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Stretch Reflex of Paraspinal Muscles in Normal Man and Hemiplegics

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ABSTRACT. Methods for obtaining the stretch reflex of paraspinal muscles are described in a study of the SRPM in 20 normal, 20 right hemiplegic and 20 left hemiplegic subjects. In order to prevent superimposition with the EKG, the EKG R-wave was used to trigger the magnetic hammer which induced the SRPM by tapping at a point between L-1 and L-2. The SRPM was recorded from leads attached bilaterally at levels L-3, L-1, T-8 and T-6. The SRPM was influenced significantly by posture, and in the standing posture. Right and left hemiplegics showed a reciprocal pattern. Possible explanations of why the SRPM was not exaggerated in hemiplegics are discussed.

Key words : stretch reflex — paraspinal muscle — spasticity — inhibiting — mechanism

In the field of rehabilitation many authors have stressed the importance of trunk muscle balance in the treatment of damage to the central nervous system[1]. However, there have been many difficulties in examining the state of trunk muscles. Since Trontelj[2] published an article regarding the stretch reflex of paraspinal muscles (SRPM), we have been interested in developing a method to use this reflex for investigation of the physiological states of paraspinal muscles.

In this study, we report on the method of obtaining the stretch reflex of paraspinal muscles and on some interesting aspects of SRPM in normal and hemiplegic subjects.

MATERIALS AND METHODS

Twenty normal, 20 right hemiplegic and 20 left hemiplegic subjects were examined. Since we intended to examine these subjects while standing, patients who could hold a standing posture were chosen. The ages of normal men ranged from 20 to 34 years with a mean of 23.4 years. The average age of right hemiplegics was 48.8 years ranging from 13 to 70 years old. The average age of left hemiplegics was 51.8 years ranging from 16 to 72 years old.

The SRPMs were taken from level L-3, L-1, T-8 and T-6 which were determined by counting the spinous processes. Skin was prepared by cleaning with ethanol and acetone. Marks were drawn bilaterally on the skin 6 cm. from

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the posterior median line at each level. A pair of silver cup surface electrodes were attached with adhesive tape at each side and level 1 cm. transversely from the mark. A ground electrode was attached to the spinous process T-12.

