Acta Dermatovener (Stockholm) 58: 487–489, 1978

# ADRENERGIC NERVE INNERVATION OF THE HUMAN CUTANEOUS GLOMUS

Takafumi Morishima and Shigeru Hanawa

*Department of Dermatology, Nihon University School of Medicine, Tokyo, Japan*

*Abstract.* Adrenergic (monoaminergic) nerve innervation of cutaneous glomus from the human thumb was examined by the fluorescence method of Falck and Hillarp for the demonstration of monoamines. The main anastomotic vessel (Suquet-Hoyer canal) was found to possess a pattern specific for nerve innervation. The Suquet-Hoyer canal was surrounded like a sheath by numerous thin adrenergic fibers, which were distributed like threads around a bobbin. These nerve fibers are superimposed directly on the outer surface of the glomus cell layer, not penetrating between these cells. They show varicose axon ramifications.

*Key words*: Adrenergic (monoaminergic) nerve; Glomus; Suquet-Hoyer canal; Fluorescence method

Glomus, the arteriovenous anastomosis, is formed in the skin of fingers, toes, palms, soles, ears, eyelids, forehead, cheeks and lips of humans, and is concerned with the regulation of body temperature and peripheral blood circulation. The basic structure of the glomus consists of anastomotic vessels and nerves (6, 8). The arterial segment of anastomotic vessels is supplied with many non-myelinated nerve fibers, as revealed by staining with silver salts (12) and by electron microscopy (6). These nerve fibers stain positive for specific acetylcholinesterase (9). However, although innervation of the adrenergic nerve in human cutaneous glomus can be expected by its physiological data, it has not yet been elucidated clearly.

The present study was undertaken in order to reveal the characteristics of adrenergic (monoaminergic) nerve innervation of the human cutaneous glomus by the fluorescence method of Falck and Hillarp.

## MATERIALS AND METHODS

A skin specimen with normal appearance was taken from the volar surface of the distal phalanx of the right thumb (amputated because of subungual malignant melanoma) of a 34-year-old male patient. The tissue specimen was divided into two parts immediately after excision and one of them was fixed in 10% formalin solution and stained with hematoxylin-eosin and Weigert–Van Gieson stain. The other was frozen in isopentanol cooled with dry ice, freeze-dried for 7 days, and treated with formaldehyde gas at 80°C for 1 hr. After embedding in paraffin, these specimens were sectioned at a thickness of 10 $\mu$m and mounted for fluorescence microscopy (11). The Nikon FL-type fluorescence microscope was used, with a Nikon Y-51 filter. The source of the activation lamp was Toshiba SHL-200 with a Nikon B filter. A dark-field condensor for oil immersion was used for the examination and photography. When thus treated, the melanocytes emit a specific green fluorescence, and adrenergic nerves around the arterial vessels and in the arrectores muscles also emit the same specific green fluorescence. Such a specific fluorescence is considered to originate in DOPA or DOPA-containing compounds in the former and in noradrenalin in the latter (1, 11).

## RESULTS

### *Light microscopy*

In the specimens stained with hematoxylin-eosin or Weigert–Van Gieson stain, an arterial segment of the anastomotic vessel, called Suquet-Hoyer canal, its venous segment or a venule, an arteriole, and a large nerve, appeared as a single unit in the lower layer of the reticular dermis. The Suquet-Hoyer canal showed a narrow lumen and its wall consisted of a single layer of endothelium and media densely packed with 4 to 6 layers of glomus cells, lacking internal elastic lamina. The outer layer of the wall was surrounded by a loose connective tissue. Vater-Pacinian corpuscles were often located near the glomus structure.

### *Fluorescence microscopy*

The presence of the Suquet-Hoyer canal was easily detected under the fluorescence microscope by the characteristic innervation of the adrenergic nerve emitting a specific green fluorescence. Fig. 1A

