

**FEMORAL BLOOD FLOW RESPONSE TO FUNCTIONAL LOW  
FREQUENCY ELECTRICAL STIMULATION  
IN CHRONIC HEART FAILURE**

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**Abstract**

**Purpose:** The aim of this study was to evaluate the effect of functional low frequency electrical stimulation of quadriceps and calf muscles on femoral blood flow in patients with chronic heart failure (CHF).

**Methods:** Fifty patients with chronic heart failure (CHF) were randomly selected from Cairo university hospital, their ages ranged from 40 to 60 years. They were divided into two groups, thirty patients for study group, and twenty patients for control group. Each patient in the study group received low frequency electrical stimulation with frequency 5 sessions per week for three successive weeks, in addition to medical treatment. Each patient of the control group received the same medical treatment, Pre and post study blood flow assessment was done for each patient of both groups.

**Results:** The result of this study revealed statistically significant difference in femoral blood flow that showed a statistically significant improvement in patients for the study group in comparison to control group.

**Conclusion:** Functional low frequency electrical stimulation of quadriceps and calf muscles improved femoral blood flow not only oxygen and nutrition also improve venous return without volume over load on the cardiovascular system in patients with chronic heart failure, therefore helped to decrease swelling, reduce pain and increase healing. FES may represent a practical and effective strategy to improve perfusion and reduce risk of vascular complication. Thus we recommend using functional electrical stimulation of quadriceps and calf muscles in order to improve femoral blood flow in patients with chronic heart failure.

**Key words:** Functional electrical stimulation, blood flow, skeletal muscles, chronic heart failure.

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**Introduction:-**

Congestive heart failure (CHF) is a condition in which the heart is unable to pump the necessary amount of blood throughout the body. This causes blood to back up in the veins. Fluid pools in the liver and lungs. Swelling occurs first in the feet, ankles, and legs, and then throughout the body as the kidneys begins to retain fluid [14].

The main symptom of HF is the progressive decrease in functional capacity associated with dyspnea with prognostic implications independent of LVEF. The pathophysiological process of HF will eventually lead to skeletal muscle weakness and atrophy, and when the symptoms will affect daily activities, to a sedentary lifestyle and social isolation with an impact on the prognosis of the patient. CHF-related skeletal muscle dysfunction is the result of an ongoing imbalance in the activation of anabolic and catabolic pathways, and has been shown to have significant prognostic importance [25].

Congestive heart failure is a clinical syndrome with a complex pathophysiology initiated by left ventricular dysfunction leading to systemic and pulmonary congestion and elevated peripheral vascular resistance. Fluid retention along with peripheral vasoconstriction and reduced skeletal muscle perfusion provides the pathophysiological basis for the symptoms. Coupled with inactivity the stage is set for deconditioning. Skeletal muscle atrophy, changes of fiber-composition (i.e. an increase of type II fibers which are mostly anaerobic, at the expense of aerobic type I fibers), reduced capillary density and reduced cytochrome oxidase activity characterize the condition [1].

The syndrome of chronic heart failure is typically characterized by decreased exercise capacity with reduced peak oxygen consumption. The exercise abnormalities are closely related to impaired skeletal muscle behavior. The skeletal muscle oxidative metabolism is depressed, intracellular PH level decrease, phosphocreatine depletion during exercise and phosphocreatine resynthesis decreases the increased sympathetic tone, stimulation of the rennin-angiotensin-aldosterone system influences the redistribution of regional blood flow and creates endothelial dysfunction of all vessels. This leads to an impaired peripheral vascular dilatation in response to vasodilator stimuli reduction of blood flow and O<sub>2</sub> supply in skeletal muscles [24].

Sympathetic nerve activation has haemodynamic implications, including vasoconstriction, and impairment in peripheral blood flow distribution. The vasoconstriction state caused by HF induces pro-inflammation, oxidative stress and protein degradation. More importantly, sympathetic activation is associated with an increased mortality rate in HF patients. Previous studies have shown that exercise training is safe and, more importantly, markedly benefits patients with HF. Exercise training reduces sympathetic nerve activity and peripheral vasoconstriction, thereby improving exercise tolerance and quality of life. However, exercise training is not recommended for unstable HF patients. Recent studies have demonstrated that involuntary muscle contraction by electrical stimulation increases muscle strength and exercise tolerance in outpatients with HF [30].

