On the physiological and clinical significance of a trapezius reflex evoked by tapping the spine

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On routine clinical examination it was observed that precussion over the thoracic spine occasionally produced reflex contraction of the intermediate and caudal parts of the trapezius muscle. The observation was made in one case of spondylitis and one case of inflammatory connective tissue disorder. Both patients had pain in the thoracolumbar regions. The neurophysiological features of this reflex have been analyzed. The incidence of the phenomenon in a randomly selected normal material was 3%. Electromyographic recording from the trapezius muscle demonstrated that the reflex is present at a subthreshold level in subjects not exhibiting the clinical reflex. The latter is established by pain and/or tension in the thoracolumbar paravertebral region.

Key words: Electromyography – pain – reflex – thoracic – trapezius

Painful conditions within the thoracic spine may have various causes (Wyke 1970), and may lead to reflex spasms in paravertebral muscles as well as more remote reflex effects (Feinstein 1977, Pedersen et al. 1956, Wyke 1970). Recently we got the opportunity to study a case of thoracic spondylitis and found a reflex contraction in the trapezius muscle elicited by percussion of the thoracic spine. An extended study on patients and healthy controls indicated that the reflex may be of value when evaluating painful conditions in the cervico-thoracic region.

PATIENTS AND METHODS

Case 1
A man at the age of 45 admitted to hospital because of pain and weakness in the waist muscles bilaterally and an ESR of 110 mm was found to have acute exacerbation of a chronic spondylitis, possibly psoriatic in origin. Examination of the back showed slight scoliosis. On percussion on vertebra Th X, the patient experienced pain. Percussion on and between the spinal processes of Th I to L III evoked a reflex contraction in the lower and middle parts of the trapezius muscle bilaterally. The patient had difficulty in changing position from lying to sitting. There were no neurological abnormalities.
The X-ray examination showed a compression of Th VII and a sclerosis of Th X, as well as reactive changes and increased thickness of the paravertebral tissue. The disc between Th X and Th XI was destroyed and adjacent surfaces of both vertebrae were irregular.

The patient responded to treatment by indometacin, and the intensity of the trapezius reflex, initially very brisk, diminished parallel to improvement of the clinical condition.

**Case 2**

A man at the age of 26 was admitted to hospital for investigation of ESR of 130 mm. He had pain in the upper thoracic spine when bending forward and also pain and tenderness in the neck corresponding to the stylo-hyoid syndesmosis. No neurological abnormalities were found. He had a scoliosis of the lower thoracic spine, convex to the right. Thorough X-ray investigation revealed no other abnormality. Although no specific diagnosis was made, a disease affecting connective tissue was suspected.

During the course of an electrocardiographic investigation (Lundh 1979, in preparation) the occurrence of a trapezius reflex was tested in 310 randomly selected healthy subjects (146 men and 164 women). Out of the nine subjects exhibiting the trapezius reflex, seven were examined electrophysiologically. In addition, two normal subjects not exhibiting the trapezius reflex were examined electrophysiologically.

The neurophysiological investigations were in all cases performed on a DISA 1500 electromyograph. The EMG records were made by surface electrodes attached to the skin over the rostral as well as more caudal interscapular parts of the muscle, bilaterally. In all cases (total 11) EMG recording was made with a needle inserted into one, or several parts of the muscle which on surface recording showed a reflex response (as in case 1, illustrated in Figures 1 and 3). In addition, in one case (case 1, Figure 3), needle-EMG-recording was made from the adjacent infraspinatus and sternocleido-mastoid muscles.

The reflex was elicited with a reflex hammer containing an electrical switch used for triggering the oscilloscope sweep when tapping the spine. On all subjects, tapping was performed on the cervical spine as well as the thoracic spine. In addition, the trapezius muscle was sometimes tapped directly.

In all cases except one, the accessory nerve was stimulated electrically with surface electrodes placed over the lateral cervical triangle. The responses to nerve stimulation were recorded by conventional needle EMG electrodes from a part of the trapezius muscle which had been shown to exhibit a reflex response to spinal tapping. The stimulus strength was graded up to a maximal direct muscle response (M-response). In four cases local electrical percutaneous stimulation was also tried in the midline over the cervical and thoracic spine and also over the trapezius muscle.

The reflex responses were recorded on a storage oscilloscope and groups of four sweeps were photographed for documentation. Only records containing an electromyographic reflex response in all four sweeps were judged as positive.

In the two control cases not showing any clinical TR, tapping of the spine was tried in a relaxed state as well as during a moderate voluntary contraction of the trapezius muscle.

**RESULTS**

The trapezius reflex (TR) is most easily demonstrated with the patient sitting relaxed and bending slightly forward with the hands resting in the lap. With a reflex hammer the thoracic spine is then briskly tapped. Each tap then evokes a symmetrical band-formed contraction clearly visible in the lower
two-thirds of the trapezius muscle.

In all nine cases exhibiting a clinical TR a reflex could also be recorded electromyographically from the caudal parts of the trapezius muscle. The reflex could always be recorded bilaterally although asymmetries appeared (Figure 1). In only five of the nine cases could a reflex response also be recorded from the rostral portion of the muscle.

