The Muscle Pump Function in Chronic Venous Insufficiency: Plethysmographic Results

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The frequency and the severity of skin lesions were studied in patients with chronic venous insufficiency compared to the function of the muscle pump measured with plethysmography. The study showed that the frequency of skin symptoms parallels the muscle pump dysfunction. Measuring the ambulatory volume change on the calf level and the refilling time required for the normalisation of the calf volume after dorsiflexions of the foot gives suitable parameters for the evaluation of the muscle pump. The plethysmography is a valuable method to quantify the grade of venous insufficiency. (Received January 25, 1984.)

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Previous studies have shown the connection of the muscle pump inability with the severity of the venous insufficiency, the former being definitely more pronounced in postthrombotic legs than in those with primary varicosis. The extensiveness of the skin lesions in the postthrombotic syndrome in comparison with their slow evolution in venous insufficiency due to other causes made us compare these cutaneous signs with the inefficacy of the muscle pump, in patients with varicose veins.

Until recently the muscle pump function was judged by measuring the ambulatory venous pressure changes with the aid of an intravenous catheter (1, 2). However, this invasive technique is not suitable for a routine screening. Several authors (3, 4) have demonstrated that this method can be replaced by plethysmography measuring the volume changes of a member during muscle activity.

MATERIAL AND METHODS

A total of 90 legs with important varicosities were investigated. Considering the skin lesions three groups were formed: group 1: no skin changes ($n=18$), group 2: varicose pigmentation with or without beginning dermatosclerosis ($n=30$), group 3: obvious dermatosclerosis and/or "atrophie blanche" and/or ulcers ($n=42$).

The plethysmography was carried out with a mercury strain gauge plethysmograph type SP_2-Medimatic. Four parameters were determined in the varicose limbs of all patients, calculating the

Table I. *A.V.C. and R.T. in relation to the degree of skin lesions*

Statistical analysis by Student's t test between the groups

	A.V.C. (ml/100 ml)	A.V.C.' (ml/100 ml)	R.T. (s)	R.T.' (s)
Group I	−1.86±0.53	−2.47±0.52	12.8±4.1	26.6±11.1
Group II	−1.40±0.53	−1.82±0.53	9.9±3.1	26.0±13.6
Group III	−1.16±0.68	−1.60±0.75	7.0±2.5	13.2±6.2
t-test I–II	$p<0.01$	$p<0.001$	$p<0.01$	$p>0.05$
t-test II–III	$p>0.05$	$p>0.05$	$p<0.001$	$p<0.001$

mean value of three consecutive measurements: (*a*) The ambulatory volume change (A.V.C.) or maximum volume change (ml/100 ml) on the calf level after five dorsiflexions of the foot. (*b*) The refilling time (R.T.) or the time (s) required for the normalisation of the calf volume after the five dorsiflexions. (*c*) The A.V.C.^{t} or the maximum volume change (ml/100 ml) on the calf level after five dorsiflexions of the foot during application of a tourniquet just below the knee. The tourniquet was used to eliminate the superficial venous flow. (*d*) The R.T.^{t} or the time (s) required for the normalisation of the calf volume after five dorsiflexions during the application of a tourniquet just below the knee.

On the basis of the anamnesis, the clinical examination, the Doppler and the plethysmographic analysis, the varicose legs were grouped according to the type of the varicosis: Type 1: lower limbs with an important insufficiency of the perforators (n=27), Type 2: Lower limbs with a truncular saphenous varicosis (n=27). Type 3: Lower limbs with insufficient perforators and truncular saphenous varicosis (n=11), Type 4: Lower limbs with a postthrombotic syndrome (n=25).

RESULTS

The average ambulatory volume changes and refilling times are summarized in Table I. The changes in the R. T. runs parallel to the A.V.C. alterations: the shorter the R.T., the smaller is the A.V.C., expressed in absolute figures. The differences in each of the four parameters between the three groups were statistically analyzed using the Student's t-test (Table I). Table II compares the various types of venous insufficiency to the importance of the skin symptoms.

DISCUSSION

Although an overlap seems to exist of the A.V.C.-, the A.V.C.^{t}-, the R.T.-, and the R.T.^{t}-values in the three groups, the mean values of three of the parameters are statistically significantly different between group I and group II (A.V.C.: $p<0.01$, A.V.C.^{t}: $p<0.001$ and R.T.: $p<0.01$), of all the parameters between groups I and III (A.V.C., R.T., A.V.C.^{t}, R.T.^{t}: $p<0.001$) and of two of the parameters between groups II and III (R.T. and R.T.^{t}: $p<0.001$). The A.V.C. and R.T. are obviously more pathological when the skin symptoms are more pronounced.

These results are in agreement with the literature (4, 5): the incidence of varicose ulcers is about 10% in patients with an A.V.C. ranging from −1.75 ml/100 ml to −1.50 ml/100 ml and rises up to 60% in those with an A.V.C. less than −0.5 ml/100 ml.

The parallelism between A.V.C. and R.T. is a logic consequence of the reflux in the veins: the more important the reflux is, the shorter the time required to regain the original volume of the extremity, i.e. the R.T.. This reflux reduces the ambulatory volume changes because a part of the expelled blood flows immediately back after the muscle contraction.

Comparing the importance of the skin symptoms with the type of venous insufficiency, one can assess that they are far more frequent and important in the postthrombotic

Table II. *The various types of venous insufficiency in relation to the importance of the skin lesions*

	Group 1	Group 2	Group 3
Type I	6	11	10
Type II	10	10	7
Type III	2	4	5
Type IV	–	5	20
n=	18	30	42

syndrome. This however does not exclude that more than half of the patients belonging to group 3 suffer from essential varicosis. One can also ascertain the fact that skin symptoms are more frequent and more severe in patients with insufficient perforators.

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