>nd</sup> and 3<sup>rd</sup> degrees of chronic venous leg ulcers resulted in decreasing volume of venous ulcers and so increasing of healing rates.

**Key Words:** Ankle resisted exercises – Venous leg ulcers healing.

**Correspondence to:** Dr. Samar Nabil, The Department of Physical Therapy for Surgery, Faculty of Physical Therapy, Cairo University

### Introduction

**VENOUS** Leg Ulcers (VLUs) account for approximately 70% of chronic leg ulcers and are the result of Chronic Venous Insufficiency (CVI) or venous disease in the lower leg [1]. Chronic venous insufficiency is a dysfunction of the venous system that occurs as a result of an impairment of the calf muscle pump [2].

Calf muscle pump dysfunction is associated with reduced ankle range of motion which is a risk factor for delayed healing of VLUs. Exercise that targets ankle joint mobility may lead to improvement in calf muscle pump function and subsequent healing [3].

However, little is known regarding the effect of exercise on healing functional ability and health related quality of life [4].

Venous leg ulcers are a major health concern in the older population [5] affecting 1-3% of the population aged over 60 years Leg ulcers may persist for years and may have a profound impact on the well-being of the individual [6].

Chronic venous insufficiency and associated venous hypertension may lead to calf muscle changes such as muscle fiber atrophy [7] abnormal gait [8] and reduced strength and functioning of the calf muscle [9]. This impairment of calf muscle pump function further worsens venous hypertension.

There is an evidence that calf muscle function in this patient population [10]. Only one study has tested the feasibility of improving calf muscle pump function by exercise in patients with venous ulceration [11].

Exercises that target knee and ankle joint mobility may lead to an improvement of calf muscle pump function and subsequent healing [12].

Studies have used a resistance training approach as a means for developing muscular strength and endurance of the calf muscle to ascertain whether this results in an improvement in calf muscle pump [13].

## Subjects and Methods

### I- Subjects:

Thirty patients who have 2<sup>nd</sup> and 3<sup>rd</sup> degrees of chronic venous leg ulcers participated in this study. Their ages were ranged from 45 to 60 years. The participants were selected from Al-Azhar University Hospitals started from July 2018 to January 2019, and randomly distributed into two equal groups.

*Design of the study:* In this study the patients were randomly assigned into two equal groups (15 patients for each group): (A) Group A (study group): This group includes 15 patients with 2<sup>nd</sup> and 3<sup>rd</sup> chronic venous ulcers who was received knee and ankle resisted exercises in addition to physical therapy program (compression therapy, ultrasound application. And ROM ex.) and medical treatment (aeroxel, mebo, bialcofan, betadine) blood clots from forming and reduce risk of deep vein thrombosis. Gramicidin, ionized silver which is an absorbant sheets requires activation with sterile water and is effective against the same organisms as silver sulfadiazine but provides a moist environment to promote epithelization). Group B (control group): This group included 15 patients with venous leg ulcers who was received compression therapy, ultrasound application, and ROM ex.) and medical treatment blood clots from forming and reduce risk of deep vein thrombosis.

### Criteria for the patients:

*Inclusion criteria:* The subject selection was according to the following criteria: Age ranged between 45-60 years. All patients participated in the study. All patients have 2<sup>nd</sup> and 3<sup>rd</sup> degrees of chronic venous leg ulcers all patients were free from diabetes mellitus. All patients enrolled to the study had their informed consent the potential participants excluded if they met one of the following criteria: Patients with history of DVT, Osteoarthritis patients diabetic patients and patients with osteoporosis.

### Evaluation process:

All patients were subjected to evaluation of venous leg ulcers volume according to using sterilized saline injection which was used for assessment of venous leg ulcers healing. All patients

were evaluated before starting the study and after 12 weeks of treatment.

### Material for treatment:

Therapeutic elastic bands (resistance bands, free weights (including standard or adjustable as dumbbells, ankle cuffs that hold weight bars, and weight Machines (multi gym).

