CERVICAL POLAR FORCE AND ELECTROMYOGRAPHIC ACTIVITY

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INTRODUCTION

Cervical dystonia is a neurodegenerative disorder that results in focal contractions of the neck muscles, forcing its victims into painful postures of the head and neck. Treatment involves chemical or surgical denervation of the driving muscles (Braun et al. 1995). However, successful muscle reorganization also depends on approxi-mating the normal balance between muscles that cross the joint. This is important for maintaining normal joint kinematics, and for preventing inappropriate moments of force which may lead to degenerative joint disease (Lindscheid 1982). If the pattern of moments of force at the neck can be used as a measure of muscle balance, then denervation therapy should also focus on approximating a normal pattern in the patient. This paper presents the force and EMG patterns throughout the polar range of motion in normal controls from which to compare patients before and after denervation therapy.

PROCEDURES

Recording Force and EMG. A load cell (JR3) was centered and secured over a clamp for the head. This unit was attached to a jig to adjust for subject height and head position. The arms of the jig were integrated into a testing chair. The electrodes were 25-micron diameter Teflon-coated stainless-steel wires, with 5 mm of insulation stripped from the tips. Two fine-wires were placed in a bipolar configuration. The sternocleidomastoid; the trapezius; the splenius capitis; the semispinalis capitis; and the scalenus were recorded bilaterally. The EMG activity was amplified (MA 100) and band-passed filtered from 20 to 600 Hz. All signals were digitized (CODAS) at 5 kHz on an IBM computer, and stored on hard-disk for later off-line processing.

Task. Subjects (N=18) were secured in the testing chair and they produced a maximal isometric force in twelve directions in the horizontal plane. There was a 30° interval between each direction of force which was marked on an x-y oscilloscope with a tem-plate. The center of the oscilloscope screen was defined as the origin (i.e., the relaxed position), and subjects learned to produce a force which appeared on screen as a vector with a magnitude and direction related to tension at the load cell. Subjects produced three maximal voluntary contractions in the desired direction of force. There were four test sessions. The first three days served as training sessions while the last day was used for data collection.

RESULTS AND DISCUSSION

The normalized force in the 90° direction corresponded to flexion while the 270° direction was extension (Figure 1). The 0° and 180° directions were right and left lateral bending, respectively. Strength in extension was greater ($p<0.05$) than in flexion while right and left lateral bending strengths were quite comparable ($p>0.05$). The normalzed neck strength values for the 300 and 330° directions were greater than those for the 210 and 240° directions ($p<0.05$). Thus, neck strength exhibited a right lateral dominance. This extends

previous findings for studies in which the neck strength was only examined in the flexion, extension, and lateral bending directions (Moroney et al. 1988).

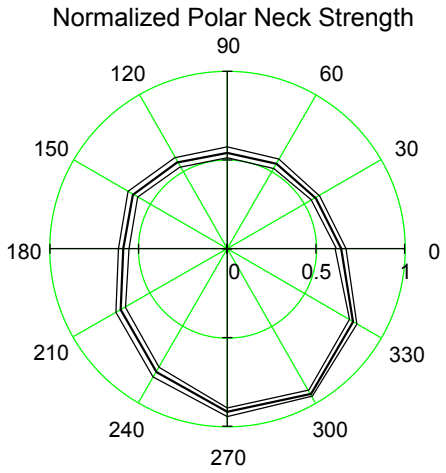

Figure 1: The mean normalized force (thick line) and standard deviation (thin lines).

Figure 2 shows normalized EMG from the right splenius capitus (RSPLEN). Peak EMG was centered at 330°. Based on the work of Dempster and Finerty (1949), this muscle served as an agonist between the 0 and 270° directions of force ($p<0.05$). Synergistic muscle activity occurred between the directions of 0-90° and 180-270° where the EMG magnitude was still appreciable ($p<0.05$). Antagonistic activity between the 90 and 180° directions of force was minimal. There was an identifiable direction of force for which each muscle served as either an agonist, synergist, or antagonist. The polar patterns of EMG for each muscle were stereotyped across subjects. However, the direction of greatest EMG activity was not bilaterally symmetric. For example, the direction of greatest EMG magnitude for left splenius capitus was 240°, not 210° as might be expected. These data extend the findings of Keshner et al. (1989) to maximal voluntary contractions.

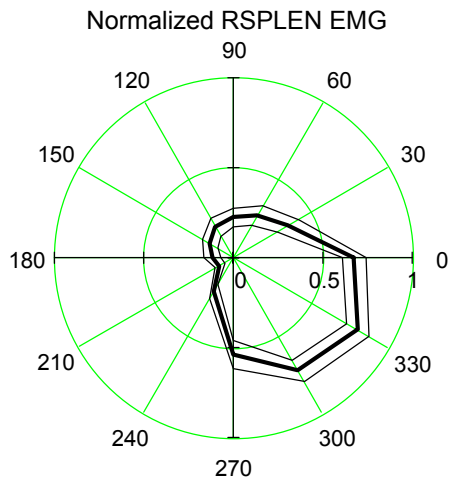

Figure 2: The mean (thick line) normalized EMG and standard deviation (thin lines).

CONCLUSION

The consistent patterns of force and EMG throughout the polar range of motion offer a basis of comparison for a patient population.

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ACKNOWLEDGMENTS

This work work was supported by the Mayo Clinic/Mayo Foundation and by an NIH training grant (HD07447).