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Patients with chronic heart failure develop significant skeletal muscle atrophy and abnormalities in skeletal muscle metabolic function. These skeletal muscle alterations may contribute to exertional fatigue which is a major limiting symptom in patients with CHF. The cause of the atrophy is related to disuse, repetitive ischemia linked to reduced blood flow on exercise [28].

The beneficial influence of exercise on the aero-metabolic capacity and fatigue tolerance in patients with chronic heart failure has been repeatedly reported. The commonly used methods of training, however, are based on systemic exercise and are not always tolerated by all CHF patients, especially by those with severe heart failure or with life-threatening arrhythmia. A new approach to cardiac rehabilitation is represented by the method of (LFES) of skeletal muscles. In vitro conditions, a LFES of 10 Hz changes the phenotype of stimulated mammalian skeletal muscle fibers. LFES transforms the myosin chains of "fast" type to "slow" type ones, which is characterized by a higher resistance to fatigue LFES and also increases capillary density and enhances perfusion in strength muscles. The most important is the fact that all these experimental results are also applicable to human condition [16].

The leg musculature seems to be affected the most, also displaying a higher percentage of type II fibers, lower activities of mitochondrial enzymes, and a decreased capillary density. Isometric strength of the knee extensor muscles in patients with CHF is markedly lower due to a smaller muscle cross-sectional area: neuromuscular electrical stimulation (NMES) is in widespread use to delay atrophy of skeletal

muscles associated with disuse in both disused and healthy muscles with the same efficacy as voluntary contraction. NMES allows training of skeletal muscles without active exertion. Thus patients with CHF using NMES could achieve positive training effects without facing the fear of over exertion or dyspnea probably appearing in voluntary exercise [28].

Many patients with severe CHF are unable to undertake more intensive physical activity. Peripheral muscles are weaker with a decreased mass, reduced aerobic capacity and increased susceptibility to fatigue. Low frequency electrical stimulation, such as used in our study, has previously been shown to produce an increase in oxidative capacity and improve muscle strength [29].

Electrical stimulation may help to reduce the risk of developing macrovascular and microvascular complications in people with spinal cord injury. Low-intensity FES has significant clinical potential because this can be applied continuously throughout the day. ES increased femoral artery diameter, basal blood flow and limb volume, and reduced peak ischial tuberosity sitting pressure gradient [32].

Neuromuscular electrical stimulation (NMES) has been consistently shown to elicit positive effects on functional capacity and skeletal muscle adaptations in patients with HF and unable to participate in traditional aerobic and/or resistance training programs at an appropriate stimulus. Prior reviews suggested that NMES produces similar improvement in a 6-min walk distance (6MWD) test, a simple test used to detect functional capacity, when compared to conventional aerobic exercise training used by cycle ergometer. Also, previous studies have shown that resistance training

improved the distance in a 6-min walk test in patients with HF [27].

Neuromuscular electrical stimulation (NMES) applied to leg muscles offers an alternative training mode and represents an attractive option for CHF patients who are unable, non-adherent or unwilling to exercise. NMES consists of repeated, rhythmic stimulation of skeletal muscles in a static state, using skin electrodes positioned on the thighs and calf muscles, at an intensity that will lead to visible muscle contractions. The stimulator delivers a biphasic current of low frequency (10–25Hz), with gradually increasing stimulation amplitude of 40–80 mA maximized to the pain threshold of the subject. NMES has been consistently shown to elicit positive effects on functional capacity and skeletal muscle adaptations in patients with HF and unable to participate in traditional aerobic and resistance training programs at an appropriate stimulus [11].

In addition, there is a difference between conventional training and LFES training. In conventional exercise, more muscle groups are utilized and there are significant changes in central hemodynamic variables. Electrical stimulation affects only a low number of muscle groups and makes the training safe even in patients with severe forms of CHF ; LFES can be considered a safe and well tolerated method that has no life-threatening side effects [13].

#### **Purpose of the study:**

Low frequency electrical stimulation (LFES) of the lower limbs may improve the skeletal muscle structural and functional patterns in chronic heart failure, including muscle strength and blood perfusion.