### Procedures of the study:

*Measurement procedures:* Measurements of ulcer's volume: The ulcer's volume are measured before starting the study by sterilized saline which is injected inside the ulcer and pulling it again and measure the volume by cubic centimeters recording measurements of all the patients before study and the other measurements recorded after 12 weeks of applying ankle resisted exercises in addition to traditional physical therapy program.

### Procedures of applying mechanical resistance:

During 12 weeks intervention period ankle resisted exercises program was included a 20 minute session three times a week (60min/week) under supervision of vascular medicine. Resistance exercises are done after ensuring that all participants can reach full ankle range of motion actively. Subjects had 10 minutes manual resisted exercises, applied by the therapist gradually then 5 minutes rest interval then 10 minutes of mechanical resisted exercises for calf muscles using elastic bands and ankle cuffs. Resistance and flexibility exercises were performed for approximately 20 minutes in order to improve calf muscle pump function, leg (predominantly calf) muscle strength, and joint (predominantly knee and ankle) mobility. Resisted exercises predominantly involved dynamic body-weight exercises with or without the use of dumbbells and free weight cuffs (e.g., calf raises and partial squats).

- Exercise was performed for two or three sets of 10 to 15 repetitions to the point of moderate muscle fatigue for flexibility, static stretches was performed for all of the major muscle groups of the legs, for a total of 60 seconds per muscle group (comprising 3 X 20 second stretches), was held at the point of mild discomfort.

A trained exercise physiologist was supervised each session, and there were a maximum of four participants per session to help ensure patient safety, successful delivery of the exercise session and collection of data. Compression garments (stockings/bandages) were monitored during each exercise session: If affected by exercise, participants were referred to the tissue-viability nursing team

for re-application, and additional visits were noted for the health economics analyses.

*Exercise forms:*

- *Stage 1: Seated heel raises:*  
 3 sets of 10 to 15 repetitions 3 times per day.  
 3 sets of 15 to 20 repetitions 3 times per day.  
 3 sets of 20 to 25 repetitions 3 times per day.
- *Stage 2: Standing heel raises:*  
 3 sets of 10 to 15 repetitions 3 times per day.  
 3 sets of 15 to 20 repetitions 3 times per day.  
 3 sets of 20 to 25 repetitions 3 times per day.
- *Stage 3: Seated heel raises with applying manual resistance:*  
 3 sets of 10 to 15 repetitions 3 times per day.  
 3 sets of 15 to 20 repetitions 3 times per day.  
 3 sets of 20 to 25 repetitions 3 times per day.
- *Stage 4: Standing heel raises with holding resistance elastic bands:*  
 3 sets of 10 to 15 repetitions 3 times per day.  
 3 sets of 15 to 20 repetitions 3 times per day.  
 3 sets of 20 to 25 repetitions 3 times per day.
- *Stage 5: Seated heel raises with applying resistance by weight cuffs:*  
 3 sets of 10 to 15 repetitions 3 times per day.  
 3 sets of 15 to 20 repetitions 3 times per day.  
 3 sets of 20 to 25 repetitions 3 times per day.

- *Stage 6: Pushing weight bar by using weight machine:*

- 3 sets of 10 to 15 repetitions 3 times per day.
- 3 sets of 15 to 20 repetitions 3 times per day.
- 3 sets of 20 to 25 repetitions 3 times per day.

*Statistical analysis:*

Descriptive statistics and *t*-test were conducted for comparison of subject characteristics between both groups. Chi squared test were conducted for comparison of sex distribution between both groups. Mixed MANOVA was conducted to compare the mean values of ulcer's volume between the study and control groups as between group comparison and between preand post-treatment in each group as within group comparison. Post-hoc tests using the Bonferroni correction were carried out for subsequent multiple comparison. The level of significance for all statistical tests was set at *p* <0.05. All statistical analysis was conducted through the Statistical Package for Social Studies (SPSS) Version 19 for windows (IBM SPSS, Chicago, IL, USA).

