The Influence of Dynamic Polyelectromyography in Formulating a Surgical Plan in Treatment of Spastic Elbow Flexion Deformity

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ABSTRACT. Keenan MA, Fuller DA, Whyte J, Mayer N, Esquenazi A, Fidler-Sheppard R. The influence of dynamic polyelectromyography in formulating a surgical plan in treatment of spastic elbow flexion deformity. Arch Phys Med Rehabil 2003;84:291-6.

Objective: To determine the influence of motor-control analysis with dynamic electromyography on surgical planning in patients with spastic elbow flexion deformity.

Design: Prospective observational design.

Setting: A Traumatic Brain Injury Model Systems–affiliated specialty referral center for the evaluation and treatment of mobility problems associated with neurologic injury and disease.

Participants: Twenty-one patients with spastic elbow flexion deformity.

Interventions: Two surgeons each formulated a detailed surgical plan for each individual muscle-tendon unit. Patients then underwent motor-control analysis in which kinetic and polyelectromyographic data were collected by using a standard protocol. Each surgeon formulated another surgical plan after independently reviewing the laboratory study.

Main Outcome Measures: The frequency of change and degree of agreement in the surgical plans after review of the laboratory data were used as measures of the effect of the laboratory studies.

Results: Fifty-seven percent of the surgical plans were changed after the motor-control study. The frequency of change did not differ by clinical experience. There was a trend toward higher agreement between surgeons after the study than before.

Conclusions: Detailed electromyographic motor-control analysis alters surgical planning for patients with spastic elbow flexion deformity. Clinical assessment alone does not accurately identify the muscles responsible for the deformity or dysfunction. More clinical experience does not result in greater accuracy. Motor-control analysis produces higher agreement between surgeons in planning surgery.

Key Words: Brain injuries; Elbow; Electromyography; Rehabilitation; Surgery.

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LIMB DEFORMITIES AND DYSFUNCTION are common consequences of an upper motoneuron (UMN) syndrome, which is usually seen after central nervous system (CNS) injuries such as stroke, traumatic brain injury (TBI), and cerebral palsy (CP). Impaired motor control, synergistic movement patterns, stimulation of distant movements, muscle paresis, muscle spasticity, and, occasionally, rigidity characterize UMN. A net imbalance of muscle forces across joints can lead to both dynamic and static joint deformities.

Surgery can be performed to treat the limb deformities.[1-4] Surgeons attempt to restore balance through selective muscle lengthening, tendon transfers, neurectomies, and muscle releases. The objective of presurgical planning is to understand muscle activity and to predict the functional behavior after surgical intervention. Five critical questions need to be answered for each muscle[2-4]: (1) Can the patient voluntarily activate the muscle (volitional control)? (2) Is the muscle, as an antagonist, activated during active movement generated by an agonist (dyssynergy)? (3) Is the muscle activated in response to a quick stretch stimulus (spasticity)? (4) Does the muscle have increased stiffness when stretched (rigidity)? and (5) Does the muscle have fixed shortening (contracture)? When many muscles cross a joint, their characteristics may vary. Information about what each muscle contributes to the movement of the joint is useful in the assessment as a whole. Successful treatment depends on having such information. Surgical interventions are directed at specific muscles; therefore, information about the neurologic control should be muscle specific.

Historically, clinical examination has been the mainstay of evaluation and decision making with patients who have spastic limb deformities. Instrumented laboratory analysis by dynamic electromyography and motion data can help characterize movement disorders. More specific information about the activity in individual muscles is provided. Studies[5,6] have shown that there is considerable variability in the patterns of muscle control in spastic elbow flexion deformities. Despite the logic behind polyelectromyographic analysis, its specific contribution to clinical and surgical decision making is not well known. Because of associated costs and lack of proven benefit, surgeons have not routinely used polyelectromyographic analysis to plan surgical reconstruction of spastic upper-extremity deformities. The clinical utility of polyelectromyographic analysis remains unproven.

Our purpose in this study was to determine the effect of instrumented polyelectromyographic analysis on surgical plan-

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Supported in part by the National Institute on Disability and Rehabilitation Research, US Department of Education (grant no. H133A70033).

No commercial party having a direct financial interest in the results of the research supporting this article has or will confer a benefit upon the author(s) or upon any organization with which the author(s) is/are associated.

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0003-9993/03/8402-7435$35.00/0
doi:10.1053/apmr.2003.50099