SRPM was elicited by tapping with an electromagnetic hammer at a point

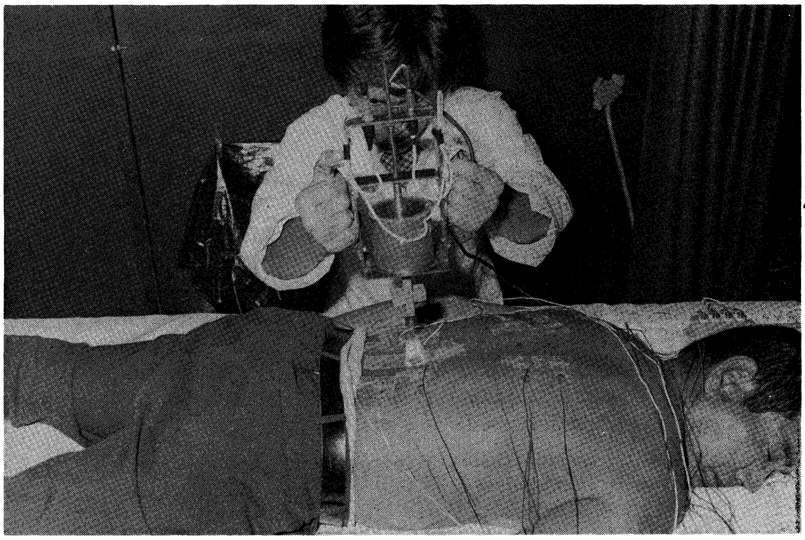

Fig. 1. Scene of an experiment

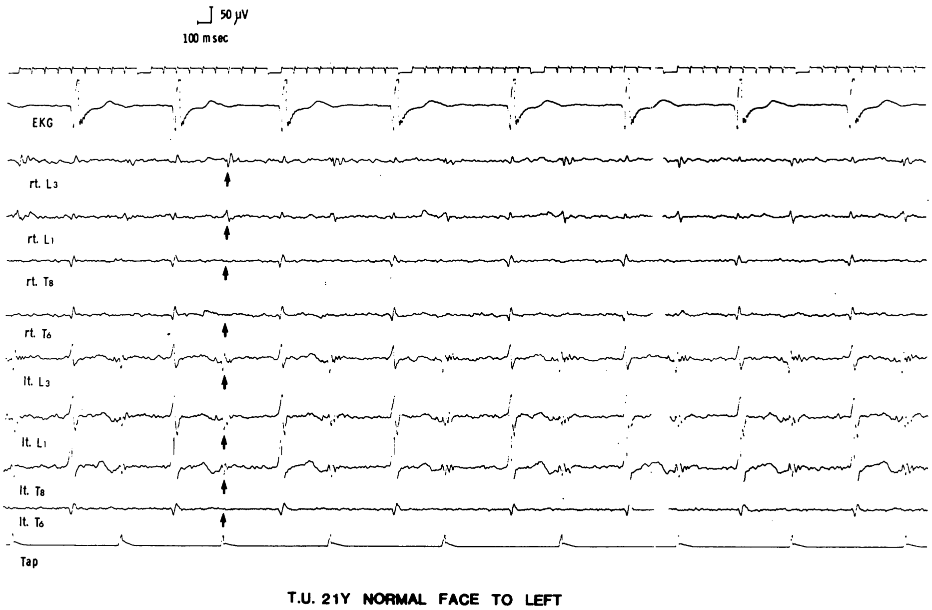

Fig. 2. Records of the EEG monitor

between the spinous processes of L–1 and L–2. The force of tapping was controlled by a current transformer, but it was influenced by the consistency of the underlying tissue. For measuring the force of tapping, a load cell was attached to the skin under the hammer (Fig. 1). To avoid the effect of EKG, the R-wave of EKG taken from the V-4 position was used for the trigger with a delay between the R-wave and the beginning of the tapping.

SRPM was recorded on an EEG monitor. One channel for EKG, 8 channels for SRPM and a channel for the tapping were recorded simultaneously (Fig. 2). Eight channels of SRPM and a channel for the tapping were also fed simultaneously to a computer averager system. Ten consecutive reflexes were averaged (Fig. 3). SRPM was taken in three postures : prone, sitting and standing at ease. The face was held forward at first and then was turned to the right and to the left. Nine records were taken on each person. Care was taken that

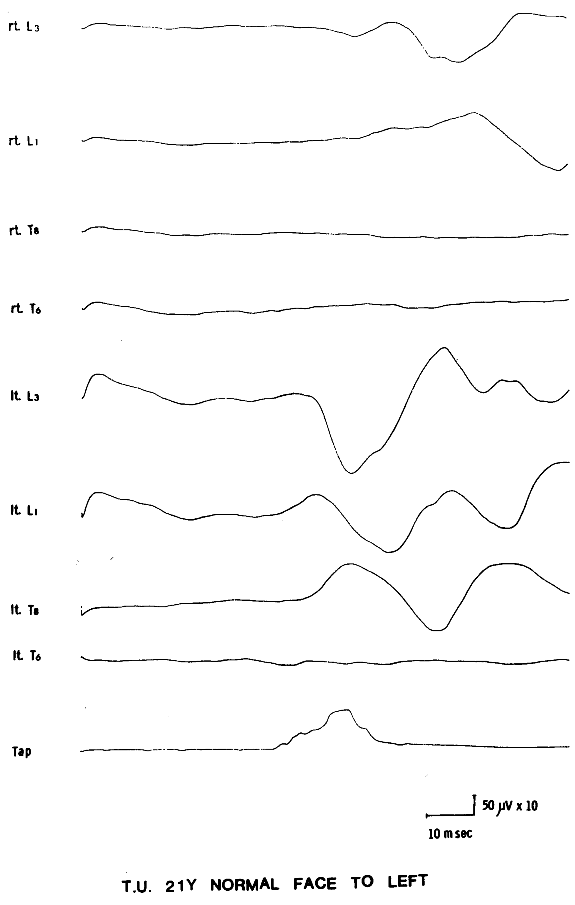

Fig. 3. Records of the averager

with the changing of the direction of the face no rotation of the trunk occurred. The peak to peak amplitudes of SRPM at each level and posture were measured, and the measurements of the right and left sides were plotted transversely so we could see them at once (Fig. 4). In this report, averaged records were used because of mild fluctuations in the amplitudes as well as because the frequency response of the EEG machine was only 60 cps while the frequency response of the computer was 1000 cps.