**Results**

*Patient demographic data:*

- *Subject characteristics:*

Table (1) showed the mean ± SD age of study and control groups. There was no significant difference between both groups in the mean age (*p*=0.37). Also, there was no significant difference in sex distribution between groups (*p*=0.74).

Table (1): Comparison of subject characteristics between study and control groups.

	$\bar{X} \pm SD$		MD	<i>t</i> -value	<i>p</i> -value
	Study group	Control group			
Age (years)	52.8±5.01	51.33±3.86	1.47	0.89	0.37*
Males/females	11/4	9/6		( $\chi^2=0.6$ )	0.74*

$\bar{x}$  : Mean. MD : Mean Difference. *p*-value : Probability value.  
 SD: Standard Deviation.  $\chi^2$  : Chi squared value. \* : Non significant.

*Effect of treatment on ulcer's volume:*

Mixed MANOVA revealed that there was a significant interaction of treatment and time (F=62.67, *p*=0.001). There was a significant main effect of time (F=431.06, *p*=0.001). There was no significant main effect of treatment (F=2.66, *p*=0.11) (Table 2).

- *Within group comparison:*

There was a significant decrease in ulcer's volume post-treatment compared with that pre-

treatment in both groups (*p*>0.001). The percent of decrease in ulcer's volume were 44.44 and 19.25% in study and control groups respectively (Table 2).

- *Between groups comparison:*

There was no significant difference between both groups in ulcer's volume pre-treatment (*p*=0.78). There was a significant decrease in ulcer's volume of study group compared with that of control group post-treatment (*p*=0.004) (Table 2).

Table (2): Mean ulcer's volume pre and post-treatment in study and control groups.

	Study group		<i>p</i> -value	Study group		<i>p</i> -value	Between groups	
	- Pre X ± SD	Post X ± SD		- Pre X ± SD	Post X ± SD		Pre <i>p</i> -value	Post <i>p</i> -value
Ulcer's volume (cm <sup>3</sup> )	2.88±0.83	1.6±0.62	0.001**	2.96±0.72	2.39±0.75	0.001**	0.78*	0.004**

X : Mean.  
SD : Standard Deviation.  
*p*-value: Level of significance.

\* : Non significant.  
\*\* : Significant.

## Discussion

The purpose of this study was to investigate the efficacy of ankle resisted exercises on healing of chronic venous leg ulcer. Thirty patients with chronic venous leg ulcers from both sexes were conducted to the study. Their ages were ranged from 45 to 60 years old.

The results of this study revealed significant improvement of venous ulcers' healing in ankle resisted exercise training group (Group A) that agreement with O'Brien et al. (2017) who found that exercise that targets ankle joint mobility may lead to improvement in calf muscle pump function and subsequent healing. The objectives of this research were to assess the impact of an exercise intervention in addition to routine evidence-based care on the healing rates, functional ability and health-related quality of life for adults with Venous Leg Ulcers (VLUs).

Partsch et al., (2016) it should be applied as early as possible by skilled practitioners, following a comprehensive assessment (Wounds, 2016). Compression therapy in the form of bandage or hosiery reduces edema, heals the ulceration, and reverses venous hypertension. Compression with a higher Static Stiffness Indicator (SSI) provides lower resting pressures and higher working pressures, making it more efficient and tolerable for patients.

Edwards et al., (2013) found the feasibility of a home-based exercise programs and examined the effects on the healing rates of venous leg ulcers. A 12-week randomized controlled trial was conducted investigating the effects of an exercise intervention compared to a usual care group. Participants in both groups (n=13) had active venous ulceration and were treated in a metropolitan hospital outpatients clinic in Australia. Data were collected on recruitment from medical records, clinical assessment and questionnaires. Follow-up data on progress in healing and treatments were collected fortnightly for 12 weeks.

