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MEASUREMENTS OF THE MOTION OF THE HAND JOINTS

(REVIEW OF THE RESULTS OBTAINED)

Measurements of motion of the human joints has been fully neglected in anthropological studies. Informations on the normal range of motion of individual joints, as well as of groups of joints are of great importance in numerous fields of medicine, as orthopaedics, plastic surgery, orthopaedic surgery, rheumatology, prothetics, kinesiotherapy and others. So far only little attention was paid to the hand joints, in spite of the fact that they are readily accessible for examination, and of their great functional importance (any damage has far reaching occupational, physical, social, aesthetic, psychical and other implications). The data reported so far consisted regularly of the range of values encountered in most individuals and were concerned with all fingers conjunctly. In order to supplement these data we have investigated the dorsovolar movements of individual joints of the hand in childhood, including both passive and active movements, since their discrimination is essential for the surgery of the hand.

The results obtained allow a comparison of the motion in pathological conditions and in normal circumstances and a more precise determination of the degree of limitation. In the immediate postoperative period and during the rehabilitation they provide the possibility to recognise specific differences according to age, sex, right and left side, and to evaluate objectively the effect of the rehabilitation procedures. At the check-up examination they contribute to an early discovery of any limitation of movements and the comparison of active and passive excursions helps to establish the diagnosis and conjunctly with other methods to decide whether surgical repair is necessary or whether therapeutic exercises will prove sufficiently effective. A limitation of joint motion is characteristic for some congenital malformations (pleonosteosis, arthrogryposis, camptodactylia, and other contractures), while on the contrary, some other conditions are associated with articular relaxations (Ehlers-Danlos syndrome, morbus Down etc.) and therefore the establishment of the normal range of motion is necessary for a definite assessment.

We have examined 1.000 children from Prague (500 boys and 500 girls) ranging in age from 6 to 16 years. To eliminate errors due to the insufficient accuracy of the measurements of angles we have subdivided the probands according to sex and age into groups covering two years and including each 100 individuals. The results were reported in earlier communications and the interested reader is referred to the list of quotations (the theses are discussed in the following paragraphs) — Šmahel 1974a, b, c, d, 1975.

Numerous studies reported in the literature propose various methods for the measurement of motion. After the exclusion of spherometry, tracing of contours, documentation and electrogoniometry (the latter because of the costly and complicated equipment) the use of planimetry appears most convenient. It consists of measurements in a single plane which are performed with the help of various types of uncomplicated goniometers, mostly with two arms. The arms are applied along the axis of the moving parts of the body (sometimes a gravity goniometer is used indicating the angle of the inclination towards the verticalis).

For practical reasons this procedure is not possible in the hand where the measurements should be performed on the dorsal side. The values obtained can be influenced by the amount of subcutaneous fat or by the configuration of the surface of the body (e.g. nails), but the actually attained accuracy proved sufficient ($\pm$ 2.5^0). The measurement of the lateral side along the axis is not feasible because of the complexity and small size of the hand joints.

A metallic sliding goniometer was constructed for the measurement of dorsovolar movements of the fingers. Its short arms are placed over a given joint on the dorsal side of the hand. Its use is evident on Fig. 1. The range of motion is recorded on the central fixed arm, calibrated within the range of 50—300^0. The two movable arms fitted with lengthening arms are used for the measurement of the dorsovolar excursions of the larger wrist joint.

During an examination we have observed the general principles of measurements of angles. For numerical expression and recording served a system of a full circle, where the plane containing the outstretched fingers is designated as 180^0. Extension or hyperextension show a trend towards higher values and flexion towards lower values. Thus marked extension is characterized by higher numerical values, while greater flexion is characterized by lower values. A system in which the starting point is represented by 'zero' and where an extension of the fingers is designated as 0^0 and where flexion and hyperextension results in an increase of values towards both sides, is not convenient for the examination of the hand (there is a lack of a continuous recording and during incomplete movements of the fingers the situation is further complicated by negative values and by the difficulties associated with the statistical evaluation, e.g. an extension of $-10^0 = 170^0$ in our measurements).

Both the accuracy of measurements and the results obtained are largely dependent on an adequate equipment, on the efforts of the proband to accomplish a maximum movement, on the personal opinion of the observer and in the first place on the set-up and on the position of the measured region (the extent of motion is changing with changes of the position). For this reason it is always necessary to mention the method used for the measurement of individual excursions and to adher to a standard procedure. The reader is again referred to our earlier papers. We begin always with the assessment of active movements and subsequently with the hand maintained in the same position a uniform pressure is applied to the relaxed fingers, i.e. passive motion (this manoeuvre requires some practice, the proband should not experience any pain). The values obtained are expressed in terms of fractions where the numerator indicates extension and the denominator flexion. The difference between both values represents the range of motion—however these data alone are of minor importance since they provide no precise informations on the zone of motion. Our examinations included besides dorsovolar excursions the radioulnar ductions of the wrist, as well as the palmar abduction, opposition and rotation of the thumb (active motion only). They are expressed in terms of the system using zero as the starting point which provides in this case more exact information. To conclude the basic theses of our results they are summed up as follows (for hand joints generally):

1. Within the investigated age group from 6 to 16 years occurs a reduction of hyperextensions (due to compacter joints), while there is a slight increase of flexions (this is explained by the predominating flexion activity of the hand). Hyperextensions are relatively marked in children.