#### **Subjects, Material and Methods**

A group of 50 patients (30males and 20females) diagnosed with CHF, classified as New York Heart Association (NYHA) classes' III to IV, were included in the study. They were selected from Kaser El Aini hospital.

Their age was ranged 40-60 years. The mean age of the study group was (47.4 + 5.6 years) and control was (47.5 + 5.7years).

Their mean ejection fraction (EF) was less than 30 %.  $E_f = \frac{SV}{EDV} = \frac{EDV - ESV}{EDV}$

All patients were on optimal pharmacological treatment (angiotensin converting enzyme inhibitor (ACEI,) beta blockers diuretics). They were divided into two groups; study group 30 patients and control group 20 patients.

#### **Evaluation equipment**

##### **Blood flow velocimetry measurement**

To evaluate changes in peripheral perfusion. The standard pulsed-wave Doppler velocimetry of the right femoral artery was performed using sonos 2000 echograph (Philips Envisor)



Fig (1) Doppler ultrasound (Philips Envisor )

### Therapeutic equipment



Fig (2) Functional low frequency electrical stimulation

An Elpha 2000 dual-channel stimulator (Diameter, Odense, Denmark) was used. The stimulated muscles included quadriceps and calf muscles on both lower extremities. Special rectangular electrodes, 80 × 100mm (St.Cloud International, Chantonnay, France), were used. (Jancik et al, 2003).



Fig (3) Electrodes and pads of electrical stimulation

### Procedure of evaluation of blood flow velocimetry:

The standard pulsed-wave Doppler velocimetry of the right femoral artery was performed before and after the end of the three weeks period of electrical stimulation (Jancik et al, 2003).



Fig (4) Doppler ultrasound (procedure)

### Procedure of the study:

Preparation of the patient:

- Explain the procedure to the patient and the purpose of the study .
- Assessment of muscle strength (for quadriceps and calf muscle) and blood flow (by Doppler Ultrasound ) were taken before starting the procedure .
- Attach the electrodes to the site of treatment ( quadriceps or calf muscle ).

### Low frequency electrical stimulation:

Electrical stimulation was performed for one hour/day for five days a week for three consecutive weeks.

- The stimulator delivers a biphasic current of 10 Hz frequency.
- The pulse duration was 200 msec with an (on-off).
- Stimulus mode (20sec stimulation, 20 sec pause).
- The maximal stimulation amplitude was 60 mA.

The muscles to be stimulated were the quadriceps and calf muscles of both legs.

- ❖ For the quadriceps muscles surface electrodes 80×100 mm were positioned on the thighs approximately 5cm below the inguinal fold and 3 cm above the upper patella border.

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- ❖ For the calf muscles the electrodes were positioned approximately 2cm under the knee joint and just over the proximal end of the Achilles tendon.



Fig (5)Electrical stimulation (quadriceps)



Fig (6) Electric stimulation (calf)

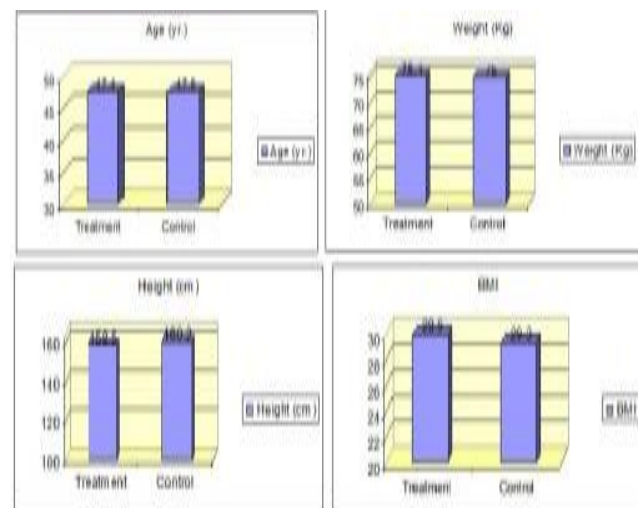
#### Data analysis

The mean, standard deviation and the range will be calculated for all subjects. Paired "T" test will be used to determine the mean value of blood flow velocity and muscles strength for each subject before and after treatment program and to compare the changes with each group.

#### Results:-

Table (1) Fig (7) shows the mean, standard deviation, maximum minimum of age, weight, height and BMI of the two different groups. These data include.

