MECHANICOCHEMICAL SPHINCTERS IN THE MICROCIRCULATORY SYSTEM OF THE EAR

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Argyrophilic sphincters ("rings" and "bracelets") are found in the internal vascular network of the ear. They do not contract when treated with myotropic agents or muscle relaxants, nor do they allow the passage of silver ions.

Active contraction of muscle fibers is known to result from interaction between the contractile protein and ATP [5]. The dephosphorylation of ATP is accompanied by liberation of energy, which is utilized by the muscle for the performance of muscular work. The enzymic activity of myosin is highly sensitive to silver ions. Experiments have shown that even low concentrations of silver ions abolish the adenosinetriphosphatase activity of myosin [7, 8]. It is thus an established fact that silver solution acts as a very powerful suppressor of the adenosinetriphosphatase (ATPase) activity of contractile proteins, thus leading to complete adynamia of the contractile structures.

The object of the present investigation was to study the nature of the argyrophilic sphincters found in the microcirculatory channels.

EXPERIMENTAL METHOD

The internal vascular network of the human ear was studied in 467 cadavers of both sexes and of various ages. Experiments were carried out on 15 rabbits weighing 2.0-2.5 kg. A combined method was used to study the terminal vascular system, including microdissection, injection of ink with gelatin, clearing, impregnation with silver by the method of Ranvier and Kupriyanov, luminescence microscopy, and the benzidine test. To determine the nature of the argyrophilic sphincters found in the microcirculatory channels, myotropic drugs (papaverin, dibazol*) and muscle relaxants (tubocurarine, listhenon) were administered to the experimental animals.

EXPERIMENTAL RESULTS

Argyrophilic "rings" and "bracelets" were discovered for the first time in the capillaries and postcapillary venules of the human inner and middle ear. These structures are revealed only by Ranvier's method of impregnation of the vessels with silver. In their shape and structure these argyrophilic sphincters differ sharply from the ordinary smooth-muscle sphincters. As a rule they are in a closed state and they do not allow silver nitrate solution to pass through them into the next sector of the vascular system (Figs. 1 and 2). Ordinary smooth-muscle sphincters are revealed by this method in a relaxed state, and they pass silver solutions freely. The experiments showed that silver has no paralytic action on the enzyme–substrate complex of the argyrophilic sphincters, and that in contrast to the smooth-muscle type they are always closed (Fig. 2).

*2-benzylbenzimidazole hydrochloride.

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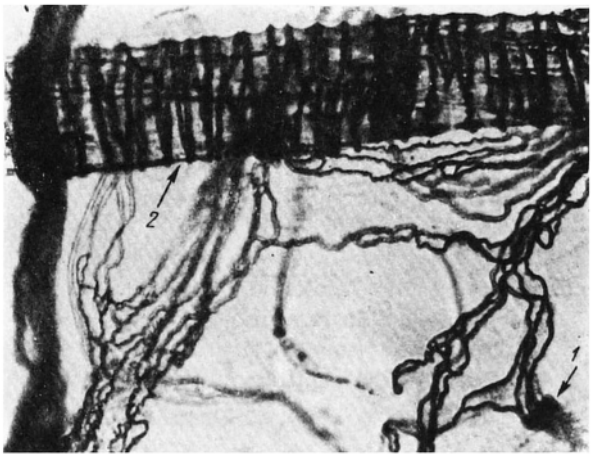

Fig. 1. Fragment of vascular network of mucous membrane of lower wall of the tympanic cavity of a woman aged 34 years: 1) argyrophilic ring in the capillary wall is in a closed state and does not allow silver solution to pass through; 2) arteriole with smooth-muscle cells arranged spirally in its wall. Impregnated with silver by Ranvier's method. 400 ×.

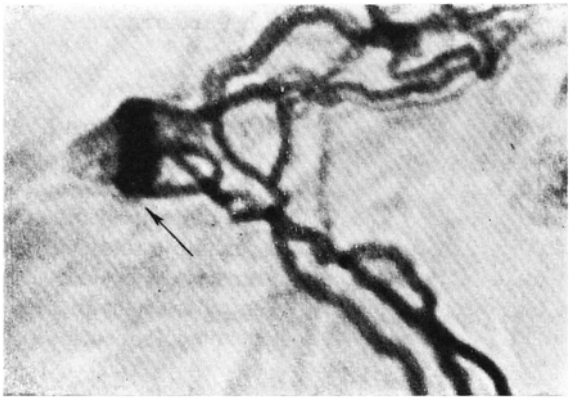

Fig. 2. Argyrophilic ring (marked by arrow) in capillary wall in mucous membrane of the bulla in a rabbit. Impregnated with silver by Ranvier's method. 420×.

The pharmacological experiment showed that, unlike smooth-muscle sphincters, the argyrophilic "rings" and "bracelets" do not react at all to myotropic agents or to muscle relaxants, and they remain in a contracted state, not allowing a silver nitrate solution to pass through them.

If the argyrophilic sphincters were in fact composed of contractile proteins of myosin-like nature [1, 2], and if the energy donor was ATP, their reaction to the various histological stains and pharmacological agents and their behavior toward silver ions would be identical with the reactions of muscle cells. However, this was not the case.

Investigation of the nature of the argyrophilic sphincters thus showed that the function of these structures is based on different energetic principles, and that they are an exception to the general rules established for contractile elements [3-8].

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