Experimental Anatomy
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MUSCLE SPINDELS IN HUMAN SUPRAHYOID MUSCLES MAY INDICATE A PROPRIOCEPTIVE FUNCTION IN MASTICATION

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SUMMARY

This study investigates the presence of muscle spindles in human suprahyoid muscles. A high density of muscle spindles may be an indication of a proprioceptive function in these muscles, beside the masticatory and swallowing functions.

INTRODUCTION

The fibre composition and occurrence of muscle spindles was studied in the masticatory, the suprahyoid and the infrahyoid muscles of animals. However, there is a gap of the knowledge in man[1]. Studies on rat show that many muscle spindles, often clustered, are present in the masticatory muscles, except in the lateral pterygoid[2]. In most of the suprahyoid muscles, these sensory structures are absent. Finally, in the infrahyoid muscles, solitary muscle spindles are found. In addition, other studies suggest that muscle spindles are absent or few in digastric and mylohyoid muscles in the cat.
In humans, it seems that some unusual aspects to the i organization of jaw muscles are present and that each muscle would be considered an entity unto itself. Thus we purpose to analyze the characteristic of the neuromuscolar fuses in human suprahyoid muscles.
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METHODS

This study is based on the analysis of eleven digastric muscles and six mylohyoid muscles. As control, four plantaris and one flexor digitorum brevis muscles were obtained. This study was performed with postmortem tissue. Spindle distribution was analyzed under light microscopy, using a Leica microscope (Leica Microsystems, Milano, Italy) calibrated to a digitizing system, and Leica FireCam 1.9.2 software (Leica Microsystems, Milano, Italy). Muscle section perimeters were traced using a x4 objective an the location of all identified spindles plotted using a x10 objective for all stained sections. The distribution of muscle spindles in the plotted muscles sections was then determined using a rectangular grid positioned over each plotted section.

RESULTS

As expected suprahyoid muscles have few numbers of spindles. In detail, digastricus muscles have from 3 to 7 spindles (average 5.1) when muscles were completely analyzed (Table 1). In addition, mylohyoideus muscles are characterized by a very low number, the majority of them show no spindles, whereas only two of them posses 1 and 2 spindles respectively. As controls we performed the same microscopy analyses on two muscles that are well known to possess a greater numbers of fusimotor receptors: plantaris (from 47 to 66, average 55.5) and flexor digitorum brevis (154 spindles). In addition, no significant spindle morphology differences were evident for the different muscles

DISCUSSION AND CONCLUSION

From a proprioceptive perspective, it appears that small muscles required for fine motor control have large spindle densities, whereas those recruited for gross movement needed comparatively a lower spindle density. Otherwise, the concept that a smaller and shorter muscle may contain a larger spindles number because they respond earlier to velocity and amplitude of stretch does not completely fit with our results on suprahyoid muscles.
Finally, it is possible to hypothesize that during evolution muscles changed their relationship with external forces, such as gravity. In fact, in the passage from quadruped to biped standing, muscles involved in temporo-mandibular articulation movements resulted to work in gravity favour.

REFERENCES

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Table 1. Absolute number of muscle spindles in selected suprahyoid muscles (Digastricus and Mylohoideus) and controls (Plantaris and Flexor Digitorum brevis).

Digastricus	N	Mylohyoideus	N	Plantaris	N	Flex. Dig. brevis	N
21 L	5	19 R	0	24 L	55	39 R	154
21 R	6	21 L	1	28 L	47		
23 L	4	41 R	0	39 R	54		
22 L	5	39 R	2	39 L	66		
50 R	3	50 R	0				
29 R	6	29 R	0				
41 R	7						
39 R	5						
41 R	4						
19 R	5						
39 R	6						
Average	5.1	Average	0.5	Average	55.5	number	154

R= right: L= left; N= number of muscle spindels counted

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