Group		Age (yr.)	Weight (Kg)	Height (cm)	BMI (Kg/m <sup>2</sup> )
Treatment Group	Mean	47.4	75.1	158.5	29.9
	S.D.	5.6	6.09	5.7	1.9
	Max.	55	85	170	34.2
	Min.	36	60	150	26.6
Control Group	Mean	47.5	75	160.2	29.3
	S.D.	5.7	6.6	5.9	1.6
	Max.	55	85	150	33.7
	Min.	36	60	172	26.7
Significance		P>0.05**	P>0.05**	P>0.05**	P>0.05**



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Table (2): Statistical analysis for Doppler ultrasound of right lower limb between the study group and control group before and after the treatment program

Group Parameter	Treatment Group	Control Group	t-value	P-value
Before program	115.43±20.9	108.31± 18.4	1.26	P>0.05**
After program	136.32± 21.9	109.98± 18.2	4.59	P<0.05*
t-value	-12.25	-5.4		
% of changes	%18.09	% 1.5		
P-value	P<0.05 *	P>0.05**		

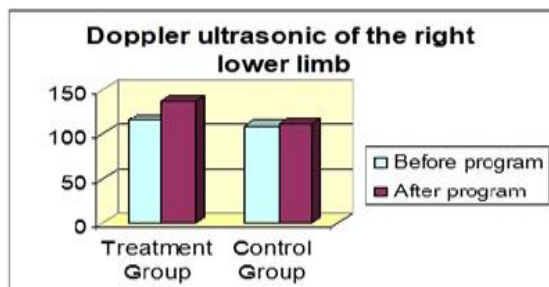


Fig (8): Statistical analysis for Doppler ultrasound of right lower limb between the study group and control group before and after the treatment program

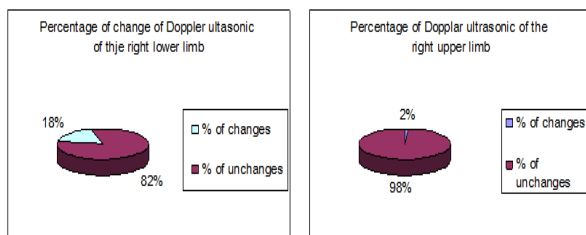


Fig (9): Percentage of Dopplar ultrasonic of the right upper limb before and after treatment for study and control group

Table (3): Statistical analysis for Doppler ultrasound of Left lower limb between the study group and control group before and after the treatment program

Group Parameter	Treatment Group	Control Group	t-value	P-value
Before program	114.5±19.9	110 ± 18.7	0.8	P>0.05**
After program	133.8 ± 22.2	110.9± 18.6	3.9	P<0.05*
t-value	-14.67	-7.7		
% of changes	%16.85	%0.81		
P-value	P<0.05 *	P>0.05**		

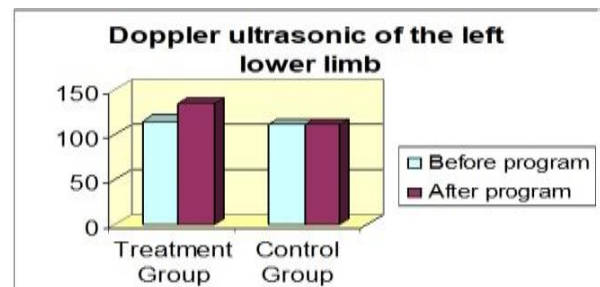


Fig (10): Statistical analysis for Doppler ultrasound of Left lower limb between the Study group and control group before and after the treatment program

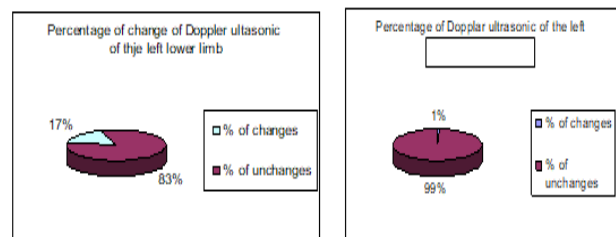


Fig (11): Percentage of Doppler ultrasonic of the left lower limb before and after treatment for study and control group

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**Discussion:-**

Our present investigation was designed to investigate whether low frequency electrical stimulation of quadriceps and calf muscles has a beneficial effect on femoral blood flow in patients with chronic heart failure (CHF) or not, with the hypothesis that there may be no effect of low frequency electrical stimulation on neither muscle strength nor blood flow in patient with chronic heart failure (CHF) classes III-IV.

