Int. J. Oral Maxillofac. Surg. 2008; 37: 567–572
doi:10.1016/j.ijom.2008.02.002, available online at http://www.sciencedirect.com

International Journal of
Oral & Maxillofacial Surgery

Research Paper
Surgical Anatomy

Trapezius muscle innervation from the spinal accessory nerve and branches of the cervical plexus

Y.-M. Pu, E.-Y. Tang, X.-D. Yang
Department of Oral and Maxillofacial Surgery, Affiliated Stomatological Hospital, Medical School, Nanjing University, Nanjing, PR China

Y.-M. Pu, E.-Y. Tang, X.-D. Yang: Trapezius muscle innervation from the spinal accessory nerve and branches of the cervical plexus. Int. J. Oral Maxillofac. Surg. 2008; 37: 567–572.

Abstract. The aim of this study was to demonstrate the extent of motor innervation of the trapezius muscle from the accessory nerve and branches of the cervical plexus using intraoperative electroneurography and histochemical staining. In 34 patients during radical neck dissection the accessory nerve and C2–C4 branches running to the trapezius were identified and stimulated. Potentials were registered under three conditions: intact accessory nerve, section of superior part of communication between the nerve and the cervical branches, and complete section of the nerve. Projections that did not elicit responses were analyzed for acetylcholinesterase activity. Before cutting the accessory nerve, its stimulation led to a recordable contraction in all parts of the trapezius muscle in all patients. C2 contributions were seen in 15, C3 in 21 and C4 in 20 patients. After sectioning of the upper half of the nerve, the results were similar. After the nerve was completely cut, C2 contributions were seen in only 2 patients, but C3 were seen in 20 patients and C4 in 19 patients. Histochemical staining revealed that the branches with no responses contained both motor and sensory axons. The accessory nerve provides the main motor input to the trapezius muscle, but preservation of the C2–C4 branches to the muscle during modified neck dissection should improve outcomes.

Keywords: electroneurography; accessory nerve; cervical plexus; acetylcholinesterase(AchE); trapezius muscle.

Accepted for publication 1 February 2008
Available online 17 March 2008

Sectioning of the accessory nerve during radical neck dissection can result in atrophy of the trapezius muscle and shoulder dysfunction, involving shoulder droop, pain, weakness, and a limited range of motion called 'shoulder syndrome'[1,10]. To avoid this serious complication, most surgeons perform a type of modified neck dissection in which the accessory nerve is spared[3,8,12]. The outcomes of such nerve-sparing procedures are not consistent: the probability of postoperative functional impairment of the shoulder joint is approximately 30%.

Sectioning of the accessory nerve during radical neck dissection does not always result in disability of shoulder function[1,7,13]. To explain this phenomenon, Soo et al.[14] performed a series of anatomical analyses in cadavers, in which they observed direct contributions from the C2, C3 and C4 branches of the cervical plexus to the trapezius muscle, besides the accessory nerve. It seemed that the

0901-5027/060567 + 06 $30.00/0

variable manifestations could be explained by varying motor innervation of the trapezius from both the accessory nerve and the cervical branches. Other authors found that innervation from the cervical plexus was primarily proprioceptive, and KIERNER et al.[5] also thought that the trapezius branches of the cervical plexus do not contribute significantly to the muscle's motor innervation.

The aim of this study was to investigate the nature of the cervical projections to the trapezius muscle, and the presence of motor input to the trapezius muscle from both the spinal accessory nerve and the C2–C4 cervical branches, by using intraoperative electroneurography and histochemical analyses.

Materials and methods

Surgical procedures

Intraoperative electroneurography was performed during neck dissection in 34 patients (21 men and 13 women), aged 43–70 years (mean age 57.9 years), between July 2006 and April 2007. The patients underwent modified radical neck dissection of regions I–VI because of malignancies of the head and neck. In each of these patients, the spinal accessory nerve in the posterior triangle was identified and preserved, as well as the contributions from the upper cervical plexus that join the accessory nerve, and some cervical plexus branches running to the trapezius independently. Then, the accessory nerve was cut, at the superior part of the communication between it and the cervical branches, and the trapezius muscle response was analyzed. Finally, the accessory nerve was severed while the independent cervical contributions were preserved.

