HEMORHEOLOGICAL ASPECTS
IN THE MICROVASCULATURE
OF SEVERAL PATHOLOGIES

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Abstract: We evaluated morphological changes in several pathologies using computerized videocapillaroscopy, and related hemorheological patterns using the laser assisted optical rotational red cell analyzer (LORCA). In addition, tissue oxygenation was measured using two oximeters with Combi sensors (Periflux 5000, Perimed).

The study included four groups of patients (pts) that were compared with a control group. **Group A Controls** (n=25: 15 males [M] and 10 females [F] aged 36±3 years); **Group B Diabetic** pts n=32 (IDDM pts n=20: 12 M and 8 F aged 43±4 years; NIDDM pts n=12: 6 M and 6 F aged 45±3 years); **Group C Glaucoma** pts n=30 (16 M and 14 F aged 42±5 years); **Group D Liver failure** pts n=6 (3 M and 3 F aged 44±5 years); **Group E Hypertensive** pts n=50 (smokers n=28: 12 M and 16 F aged 40±4 years, and non-smokers n=22: 12 M and 10 F aged 38±3 years). In all patients hemorheological measurements were made using the LORCA (including red blood cell [RBC] deformability and aggregability), morphology was evaluated using computerized videocapillaroscopy (magnification 200 x), and transcutaneous oxygen partial pressure measurements (TcpO\textsubscript{2}) were made with the Periflux 5000.

In patients with diabetic microangiopathy: the capillary loops in 50% (16/32) of these pts showed formations such as ‘deer horns’, 72% (23/32) showed formations such as ‘elephant nose’, and in 45% (14/32) formations such as a ‘cork screw’; in diabetics with POAD an important capillary rarefaction was found in 26% (9/32) of the pts. In glaucoma patients, in 84% (25/30) we observed ‘capillary meandering’ and images such as ‘a comb’. In patients with more complicated pathology capillary rarefaction was found in 70% (21/30) of the patients. An improvement in the perfusion of non-functional loops was found in deceased patients who had suffered liver failure one week after liver transplantation in 90% (5/6) of the studied cadavers. In non-smoking hypertensives morphological changes were found in 25% (6/22) of the patients, and in hypertensive smokers in 47% (13/28). RBC deformability was detected using LORCA and expressed

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as the Elongation Index (EI), and RBC aggregability was detected using LORCA and expressed in t½ (seconds) indicating the RBC aggregability peak. Group A controls: EI 0.59±0.02; t½ 3±1 sec; Group B: IDDM EI 0.55±0.01; t½ 2±0.5 sec p<0.05; NIDDM EI 0.56±0.01; t½ 2±0.2 sec p<0.04; Group C glaucoma: EI 0.56±0.01; t½ 2±0.3 sec p<0.05; Group D liver failure: EI 0.56±0.02; t½ 2±0.4 sec p<0.03; Group E hypertensives: smokers EI 0.56±0.02; t½ 2±0.6 sec p<0.04; non-smokers EI 0.57±0.02; t½ 2±0.6 sec p<0.04 compared with controls. We also measured the TcpO\(_2\) at the dorsum of the right foot as a standard site representing peripheral control of microvasculature perfusion. Group A 96±11 mmHg; Group B IDDM 74±9 mmHg p<0.05; NIDDM 76±8 mmHg p<0.05; Group C glaucoma 75±9 mmHg p<0.05; Group D liver failure 69±6 mmHg p<0.05; Group E hypertensives: smokers 70±5 mmHg p<0.05, non-smokers 77±9 mmHg p<0.05 compared with controls.

This study presents an interesting and complete methodology to evaluate the microcirculation in different pathologies that induce changes in the microvasculature.

1. INTRODUCTION

The first to describe the circulatory system in detail was Sir William Harvey (1628; Fig.1); however, he did not explain the connection between the venous and the arterial system in his *De Motu Cordis*. In Italy the studies of Marcello Malpighi (1661; Fig. 2) have been very important, particularly his *De pulmonibus Observationes Anatomicae*. In his studies Malpighi described preliminary but nevertheless very important observations about the capillary system.

In Holland, Antoni van Leeuwenhoek (1675) devised a prototype instrument to directly study red blood cells (RBC): i.e. a microscope. In a letter to the Royal Scientific Society of London (1686) he reported his observations on RBC in the narrow capillaries described by Malpighi [1]. Subsequently, many other researchers made various scientific contributions. For example, in 1895 the ‘Starling Law’ described the oncotic and osmotic pressure in the filtration mechanism of vessel-tissue absorption; Starling observed that the contraction energy of the myocardiocytes is directly related to their initial length [2].

T. Lewis (1917), A. Krogh (1922) and Zweifach (1940) marked the birth of scientific knowledge on the microcirculation. In subsequent years studies were published on hemorheology and blood viscosity (L. Dintenfass 1971, T. Di Perri 1979, S. Forconi 1987, H. Meiselman 1989, M.R. Hardeman 1991); as well as on microhemodynamics (R. Del Guercio 1986), and on ischemia/reperfusion, especially during organ transplantation (G. Cicco 2003).

Today molecular and cellular biology are able to explain the relationships between the endothelium and the blood stream, leukocyte rolling and adhesion.

Endothelial functions are not included in the normal balance of endothelial cell stimulation and/or inhibition and are able to favour circulatory diseases. It then became interesting to study the hemorheological and morphological changes in tissue oxygenation in the microcirculation of various patients: including diabetics, hypertensives, patients suffering from lipoidoproteinosis, those with peripheral arterial occlusive disease (PAOD), with systemic pathologies such as systemic lupus erythematosus (LES), progressive systemic sclerosis (PSS= scleroderma), those