

The effect of a program of combined aerobic physical exercise with exercises of localized muscular resistance in the improvement of systemic and local circulation: a case study

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ABSTRACT

Introduction: Thrombophilia, elapses the existence of alterations of the hemostasis, being congenital or to be acquired. The protein S deficiency, occurs for the lack of the cofactor for protein C, is a congenital alteration that can result in thrombophilia. Physical rehabilitation, an efficient therapeutic option, has its paper defined in the prevention and treatment of cardiovascular illnesses. **Objective:** This study aimed to verify the influence of the associated aerobic physical exercise to the exercises of muscular resistance in the systemic and collateral circulation of the right upper/lower member and in the reduction of the consequences caused for the decurrent retractions of the surgeries. **Material and method:** The sample, composed by a patient of the feminine sex, 19 years, carrier of the syndrome of congenital thrombophilia because of protein S deficiency, with total obstruction of the right axillary artery and partial obstruction of the right superficial femoral artery. The program of exercises were divided in two phases. Phase I: Activities for increase of the amplitude of movements, became fulfilled kept application of heat, manual passive stretching, lymphatic draining and Effleurage manipulations. Phase II: Constituted of aerobic exercise (45 minutes of walked, 3 times per week, intensity of 60% 85% of the maximum cardiac frequency), and exercises of located muscular resistance (dynamic contractions, three se-

ries with the maximum of possible repetitions, low intensity, favoring aerobic factors). **Result:** 1. Improvement of the collateral circulation to the axillary artery, evidenced for the increase in the speed of systolic pulse (verified by pulsed Doppler examination) – in the radial artery passed of 3.4 cm/s for 16.8 cm/s; in the brachial artery, of 8.7 cm/s for 45.9 cm/s. 2. Better tolerance to the aerobic exercise. 3. Recovery of the functional capacity and amplitude of movement of shoulder. 4. Full recovery of the autonomy for the daily activities. **Conclusions:** The gotten results had demonstrated that the adopted therapy was efficient in the treatment of thrombophilia consequences.

Key words: Rehabilitation program. Systemic and collateral circulation. Thrombosis. Physical exercises.

INTRODUCTION

Thrombophilia is a condition that predisposes the occurrence of thrombosis as a result of the existence of hemostasia alterations¹. The alterations may be either congenital, being established by genetic modifications, inherited by the family members, or situations to be acquired, modifying the hemostasia equilibrium². The inherited thrombophilic disorders, such as the resistance to the activated protein C (factor V Leiden), the lack of protein C, protein S and antithrombin III, are abnormalities related to the quality of activated factors³. The protein S deficiency mechanism is the lack of the cofactor for protein C, where there is no inactivation of the factors Va and VIIIa, as for the deficiency of the protein C². The deficiency of the protein S represents 5-6% of the cases of hereditary thrombophilia³.

The cardiovascular rehabilitation has been currently widely employed and supported by the medical and scientific community. Once physical exercises play a well-defined role on the primary and secondary prevention not only of cardiovascular illness but of other illnesses as well, in other words, the prescription of physical exercises is a therapeutics⁴⁻⁷.

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The movement amplitude gain is administered in order to provide mobility and flexibility to the soft tissues around the articulation (muscles, connective tissue and skin)⁹, as well as to revert the existing contractive status, giving back to the articulation its regular movement amplitude^{9,10}.

The physical exercise has beneficial effects that seem to result from complex interactions of psychological and physiological effects. Furthermore, it is worthy emphasizing the stress reduction, the improvement of the cardiorespiratory function, the removal of factors such as the smoking habit and the alimentary reeducation^{5,7,11}.

The improvement of the systemic circulation occurs, among other factors, since exercise contributes for the hematocrit reduction (as plasma volume is increased) and causes increase on the erythrocyte plasticity, furthering an increase on the blood flow and a better distribution of the oxygen on the cell-capillary interface¹². However, both anatomical and physiological significant modifications of the cardiovascular system may yet occur with improvement of the oxygen transport, extraction and utilization systems¹³.

Studies demonstrate that the exercises of localized muscular resistance may contribute for the increase of the collateral blood circulation¹⁴⁻¹⁷. However, the theory that regular exercises further the development of the collateral arteries in human beings requires a more conclusive evidence¹³. Studies in animals that had their coronaries arteries artificially blocked submitted to controlled regular exercises, demonstrated that the coronary vascularization had improved¹⁵, what led to the conclusion that the moderate and severe arterial narrowing result in the development of collateral arteries proportionally to the obstruction degree¹⁴.

