STUDY OF THE DISTRIBUTION OF MOTOR END-PLATES IN DIFFERENT MUSCLES OF THE BODY OF THE ALBINO RAT

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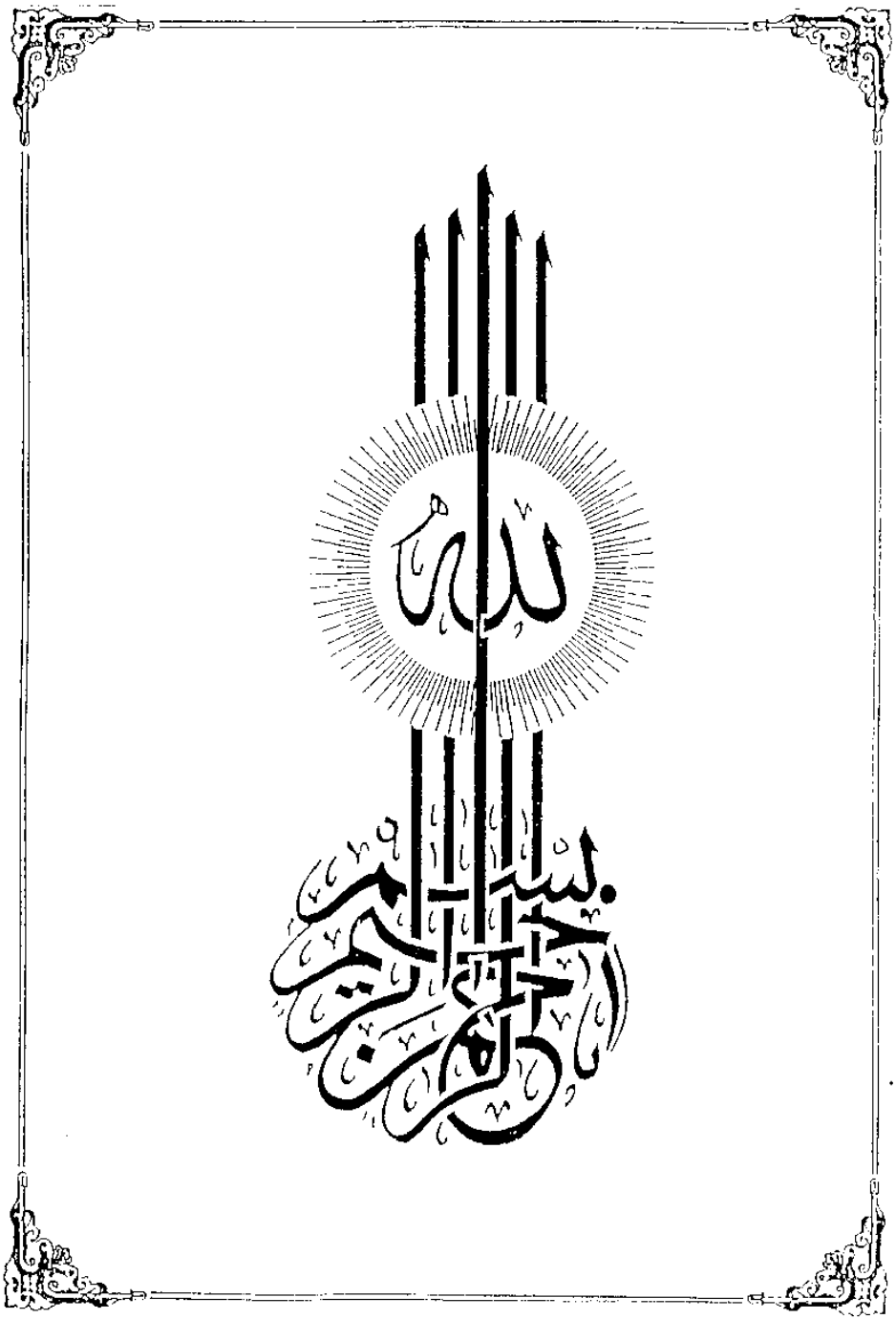

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INTRODUCTION

The histology and morphology of motor endings on the extrafusal skeletal muscle fibres of various animals as well as man have been investigated by many authors. Most of these studies were concerned with correlation of the anatomy of the motor endings with the functions of the examined muscles. In the present study, a trial was made to correlate the site and distribution of the motor end-plates with the arrangement of the extrafusal muscle fibres in the skeletal muscles of the body of albino rat.

