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STRUCTURAL OBSERVATIONS ON THE
NORMAL AND DENERVATED CAROTID BODY
AND CAROTID SINUS IN THE SHEEP

(Ovis aries)

A thesis presented in partial fulfilment of the
requirements for the degree of Doctor of Philosophy
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MAUNG SHA-BAN

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Dedicated to my parents,
Daw Nu Ron and Maulvi U Maung Gale

ABSTRACT

Structural and ultrastructural observations on the normal and denervated carotid body and carotid sinus of 50 lambs and 7 adult sheep (*Ovis aries*) were made employing various anatomical, histological, fluorescent, microscopical and ultrastructural techniques. Chronic denervation experiments were performed by (i) unilateral sectioning of the carotid sinus nerve with or without sectioning of the glossopharyngeal nerve and pharyngeal branches of the vagus nerve, and (ii) unilateral sectioning of the sympathetic filament (external carotid nerve) to the carotid trifurcation, or unilateral cranial cervical ganglionectomy.

The gross anatomical studies demonstrated that there is variation in the mode of branching of the common carotid artery and the pattern of the venous drainage of the entire carotid region. The position, blood supply and venous drainage of the carotid body were also found to be variable. The major arterial source of supply for almost all the structures associated with the carotid trifurcation is the occipital artery. The dual innervation of the carotid body and the carotid sinus from the glossopharyngeal nerve (via the carotid sinus nerve) and the cranial cervical ganglion (via the external carotid nerve) is described.

From the histological studies it was found that there is widespread distribution of carotid body tissue at the carotid trifurcation. Two major cell types were seen in the carotid body, the chief or type I cells and the sustentacular or type II cells. The former included "light" and "dark" cells but it was not possible to identify these cells with certainty under the electron microscope.

The carotid body and carotid sinus receive predominantly glossopharyngeal fibres which were traced close to the type I cells in the carotid body, and in the carotid sinus to the deeper tunica adventitia. The large diameter nerve fibres which degenerated after sectioning of the carotid sinus nerve, were seen to terminate in close association with the type I cells. The carotid body cells or the carotid sinus wall did not exhibit any marked morphological changes after sectioning of the carotid sinus nerve or after sympathectomy; however, a marked dilatation of the blood vessels was seen in both the carotid body and carotid sinus.

The carotid sinus is a swelling, dilatation or diverticulum at the origin of the occipital artery or the occipitoascending pharyngeal arterial trunk. The extent of the elastic tissue varies according to the position of the carotid body. The carotid sinus is predominantly of the elastic type. The terminal nerve fibres end as diffuse endings. The large diameter myelinated nerve fibres which degenerated after sectioning of the carotid sinus nerve are suggested to be of glossopharyngeal origin, whereas the fine nonmyelinated fibres which could be traced to the medioadventitial border or superficial media are suggested to be of sympathetic origin.

Both the normal and sympathetically denervated carotid body cells exhibited intense fluorescence, the intensity of the fluorescence remaining the same up to 8 weeks after sympathectomy. It is suggested that normal carotid body cells contain catecholamines consisting mainly of noradrenaline and dopamine which are not affected by chronic sympathetic denervation.

Fluorescent nerve fibres were seen on the outermost layer of the adventitia of the normal carotid sinus, along the carotid body artery, and in the adventitia and the medio-adventitial border of the common carotid and external carotid arteries. They were not present in the denervated specimens. It is suggested that the carotid sinus, carotid body artery and the common carotid and external carotid arteries receive sympathetic adrenergic innervation.

Ultrastructural studies confirmed the presence of type I and type II cells in the carotid body. The predominant type I cells are characterized by the presence of numerous dark-cored osmiophilic vesicles and mitochondria. The type II cells are irregular shaped cells with a characteristic nucleus, extensive cytoplasmic processes, fewer mitochondria and indistinct endoplasmic reticulum. Blood vessels are numerous in the carotid body. The nerve endings are of two types - large and small, the former being particularly associated with type I cells. Sometimes fine nonmyelinated small axons were seen in the small grooves of the type I cells. Most of the large diameter myelinated nerve fibres and the large type of nerve endings degenerated after sectioning of the carotid sinus nerve. The degeneration was almost complete at 2-8 weeks after nerve transection. After sympathectomy small diameter nonmyelinated nerve fibres which were usually related to the blood vessels, degenerated. It is suggested that the large diameter myelinated nerve fibres and large nerve endings belong to the glossopharyngeal system, and the small diameter nonmyelinated nerve fibres, which are usually related to the blood vessels, are from the sympathetic system.

The ovine carotid sinus presented a very similar fibre architecture to that found in the laboratory animals, and the endothelial cells possessed complex endothelial folds. Those nerve terminals which possessed indistinct perineural sheaths and few electron dense-cored vesicles degenerated after sectioning of the carotid sinus nerve, and these nerve terminals are suggested to be derived from the glossopharyngeal nerve. As the nonmyelinated sheathed nerve terminals at the medioadventitial border of the carotid sinus degenerated after sectioning of the external carotid nerve or cranial cervical ganglionectomy, they are suggested to be from the sympathetic system.

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LIST OF ABBREVIATIONS

a, ap	ascending pharyngeal artery
br	communicating branch to the external carotid nerve or the carotid sinus nerve
cb	carotid body
cc	common carotid artery
ccg	cranial cervical ganglion
cct	cervical sympathetic trunk
cl, b	cranial laryngeal artery
csn	carotid sinus nerve
csn1	carotid sinus nerve, first branch
csn2	carotid sinus nerve, second branch
ecn	external carotid nerve
ic, c	internal carotid artery
icn	internal carotid nerve
la	lingual artery
m	muscular branch
o	occipital artery
opt	occipitoascending pharyngeal arterial trunk
vb	a small branch from the pharyngeal branch of the vagus nerve