Fifty patients diagnosed with CHF, classified as New York Heart Association (NYHA) classes III to IV, on optimal medical treatment (angiotensin converting enzyme inhibitor (ACEI), betablockers, diuretics) were randomly selected from Cairo university hospitals (cardiology department) randomly assigned into two groups, study group thirty patients and, control group twenty patients, Each subject of the study group received electrical stimulation for one hour/day, five days a week, for three consecutive weeks in addition to medical treatment, on the other hand each subject of the control group received medical treatment only, Pre and post program femoral blood flow velocity assessment was done for each subject of both groups.

This is very similar to that used by [23], who first reported a significant improvement of exercise capacity parameters in fourteen patients with CHF after five weeks of LFES, namely an improvement of functional capacity, and a 6 minute walking test. In the same study, a nuclear magnetic resonance test showed a significant increase in the muscle mass of the triceps surae muscle.

Similarly [33], found a significant increase in functional capacity in CHF

patients after eight weeks of electrical stimulation of the lower limbs. The beneficial influence of LFES on muscle strength was reported.

Egginton and Hudlick [7] stated that Chronic low frequency electrical stimulation has been shown to decrease fatigue in fast twitch muscles after a much shorter period of stimulation than that needed for decreased muscle fatiguability achieved by endurance training, Improved resistance towards fatigue preceded increased activity of oxidative enzymes and occurred concomitantly with increased capillary supply. a dissociation between muscle endurance and oxidative capacity has also been demonstrated, where stimulation increased fatigue resistance within five to seven days without accompanying changes in the activity of oxidative enzymes, , an increase in the activity of oxidative enzymes has been described in tibialis anterior muscle after ten days of stimulation.

Lewis [20] demonstrated that LFES is well tolerated, safe, and results in significant improvement in markers of functional capacity. There was improvement in quality of life for both groups when examined together, and there was a trend towards improved quality of life when LFES and bicycle groups were examined separately. LFES appeared to produce similar improvements in exercise capacity as bicycle training for the patients participating in the study, and it is a potentially attractive form of therapy since it requires less motivation and can be performed whilst a subject is sedentary. As such, it may be suitable for those Patients who are either unwilling or unable to perform more conventional forms of exercise.



Similar experiences have already been reported in the studies by Harris [11], Nuhr, [24], Eicher, [8], according to Maillefert, [21] and Vaquero, [31]. LFES does not cause any significant change in cardiac output and heart frequency. During the eight weeks of stimulation we did not observe any life threatening side effects of LFES on blood pressure or heart rate.

While also confirming the previous findings of increased capillary supply in muscles stimulated for two to four days, capillary supply started to increase at four days with a 40% increase seen at seven days. at seven days, the total capillary surface area available for substrate delivery and metabolite exchange was increased by 30% and this may help to explain the improved muscle performance previously demonstrated that capillary growth is stimulated by sustained high blood flow induced by infusion of vasodilators [12].

The contribution of LFES on vascular remodeling observed in the significant increase of the inner diameter of the right femoral artery after electrical stimulation. The significant increase in blood velocity in the femoral artery during stimulation may reflect the importance of the global vascular benefit for the peripheral muscle mass after LFES. This finding may also be considered as a sign of improved adaptation of the local muscle vasculature to the exercise workload [3].

Wiesinger, [32] stated that fifteen patients with (CHF) (NYHA class III&IV) had three weeks of LFES, five days /week, one hour /day. Significantly increased both muscle strength and blood flow velocity. It was concluded that LFES may improve the structural and functional patterns of skeletal muscles and may be useful in the treatment

of patients with severe chronic heart failure the beneficial effects of chronic low-frequency stimulation of thigh muscles in patients with advanced chronic heart failure were described also.

It is possible to suppose that stimulation-induced changes of blood flow velocity are most probably related to the modification of endothelial functions by long-term electrical stimulation, and thus may be NO dependent. The significant increase of the blood flow velocity in femoral artery during stimulation observed in our study may reflect the importance of achieved global vascular benefit for the peripheral muscle mass after three weeks of LFES [21].