In four of the five cases in which a reflex response was obtained from the upper as well as the lower trapezius a "local sign" was demonstrated (Figure 2). The reflex response in the upper trapezius was most easily elicited by tapping the lower cervical and upper thoracic spine, whereas the reflex in the lower trapezius was primarily produced by tapping the intermediate thoracic region. A local sign is also demonstrated in Figure 1 (case 1), where the largest TR in the caudal trapezius were elicited by tapping the spine at levels corresponding to the recording site, the response amplitudes decreasing when tapping more cranial or caudal parts. The same phenomenon could be confirmed by EMG needle recording illustrated in Figure 3 (left row of records). In this case the needle recordings from the infraspinatus and sternocleidomastoid muscles and from the upper trapezius muscles showed no reflex activity (Figure 3, right row of records).

Figure 1. Bilateral surface EMG records from the interscapular part of the trapezius muscle on tapping of the different parts of the spine. Case 1.
The mean values of the latencies of the reflex response in the lower trapezius and upper trapezius are 31.4 (n = 9) and 31.2 (n = 5) ms, respectively, i.e. almost identical. Standard deviations were 3.53 and 3.46 ms, respectively. In four cases a reflex response earlier than that around 30 ms was observed with latencies around 10 ms (C: VI taps: 13 ms; 13 ms; 9.6 ms. Th: III tap: 9 ms; 9 ms). This early response was interpreted as a monosynaptic stretch reflex (see below).

In five of the cases a clearcut recruitment of the reflex response was observed as in Figure 4 D. At rapidly repeated taps (around 2 Hz) to a dorsal spinal process a successive shortening of latencies was observed (see arrows in Figure 4 D). Simultaneously, there was a recruitment of the number of motor units responding.

Direct percussion of the trapezius muscle evoked a direct muscle response in underlying muscle but no reflex responses were noted.

In addition to a reflex excitation at a latency around 30 ms, a period of

Figure 2. Surface EMG responses recorded from the upper (UT) and lower (LT) parts of the trapezius muscle on tapping the spinal process of C VIII and Th III, to illustrate the local sign of the TR. Case 6.
electromyographic silence was regularly produced indicating a period of inhibition of the motor neurons, (Figures 3 and 4 A). The duration of the silent periods was 105-150 ms from the taps.

The pattern of reflex excitation followed by inhibition which was evoked by tapping the spine could also be reproduced by electrical stimulation with surface electrodes placed over the dorsal spinal processes illustrated in Figure 4 B, (compare with Figure 4 A). The reflex effects of electrical stimulation were always weaker than the effect of tapping. The threshold current for elicitation of the reflex was much higher than the threshold of conscious perception of the electrical shocks (25 mA as compared with 5 mA), but the current was subthreshold to elicitation of muscle twitches in the paravertebral

![Figure 3. Left row: Needle EMG records from the caudal part of the trapezius muscle on tapping different sites along the spine. Note the maximal response evoked by tapping Th III and Th VII. Right row: Needle EMG records from various muscle sites indicated on tapping the Th III vertebra. Case 1.](image-url)
muscles. The effective area was limited to the region of the spinal dorsal processes and cutaneous stimulation over the trapezius muscle was ineffective. Also with electrical stimulation there was a clear "local sign" similar to that described above for tapping. Painful stimulation was not necessary for eliciting a reflex.

In all cases except one, electrical stimulation of the accessory nerve was performed (illustrated in Figure 4 C). Stimulation of the nerve at the neck produced a direct muscle response at a latency of around 4.5 ms, followed by a silent period of 100–150 ms duration. No excitatory reflex effects were ever recorded.

The two control subjects without clinical TR did not show any electromyographic reflex response when relaxed during the test. However, when the subjects were asked to activate their trapezius muscles tonically a low intensity (auditory feed-back via the loudspeaker), tapping of the spine evoked excitatory and inhibitory reflex responses closely similar to those found in cases 1–9.

The incidence of clinically visible TR, tested in 310 normal subjects was nine (3%). Out of these, seven subject volunteered to a neurophysiological investigation as well as X-ray of the spine and a neurological examination. The main clinical features of the two patients and the seven "normal" subjects are summarized in Table 1.

Figure 4 A–C. Needle EMG responses from upper part of the trapezius muscle on tapping the Th III vertebra (A), electrical stimulation of the skin overlying the C VIII (B), and electrical stimulation of the accessory nerve at the neck (C). Case 6. In D (case 7) the tap to Th III was repeated at 2 Hz frequency and needle EMG recording was made from the lower part of the trapezius muscle. Four consecutive traces were photographed.
Table 1. Clinical features of the two patients and the seven TR positive “normal” subjects. (Presence of a feature indicated by X)

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DISCUSSION

The trapezius reflex described in the present paper was evoked by mechanical tapping of the spine from the caudal part of the cervical region down through the thoracic spine. Some of the reflex responses could have been caused by mechanical spread to receptors remote from the site of tapping. This was presumably the case in Figure 3 where percussion of the occiput and of the spine as low as L: IV caused a reflex activation of the trapezius muscle. However, the “local sign” of the reflex (Figures 1 and 2), demonstrates a differential effect of receptors in rostral and more caudal parts of the spine on different parts of the trapezius muscle.