Electroneurography

The nerves were stimulated under the three different surgical conditions, using the same amperage for all patients. Potentials were recorded with a conventional unit (Medelec Synergy EMG/EP systems, Oxford) by needle electrodes that were fixed in three parts of the trapezius muscle (descending, transverse and ascending) preoperatively. For the descending part, the active recording electrode was placed 5 cm lateral to the spinous process of the seventh cervical vertebra. For the transverse part, it was placed halfway between the midpoint of the ipsilateral scapular spine and the spinous process of the thoracic vertebra at the same level. For the ascending part, it was placed two fingers' breadth from the spinal column on a line perpendicular to the spinal column at the level of the inferior angle of the ipsilateral scapula.

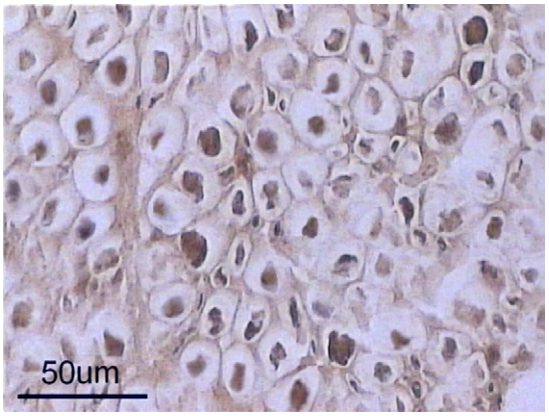

Fig. 1. Accessory nerve (10×40). Positive staining within axoplasm for AChE.

Acetylcholinesterase (AChE) histochemical staining

Branches that elicited no response to stimulation at the three locations were cut with a knife to minimize tissue loss and enzyme leaching. They were immediately fixed in 2.5% glutaraldehyde for 30 min at 3–4 °C. The nerves were then well rinsed in 0.1 M phosphate buffer (PB) at pH 7.4 for 10 min and sequentially cryoprotected in 10%, 20% and 30% sucrose for 15 min at each concentration. The nerves were embedded in OCT (optimal cutting temperature) compound and frozen in liquid nitrogen before 10-μm cryostat sections were cut and mounted on 0.5% chrome alum gelatin-subbed slides. The sections were air dried for 5 min and then post-fixed for 5 min in 2.5% glutaraldehyde, followed by another rinse in 0.1 M PB. The slides were incubated for 24 h at 4 °C, rinsed in distilled water, dehydrated, cleaned and mounted.

The Karnovsky-Roots medium contained 12.5 mg acetylthiocholine iodide, 7 mL 0.1 mol/L sodium biphosphate, 9 mL 0.1 mol/L sodium phosphate, 1 mL 0.1 M sodium citrate, 2.5 mL 0.03 M copper sulphate, 2.5 mL 0.005 M potassium ferricyanide and 2 mL distilled water. The pH was adjusted to 6.5 for optimal AChE enzyme activity.

The histochemical control for motor axon staining was the accessory nerve (Fig. 1) and for sensory axons was the greater auricular nerve (Fig. 2).

Results

Changes in electroneurographical responses

The accessory nerve was stimulated before manipulation, and elicited clearly visible and recordable contractions of all three parts of the trapezius muscle in all cases investigated. C2 contributions were seen in 15 out of 34 patients in the descending trapezius, 13 out of 34 in the

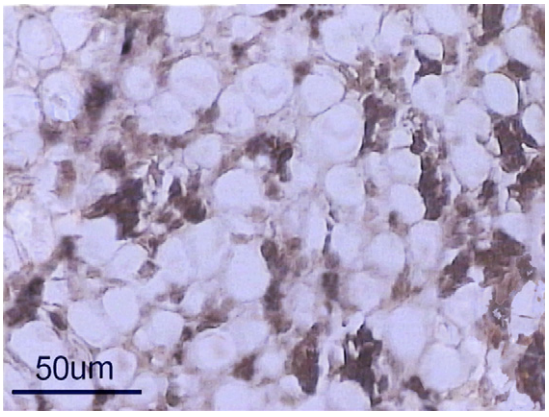

Fig. 2. Great auricular nerve (10×40). Staining extra-axonally out side of the myelin sheath.