A Case of the Human Sternocleidomastoid Muscle Additionally Innervated by the Hypoglossal Nerve

By

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Summary: An anomalous nerve supply from the hypoglossal nerve (XII) to the sternocleidomastoid muscle (SM) was observed in the right neck of an 82-year-old Japanese female. This nerve branch arose from the hypoglossal nerve at the origin of the superior root of the ansa cervicalis. The nerve fiber analysis revealed that this branch consisted of fibers from the hypoglossal nerve, the first and the second cervical nerves and had the same component as the superior root of the ansa cervicalis. SM appeared quite normal and the most part was innervated by the accessory nerve and a branch from the cervical plexus. The anomalous branch from XII supplied the small deep area near the anterior margin of the middle of the sternomastoid portion of SM.

It is reasonable to think that the small deep area of SM, which was innervated by the anomalous branch from XII, occurs as the result of fusion of the muscular component from infrahyoid muscles. If the muscular component does not fuse with SM, it is thought to appear as an aberrant muscle such as the superior sternoclavicular muscle (Hyrtl) which is also supplied from a branch of the superior root of the ansa cervicalis.

The human sternocleidomastoid muscle is usually innervated by the accessory nerve and a branch from the cervical plexus. During the student course of gross anatomy dissection at Iwate Medical University School of Medicine in 1992, in addition to this dual innervation, a rare nerve supply from a branch of the hypoglossal nerve was observed in the right neck of an 82-year-old Japanese female who had expired from cerebral infarction.

The dual innervation of SM by two different nerves, one from the eleventh cranial nerve (accessory nerve) and the other from the sternocleidomastoid branch from the cervical plexus (the spinal nerve), is well-known and has been discussed among many anatomists. It is widely accepted that the accessory nerve is motor and the sternocleidomastoid branch is mostly sensory. However, the finding that a branch from the cervical plexus sometimes innervates independently a part of SM confirms the motor supply to SM through the cervical nerve (Yoshizaki, 1961; Caliot et al. 1984; Ookubo et al. 1987). According to phylogenetical and ontogenetical studies of the accessory nerve and the musculature, Strauss et al. (1936) considered that the sensory element, included in the accessory nerve in lower vertebrates and embryos of mammals, migrated at later stages to the dorsal roots of adjacent cervical nerves, and subsequently some motor fibers in the accessory nerve also migrated to the cervical nerves.

On the other hand, some authors cast doubt on this migration (Kumaki, 1970) and understood this independent motor supply to a deep portion of SM of the cervical nerve was due to the fact that the deep portion of SM derived from the myotome and was probably homologous with the omocervicalis muscle found in most other mammals (McKenzie, 1962).

In our case, the anomalous nerve branch to SM originated from the hypoglossal nerve, the twelfth cranial nerve. Phylogenetically the hypoglossal nerve is understood to be originally the uppermost motor roots of the spinal nerve which are taken into the cranium at a later stage (Streeter, 1905). Therefore, our findings also suggest the intimate relationship between SM and cervical muscles which was of myotomic origin.

From this point of view, our findings are considered to be quite important in discussing the morphological significance of the dual innervation of SM, which is still argued by many anatomists as to the relationship between SM and the cervical muscles, especially infrahyoid muscles.
Findings

After appearing from the jugular foramen, the external branch of the accessory nerve (XI) crossed superficially to the internal jugular vein from ventral to dorsal direction and branched off to the deep surface of SM at approximately the junction of the upper and middle thirds of SM (Fig. 1). Before entering SM, this branch from XI joined with a branch from the cervical plexus. This cervical branch was composed of the second (C2) and third (C3) cervical nerves. Then XI passed underneath the SM and supplied the trapezius muscle at its deep surface communicating with a branch from C3 and the fourth (C4) cervical nerve. In addition to these nerves, a fine nerve (\(*\)) supplied the anterior region of the middle third of SM at the deep surface. This anomalous nerve branch arose from the ventral surface

Fig. 1. Representation of the right lateral neck deep to platysma. The origin of the sternocleidomastoid muscle (SM) is cut and reflected cranially through the space between internal and external jugular veins. In addition to the normal nerve supply from a branch of accessory nerve and cervical plexus (Rsm), a part of SM is innervated by a branch of hypoglossal nerve (solid line). This anomalous nerve branch derives from the origin of superior root of the ansa cervicalis and supplies SM at its deep surface (\(*\)).

