Correlation Between Upper Limb Volume and Arterial and Venous Blood Flow Velocity in Lymphedema Secondary to Breast Cancer Treatment

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Abstract

Objective: The purpose of this study was to correlate upper limb volume and arterial and venous blood flow velocity in breast cancer survivors.

Methods: A cross-sectional study was conducted on 30 women with lymphedema and a mean age of 55.60 years (standard deviation = 8.12). For the assessment of upper limb volume, perimetry was performed with measures at 6 points on the limb, which were mathematically calculated as volume. The blood flow velocity of the axillary and brachial arteries and veins were assessed by Doppler ultrasound with a probe at 4 MHz. In the statistical analysis, a Shapiro-Wilk test determined a non-normal data distribution. Spearman correlation coefficients (ρ) were calculated to determine the association between the variables blood flow velocity and lymphedema volume.

Results: We identified significant and positive associations between all variables correlated with limb volume: blood flow velocity of the axillary artery ($\rho = 0.381$, $P = .041$), axillary vein ($\rho = 0.383$, $P = .039$), brachial artery ($\rho = 0.375$, $P = .044$), and the brachial vein ($\rho = 0.373$, $P = .045$).

Conclusion: There is a positive association between limb volume and blood flow velocity in the upper limbs of women with lymphedema secondary to breast cancer treatment. (J Manipulative Physiol Ther 2017;xx:1-5)

Key Indexing Terms: *Physical Therapy; Breast Cancer; Blood Flow Velocity; Lymphedema*

Introduction

Surgery is the principal treatment of breast cancer and may be associated with axillary dissection or sentinel node biopsy and adjuvant treatments such as chemotherapy and radiotherapy. These may favor several morbidities, with particular emphasis on chronic edema or lymphedema.[1,2]

Surgical treatment, combined with the adjuvant treatment of breast cancer and the individual's genetic predispositions, favor the development of lymphedema, which was recently named as the main consequence of lymphatic dysfunction resulting from therapy.[3] However, these therapeutic procedures may also produce changes in arterial and venous blood flow that are not yet fully clarified.[4]

Because of the relationship between the lymphatic and blood systems, especially in maintaining hemodynamic balance, several studies[4-6] used Doppler ultrasound to assess the blood circulation of the ipsilateral limb to the surgical procedure in breast cancer survivors. With this technology, it is possible to evaluate changes in venous and arterial blood systems by means of ultrasonic waves emitted and projected obliquely across the blood flow.[6] However, in the literature the relationship among the ipsilateral limb volume, the surgical procedure, and the velocity of the arterial and venous blood flow is not clear.

Thus, this study is justified by the need to establish the possible association between lymphedema volume and arterial and venous blood flow. The objective of this study was to correlate lymphedema volume and arterial and venous blood flow velocity in the upper limb of breast cancer survivors. In this context, assuming the hypothesis that there is a significant correlation between these variables, the results of this study could endorse the use of blood flow velocity assessment in

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both clinical studies and practice in the management of lymphedema in breast cancer survivors.

Methods

Ethical Aspects

The procedures of the present study were approved by the Research Ethics Committee of the Clinics Hospital of the Medical School of Ribeirão Preto of the University of São Paulo, according to protocol number 810616/2014. The patients gave consent by verbal invitation from the Breast Cancer Teaching, Research, and Rehabilitation Center of the Nursing School of Ribeirão Preto of the University of São Paulo.

Study Design

A blind cross-sectional study was carried out in which 1 experienced physiotherapist was responsible for recruiting, diagnosing, and evaluating the volume of upper limbs, a second was responsible for blood flow assessment, and a third researcher was in charge of data processing and analysis.

Sample

The calculation of the sample size was performed using the Ene program, Version 3.0 (Autonomic, University of Barcelona, Barcelona, Spain). The calculation was based on moderate association detected ($r = 0.50$) between variables, based on the study of Munro.[7] Considering a statistical power of 80% and an α of 0.05, a number of 26 patients was determined. Considering possible sample loss, 30 volunteers were included in the study.

Thirty patients aged between 40 and 70 years diagnosed with lymphedema of the upper limb resulting from breast cancer treatment and who had normal values for the ankle–brachial index (ABI) were recruited. These measures were assessed in the supine position after 5 minutes of rest, and the systolic blood pressure of the posterior tibial artery, dorsalis pedis artery, and brachial artery were measured bilaterally. The result was obtained by the ratio between the highest of the pressures at the ankle by the higher systolic pressure found in the brachial artery of the upper limbs. Normal values on the ABI are between 0.90 and 1.40; the highest values (to 1.40) represent an increase in resistance arteries and lower rates (to 0.90) indicate the presence of peripheral arterial disease.[8]

The following exclusion criteria were established: muscle-tendon injury and/or joint injury in the affected upper limb, skin conditions, diabetes, adjuvant therapy in progress, history of bilateral axillary dissection, and diagnosis of metastasis. Considering these eligibility criteria, there was no sample loss in this study.

Clinical evaluation consisted of standard anamnesis containing personal data, previous diseases, use of medication, data related to the treatment of breast cancer, and physical examination with a measurement of the mass, height, and body mass index.

Blood Flow Velocity

For the assessment of blood flow, patients rested for 10 minutes in a room with the temperature controlled at 23°C in the supine position with their arms also supine.[9] The measurement of the mean velocity of the arterial and venous blood flow was performed by Doppler ultrasound SONARA/Tek (Nicolet Vascular, Natus, Pleasanton, CA), calibrated, and with a probe at 4 MHz. The analysis of the mean blood flow velocity was performed with the probe positioned at 45° to the blood vessel to be measured, on greased skin with water-soluble gel.

To evaluate the axillary vein and artery, the patient was situated in the supine position with the arm to be evaluated with abduction and flexion of the elbow at 90° and the probe positioned in the axillary region. For the evaluation of the brachial vein and artery, patients remained in the supine position, the upper limb was positioned at 45° of abduction of the shoulder and extension of the elbow, and the probe was positioned in the anterior middle of the cubital line. Each evaluation was performed 3 times (4 seconds for each windowing) and the average of the blood flow velocity of the axillary and brachial arteries and veins was used in the statistical analysis.

Upper Limb Volume

The perimetry was performed bilaterally by a researcher familiar with the procedure. The 7-point measure distributed on the upper limbs was established,[10] and the tape used to measure the circumference was modified by inserting a charge at the end to achieve exactly the same tension in all measurements.[11]

The calculation of the upper limb volume was performed via an indirect method by adding the approximate volume of the 6 truncated cones formed by the measurement points of the circumference of the 7 points of the arm and forearm. The addition of these 6 parties provided the total volume number.[11] This method of calculation has good levels of reliability, with an intraclass correlation coefficient value of 0.99 for both inter- and intrarater reliability.[11] For correlation with blood flow, the difference in volume between the lymphedema-affected upper limb and the unaffected upper limb was considered.[12]

Statistical Analysis

The Shapiro-Wilk test was used to determine the normality of the data. The Spearman correlation coefficient (ρ) was calculated to determine associations among the variables, using the interpretation proposed by Munro[7]: 0.26 to 0.49 (weak), 0.50 to 0.69 (moderate), 0.70 to 0.89 (strong), and 0.90 to 1.00 (very strong). The level of significance was