Stewart & Gibbs, 2013 concluded that calf muscle pump function data were collected at baseline and 12 weeks from recruitment. Range of ankle motion data were collected at baseline, 6 and 12 weeks from recruitment. This pilot study indicated that the intervention was feasible. Clinical significance was observed in the intervention group with a 32% greater decrease in ulcer size ( $p=0.34$ ) than the usual care group, and a 10% ( $p=0.74$ ) improvement in the number of participants healed in the intervention group compared to the usual care group. Significant differences between groups over time were observed in calf muscle pump function parameters [ejection fraction ( $p=0.05$ ), residual volume fraction ( $p=0.04$ )] and range of ankle motion ( $p=0.01$ ).

Kerr et al., (2014) reported a description of the supervised exercise programme is provided separately (additional file 2). Participants allocated to the intervention group were invited to attend three sessions of supervised exercise each week for 12 weeks (total of 36 sessions) at one of the two study exercise training facilities.

Finlayson, 2014 designed that each exercise session was approximately 60 minutes and will comprise a combination of aerobic, resistance and flexibility exercises.

Each session begin and end with 5 minutes of low-intensity treadmill walking or cycling for a warm-up and cool-down, respectively. The aerobic component was approximately 30 minutes, and whether the exercise mode was treadmill walking, cycling, or a combination of both is determined by the physical function and preference of participants. Tread-mill hill-walking was the preferred mode since it promoted greater recruitment of the calf musculature than cycling.

### Conclusion:

Application of 12 weeks ankle resisted exercises in patient with 2<sup>nd</sup> and 3<sup>rd</sup> degrees of chronic venous leg ulcers if effective in decreasing volume of venous ulcers and so increasing of healing rates.

## References

- 1- ABBADE L.P.F. and LASTORIA S.: "Venous ulcer: Epidemiology, physiopathology, diagnosis and treatment" *Int. J. Dermatol.*, 44: 449-56, 2005.
- 2- YIM E., MANDEL D.W., CHEN S.C., KIRSNER R.S., GAILEY R.S. and TOMIC CANIC M.: "Effect of physical therapy on wound healing and quality of life in patients with venous leg ulcers" a systematic review, 2014.
- 3- VAN UDEN C.J.T., KOOLOOS J.G.M., HAENEN J.H. and WOLLERSHEIM H.: "Gait and Calf Muscle Endurance in Patients with chronic venous insufficiency" *Clin. Rehabil.*, 19: 33-44, 2005.
- 4- SIMKA M.: Calf muscle pump impairment and delayed healing of venous leg ulcers: Air plethysmographic findings. *Journal of Dermatology*, 34 (8): 537-44, 2007.
- 5- HARRISON M., GRAHAM I., FRIEDBERG E., LORIMER K. and VANDEVELDE-COKE S.: "Assessing the population with leg and foot ulcers". *Can. Nurse*, 97: 18-23, 2001.
- 6- HEIT J.A., ROOKE T.W., SILVERSTEIN M.D., MOHR D.N. and LOHSE C.M.: The incidence of venous stasis syndrome and venous ulcer": A 25-year population-based *JAMA Dermatol.*, 151: 320-27, 2001.
- 7- QIAO T., LIU C. and RAN F.: The impact of gastrocnemius muscle cell changes in chronic venous insufficiency. *European Journal of Vascular and Endovascular Surgery*, 30 (4): 430-6, 2005.
- 8- VAN DER VLEUTEN C.J.M., VAN UDEN C.J.T., KOOLOOS J.G.M., HAENEN J.H. and WOLLERSHEIM H.: "Gait and Calf Muscle Endurance in Patients with chronic venous insufficiency" *Clin. Rehabil.*, 19: 339-44, 2005.
- 9- ORSTED H.L., RADKE L. and GORST R.: The impact of musculoskeletal changes on the dynamics of the calf muscle pump. *Ostomy/Wound Management*, 47 (10): 18-24, 2001.
- 10- PADBERG F.T., JOHNSTON M.V. and SISTO S.A.: Structured exercise improves calf muscle pump function in chronic venous insufficiency: A randomized trial. *Journal of Vascular Surgery*, 39 (1): 79-87, 2004.
- 11- JULL A.B., RODGERS A. and WALKER N.: (Honey as a topical treatment for wounds. *Cochrane Database of Systematic Reviews*, 4, CD005083, 2008b.
- 12- RADKE L. and GORST R.: The impact of musculoskeletal changes on the dynamics of the calf muscle pump. *Ostomy/Wound Management*, 47 (10): 18-24, 2001.
- 13- WAKEFIELD T.W., ZAJKOWSKI P.J., DARPER T., BLOOM J. and HENKE P.K.: "Exercise with compression stockings improves reflux in patients with mild chronic venous insufficiency" *Phelebology*, 2006.
- 14- O'BRIEN J., FINLAYSON K., KERR G. and EDWARDS H.: Evaluating the effectiveness of a self-management exercise intervention on wound healing, functional ability and health related quality of life outcomes in adults with venous leg ulcers: A randomised controlled trial. *International Wound Journal*, 14 (1): 130-7, 2017.
- 15- PARTSCH H., SCHUREN J., MOSTI G. and BENIGNI J.P.: The Static Stiffness Index: An important parameter to characterise compression therapy in vivo. *J. Wound Care* 25 (Suppl 9): S4-10, 2016.
- 16- EDWARDS H., COURTNEY M., FINLAYSON K., GRAVES N., GIBB M. and PARKER C.: Health Service pathways for patients with chronic venous leg ulcers. identifying effective pathways for facilitation of evidence based wound care *BMC health service*, 2013.
- 17- STEWART I. and GIBBS H.: A home-based progressive resistance exercise programme for patients with venous leg ulcers: A feasibility study. *Int. Wound J.*, 10: 3 89-96, 2013.
- 18- KERR G., O'BRIEN J.A., FINLAYSON K.J. and EDWARDS H.E.: Testing the effectiveness of a self-efficacy based exercise intervention for adults with venous leg ulcers: Protocol of a randomised controlled trial. *BMC Dermatol.*, 14: 16, 2014.
- 19- FINLAYSON K., GRAVES N., GIBB M. and PARKER C.: Health Service pathways for patients with chronic venous leg ulcers. Identifying effective pathways for facilitation of evidence based wound care *BMC health service*, 2013.