Karavidas, [17], published bilateral quadriceps, calf muscle: NMES, 25 Hz, biphasic On/off time: 5/5 s Intensity: visible muscle contraction not strong enough to elicit discomfort or joint movement 30 min/d, 5 d/wk., 6 wk. Control: Sensory electrical stimulation only 30 min/d, 5 d/wk., 6 wk. No adverse events reported Significant increase in the NMES group: 6MWT (11.9%), Quality-of-life score (18.4%), TNF $\alpha$  (17.5%), sICAM-1 (15.6%), sVCAM-1 (13.1%). Baseline brachial artery diameter (2.0%). Hyperemic brachial artery diameter (3.5%). Flow mediated dilatation, (29.6%). No change in the aforementioned variables in the control group Peak VO<sub>2</sub> and LVEF did not significantly improve in either group.

Kelsall, [18], reported that the contractions initiated by local electrical stimulation of the strength muscle may cause similar (or identical) vascular reactions as seen during physical exercise, namely the exercise-induced reactive hyperemia in working muscles. Thus, the

previously mentioned beneficial effects of LFES on vascular function are most probably related to the effect of increased pulsatile flow on the vessel's endothelial layer. It is likely that the LFES induced changes in blood flow by long-term electrical stimulation are related to modification of endothelial function, and thus may be mostly NO-dependent, but as mentioned earlier.

Dobsak, [6], reported additional mechanisms cannot be excluded, especially the possible growth enhancement of new vessel collaterals, as occurs after physical exercise training. The contribution of LFES on vascular remodeling observed in this study may be seen in the insignificant increase of the inner diameter of the right femoral artery at the end of the sixth week of stimulation. The significant increase in blood velocity in the femoral artery during stimulation may reflect the importance of the global vascular benefit for the peripheral muscle mass after six weeks of LFES.

Banerjee, [2], compared LFES and conventional exercise training in a group of stable CHF patients: Bilateral quadriceps, hamstrings, calf muscles, and gluteal muscles 4 Hz, rhythmic contraction Maximum current: 300 mA Intensity: 90% of heart rate reserve, determined individually 60 min/d, 5 d/wk., 8 wk. Washout phase: Return to habitual physical activity level. No adverse events reported but inability to tolerate NMES was the drop out cause for 2 patients Significant increase in the NMES group: Peak VO<sub>2</sub> (10%), 6MWT (9.6%), maximal knee extensor isometric contraction at 90° (7.1%) No significant difference in the aforementioned variables between baseline and washout. The greatest improvements were achieved

by those with the lowest baseline exercise capacity and strength. No changes in LVEF and diastolic function.

Deftereos, [4], reported in the study that: Bilateral quadriceps and calf muscles,: NMES 25 Hz On/off time: 5/5 s 30 min/d, 5 d/wk., 6 wk. Bicycle: 30 min/d, 5 d/wk., 6 wk., 70 % of maximal HR No adverse events reported Significant increase in the NMES group: 6MWT (10%), Peak VO<sub>2</sub> (6%), endothelial function FMD (38%), Endothelium-independent vasodilation (1.4%), Significant increase in the bicycle group: 6MWT (13%), Peak VO<sub>2</sub> (14%), endothelial function (48%), endothelium-independent vasodilation (2%). Significantly higher FMD value after bicycle training compared to NMES Significantly higher 6MWT and Peak VO<sub>2</sub> after bicycle training compared to NMES LVEF did not significantly improve in either group

Similarly, Dobsak, [5], stated in the study that NMES: bilateral quadriceps and calf muscles, 10 Hz, biphasic On/off time:20/20 s Intensity: 60 mA 60 min x 2/d, 7d/wk., 12 wk. ET: 12 wk. total with bicycle: 40 min 2 wk., 20 min in the last 10 wk. and resistance training 20 min last 10 wk. No adverse events reported Significant beneficial effects in the NMES group: Peak VO<sub>2</sub> (9.8%). Big-endothelin pmol/L (-25%), CRP mg/L (-65.3%) Significant beneficial effects in the aerobic ET group: Peak VO<sub>2</sub> (11.2%), Big-endothelin pmol/L (-8.2%), CRP mg/L (-60%) Aforementioned improvements were not statistically significant between groups No changes in LDL, HDL and glucose level Positive effect after 12 weeks of ET or NMES on arterial stiffness and autonomic balance in patients with moderate CHF