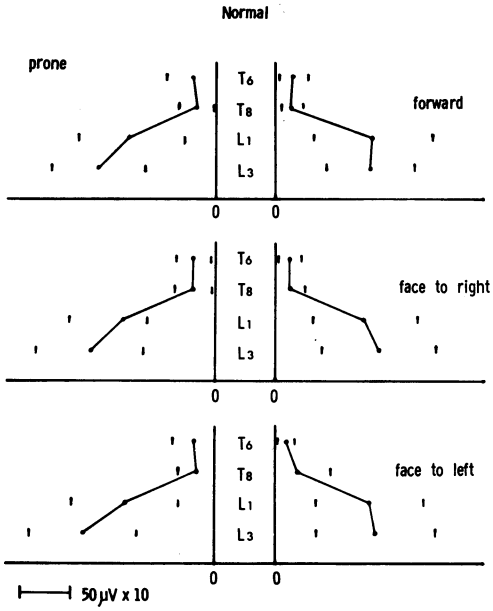

Fig. 4. Graphs of mean amplitudes (dot) with standard deviations (apostrophe).

The mean value obtained while the subject faced forward was chosen as the standard for comparing SRPM amplitude changes occurring when the direction of the face was changed. When the mean amplitude of SRPM was more than 120 per cent of the standard, it was considered exaggerated. When the mean amplitude of SRPM was less than 80 per cent of the standard, it was considered inhibited. The intermediate values were considered as no change. These comparisons were made only for levels L-1 and L-3 because of less tendency of the responses to fluctuate. There were differences between the ages of normal and hemiplegic subjects. However, the differences of the mean amplitudes of SRPM in normal and hemiplegics were insignificant.

RESULTS

In general, SRPM had the largest amplitude in the prone position, especially at levels L-1 and L-3 (Fig. 5,6,7) The amplitudes of SRPM were influenced

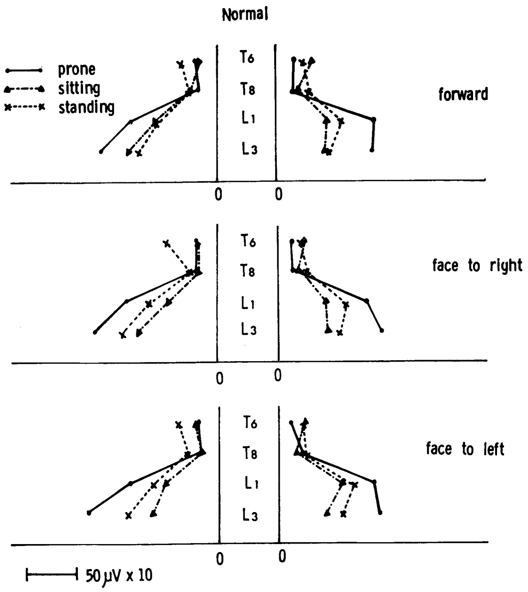

Fig. 5. Graphs of mean amplitudes of normal subjects in the three postures and three directions of the face (standard deviations were omitted).

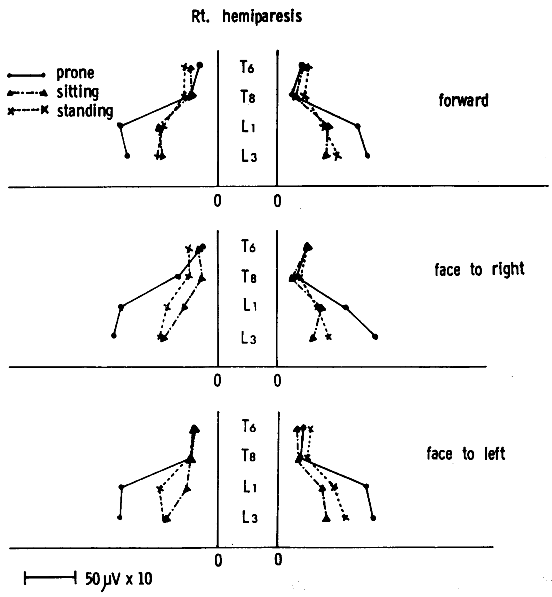

Fig. 6. Graphs of mean amplitudes of right hemiplegics in the three postures and three directions of the face (standard deviations were omitted).