2. The range of passive movements is identical or closely similar in both sexes, while girls show a greater range of active movements. Girls are thus capable of a higher degree of utilization of their possible range of motion for an active excursion.

3. There is obviously a certain equalization of the movements between groups of joints if both hands compared, which alternates. Generally, it can be said however that the fingers of the left hand have a greater mobility.

4. The above stated findings do not apply for the joints of the thumb, showing substantially differing characteristics of motion (changes according to age, differences between both sexes and both hands, and a greater variability of motion) compared to the other fingers of the hand. These differences are due to its distinct functional role (there is a less marked predomination of flexion over hyperextension).

5. For the wrist holds true the same as stated under 1. and 2. and thus it resembles functionally rather to the joints of the fingers with three phalanges. Both ductions decrease with age; with the hand in supine position the adduction is approximately three times greater than abduction. Flexion and hyperextension are identical in extent in the youngest group of children while adults have a more marked flexion. The differences between the range of motion of both sides are negligible.

6. Differences between the mobility of joints according to sex develop in adolescence. They occur mainly in the joints of the thumb and of the wrist and are only slight in the other fingers with three phalanges (showing a greater mobility in girls).

7. The fingers with three phalanges differ somewhat by their mobility. Thus e.g. the basal joint of the second finger is capable of the slightest flexion compared to the other fingers this holds true for the middle joint of the fifth finger and for the terminal joint of the fourth finger — the third finger is therefore capable of the most pronounced total flexion. Hyperextensions especially passive show equally differences among individual fingers. The range of motion of the digital joints decreases in distal direction (while it increases in the joints of the thumb.)

8. The comparison of changes of passive and active excursions with age showed that at hyperextensions there is a quicker limitation of passive

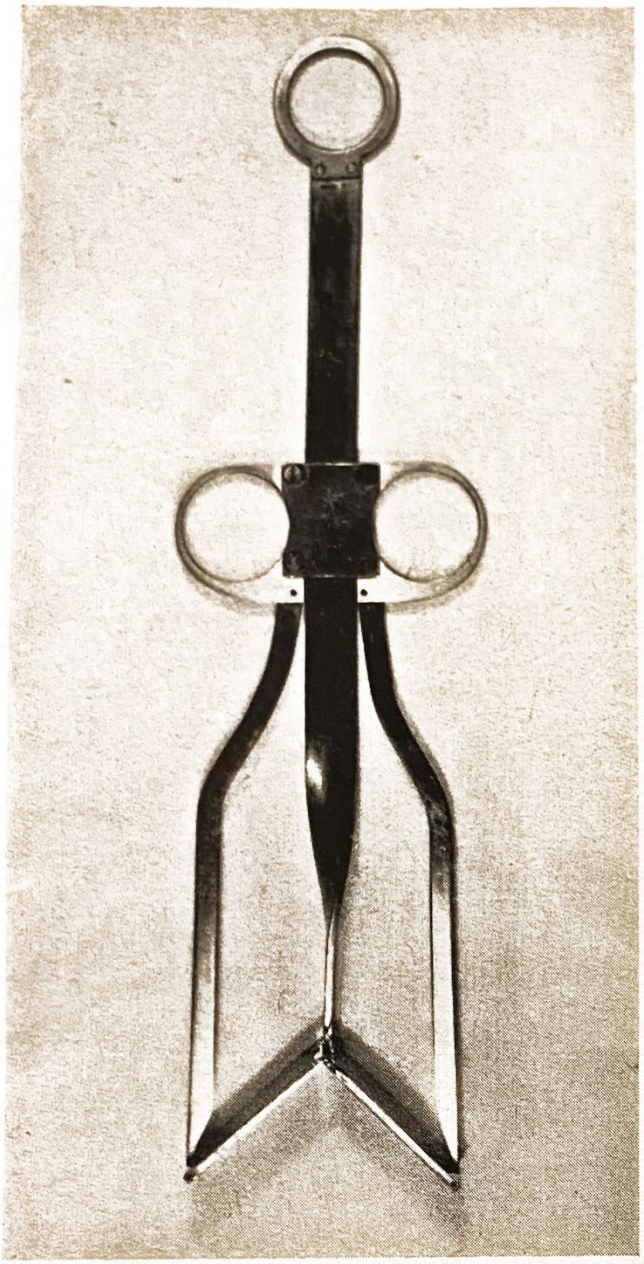

FIG. 1 *Goniometer for the measurement of dorsovolar joint excursions of the fingers. It is applied on the dorsal side over the respective joint with the short movable arms along the moving phalangae. The extent of movement is transferred on the long calibrated arm (an extent of 50—300° is quite sufficient). The two short arms fitted with lengthening arms are used for the measurement of the dorsovolar excursions of the larger wrist joint.*

movements (of primary importance are more compact joints), while at flexions there is a more rapid increase of active movements (of primary importance is the functional effect). The global mobility of the hand decreases with age.

SUMMARY

The importance and the methods of the measurements of the mobility of hand joints are documented and obtained results are presented.

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