OPHTHALMODYNAMOGRAPHY AND OPHTHALMODYNAMOMETRY
IN NEUROLOGICAL PRACTICE

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ABSTRACT

Inventarisation of atraumatic methods of analysing the circulation in the carotid region shows that they generally can be classified as physiological or anatomical.

Physiological methods focus on blood circulation time or on the pulsating changes in blood pressure, blood velocity, blood vessel diameter and cerebral volume.

In this study the reliability of two pressure-dependent methods, namely ophthalmodynamography and ophthalmodynamometry, for the detection of haemodynamically significant carotid stenosis is established.

Correct results were found in 78–82% of cases.

Ophthalmodynamography, and the advantage of combining this method with ophthalmodynamometry, are more extensively investigated.

Although in recent years attention has been focussed on the study of the blood velocity pulsations with the Doppler technique, maximal diagnostic efficacy can be expected from a combination of pressure and flow wave studies.

A way to compare all the information contained in the curves can be found in the technique of Fourier analysis.

The results obtained by Fourier analysis of the ophthalmodynamographic curves are presented.

INTRODUCTION

It is 25 years ago since the first reports of successful relief of obstruction in a stenosed internal carotid artery were published. In those days transient cerebral and retinal disturbances were explained on the basis of haemodynamic processes. Later attention was focussed on thrombo-embolic phenomena.

Clinical arguments as well as angiographic findings and determinations of regional cerebral blood flow can be used in support of both theories. It is possible, however, that these theories are not interchangeable and that, consequently, the question arises in each individual case whether the one or the other explanation is to be preferred and whether all the phenomena observed can be explained by the same theory. With some reservations it might generally be expected that the haemodynamic theory is to be preferred for pa-
tients with partial obstruction, while the micro-embolic theory is preferable for patients with an ulcerated atheromatous plaque. Most often extracranial vascular obstruction, which is accessible to surgical techniques, is based on atheromatous degeneration of the vascular wall. In about 2% of cases, however, the possibility of various other processes should be considered. Angiographic examination is still indispensable as a means of obtaining definitive anatomical information. However, all angiographic techniques entail certain risks. A mortality of 0.1–1% and transient or permanent neurological dysfunction in 1–10% of cases can be expected. So, from the beginning of the development of vascular surgery of the neck vessels, there has been a need for atraumatic methods to detect extracranial vascular disease, giving rise to obstruction and/or thrombo-embolism.

At first ophthalmodynamometry as described by Baillart (1917) was the only method available to determine the blood pressure in the ophthalmic artery. This method was refined and rigorously standardized by Weigelin and co-workers.

In subsequent years a number of methods were described which can be summarized as follows.

Methods which focus on blood circulation time or on the pulsating changes of blood pressure, blood velocity, blood vessel diameter and cerebral volume must be classified as physiological. These are specially useful in detecting haemodynamic changes. Studies of the electroretinogram and the visual evoked response belong to the same category.

Besides the foregoing, methods have been developed which give anatomical information about the region of the carotid bifurcation (where 85% of all surgically accessible lesions are located). It will be clear that from the measurement of the cross-sectional area of the vessel and of the mean flow-velocity, flow rate can be calculated. A resultant of blood flow in the ophthalmic artery, the dermal temperature of the medial part of the forehead, can be measured by thermometry and thermography.

Finally the pulsatile variations of cerebral impedance can be recorded by rheoencephalography. Although carotid compression tonography is non-invasive it cannot be regarded as atraumatic. In the use of carotid compression fatal complications have been described; the overall complication rate amounts to 0.2–0.5%.

Physiological methods are only able to detect stenosis which influence the haemodynamic situation. The effect depends on several factors. Until now little attention has been paid to disturbances in the shape of oscillations in order to find smaller degrees of stenosis. Lastly, since thrombo-embolism is relevant to platelet activity and fibrin formation, biochemical studies and the use of isotope-labelled blood elements might be illuminating.