PATTERN OF INTRINSIC INNERVATION OF HUMAN CORONARY ARTERIES

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SYNOPSIS

The pattern of the intrinsic innervation of the human coronary arteries was studied by Bodian's, Holme's silver, modified Gros Bielschowsky and Nauta techniques. A ganglion was found among the nerve bundles surrounding the beginning of the right coronary artery. Nerve fibres, arranged in a plexiform fashion, surrounded the coronary arteries and their ramifications forming an adventitial plexus. Several bundles of nerve fibres were found dispersed in the media. However, the density of innervation of the media varied significantly not only with the diameter of the artery but also in consecutive segments of the same artery. From the adventitial plexus nerve fibres traversed the media some of which could be traced up to the subintimal region. The significance of this pattern of innervation was discussed.

INTRODUCTION

The superficial and deep cardiac plexuses are formed by the cardiac branches of both vagi and sympathetic trunks. These are interconnected and send secondary branches to supply the right and left coronary arteries (Warwick and Williams 1973). Kuntz (1947) mentioned that large fibres of vagal origin terminate in the adventitia of the coronary arteries, apparently without penetrating the media. Recently some studies dealt with the intrinsic innervation of the coronary arteries in cats and dogs (1, 8, 4, 2). Moreover, numerous ganglia were described on the posterior surface of both atria and at the roots of great vessels (7). In the literature, histological studies concerned with the innervation of the coronary arteries in man are meagre. Therefore, the aim of the present work is to investigate the pattern of intrinsic innervation of the human coronary arteries and compare it with that described in other animals. Moreover, an attempt was made to study the existance of ganglia in relation to them.

MATERIAL AND METHOD

The coronary arteries used in this study were obtained from 25 bodies subjected to the postmortem examination in Ain Shams Faculty of Medicine. Irrespective of sex, these were 5 full term neonates, 7 children, 5 adolescents and 8 adults. All died from non-cardiovascular causes.

Samples for histological study were taken from the emergence region of the right and left coronary arteries, posterior and anterior interventricular arteries as well as the diagonal, circumflex and marginal branches and fixed in Carnoy's fluid. Serial transverse sections were cut at 10 u thickness and stained with Bodian, Holme's silver, modified Nauta and Gros Bielschowsky techniques.

RESULTS

The classical histologic picture of the coronary arteries described in textbooks was identified. The broad perivascular connective tissue coat contained bundles of nerve fibres. Among the bundles that surrounded the beginning of the right coronary artery a ganglion was located. This possessed a definite connective tissue capsule and framework (Fig. 1). The ganglion cells showed some variations in their cellular morphology assuming any form between ovoid and polygonal. The nuclei were usually eccentrically placed, single with a well defined nucleolus. Each cell was surrounded with satellites. The left coronary artery was surrounded by a similar bundle of nerve fibres but neither solitary nor aggregated ganglionic cells were detected in its vicinity.

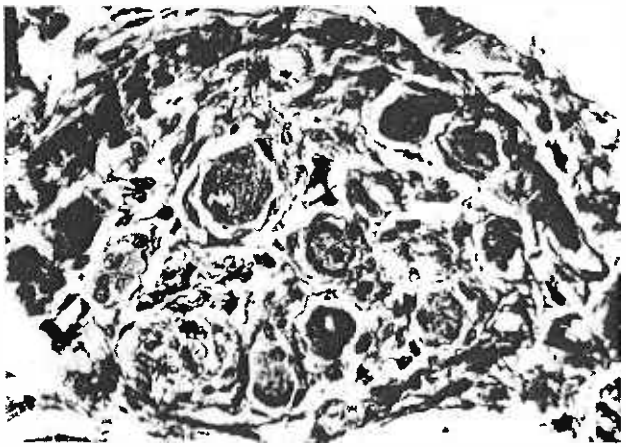

Figure 1. Photomicrograph of a coronary ganglion showing ganglion cells. Holme's stain X 270

As the nerve fibres approached the wall of the coronary artery, they divided and spread out in a plexiform fashion around the vessel to form an adventitial plexus. This plexus consisted of thick nerve fibres that ramified among and parallel to the concentric lamellae of the elastic material of the adventitia (Fig. 2). From the adventitial plexus, thick nerve fibres could be seen traversing the media either solitary or in bundles (Figs. 2, 3 and 4). Some could be traced up to the subintimal region (Fig. 4). These were detected in the anterior interventricular (Fig. 2), posterior interventricular (Fig. 3), and the proximal segment of the right coronary artery (Fig. 4).

The media was richly supplied by nerve fibres. In general these were concentrically arranged forming several medial plexuses, one on its outer part, another in its inner and one or more in between (Fig. 5). Some of these fibres were noticed in between the smooth muscle fibres of the media, others pursued a spiral course on the surface of the muscle fibres and showed nodose thickenings (Fig. 5). However, the density of innervation of the media varied significantly not only with the diameter of the artery but also in consecutive segments of the same artery.

