MUSCLE TENSION AND JOINT MOBILITY

BY

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Even when the muscles surrounding a joint are inactive, they still exert a damping effect on joint mobility, because of the passive elastic tension exerted by the stretched muscle fibres and their connective tissue (Clemmesen, 1951). For example, if the forearm muscles are allowed to relax and the forearm is then shaken violently, the hand will swing loosely at the wrist; however, if the experiment is repeated post mortem after all the tendons that cross the wrist have been severed, it is obvious that wrist mobility is considerably increased.

Johns and Wright (1962) have estimated the effect of passive elastic tension in muscles by comparing the freedom of movement exhibited by an anaesthetized cat's wrist before and after dividing the forearm tendons. In the present study, measurements have been made of finger mobility in man after the muscles and tendons have been rendered ineffectual.

Material and Methods

Twenty adults (fifteen men and five women), ranging in age from 18 to 22 years, were the subjects of the experiment. Each sat in a comfortable, relaxed posture with the right forearm supported on a padded armrest, active contraction of the forearm musculature thus being reduced to negligible levels (Wright and Johns, 1960).

The middle finger of the right hand had a pendulum attached to its tip, as in experiments previously described (Barnett and Cobbold, 1962). The pendulum was set swinging by releasing an electromagnet and the amplitude of the pendulum was continuously recorded by cinematography (Fig. 1).

From the rate of decay of amplitude it was easy to calculate the fraction \( F/W \), \( F \) being the lateral force needed to set the terminal phalanx in motion at the distal interphalangeal joint and \( W \) the force compressing the middle and distal phalanges together. In a pendulum suspended from an engineering bearing, this fraction \( F/W \) corresponds to the coefficient of friction between the fixed and moving bearing surfaces. Although this term is often loosely used in articular mechanics, it is more appropriate to speak of a "coefficient of resistance to movement", for mobility of the joint is hindered not only by friction between the articulating surfaces but by at least two other additional factors: tension within the ligaments and other soft tissues surrounding the joint, including the articular capsule, and passive elastic tension in the muscles.
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tested (Fig. 2). In the posture shown above (A), the terminal phalanx was remarkably flail-like and could not be flexed or extended actively. Both the flexor and extensor tendons were rendered completely lax and there was no passive elastic tension in the corresponding muscles (Barnett and Cobbold, 1962). In the lower posture (B) full voluntary control of the distal interphalangeal joint was possible; the obvious reduction of mobility at the joint when the hand changed from posture A to posture B depended on the restoration of the normal passive elastic tension in the flexor and extensor muscles of the forearm.

Each subject was tested with his hand first in posture A and then in posture B, and the rate of decay of amplitude of the pendulum was recorded.

Observations and Discussion

The coefficient of resistance to movement at the distal interphalangeal joint was calculated for both hand postures in each of the twenty subjects. The results are shown in the histogram (Fig. 3). The maximum angular amplitude of the pendulum was 18°.

The terminal phalanx was invariably less mobile when the hand was held in posture B than when it was held in posture A. The difference—predominantly due to the effect of passive elastic tension in the forearm muscles—varied somewhat, doubtless because active contraction of the forearm musculature had not been eliminated in all subjects. The mean coefficient was 0·0055 for posture A and 0·0104 for posture B.

As a result of the present experiments, one can state that, on average, the elastic tension in muscles accounts for about half the resistance to movement at a joint when it is moving in the middle part of its range. This result is in accordance with the
findings of Johns and Wright (1962) in animals. It confirms the clinical dictum that a flail limb is much more likely to result if paralysed muscles are stretched than if they are maintained at their original length.

Summary

The mobility of the distal interphalangeal joint of the middle finger has been measured in twenty young adults. When the terminal phalanx is being moved near the middle part of its range, the passive elastic tension in the digital flexor and extensor muscles accounts for about half the total resistance to movement.

REFERENCES


La tension musculaire et la mobilité articulaire

RÉSUMÉ

La mobilité de l’articulation digitale distale du médius a été mesurée chez vingt jeunes adultes. Quand on imprime à cette articulation un mouvement passant par le milieu de son amplitude, presque la moitié de la résistance qui s’y oppose est due à la tension élastique passive des muscles extenseurs et fléchisseurs.

Tensión muscular y movilidad articular

SUMARIO

Se ha medido la movilidad de la articulación interfalángica distal del dedo medio (cordial) en veinte adultos jóvenes. Cuando la falange terminal se mueve hasta cerca de la parte media de su desplazamiento normal, cerca de la mitad de la resistencia total al movimiento es motivada por la tensión elástica pasiva de los músculos flexor y extensor digitales.
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