How Do the Cervical Plexus and the Spinal Accessory Nerve Contribute to the Innervation of the Trapezius Muscle?

As Seen From Within Using Sihler’s Stain

Antonius C. Kierner, MD; Irmgard Zelenka, MD; Martin Burian, MD

Objective: To determine how the spinal accessory nerve and the trapezius branches of the cervical plexus contribute to the innervation of each of the 3 parts of the trapezius muscle. Special emphasis was placed on the nerve supply of the clinically most important descending part of the muscle.

Design: Anatomical analysis of the distribution of the cervical plexus and spinal accessory nerve branches in the human trapezius muscle.

Materials: Twenty-two trapezius muscles from 11 perfusion-fixed human cadavers ranging in age from 66 to 92 years (mean, 81.7 years).

Interventions: The specimens were dissected free and macerated, decalcified, and stained according to Sihler’s technique for about 6 weeks. The translucent, stained muscles were then backlit, and the findings were documented photographically and by schematic drawings.

Results: In all 22 muscles, the innervation of each of the 3 parts of the trapezius muscle was seen. In all muscles investigated, the nerve supply to the descending part of the muscle consisted of a single fine branch of the spinal accessory nerve, whereas the transverse and ascending parts were innervated by both the spinal accessory nerve and the trapezius branches of the cervical plexus.

Conclusion: Our results, especially those involving the descending part of the trapezius muscle, may help to minimize the rate of unexpected trapezius muscle paresis after surgery of the neck.


As shown in a recent article, there are more questions than answers concerning the innervation of the trapezius muscle. Against the backdrop of a high rate of unexpected trapezius muscle paresis after surgery of the neck, these questions still demand attention. For the physician, the descending part of the trapezius muscle gains outstanding interest because it maintains the stability of the shoulder girdle. Various sources of innervation to this muscle have been described. Apart from the majority of the statements on this question being purely speculative, the data presented are often confusing or even contradictory. Since almost all surgeons try to save the spinal accessory nerve (SAN) during modified radical neck dissection, the high rate of unexpected trapezius muscle paresis remains unclear. Until now, none of the hypotheses published on trapezius muscle innervation could resolve this problem, perhaps partly because almost all investigations dealing with this topic were based on either gross dissection or electromyography, both of which have considerable limitations. Thus, a final, reliable statement on the innervation of each of the 3 parts of the trapezius muscle could not be made on the basis of the results obtained by using these techniques.

Our aim was to elucidate how the branches of the cervical plexus and the SAN contribute to the innervation of the 3 parts of the trapezius muscle. The simple, reliable technique of Sihler, recently recalled by Wu and Sanders, was used to stain nerve fibers while simultaneously making muscle tissue translucent.

RESULTS

The SAN and the trapezius branches of the cervical plexus merged on the ventral surface of the transverse part of the trapezius muscle, or a little caudal to that, in all 22 specimens (Figure 1 and Figure 2). Thus, the SAN and cervical plexus branches also passed into the same...
PARTS OF THE MUSCLE IN ALL SPECIMENS (FIGURE 2 AND FIGURE 3).

In all specimens, 1 to 8 (mean, 7.3) dorsal cutaneous branches were found. These segmental branches always passed through the tendinous plane, from which the muscle takes its origin; none of them branched inside the trapezius muscle (Figure 2).

A single fine branch of the SAN passing to the descending part of the muscle, however, is innervated solely by a single fine branch of the SAN (Figure 2 and 3). Furthermore, we showed that the so-called segmental branches do not branch within the trapezius muscle and are obviously identical to the cutaneous nerves arising from the posterior divisions of the cervical nerves, which are thought to be purely afferent. Beside the well-known innervation of the trapezius muscle by the SAN and the rami trapezii of the cervical plexus, no other nerve supply could be found. This contrasts with the findings of Soo et al., Krause et al., and Niemeyer and Ludolph. Furthermore, we could not detect any branches, other than the one arising from the SAN, passing toward the descending part of the muscle and indicating a dual innervation as stated by Krause et al. However, a purely cervical innervation of the descending part, as suggested by Haas and Sollberg, seems even more unusual and has never been proven. On the basis of more recent work by Karuman and Soo and our own findings, we strongly disagree with the statement by Weitz et al. that the whole trapezius muscle has a dual innervation and the surgical consequences they propose. On the other hand, as early as 1974, Fahrer et al. pointed out that, based on