The aim of this study was to verify the influence of the physical exercise combined with exercises of localized muscular resistance on the improvement of the systemic and local circulation in a female patient, with deficiency of protein S with total thromboembolic obstruction in the right axillary artery and partial obstruction in the right superficial femoral artery.

MATERIAL AND METHODS

This research deals about a singular case study of a patient, carrier of congenital thrombophilia for deficiency of protein S; white, female, 19 years of age, from the city of Florianópolis, previously submitted to three angioplasties at the right axillary artery, with re-thrombosis occurrence with one-centimeter total obstruction at the right axillary artery and partial obstruction at the right superficial femoral artery.

The time elapsed between surgeries and the beginning of the physical rehabilitation was of seven days, where the

patient performed clinical treatment with anticoagulating sodic heparin (application of 12/12 hours, daily dosage of 15,000 U, subcutaneous way) during the seven first days of rehabilitation. Oral anticoagulating coumarins derivate (warfarin) with folic acid was progressively administered and maintained until the end of the therapeutics.

Data were obtained through interviews, method used when one intends to complement data extracted from other sources or when there are no safe sources for the attainment of the desired information. Other facilities for obtaining data were the measuring the cardiac frequency at the moment of limping of the right lower member and the distance elapsed in a 30-minutes period.

The performance of the colored arterial Doppler Echo complementary examination of the right upper member in order to verify the fluxometry in color, the peak systolic velocity, the peak diastolic velocity and the presence of stenosis in both the pre and post therapeutics, is required in order to verify the treatment efficiency, being a non-invasive and quite effective intervention.

The materials used during the therapeutics were: mattresses, towels, elastic materials for the resistance exercises, label *Mercur*, model *Thera-band*, cardiac frequency monitor label *Polar* model A1, stethoscope, sphygmomanometer label *Glicomed* model Premium and chronometer label *Casio*.

Rehabilitation program

The rehabilitation program was performed during 15 weeks, with three weekly sessions, being divided in two phases:

1. Activities in order to increase the movement amplitude – This phase lasted four weeks and occurred due to the patient had been submitted to three angioplasties (two of them with incision in the right ulnar cavity and one at the axillary region) what made the shoulder and elbow articulations of the right upper member to be contractive due to scar adhesions, what resulted in limitations in the articular mobility.

In this phase, the session was initiated by a previous application of heat on the area surrounding the articulations to be elongated, once the heating of the soft tissue and muscles before elongation increases the extensibility of the shortened tissue^{8,10,18}. Following, a manual passive elongation was performed in which the therapist applies an extreme power and controls direction, velocity, intensity and duration of the elongation (four repetitions of 30 seconds on average)¹⁷.

For the application of the elongation techniques, the movement functional and anatomical levels were considered, being the shoulder emphasized regarding flexion, hy-

perextension, abduction, external and internal rotation and horizontal abduction, extension, supination and pronation for the elbow^{10,19}.

As the elongation was carried out, the lymphatic drainage of the member was performed for the solution of the lymphedema as well as the *Effleurage* manipulations through the slow smoothing out movement, performed with progressive pressure, towards the venous and lymphatic flow, for the pain relief²⁰.

2. Anaerobic exercises and exercises of localized muscular resistance – This phase lasted 11 weeks and attempted to verify whether such therapeutic modality would further a better blood flow in the effected members through the improvement of the collateral circulation to the right axillary artery. In this phase, the session was composed of two periods:

2.1. Aerobic exercise

The aerobic exercise was performed three times per week with 45-minutes duration each period in which the 7 first minutes applied to the warming up, 3 minutes applied to elongate the main muscular groups in order to reduce the probability of injuring a muscle or conjunctive tissue; 4 minutes of low intensity walking recommended to increase the muscular temperature and to accelerate the blood flow^{4,21}.

The aerobic training was performed for 30 minutes with the target cardiac frequency established between 60% and 85% from the maximal cardiac frequency observed in a conventional effort test^{11,22-24}. Within these values, it was attempted to maintain the patient in activity, even though before the limping symptoms/signals and the discomfort in the right lower member, in the attempt to improve the collateral circulation of the superficial femoral artery^{23,25}.

The slowing down exercises (cooling) were performed for 8 minutes as follows: 5 minutes of low intensity walking, used in order to prevent blood stagnation at extremi-

ties, especially at legs; 3 minutes of static elongation in order to prevent the appearance of muscular lesions^{4,5,21}.

