

THE UNIVERSITY OF MANITOBA

A METHOD OF ELECTROMYOGRAPHIC ANALYSIS OF NORMAL AND
ABNORMAL MOVEMENT IN THE SHOULDER COMPLEX

by

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ABSTRACT

The activity of the shoulder muscles, the anterior, middle and posterior fibres of deltoid, trapezius and serratus anterior was evaluated during raising and lowering the arm in the scapular plane of abduction in 30 normal subjects. In addition, the activity of the same muscles was evaluated in 21 subjects with hemiplegia and in 18 subjects with a lesion of a glenohumeral joint structure.

The evaluation procedure included an analysis of the electromyographic record of muscle activity. The electromyographic signals were obtained from all subjects by means of bipolar surface electrodes. The signals were recorded for analysis on a pen-writing oscillograph. Information on arm position was obtained from a gravity reference electrogoniometer. The electrogoniometer signal was correlated, at every 10° , with the electromyographic data to indicate the varying muscle contribution during raising and lowering the arm.

The normal subjects showed patterns of progressive activity during raising the arm, with some levelling off of activity as the limb approached the position of maximum elevation.

Descent of the arm produced a progressive decrease in electromyographic activity. Activity levels recorded during arm lowering were less than that obtained during arm raising. The mean age of the normal group was 46.2 years. The ages ranged from 10 to 88 years.

The activity patterns of the muscles of the left shoulder in 16 of the 30 normal subjects was compared with the data obtained from measurements of activity of the right shoulder muscles in the total group of normal

subjects. Analysis of this data demonstrated similar patterns of activity in the muscles of both sides,

A comparison of muscle activity seen in the 15 younger subjects of the normal group of 30 subjects was made with the 15 older subjects. The activity of the two groups was similar.

The activity of the muscles of the shoulder complex was assessed in a group of 21 hemiplegic subjects. Eleven subjects exhibited lesions on the right side and 10 exhibited lesions on the left side.

The age group of the hemiplegic subjects ranged from 28 to 73 years with a mean age of 58.4 years. The analysis of the electromyographic activity in the hemiplegic group showed trapezius and the anterior and middle fibres of deltoid exhibiting patterns of activity similar to normal. The posterior fibres of deltoid showed increased activity, and serratus anterior exhibited decreased activity. The range of movement in the hemiplegic group was less than that seen in the normal group.

In addition to the normal and hemiplegic subjects, the muscle activity was assessed in a group of 18 subjects with lesions of a glenohumeral joint structure. The age group of these subjects ranged from 39 to 70 years with a mean age of 53.1 years. The analysis of the activity in this soft tissue lesion group showed the middle fibres of deltoid and serratus anterior exhibiting activity similar to that seen in normal subjects. Trapezius showed a slight increase in activity in lesions affecting the left side, but only at the end of the movement. The posterior and anterior fibres of deltoid exhibited increased activity, particularly during arm lowering. Subjects in the group with soft tissue lesions demonstrated limitation of shoulder movement.

The activity of the muscle groups in the 30 normal subjects was compared with the activity of the same muscles of the unaffected shoulder of 10 subjects in the group with hemiplegia and 10 in the group with soft tissue lesions. The hemiplegic group showed patterns of activity similar to that of normal subjects. Subjects with soft tissue lesions showed increased activity in the posterior fibres of deltoid. In these subjects decreased activity levels were identified in serratus anterior. Trapezius, middle and anterior fibres of deltoid showed activity similar to that of the normal group.

The range of movement in the groups with hemiplegia and soft tissue lesions was less than that seen in normals,

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CHAPTER I

INTRODUCTION

The word shoulder is used in the English language with a variety of meanings. It can mean support, and the classical reference is to Atlas who supported the world on his shoulders. In another context the word means to give personal assistance, as is illustrated by the phrase 'shoulder to the wheel'. In anatomical terminology the term is applied to the mechanism by which the upper extremity is attached to the trunk (Moseley, 1969).

The upper limb provides man with a unique mechanism to interact with his environment. At the end of the upper extremity the hand can carry out a wide variety of prehensile and non-prehensile acts. In a functional sense the upper limb is organized about the hand as the principal feature of the system. A primary function of the upper limb is to position the hand for its sensory, contacting and connective uses (Dempster, 1965). The positioning of the upper extremity with respect to the head allows for a visual and aiming control which cannot be duplicated elsewhere in the body (Kelly, 1971).

Considerable research has been done on the mechanism of the shoulder complex, and several analyses describe the muscle and joint activity in movements of the arm (Duvall, 1955; Bearn, 1961; Saario, 1963; Dempster, 1965; Shevin et al, 1969; Long, 1970; Jones, 1970 and Lucas, 1973). The most recent studies have correlated precisely arm position with the phasic activity of the muscles acting on the scapula and glenohumeral joints in normal subjects.

There is a considerable volume of literature on the numerous clinical lesions which affect the shoulder complex (Moseley, 1969; Cyriax, 1969; Brunnstrom, 1970; Bateman, 1972; De Palma, 1973). Kent (1971)

states "probably more volumes of material are written about the shoulder complex and resulting disabilities in this area than about any other joint in the body".

Standard texts in medicine describe the clinical lesions of the shoulder complex in detail. The literature abounds with comments on lesions which produce limitation of shoulder movement and descriptions of the changes in movement patterns, but a review of the literature indicates a lack of detailed analysis of the muscle groups acting on the shoulder complex in the abnormal state.

In rehabilitation medicine the patient with chronically limited shoulder mobility presents serious medical, social and economic problems. A limitation of shoulder movement can severely limit the effective use of the hand.

In clinical practise the major emphasis has been directed towards the accurate identification of the lesion. Musculoskeletal lesions of the shoulder have been particularly difficult to identify and classify (Bateman, 1972). There is some disagreement in the literature on the most appropriate method of classification of soft tissue lesions affecting the shoulder complex. This is in part due to the intricate structure of the shoulder region. Many accounts exist describing the mechanisms in hemiplegia involved in the production of the abnormal muscle movement patterns which can severely affect voluntary function (Kabat, 1965; Bobath, 1970; Brunnstrom, 1970).

Apart from the accurate identification of the lesion producing the disability, the main interest has been directed towards the treatment and rehabilitation of the lesion. Treatment has been directed