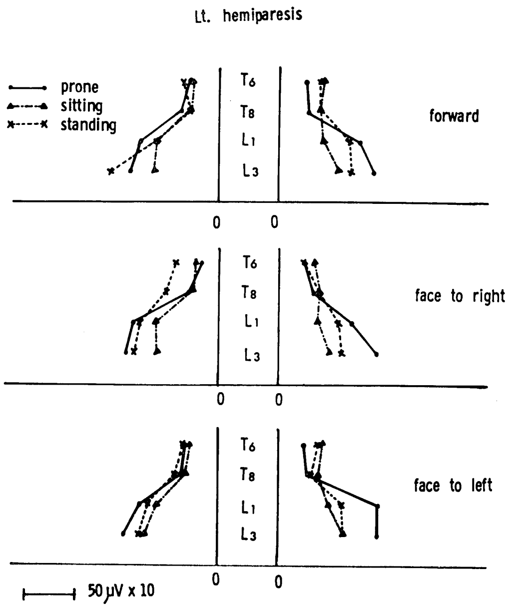

Fig. 7. Graphs of mean amplitudes of left hemiplegics in the three postures and three directions of the face (standard deviations were omitted).

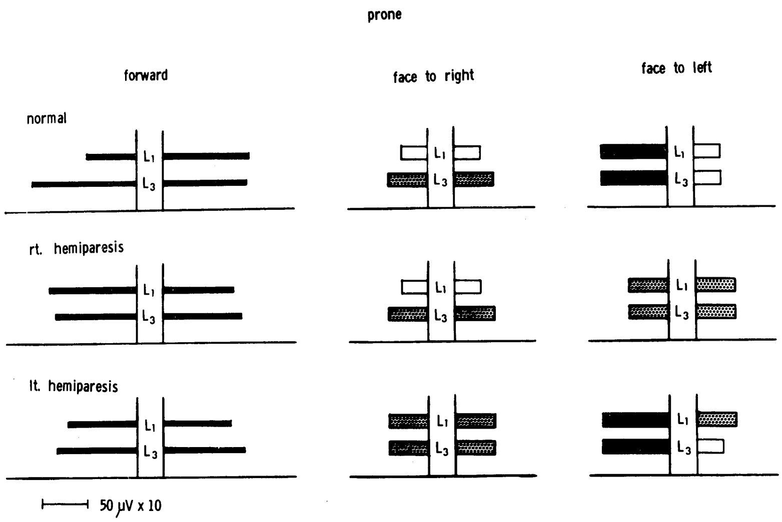

Fig. 8. Comparison of amplitudes of SRPM with the face directed forward, to those with the face directed to the right or left in the prone position. White bars show inhibition ; dotted columns, no change, and black columns, exaggeration.

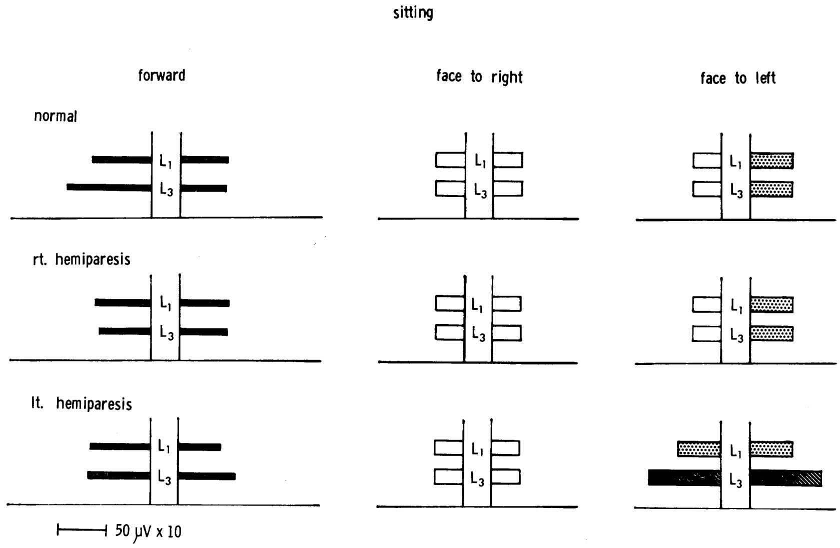

Fig. 9. Comparison of amplitudes of SRPM in the sitting position. See Fig. 8 for explanation.