2.2. Exercises of localized muscular resistance

The exercises of localized muscular resistance were performed shortly after the aerobic exercise⁵ and were composed of dynamic contractions performed in three series with the maximal possible repetitions, with or without low resistance, low intensity and long duration, where the aerobic factor was preponderant, once those exercises did not aim at the muscular hypertrophy, but rather the increase on the local blood flow and the vascular improvement or neoformation^{5,17}.

In the resistance exercises program, the anatomical, kinetics and functional features of the upper member as well as the functional limitation imposed by the problem were taken into consideration^{10,19}. The techniques used were: shoulder horizontal abduction, internal and external rotation, elbow flexion and extension, wrist flexion and fingers and thumb flexion and extension^{8,19}.

At the end of this period, elongations were performed as well as muscular relaxation through massage, avoiding muscular lesions and blood stagnation^{4,5}.

It is worthy emphasizing that at the beginning and at the end of each session, the diastolic and systolic arterial pressure, the cardiac frequency, the respiratory frequency and the presence of right and left radial pulse were measured.

RESULTS AND DISCUSSION

The return to the productive life was one of the therapy results applied to the patient. Significant data were reported, such as the simple act of pulling the blanket at night with the right upper member, the school activities (writing and carrying the books), the hygiene habits, the act of eating and the act of changing clothes, impracticable at the beginning of the therapy, progressively started being performed and at the end of treatment, limitations were not found (table 1). The rehabilitation enabled an improvement

TABLE 1
Weekly evolution of activities performed by the patient, considering the possibility of full performance

Activities	1 st week (beginning)	2 nd to 5 th week	6 th to 9 th week	10 th to 15 th week
Writing	Unable	3 lines	30 lines	No restrictions
Bathing	With aid**	Trunk region	Trunk region UM***	No restrictions
Brushing teeth	With aid**	UM*** sustained	UM*** sustained	No restrictions
Changing clothes	With aid**	Large clothes	To button the blouse	No restrictions
Eating	With aid**	With restrictions	With restrictions	No restrictions
Domestic duties*	Did not perform	Did not perform	Picked up the dishes	Washed the dishes

* To pick up and to wash dishes.

** Aid provided by relatives.

*** Upper members.

of the life quality through the evolution in the functional capacity furthering higher independence in the daily life activities^{5,11,19}.

Aerobic exercises

The graphic 1 shows the progressive increase of the distance elapsed during the 30-minutes aerobic training, which at the beginning of the treatment was of 2,400 meters and, at the end, 4,000 meters, an increase of 66.6% in relation to the initial distance.

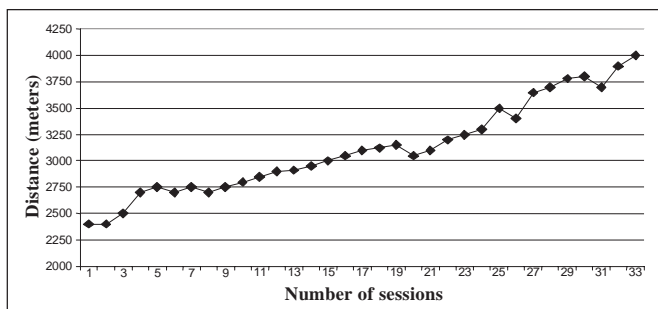
In graphic 2, one may observe that the cardiac frequency the patient presented at the moment of limping increased from 108 at the beginning of the therapy up to 146 beatings per minute at the end of treatment, showing an increase on the intensity in order to lead the patient to limping. It is worthy emphasizing that during the 30-minutes aerobic training (walking), the patient was led to limp the right lower member twice.

It is interesting observing that the evolution of the distance elapsed is coincident with the increase on the cardiac frequency that elevates limping, what corroborates that the tolerance to the aerobic training has improved; recent

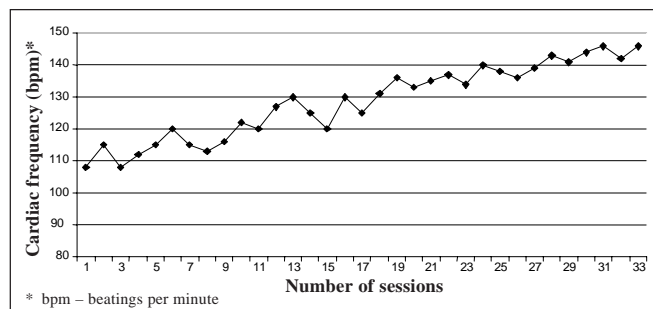
studies have demonstrated that walking may increase significantly the distance elapsed (150%)²⁶ or to generate an increase of 122% on the distance²⁴, in individuals who feel limping in the lower members by arterial obstructions. This increase on the walking capacity is associated with significant changes on distance and velocity¹¹, or with the functioning of the member free of pain^{11,24}; such evolution is related to the regression of the partial obstruction of the superficial femoral artery^{27,28}, and to the improvement of the collateral circulation^{14,16,24}.