Abbreviations for figures
of the hypoglossal nerve (XII) at the origin of the superior root of the ansa cervicalis. There were three inferior roots of the ansa cervicalis, two were from C2 and the other from C3 + C4. All ran deep to the internal jugular vein to form the ansa cervicalis with the superior root from XII. SM itself appeared quite normal.

Then XI and XII were released from the jugular foramen and the hypoglossal canal, respectively, and the roots of the cervical plexus from C1 to C4 were cut off. Finally, SM with the relevant structures was removed for the minute study of nerve fibers under a stereomicroscope. The results were as follows.

The nerve fiber analysis showed that the cervical nerve branch to SM (Rsm-C) carried the fibers from C2 and C3 (Fig. 2). The branch (*) from XII originated from the complex part at which the vagus nerve, XII and C1 + 2 were joining and supplied SM without communicating with any other muscular branches. More detailed examination revealed that this hypoglossal branch consisted of the fibers from XII and the cervical nerves from C1 + 2 (rectangular inset in Fig. 2). The nerve branch to the superior belly of the omohyoid muscle (OHS) and the superior part of the sternohyoid muscle (SHS) was derived from the superior root (Rs) of the ansa cervicalis, which also contained the nerve fibers from XII, C1 and C2. Other infrahyoid muscles were innervated by the branches of the ansa cervicalis.

The XI and Rsm-C joined with each other and then spread out in many fine branches just before entering SM (Fig. 3). The fact that the nerve fibers from XI (Rsm-XI) and Rsm-C were mixed together quite intimately suggested that each muscular branch to SM contained both fibers from XI and the cervical nerves (Fig. 4). The branch indicated by • in Fig. 3 carried only the accessory nerve fibers, but it communicated with the other branches in SM. According to Yoshizaki (1961), SM consisted of four parts, that is, the sternomastoid (S-M), sternocervical (S-O), cleidomastoid (C-M) and cleidooccipital (C-O) portions. Most muscular branches supplying SM entered the deep surface of the cleidomastoid portion

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**Fig. 2.** The nerve fiber analysis of the superior root of ansa cervicalis (lateral view). The more detailed examination of the shaded area is shown in the rectangular inset. The origin of the anomalous nerve branch (solid line) is bifurcated. One is from the hypoglossal nerve and the other from the branch including the first (C1) and second (C2) cervical nerve fibers. The nerve to the superior belly of omohyoid muscle and superior part of sternohyoid muscle is branched from the superior root of ansa cervicalis (Rs), which includes fibers from C1, C2 and hypoglossal nerve (XII). Other infrahyoid muscles are supplied by the branches from the ansa cervicalis.
Fig. 3. The branching pattern of Rsm and intramuscular nerve distribution of SM in our case (dorsal view). SM is composed of four parts, sterno(S)-mastoid(M), sterno-occipital(O), cleido(C)-mastoid and cleido-occipital portions. C-M portion is deepest. All branches to S-M and S-O portions penetrate C-M portion. The portion of nerves indicated by double line and solid line are situated out and in the muscle respectively. And the hatched nerves run under or in the C-M portion. The branches indicated by • and ▲ supply the C-M portion. The anomalous nerve branch from XII (+) supplies only small middle part of S-M portion and communicates with the branch which supplies the main part of S-M portion (+). Detailed fiber analysis of the communication between the branch from the accessory nerve (Rsm-XI) and muscular branch from the cervical plexus (Rsm-C) is shown in Fig. 4. The branches indicated by a, b and A to I are coincidental with the branches shown by the same letters in Fig. 4.
which was the deepest part of SM and the cleidoccipital portion, while the branch from XII entered the sternomastoid portion.

The study of the intramuscular distribution of nerves revealed that the branch from XII supplied only a small part of the sternomastoid portion and the remaining part was innervated by the branches of XI with cervical nerves. The communication (* in Fig. 3) between the branch from XII (*) and the one from XI with Rsm-C (b in Fig. 3) was found.

**Discussion**

In the study of SM, Maubrac (1884) and Pye-Smith et al. (1870/71) described the additional nerve supply of the hypoglossal nerve. According to Eisler (1912) and Testut (1911), Breglia (1890) also reported the cases with the branch from the hypoglossal nerve additionally supplying SM. Among these three reports, only Pye-Smith et al. described that the nerve concerned in the case was the descending branch from the hypoglossal nerve (superior root of the ansa cervicalis). Therefore, the case of Pye-Smith et al. is considered to be equivalent to our case in which the hypoglossal branch to SM derived from the origin of the superior root of the ansa cervicalis.