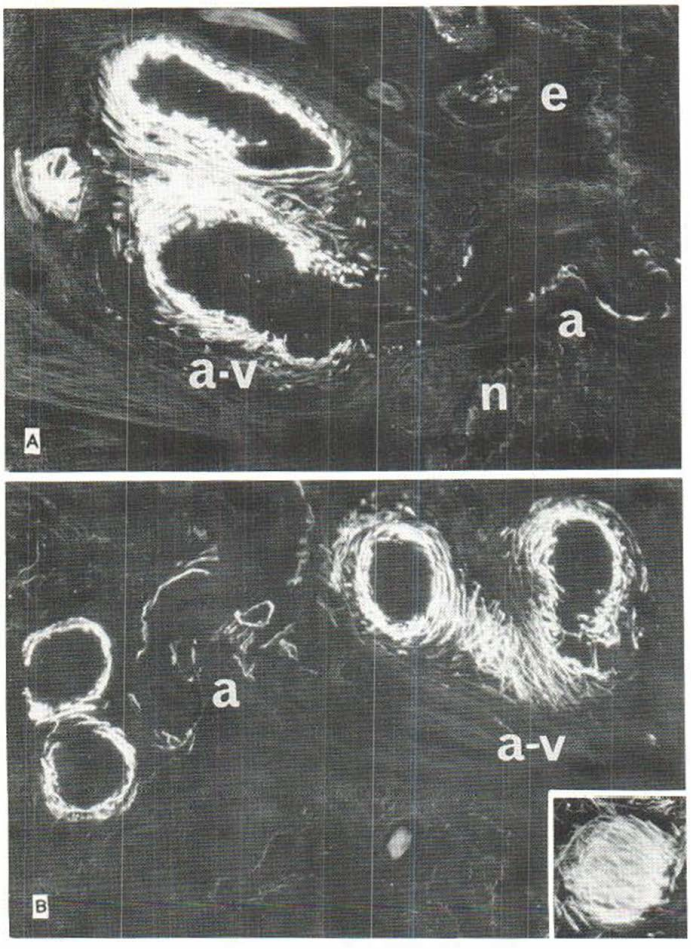


*Fig. 1.* Adrenergic nerve innervation of the glomus. As with cutaneous arterial vessels, the arteriole possesses autofluorescence of elastic fibers in the tunica interna, and adrenergic nerves in the adventitia. In the Suquet-Hoyer canal, the lumen narrows, autofluorescence of the internal elastic lamina disappears, and adrenergic nerves are densely superimposed on the outer surface of the glomus cell layer. The mode of this adrenergic nerve innervation simulates a thread densely wound around a bobbin. (A) Longitudinal section. (B) Transverse section.
The inset in (B) shows a tangential section of the Suquet-Hoyer canal seen in another specimen. *a–v*, Suquet-Hoyer canal; *a*, arteriole; *v*, vessel with venous configuration; *n*, nerve; *e*, eccrine sweat gland.

shows a longitudinal section of the connection of the arteriole and the Suquet-Hoyer canal. The arteriole, similar to a normal cutaneous arterial vessel, displays autofluorescence of the internal elastic lamina and an adrenergic nerve superimposed on adventitia in a distance. With transition to the Suquet-Hoyer canal, the lumen suddenly narrows, autofluorescence of the internal elastic lamina disappears, and distribution of the adrenergic nerve in the adventitia becomes marked. Fig. 1B shows transverse and tangential sections of the Suquet-Hoyer canal. Like a thread coiled around a bobbin, densely distributed adrenergic nerve fibers surround the Suquet-Hoyer canal, as a sheath. These adrenergic nerves do not penetrate the glomus cell layer and do not form special nerve-end organs, but form varicose axon ramifications. The venous segment of the anastomotic vessel and the venule lack adrenergic nerve innervation.

## DISCUSSION

The fluorescence method of Falck and Hillarp now available has made it possible to demonstrate directly the localization of monoamines and some of their precursors at the cellular level (2, 3, 4). Examination of the innervation of adrenergic nerves of the normal skin indicates that the nerve is present only around the arterial vessels and in the arrectores muscles (5, 10, 11). In the arterial wall, the adrenergic nerves display a varicose appearance and are present on the outer surface of the smooth muscle layer, the muscle layer itself being devoid of innervation.

Comparison of the adrenergic nerve innervation of the Suquet-Hoyer canal as found in the present study with that of the normal cutaneous arterial vessel indicates that varicose axon ramifications and absence of penetration into the media are common to both but there is a great difference in their

distribution density. The Suquet-Hoyer canal is densely surrounded by adrenergic nerve fibers, like a bobbin wound by a thread. This pattern is similar to the distribution of cholinergic nerves illustrated by Mescon et al. (9). Henningsen (7) found that the glomus caudale of the rat is innervated by a cholinergic and adrenergic network of a similar density.

Considering the above facts, human cutaneous glomus may be presumed to possess a dual autonomic innervation, similar to that of the cutaneous arterial vessel.

## REFERENCES


1. Agrup, G., Falck, B., Olivecrona, H. & Rorsman, H.: Formaldehyde-induced fluorescence of epidermal melanocytes of Caucasian and Negro Skin. Acta Dermatovener (Stockholm) *51*: 350, 1971
2. Corrodi, H. & Jonsson, G.: Fluorescence method for the histochemical demonstration of biogenic monoamines. J Histochem Cytochem *15*: 65, 1967.
3. Falck, B.: Observation on the possibilities of the cellular localization of monoamines by a fluorescence method. Acta Physiol Scand *56*: Suppl. 197, 1962.
4. Falck, B., Hillarp, N.-Å., Thieme, G. & Torp, A.: Fluorescence of catecholamines and related compounds condensed with formaldehyde. J Histochem Cytochem *10*: 348, 1962.
5. Falck, B. & Rorsman, H.: Observation on the adrenergic innervation of the skin. Experientia 19: 205, 1963.
6. Goodman, T. F.: Fine structure of the cells of the Suquet-Hoyer canal. J Invest Dermatol *59*: 363, 1972.
7. Henningsen, B.: Zur Innervation arterio-venöser Anastomosen. Z Zellforsch *99*: 139, 1969.
8. Lever, W. F. & Schaumburg-Lever, G.: The glomus. *In* Histopathology of the Skin. 5th ed., p. 38. Lippincott, Philadelphia and Toronto, 1975.
9. Mescon, H., Hurley, H. J. & Moretti, G.: The anatomy and histochemistry of the arterio-venous anastomosis in human digital skin. J Invest Dermatol *27*: 133, 1956.
10. Möller, H.: The catechol amines of the skin. Acta Dermatovener (Stockholm) *42*: 386, 1962.
11. Morishima, T.: Histochemical studies on the monoaminergic nerve in the skin chiefly by the fluorescence method of Falck & Hillarp. Acta Dermatovener (Stockholm) *50*: 329, 1970.
12. Tozawa, T.: Über Glomus cutaneum. Jpn J Dermatol *52*: 421, 1942 (in Japanese).


*Received February 24, 1978*

T. Morishima, M.D.
Department of Dermatology
Surugadai Nihon University Hospital
1-8-13, Surugadai, Kanda
Chiyoda-Ku
Tokyo, Japan