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On the other hand, Soska, [29], reported that bilateral extensors muscle,: NMES, 10 Hz, On/off time: 20/20 s 60 min x 2/ d, 7 d/wk., 12 wk. AT: Bicycle, 10 min+40 min +10 min, 3x/wk., to individual anaerobic threshold, first 2 wk. AT 20 min and resistance training 20 min for the following 10 wk. AT + NMES: identical AT + identical NMES, 12wk No adverse events reported Significant beneficial effects in the NMES group: Peak VO<sub>2</sub> 8.3%), Duration of exercise min (9.4%), quality of life MLHF score (-16.6%) Significant beneficial effects in the AT group: Peak VO<sub>2</sub> (15.2%), Duration of exercise min (19.8%), quality of life MLHF score (-27.9%) Significant beneficial effects in the AT+NMES group: Peak VO<sub>2</sub> (15.3%), Duration of exercise (min) (10.7%), quality of life MLHF score (-29.1%) The results of the three studied rehabilitation training protocols did not significantly differ statistically. It can be stated that aerobic ET combined with EMS adds no statistically significant benefit

Similarly, Kadoglou, [16], concluded that bilateral quadriceps and gastrocnemius muscles: NMES 25 Hz On/off: 5/5 s Intensity: visible muscular contraction 30 min/d, 5 d/ wk., 6 wk. Placebo: 5 Hz, not leading to a visible or palpable contraction No adverse events reported Significant beneficial effects in the NMES group: 6MWT, hospitalization rate. Patients after NMES had no difference compared to non-NMES patients in terms of survival The hospitalization rate was significantly lower in the NMES group before and after adjustment for major prognostic factors

On the other hand, Iliou, [13], concluded that NMES+ET: 20±5 low frequency NMES for quadriceps muscles after aerobic training and/or additional

physical activities, 10Hz biphasic current, Pulse duration 200µs, On/off: 20/40 s, ET: 20±5 physical training sessions, 4–8 weeks Session: 30–60-minute period of aerobic exercise training on a bicycle or treadmill NMES on top of ET does not demonstrate any significant additional improvement in exercise capacity in moderately severe and stable CHF patients.

Ploesteanu, [25], concluded that research conducted in the last two decades suggests that neuromuscular electrical stimulation of the lower limb muscles (NMES) may be a "bridge" to conventional exercise or an alternative for patients with advanced chronic heart failure (CHF), non-compliant or non-responsive to physical training. Through stimulating the work of the skeletal muscles, NMES increases the functional capacity, muscle mass and endurance in patients with CHF. A beneficial effect of NMES on functional capacity, vascular endothelial function, quality of life and aerobic enzymes activity has been shown. A significant benefit of this novel therapy in heart failure is the fact that the procedure can be home-based, after prior guidance of the patient.

On the contrary, Jirka Cops, [15], published the importance of physical activity has become evident since a sedentary lifestyle drives cardiovascular disease progression and is associated with increased morbidity and mortality. The favorable effects of exercise training in chronic heart failure (HF) and chronic kidney disease (CKD) are widely recognized and exercise training is recommended by European and American guidelines. However, the application of exercise intervention in HF patients hospitalized for acute decompensation or acute worsening in

cardiac function has not been explored extensively and, as a result. Acute HF is often accompanied by signs and symptoms of congestion, termed acute decompensated heart failure (ADHF), which leads to worsening renal function (WRF) and eventually negatively affects both thoracic and abdominal organs. Therefore, we first provide a comprehensive overview of the impact of exercise training in hospitalized patients demonstrating acute decompensating HF.

**Conclusion:**

Functional low frequency electrical stimulation of quadriceps and calf muscles improved femoral blood flow not only oxygen and nutrition also improve venous return without volume over load on the heart in patients with chronic heart failure, therefore helped to decrease swelling, reduce pain and increase healing. FES may represent a practical and effective strategy to improve perfusion and reduce risk of vascular complication. Thus we recommend using functional electrical stimulation of quadriceps and calf muscles in order to improve femoral blood flow in patients with chronic heart failure.

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