Eisler (1912) stated that the occurrence of the motor supply of the hypoglossal nerve to SM was closely related to the appearance of the anomalous muscle called the superior sternoclavicular muscle (Hyrtl) on the surface of clavicula, which was also innervated by the descending branch of the hypoglossal nerve. According to his description, this superior sternoclavicular muscle (Ss) was defined as the muscle which arose from the upper margin of the sternum, ran deep to the origin of SM on the surface of the clavicula and ended by attaching to the clavicula. Then, together with Ss, the sternofacial muscle, the singular supraclavicular muscle (Gruber) and the cleidohyoid muscle were grouped as the Ss and its equivalent muscles based on the equal innervation from the descending branch of the hypoglossal nerve (superior root of the ansa cervicalis). Recent reports (Koda et al. 1985, Kida et al. 1985) also described precisely the innervation of Ss by a
twig of the muscular branch to the superior belly of omohyoid muscle from the ansa cervicalis, like the cases observed by Eisler. In our case, the muscular branch in question (+ in Fig. 2) arose from the hypoglossal nerve just proximal to the origin of the superior root of the ansa cervicalis and was composed of the fibers from the hypoglossal nerve and cervical nerves (C1 + C2). Consequently, the hypoglossal branch to SM in our case was considered to be equivalent to the branches reported by Eisler, Koda and Kida.

Concerning the derivation of Ss, Eisler proposed a cervical muscular mass which was supplied by C1 through the superior root of the ansa cervicalis. He discussed that when this cervical muscular mass occurred independently, it appeared to be Ss and when the muscular mass fused to the deep surface of SM, it happened to be the case in which a part of SM was innervated by a branch from the descending branch of XII (superior root of ansa cervicalis). Furthermore, he believed that this cervical muscular mass belonged to the more dorsal muscle group other than the infrahyoid muscle group, but there is no obvious evidence. Jinguji et al. (1983) described in their report about the singular supraclavicular muscle that the anomalous muscle supplied by a branch of cervical plexus was wrapped in a superficial layer of the cervical fascia together with SM and was not likely the split of infrahyoid muscles but the muscular slip which was fused to SM in normal appearance. They did not mention the origin of this muscular slip. However, according to their findings that the nerve supply to this muscle was from the ansa cervicalis and that the branch ran superficial to the omohyoid muscle, it is reasonable to suppose that this anomalous muscle belongs to the same group as the infrahyoid muscles. In other words, during development a part of the infrahyoid muscle group is thought to separate and descend along the deep surface of SM to the clavícula.

Further, Eisler reported one interesting case in which the nerve supplying Ss was coming through SM. He described that unfortunately the origin of this nerve was damaged and was not confirmed. However, judging from the fact that this nerve to Ss sent some branches in SM, it is likely that the origin of this nerve was XI including the cervical nerve fibers. This case suggested the intimate relationship between SM and Ss. Recently a special case in which Ss was innervated dually by a twig of the muscular branch to SM and the superior root of the ansa cervicalis was observed by Kudo et al. (1992). We consider that this special case, together with the above mentioned case of Eisler, suggests the migration of a part of the muscular component of SM to Ss. Moreover, Yamasaki (1983) reported the aberrant digastric muscle which extended between the deep surface of the mastoid origin of SM and the intermediate tendon of the omohyoid muscle beneath SM. The superior belly was supplied by XI and the inferior belly was innervated by a branch arising from the ansa cervicalis just proximal to the origin of the branch to the superior belly of the omohyoid muscle. Yamasaki concluded in his paper that this aberrant digastric muscle occurred as the result of the fusion of two different muscular components; one from the cleidomastoid portion of SM and the other from the superior belly of the omohyoid muscle. We recognize that this finding also shows the possibility of exchange of muscular components between SM and the infrahyoid muscles.

Thereafter, we concluded that our notable case in this paper occurred as the result of the fusion of a muscular slip deriving from the infrahyoid muscles to the deep surface of SM. When this kind of muscular slip happens independently, it appears to be Ss or the inferior belly of the anomalous muscle observed by Yamasaki (1983). In our case, the fact that the intramuscular distribution of the branch from XII was restricted to the small part near the anterior margin of the middle of SM, which was situated just over the infrahyoid muscles, supports this conclusion.

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