MATERIALS AND METHODS

Twenty-two trapezius muscles were taken from 11 cadavers of both sexes that ranged in age from 66 to 92 years (mean, 81.7 years) and had been donated to the Institute of Anatomy 2, University of Vienna, Austria. The nerves passing into the muscles, i.e., the SAN and trapezius branches of the cervical plexus, were identified and marked with a colored thread before the muscles were dissected free on both sides. The muscles were fixed for at least 6 weeks in 4% paraformaldehyde buffered with 0.1M phosphate buffer to pH 7.4 and then stained according to the modified method of Sihler as described by Wu and Sanders, as follows:

- The fixed specimens were macerated in a solution containing 4 mL of 3% hydrogen peroxide and 2000 mL of 3% potassium hydroxide for approximately 3 weeks.
- The macerated specimens were decalcified by immersion in a combination of 250 mL of glacial acetic acid, 250 mL of 100% glycerin, and 1500 mL of 1% aqueous chloral hydrate (solution 1) for 2 to 4 weeks.
- The decalcified specimens were then stained by immersion in a combination of 250 mL of Ehrlich’s acid hematoxylin, 250 mL of 100% glycerin, and 1500 mL of 1% aqueous chloral hydrate (solution 2) for 2 to 3 weeks.
- After staining, the specimens were again transferred to solution 1 for approximately 6 hours.
- For neutralization, the specimens were then immersed in 0.05% lithium carbonate for approximately 1 hour.
- Finally, the specimens were immersed in increasing concentrations of glycerin daily and preserved in 100% glycerin with a few thymol crystals (day 1, 30%; day 2, 50%; day 3, 60%; day 4, 70%; day 5, 80%; and day 6, 100% plus thymol).

Subsequently, all muscles were pressed between 2 glass planes. The specimens were backlit, and the exact number and topography of all nerves passing into or running through each muscle were recorded. All representative cases were photographed.

Figure 1. Schematic illustration of the trapezius muscle innervation. Note the fine branch of the spinal accessory nerve (SAN) (top arrow), which could be found in all 22 specimens investigated. The solid circle (bottom arrow) indicates the approximate point where the SAN and the trapezius branches (dashed lines) of the cervical plexus (rami trapezii) merge, which occurred in all 22 specimens.

COMMENT

As far as we know, this is the first study showing that the SAN and the trapezius branches of the cervical plexus merge and pass together to the transverse as well as to the ascending part of the trapezius muscle (Figures 1 and 2). The descending part of the muscle, however, is innervated solely by a single fine branch of the SAN (Figures 2 and 3). Furthermore, we showed that the so-called segmental branches do not branch within the trapezius muscle and are obviously identical to the cutaneous nerves arising from the posterior divisions of the cervical nerves, which are thought to be purely afferent. Beside the well-known innervation of the trapezius muscle by the SAN and the rami trapezii of the cervical plexus, no other nerve supply could be found. This contrasts with the findings of Soo et al., Krause et al., and Niemeyer and Ludolph. Furthermore, we could not detect any branches, other than the one arising from the SAN, passing toward the descending part of the muscle and indicating a dual innervation as stated by Krause et al. However, a purely cervical innervation of the descending part, as suggested by Haas and Sollberg, seems even more unusual and has never been proven. On the basis of more recent work by Karuman and Soo and our own findings, we strongly disagree with the statement by Weitz et al. that the whole trapezius muscle has a dual innervation and the surgical consequences they propose. On the other hand, as early as 1974, Fahrer et al. pointed out that, based on
their clinical experience, a purely cervical supply to the upper part of the trapezius muscle as suggested by Rosenstein could not be accepted as a rule, and Fahrer et al could find no evidence that the trapezius muscle can be supplied by cervical fibers only.

It must be stressed that the previous studies mentioned are all based on clinical experience, gross dissection, and/or electromyography, which leaves a shade of doubt on the reliability of their findings.

Since the branch of the SAN passing to the descending part of the trapezius muscle was the only nerve found in this part of the muscle, we believe that it is a mixed nerve. Nonetheless, this important chapter on the innervation of the trapezius muscle still cannot be closed.

In conclusion, although our findings regarding the innervation of the descending part of the trapezius muscle have yet to be proven in clinical practice, we are convinced that they can help minimize the rate of unexpected trapezius muscle paresis after surgery of the neck.

Accepted for publication May 16, 2001.

Corresponding author and reprints: Antonius C. Kierner, MD, Schwanheimerstr 3, D-60528 Frankfurt a.M., Germany (e-mail: kierner@em.uni-frankfurt.de).

REFERENCES