The study indicates that the receptors responsible are not situated within the muscle itself. Local mechanical or electrical stimulation of the trapezius muscle or the overlying skin did not produce a reflex response. However, localized electrical stimulation close to the dorsal spinal processes did produce a response similar to that evoked by tapping. The rather high electrical threshold indicates that the receptors are situated in subcutaneous or intervertebral connective tissue rather than in the overlying skin. It is very likely that the receptors responsible are situated within the interspinous ligaments and that the electrical stimulation reached the posterior primary rami of the segmental spinal nerves, known to contain myelinated as well as unmyelinated afferent fibers (Pedersen et al. 1956, Wyke 1970).

The complete absence of any excitatory reflex response in the trapezius muscle after electrical stimulation of the accessory nerve at the neck level indicates that the afferent nerve fibers of the reflex loop are not passing through this nerve which is the main efferent supply to the muscle (Fahrer et al. 1974). The results suggest rather that the afferent impulses enter the
spinal cord via segmental dorsal roots. In fact, the proprioceptive afferents from the trapezius muscle have been shown to take a route not via the accessory nerve, but rather via the second to the fourth cervical dorsal roots (Straus & Howell 1936, Godynicka et al. 1976). The receptors involved in the reflex under study are not restricted to the trapezius muscle itself (see above) and the afferents responsible presumably enter the spinal cord also through lower cervical and thoracic dorsal roots. In this connection it is interesting to note that Sherrington (1898) in the spinal monkey described a reflex retraction of shoulder after stimulation of the central end of the cut dorsal root of the third to the fifth thoracic segment, as well as by stimulating the second to the sixth cervical dorsal root. Sherrington also observed motor effects in the trapezius muscle by stimulation of the distal cut ends of the ventral roots of the second to the fourth cervical segment (Sherrington 1898, Lehr et al. 1973). From our results we cannot exclude that some of the reflex effects were mediated by such efferent fibers rather than via the accessory pathway.

The silent period of EMG activity produced after the reflex response, and that produced by accessory nerve stimulation, are presumably not equivalent phenomena. Pauses of activity after tapping were sometimes produced without a significant preceding excitatory response and is presumably the result of a genuine reflex inhibitory action on trapezius motorneurons. The profound silent periods after accessory nerve stimulation are likely to be caused by a massive antidromic invasion of the motorneurons with resulting recurrent inhibition.

The rather constant latency of the reflex of about 30 ms indicates a more complex reflex loop than a direct or oligosynaptic connection with the trapezius motorneurons, considering the rather short peripheral conduction distance. The latency for the monosynaptic finger jerk is around 20 ms with shorter latencies for more proximal muscles (Marsden et al. 1973). The early reflex response sometimes observed after tapping at a latency of around 10 ms is likely to represent a monosynaptic stretch reflex in the trapezius muscle.

The quite stable reflex latency also with high tapping rates suggests rather a long efferent and afferent loop and a oligosynaptic relay. The possibility that the reflex is supraspinal rather than spinal will have to be considered. Tapping of the dorsal spinal processes at the level of Th III evoked responses over the sensorimotor area of the scull at a latency of 12.5 ms (unpublished observations). With an efferent conduction time from the internal capsula to proximal muscles of less than 10 ms (Pagni et al. 1964) time would still remain for a couple of synaptic relays in the sensorimotor cortex. From latency reasons alone it is therefore possible that the reflex is cortical, not to mention possible relays in the brain stem.

However, the interesting observation of Sherrington (1898) of a reflex
retraction of the shoulder after dorsal root stimulation at thoracic levels in the spinal monkey might after all suggest a possible spinal reflex origin of the TR.

Our control experiments with subjects not exhibiting the clinical TR demonstrate that the phenomenon should not be looked upon as an abnormal reflex but rather as an exaggerated response in a normally existing reflex pathway. The normal function of the reflex is unknown but might be one of stabilizing the cervico-thoracic region as a result of mechanical strain in the intervertebral connective tissue. The clinical features of the two patients and the seven “normal” subjects exhibiting a clinical TR are summarized in Table 1. It is interesting to note that both patients and four of the seven “normal” subjects investigated had major subjective symptoms from their spinal regions and also X-ray abnormalities in the columnar region. Of the remaining three “normal” subjects, all showed very brisk reflexes generally and two had back pain symptoms as well. Another remarkable feature was the good correlation in case 1 between the TR response amplitude and the clinical intensity of symptoms. Although unspecific in relation to specific spinal columnar disorders, it seems that the TR is uncommon in a normal population and that conditions such as pain, pain-induced muscle tension, inflammatory changes, trauma and scoliosis, may increase the likeliness for a reflex to be produced. The value of the reflex as a screening test for columnar disorders in the cervico-thoracic region will therefore have to be further evaluated.

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