## تأثير تمارينات المقاومة لمفصل الكاحل على إنتئام قرح الساق الوريدية

الهدف من الدراسة: كان الهدف من البحث هو إستكشاف تأثير التمارينات المقاومة لمفصل الكاحل على إنتئام قرح الساق الوريدية عن طريق قياس حجم القرع بحقنة معقمة من المحلول الملحي قبل تطبيق العلاج بتمارين المقاومة لمفصل الكاحل وبعد مرور ٢١ إسبوع من بدء تطبيق الدراسة.

الأشخاص والعينة: إشتراك في هذه الدراسة ثلاثون مريضاً من مرضى قرح الساق الوريدية المزمنة وكانت أعمارهم تتراوح من ٤٥-٦٠ سنة ولقد تم تقسيمهم إلى مجموعتين متساويتين في العدد.

الوسائل والأدوات: مجموعة إختبار تتلقى برنامج العلاج بتمارين التقوية بالإضافة إلى العلاج الدوائى التقليدى ومجموعة ضابطة تتلقى العلاج الدوائى التقليدى فقط لا غير.

النتائج: بتحليل البيانات أثبتت النتائج التالية: وجود تحسن ملحوظ فى إنتئام قرح الساق الوريدية فى مجموعة الدراسة مقارنة بالمجموعة الضابطة بعد تطبيق العلاج بتمارين المقاومة لمفصل الكاحل بالإضافة إلى العلاج الدوائى التقليدى لمجموعة الإختبار فقط بعد ثلاثة أشهر من إجراء العلاجات المذكورة سابقاً.

المضمون: فى حدود هذه الدراسة يمكننا أن نستنتج بأن تأثير العلاج بتمارين المقاومة لمفصل الكاحل بالإضافة إلى العلاج الدوائى التقليدى كان له تأثيراً كبيراً ومفيداً على إنتئام قرح الساق الوريدية.