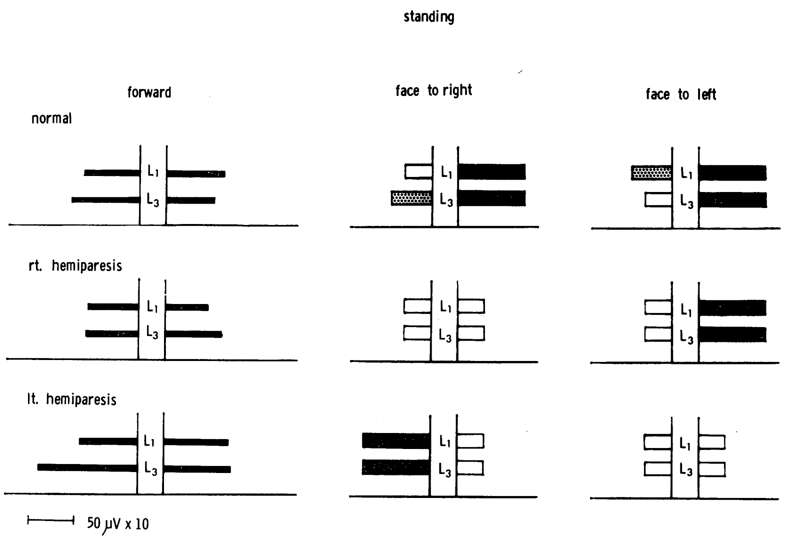

Fig. 10. Comparison of amplitudes of SRPM in the standing position. See Fig. 8 for explanation.

significantly by both posture and direction of the face. However there were no significant differences between sitting and standing. SRPM were inhibited in the sitting and standing postures compared to the prone position.

In the prone posture, SRPM at L–1 were inhibited in normal and right hemiplegic subjects when the face was directed to the right. When the face was directed to the left, normal subjects and left hemiplegics showed exaggeration of SRPM at levels L–1 and L–3 on the left side (Fig. 8). In the sitting posture, SRPM were inhibited when the face was directed to the right at each level on both sides. When the face was directed to the left, the left side SRPM were inhibited and the right side remained unchanged in normal subjects and right hemiplegics. In left hemiplegics, L–1 SRPM remained at the same level and L–3 SRPM were exaggerated bilaterally (Fig. 9). While standing, right and left hemiplegics showed a reciprocal pattern. In right hemiplegics, L–1 and L–3 SRPM were inhibited bilaterally when the face was turned to the right, and when the face was turned to the left, the left side SRPM were inhibited while the right side SRPM were exaggerated at each level. In left hemiplegics, the left side SRPM were exaggerated and the right side SRPM were inhibited at each level when the face was turned to the right. When the face was turned to the left, the SRPM of both sides were inhibited at each level in left hemiplegics (Fig. 10).

DISCUSSION

In 1978, Carlson[3] reported on the stretch reflex of lumbar back muscles of the cat with mention of the influence of the position of the lumbar area relative to the pelvic girdle. In this study Carlson stimulated the iliocostalis and longissimus muscles by pulling directly on them. In 1979, Trontelj et al. reported on the stretch reflex of the paraspinal muscle of scoliotic patients. They compared the integrated values of the reflex wave at the convex and concave sides of the apex of the curve. These experiments were done in either standing or prone position. He did not mention the position of the neck. As a clinical report, his paper is important because of its making this reflex known. However, it is apparent that the stretch reflex of the paraspinal muscle is influenced significantly by the position of neck, and therefore his work needs to be reevaluated.

As far as the nature of the wave is concerned, SRPM is equivalent to the T-wave of the triceps surae. For this reason an exaggerated reflex wave was expected in hemiplegics[4,5]. The reason why SRPM are not exaggerated in hemiplegics is not clear yet, but we suspect that, the inhibiting mechanism of the extremities being stronger than that of the paraspinal muscles may be the cause.

The influence of positions of the neck on SRPM are important.
Carlson stressed the importance of the position of the lumbar spine and relation to the pelvic girdle as one of the important factors in the evaluation of SRPM.

In the standing posture, right and left hemiplegics showed a reciprocal pattern in regard to changes in the direction of the face. The reason for this cannot be explained only by the change in the position of the center of gravity because in normal cases there were no regularities in the changes in SRPM according to direction of the face. A tonic neck reflex occurring in asymmetric posture could be an answer to this problem. The SRPM of the side contralateral to the hemiplegic side were always inhibited. In the hemiplegic side, SRPM were influenced by the position of neck. The paraspinal muscles of the unaffected side must always work to maintain spinal balance because the affected side cannot cope with quick requirements for keeping spinal balance. Considering the asymmetric tonic neck reflex, the paraspinal muscles in the hemiplegic side seem to act physiologically as flexors while standing.

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