Away from the classically studied muscles, as extraocular and intercostal muscles, tibialis anterior, the superficial head of flexor digitorum profundus and palmaris longus muscles were taken as unusual examples to confirm the unique structure of the motor end-plate in all voluntary muscles of mammals.

REVIEW OF LITERATURE

REVIEW OF LITERATURE

I- SMALL NERVE BUNDLES AND PRETERMINAL FIBRES

Hines (1931), studied the motor innervation of the extraoccular muscles of rabbit by using the technique of intra-arterial infusion of methylene blue. He found that the small intramuscular nerve bundle ran parallel to the muscle fibres and from which preterminal fibres arose in groups and ran also parallel to the muscle fibres to end on motor end-plates. He also observed that, sometimes, a preterminal fibre was seen to divide into branches; one supplied a typical motor end-plate on a muscle fibre, while the other, which he called the "accessory ending", terminated freely on the same or on a nearby muscle fibre. In the latter case, it was possible to demonstrate that the "accessory ending" was not the only efferent terminal on that muscle fibre. He also mentioned that the "accessory ending" was so called because it acted as an adjunct to the efferent nervous impulse which reached the muscle fibre via its motor end-plate.

Feindl, Hinshaw and Weddel (1952), examined the tibialis anterior, rectus femoris and interossei muscles of rabbit and monkey by using the technique of slow intravenous perfusion of methylene blue. He found that the small nerve bundles ran in different directions within the muscle forming intramuscu-

lar nerve plexuses. Preterminal fibres arose from these plexuses and passed obliquely, crossing two or more muscle fibres before they terminated in motor end-plates. They also observed, in the interossei muscles, that each preterminal fibre tended to divide into two or more branches which fanned out to supply motor end-plates on different muscle fibres.

Maximow and Bloom (1952), mentioned that, in human skeletal muscles, the so called "accessory endings" were either somatic sensory or sympathetic fibres.

Bowden and Mahran (1956), observed, in their experimental work on the quadratus labii superioris muscle of rat using a modification of Ranvier's gold chloride technique, that the small intramuscular nerve bundles were arranged in a direction almost perpendicular to the long axis of the muscle fibres. They added that preterminal fibres arose from these bundles, either singly or in groups and ran parallel to the muscle fibres. They also noticed that each preterminal fibre either supplied a single motor end-plate or, more commonly, it divided into two branches supplying one or two motor end-plates on a muscle fibre. They also observed that, sometimes, one of the two terminal branches of the motor axon was seen supply a motor end-plate while the other ended freely on a muscle fibre. These free nerve endings were accepted by Bowden and Mahran to be sensory. They also mentioned that, occasionally, a single motor end-plate was supplied by two diffe-

preterminals of unequal sizes. They added that the functional significance of a single motor end-plate supplied by different preterminals was obscure.

Cole (1957), using a modification of Ranvier's gold chloride impregnation technique, described, in the rectus femoris muscle of rat, that the small nerve bundles were disposed nearly at right angle to the long axis of the muscle fibres. He also reported that preterminal fibres were splitted off these bundles and most of them crossed one or more muscle fibres before direct termination in motor end-plates. Cole added that, in few cases, the preterminal fibres were seen to be disposed in line with the muscle fibres and occasionally, they were observed to divide into two or more branches.

Krnjevic and Miledi (1958), examined the motor innervation of the gracilis muscle of albino rat by using methylene blue. They found that the small intramucular nerve bundles arose from the main nerve trunks and ran perpendicular to the long axis of the muscle fibres. They also reported that preterminal fibres were seen to split off these bundles and most of them terminated directly on motor end-plates except in very few cases where they divided into two or more branches.

Guth and Zalewski (1963), using silver staining method, reported in the tibialis anterior muscle of rat that the small nerve bundles took a direction more or less perpendicular to the long axis of muscle fibres. They also

mentioned that the vast majority of the preterminal fibres tended to cross one or more muscle fibres obliquely before they terminated directly in motor end-plates. They also added that splitting of preterminals into two or more branches was uncommon.