DISCUSSION

In various vertebrates, Woollard (12) described ganglia on the anterior and posterior surfaces of the left

Figure 2. Photomicrograph of the anterior interventricular artery of an adult showing the adventitial plexus with penetrating thick nerve fibres traversing the media. Gross Bielschowsky technique. X 270

Figure 3. Photomicrograph of the posterior interventricular artery for adult male showing thick nerve fibres penetrating through the media. Modified Nauta technique. X 270

Figure 4. Photomicrograph of the right coronary artery of a child (5 years) showing thick penetrating nerve fibres from the adventitial plexus reaching the subintimal one. Gross Bielschowsky stain. X 270

atrium, a chain of ganglia extending along the interatrial septum, several large ganglia in the region of the atrioventricular sulcus, numerous smaller ones adjacent to the base of the pulmonary artery and along the proximal portion of its course. In man, Perman (7) noticed numerous ganglia on the posterior surface of the atria and the roots of the great vessels incorporat-

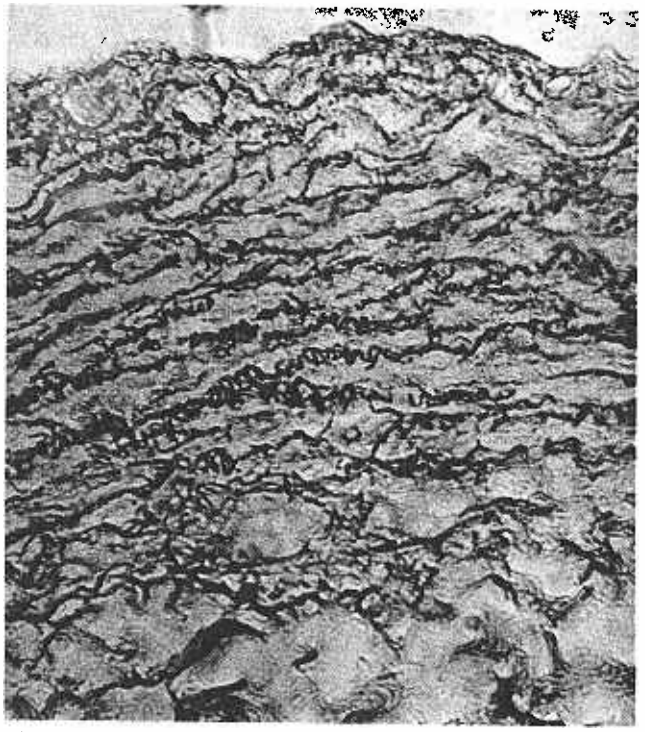

Figure 5. Photomicrograph of the anterior interventricular artery of a child (3 years) showing adventitial plexus, medial plexuses and the subintimal one. Gross Bielschowsky stain. X 270

ed in nerve trunks. The present study demonstrated a right coronary ganglion that existed in relation to the beginning of the right coronary artery. The presence of such coronary ganglion might be explained by the possibility of further migration of some neuroblasts from the region of the roots of the great vessels along the nerve bundles scattered around the beginning of the right coronary trunk to form a terminal ganglion at such site.

Dolezel et al (2) found loops of sympathetic nerve plexus that regularly distributed throughout the circumference of the artery. No direct innervation of the media could be found in large coronary trunks. Exceptionally they found solitary terminal fibres situated on the internal border of the adventitia. In smaller coronary arteries, the plexus was commonly situated on the surface of the media. In terminal coronary branches, this plexus aggregated into two strands running parallel to the vessel. Moreover, an adrenergic nerve plexus lying close to the outer media in the coronary artery of dog was described by Dahlstrom et al (1). Woollard (12) described two varieties of nerve fibres innervating the coronary arteries. The first consisted of thicker vagal fibres that ended in the adventitia of the vessels without penetrating the media. He described the second type of nerve fibres as non myelinated (sympathetic) with nodose thickenings and ended in relation to the individual smooth muscle fibres of the media. In the present study, a well defined adventitial plexus of nerve fibres was observed. Moreover, the media was richly supplied with nerve fibres. However, the density of its innervation varied significantly not only with the diameter of the artery but also in the consecutive segments of the same artery.

Kuntz (5) mentioned that large nerve fibres of vagal origin terminated in the adventitia of the human coronary arteries, apparently without penetrating through the media. The same was supported by Dahlstrom et al (1) and Leontieva (6). But this was challenged by the findings of Schenk and Elbadawi (8) and Krokhina (4). The present study demonstrated thick nerve fibres extending from the adventitial plexus, penetrated the media and traced up to the subintimal region at certain sites (proximal segment of right coronary, anterior descending and posterior descending coronary arteries). Ganong (3) mentioned that injection of veratridin into the branches of the coronary arteries supplying the left ventricle caused apnea, hypotension and bradycardia (the coronary chemoreflex, or Bezold Jarish reflex). He attributed the coronary chemoreflex to be triggered by chemical stimulation of the stretch receptors in the ventricular wall, or it might be due to stimulation of as yet unidentified chemoreceptors in the myocardium. Clinically, hypotension and cardiogenic shock not infrequently complicated acute myocardial infarction and acute coronary occlusion. These penetrating nerve fibres showed the same sites of predeliction of coronary atherosclerosis and occlusion (9). Therefore, it might be suggested that these fibres might play a role in the mechanism of hypotension that could be mediated through the vagi. Ganong (3) mentioned that Bezold Jarish reflex could be abolished by vagotomy.

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