Exercises of localized muscular resistance

The table 2 shows the muscular groups trained, the number of repetitions and the load during the 2nd phase of the employed treatment. One may observe that at the beginning of the therapy, the right upper member showed cyanotic and cold, and it became necessary to cover it with a cotton band in the attempt of maintaining it at a given temperature. As the treatment was carried out, the cotton band had been put away once the member improved its color and temperature, being with normal appearance from the ninth week of treatment. Researches verify that exercises



Graphic 1 – Distance elapsed in each session in a 30-minutes aerobic training



Graphic 2 – Cardiac frequency at the moment of limping, verified in each session

TABLE 2

Monthly evolution of exercises of localized muscular resistance considering the number of repetitions and the load

Muscular group	Number of repetitions and load beginning	Number of repetitions and load 1 st month	Number of repetitions and load 2 nd month	Number of repetitions and load 3 rd month
Horizontal abduction	3 x 8/Without	3 x 12/Without	3 x 15/Without	3 x 19/Without
Internal rotation	3 x 10/Light*	3 x 15/Light*	3 x 20/Light*	3 x 18/intermediate*
External rotation	3 x 10/Light*	3 x 15/Light*	3 x 18/Light*	3 x 18/intermediate*
Elbow flexion	3 x 10/Without	3 x 20/Without	3 x 18/Light*	3 x 20/Light*
Elbow extension	3 x 10/Without	3 x 15/Without	3 x 18/Without	3 x 20/Light*
Wrist flexion	3 x 10/Without	3 x 15/Without	3 x 20/Light*	3 x 20/Light*
Ankles	3 x 10/Without	3 x 12/intermediate*	3 x 20/intermediate*	3 x 20/intermediate*

* In agreement with the Mercur manufacturer.

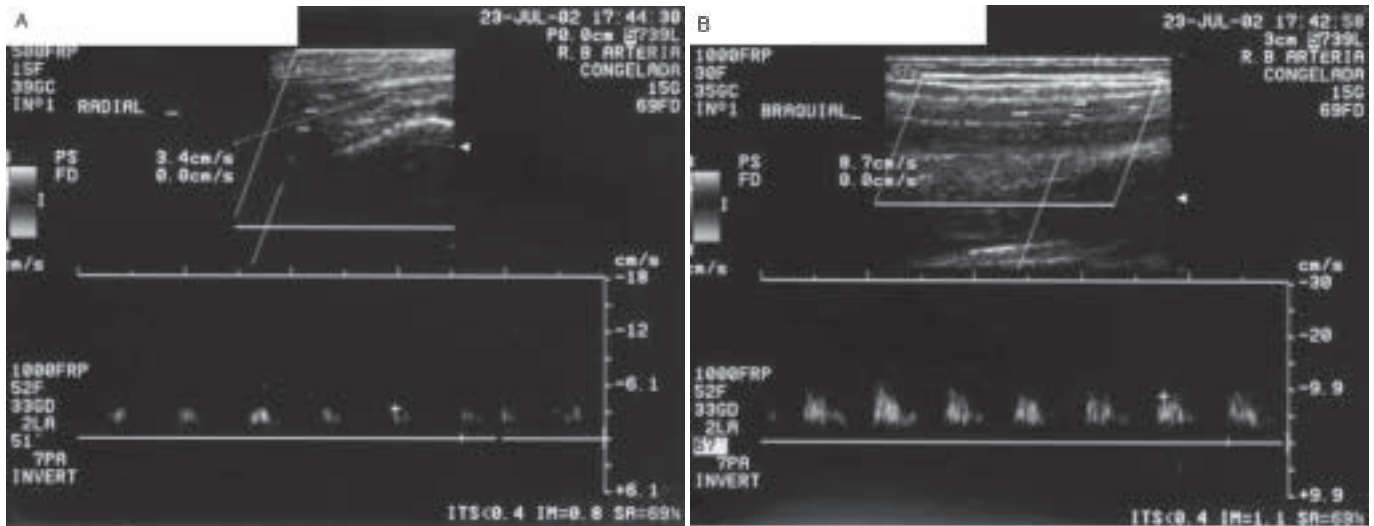


Fig. 1 – A) (radial). B) (brachial) – Pulsed Doppler performed with GE logic 700 equipment two weeks before the beginning of treatment.