Karlsen (1965), examined the masseter muscle of the adult albino rat by using Miller's, van Gieson and Bodian's stains and showed that the preterminal fibres ran a straight course either parallel to or across the muscle fibres. He also mentioned that the preterminals tended to terminate directly in motor end-plates except in very few cases where they were seen to split into two or more branching supplying more than one end-plate.

Mahran and Sakla (1965), using Holmes' silver stain, observed the extraoccular muscles of the albino mouse that the small intramuscular nerve bundles ran at right angles to the long axis of the muscle fibres while the preterminal fibres branched from these bundles singly or in groups, ran parallel to the muscle fibres. They added that each preterminal fibre either terminated directly in a motor end-plate or more commonly, divided into two or three branches each of which supplied a motor end-plate. They also reported that sometimes, a preterminalwas seen to divide into two branhes; one supplied a motor end-plate while the other ended freely on a muscle fibre. They detected that the free nerve endings were most pro-

bably, sensory in function.

Abd El-Rahman (1969), in her study on the motor innervation of the levator nasolabialis muscle of dog by using gold chloride stain, mentioned that the small intramuscular nerve bundles ran across the muscle fibres and gave off preterminals which passed parallel to the muscle fibres. Each preterminal fibre either entered a motor end-plate directly or more frequently, it divided into two brancnes which supplied one or two motor end-plates on the same or on two different muscle fibres.

Ibrahim (1978), examined the cricothyroid muscle of dog by means of gold chloride and Holmes'silver stain. He observed that the preterminal nerve fibres ran in a direction nearly parallel to the muscle fibres and they neither supplied the motor end-plates directly or, more frequently, a preterminal fibre divided into two branches which supplied one or two motor end-plates on one muscle fibre. Occasinally, the two branches of the preterminal fibre were unequal in diameter.

Ribchester and Toxt (1984), using zinc iodide-osmium stain, reported that, in interossei muscles of rat's hindlimb, the most of the preterminal fibres were disposed in line with the muscle fibres and each of which tended to divide into two branches. In very few cases, they found that the pre-

terminals crossed one or more of muscle fibres before termination on motor end-plates.

II-TYPES AND MORPHOLOGY OF MOTOR ENDINGS

A In lower vertebrates

Kulchitsky (1923), in his experimental work on the skeletal muscles of snakes by using Ranvier's method of gold chloride stain, mentioned that two types of motor endings were present on the extrafusal skeletal muscle fibres of that reptile. These were:

(1) "Termination en-grappe"; in which a non-medullated nerve fibre divided into a number of terminal filaments each of which ended in a botton-like enlargement on the surface of the sarcolemma. Such termination resembled a bunch of grappe and its stem; hence "termination en-grappe". He also mentioned that this type of endings was a characteristic of reptilian skeletal muscles.

(2) "Termination en plaque" or motor end-plate; in which the axis cylinder of a medullated nerve fibre, after loosing its myelin sheath, passed through the sarcolemma and divided into a number of ramifications which spread over a small rounded or oval area of the sarcoplasm.

Murray (1924), examined the skeletal muscles of fishes and found that the motor endings on the muscle fibres were of the "en-plaque" variety.

Cole (1955), in his experimental work on the paravertebral muscles of different animal species of the subphylum vertebrata by using gold chloride impregnation technique, found that:

- In Telestomi: the motor nerve endings on the extrafusal skeletal muscle fibres were in the form of compact nerve nets formed of thick nerve filaments and contained granular material in their meshes. He classified these endings as "termination en-plaque".
- In Amphibia: the motor endings were of the "T" variety in which the axis cylinder, devoid of myelin, pierced the sarcolemma of the muscle fibre and divided into a number of terminal branches. These were long and slender and extended some distance along the muscle fibre, with only here and there little sole protoplasm which never aggregated into a mass. He also mentioned that the division of the axis cylinder under the sarcolemma was at right angles and formed a multiple "T"; hence the name.
- In Reptiles: two types of motor endings were seen: the "termination en-plaque" and the "termination en-grappe". In both types, the motor ending was supplied by a medullated nerve fibre and was present hypolemmaly.
- In Aves: the motor nerve endings were of "en-plaque" variety i.e. motor end-plates.

He also reported that there seemed to be a steady progression from the compact elemental ending of fishes to the T-ending of amphibia to the "termination en-plaque" of reptiles and