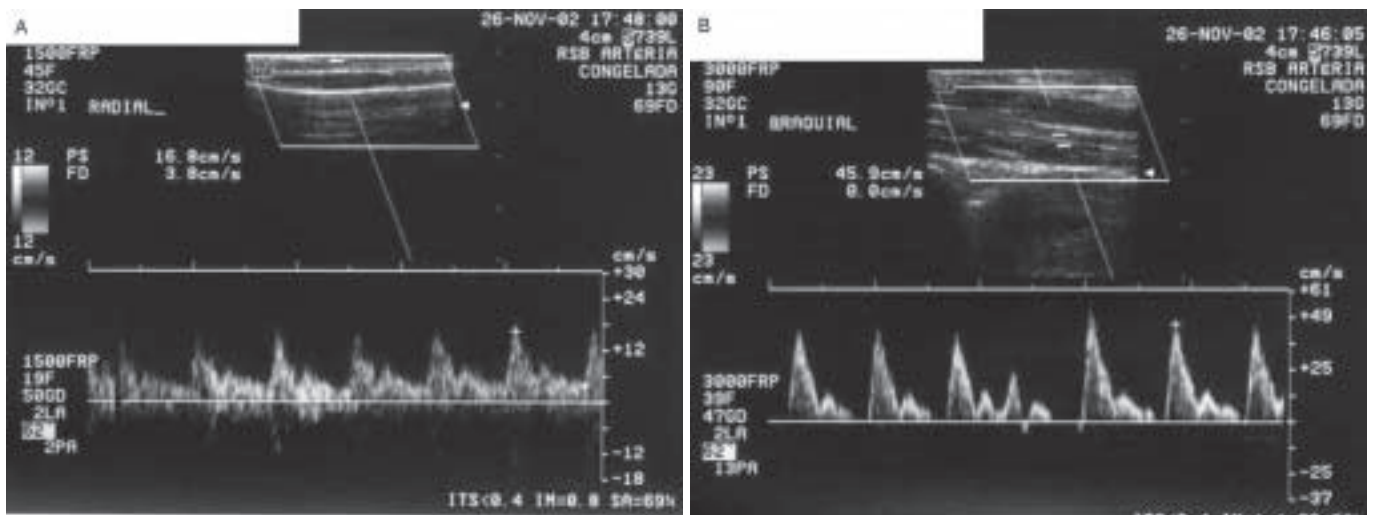


Fig. 2 – A) (radial). B) (brachial) – Pulsed Doppler performed with GE logic 700 equipment after the end of treatment.

mostly aerobic improve the blood circulation of the member to be exercised^{11,17}, as well as the skeletal muscle metabolism, enabling the oxygen utilization²⁹.

The figures 1 and 2 illustrate the pre- and post-therapy pulse velocity (verified through pulsed Doppler). One may observe that the improvement on the systolic pulse velocity was significant. The pulse velocity in the right brachial artery, which was of 8.7 cm/s before therapy (figure 1B), increased up to 45.9 cm/s at the end of the treatment (figure 2B), showing an increase of 427.9%. The same effect occurred to the pulse velocity of the right radial artery, which increased from 3.4 cm/s (figure 1A) to 16.8 cm/s (figure 2A) of systolic pulse, what evidences an improvement of 394.12%. This increase on the systolic pulse velocity may occur due to a favorable potential of the fibri-

nolytic activity due to training with aerobic predominance^{14,27,28}, associated to a change on the blood flow of the collateral circulation^{11,16}, or to a vasodilatation as result of the treatment¹⁴. Thus, it is verified that the employed treatment does not seem to be worse than interventionist therapeutic procedures employed to similar cases⁷.

CONCLUSION

Through the therapy employed, a significant improvement of the patient's life quality was observed with return to the productive life and higher independence in the daily activities such as the act of writing and the hygiene habits.

It was also verified a remarkable reduction on the limitation caused by the circulatory dysfunction, verified by the increase on the limping threshold of the right lower

member, in other words, higher tolerance to the aerobic exercise and by the increase on the velocity of the systolic pulse in the brachial and radial artery of the right upper member.

This study suggests that the treatment established for this patient may be considered for similar cases; such procedures could yet reduce some cardiovascular risk factors as well as the symptoms of the own disease.

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