The range of movement of the thumb

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Abstract

Purpose The movements at each thumb joint are flexion and extension (called radial abduction in the CMCJ) and additional movements of anteposition, retroposition and opposition at the CMCJ, due to the saddle shape of the articulation. Our study was designed to provide a means of thumb movement measurement and provide a range for each.

Methods A prospective cohort study was performed looking at 100 consecutive individuals without thumb pathology to determine thumb joint range of movements and evaluate the reliability of such measurements.

Results The mean age was 26 (range of 18–37) with 62 female individuals. The mean range of movement of the IPJ was flexion of 88 ° (80–90 °) and extension of 12 ° (0–45 °). That of the MCPJ was flexion of 60 ° (43–70 °) and extension of 8.1 ° (0–15 °). That of the CMCJ was anteposition of 61.2 ° (50–71 °), retroposition of 31.1 mm (25–38 mm), radial abduction of 62.9 ° (53–71 °), opposition Kapandji grade 9 (grades 9–10) and adduction of 10.2 ± 4 ° (5–20 °). CMC adduction was difficult to measure with a poor intra- and inter-observer correlation (inter-reliability correlation coefficient of 0.02 and intra-reliability coefficient of 0.04). For the remaining measurements, the mean inter-reliability correlation coefficient was 0.82 ($p < 0.01$) while the mean intra-reliability correlation coefficient was 0.93 ($p < 0.01$). There was negative correlation identified between IPJ extension and MCPJ

extension (−0.50) and between CMCJ radial abduction and MCPJ extension (−0.60).

Conclusions Having established the normal ranges of movements for the thumb joints and shown that our measurement methods are reliable and reproducible, we have identified that a reduction in certain thumb joint movements appears to be compensated for by an increased movement range in the other joints.

Keywords Correlation · Measurement · Movement · Range · Thumb

Introduction

The ape hand is characterised by a diminutive thumb in combination with long curved fingers. The human hand has a much larger, mobile and fully opposable thumb that has enabled delicate motor skills and the precision and power grips [7]. The opposable thumb is an integral aspect of human hand function.

The thumb consists of three joints: the carpometacarpal joint (CMCJ), metacarpophalangeal joint (MCPJ) and the interphalangeal joint (IPJ). The movements at each joint are flexion and extension (the latter in the CMCJ is now called radial abduction) but the CMCJ due to the saddle shape of the articulation has in addition movements of palmar abduction, retroposition, adduction and opposition. The MCPJ and IPJ are hinge joints and therefore only allow flexion and extension.

Thumb joint pathology is common with degenerative disease affecting all three joints [1]. It was observed by the senior author that movements of one thumb joint could affect movements of an adjacent thumb joint. In order to study that, it was necessary to identify normal ranges. While movements of the IPJ and MCPJ may be reasonable to measure, movements of the CMCJ are not.

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The aims of this study were to define the normal range of movement of the three joints of the thumb using measurement methods which were both reliable and reproducible, and to determine if restriction of movement of one the thumb joints influenced movement of the other joints.

Materials and Methods

A prospective cohort study was performed looking at 100 consecutive consented individuals without thumb pathology to determine ranges of flexion and radial abduction, palmar abduction, reposition and opposition of the CMCJ. Ranges of IPJ and MCPJ movements were also measured in order to obtain the normal ranges of thumb movement of each individual.

All the measurements were performed by two examiners. All individuals with pain, clinical deformity, previous hand/wrist surgery, known diagnosis of hand/wrist arthritis or history of hand/wrist trauma were excluded. All measurements occurred on the right thumb.

Standard measurements of range of movement were performed [4] (Fig 1).

The measurement of thumb opposition used the method described by Kapandji [5]. This is an opposition scale of 1–10 whereby each number corresponds to a specific area on the hand that the thumb can reach (Fig 2).

Inter-observer and intra-observer correlation was performed on a representative random ten individual sample group. The measurements were performed twice by the first author on this representative subset at different times for the intra-observer correlation and the same measurements were

Fig. 2 The ‘total opposition scale’ described by Kapandji for the opposition movement of the CMCJ

performed independently by the first and third authors on the same subset for the inter-observer correlation. The Pearson’s correlation and intra-class correlation statistical tests were used for inter-observer and intra-observer correlation measurements respectively. Correlations were also performed on all the range of movements of the thumb to assess whether changes in movement of one joint affected any of the others.

Results

The mean age of the study sample was 26 years old (range of 18–37) with 62 female and 38 male individuals. Seven-fifty percent were Caucasian, 15 % were of mixed ethnic background and 10 % were Afro-Caribbean.

The Interphalangeal Joint

The mean range of movement of the IPJ flexion was $88 \pm 2.3^\circ$ (range 80 – 90°) and extension was $12 \pm 9.2^\circ$ (range 0 – 45°).

The Metacarpophalangeal Joint

The mean range of movement of the MCPJ was flexion of $60 \pm 5.5^\circ$ (range 43 – 70°) and extension of $8.1 \pm 4.4^\circ$ (range 0 – 15°).

Fig. 1 Reference points for CMCJ measurements

The Carpometacarpal Joint

The mean range of palmar abduction of the CMCJ was of $61.2 \pm 4.4^\circ$ (range $50\text{--}71^\circ$), retroposition of $31 \pm 4^\circ$ (range $25\text{--}38^\circ$), radial abduction of $62.9 \pm 4.3^\circ$ (range $53\text{--}71^\circ$), opposition Kapandji grade 9 ± 0.5 (grades 9–10) and adduction of $10.2 \pm 4^\circ$ (range $5\text{--}20^\circ$).

Measurement Reliability

Thumb adduction demonstrated no inter-observer (coefficient of 0.02) and intra-observer (coefficient of 0.04) reliability correlation. Excluding adduction, the mean inter-reliability correlation coefficient was 0.82 ($p < 0.01$) while the mean intra-reliability correlation coefficient was 0.93 ($p < 0.01$), with significance demonstrated on testing for all the other ranges of movement of the joints of the thumb.

There was no correlation between palmar abduction, retroposition and opposition but there was a negative correlation of -0.50 ($p < 0.01$) between CMCJ radial abduction and MCPJ extension, and a further negative correlation of -0.60 ($p < 0.01$) between MCPJ extension and IPJ extension, indicative of the fact that as extension increases in one joint, the same movement in the other one decreases.

Discussion

The thumb lies in pronation almost 90° to the plane of the palm, and while it has three separate joints, the most distinguishing one is the carpometacarpal joint (CMCJ). Studies suggest that a primitive autonomisation of the first CMCJ occurred in dinosaurs approximately 365 million years ago. A real differentiation appeared 70 million years ago in early primates, while the shape of the human thumb CMCJ finally appeared about 5 million years ago [2].

Identifying the normal ranges of movements of these joints using reliable and reproducible methods is vital in identifying treatments for and aiding management of thumb joint pathology.

There have been multiple studies that have attempted to explain thumb joint movement, address methods of measurement and provide standardised protocols for that [3, 8, 9]. Some studies have addressed the impact of thumb range of movement on activities of daily living [6]. Very little, however, has provided a range of movement for each joint which can be reliably measured and none has attempted to link variations between the ranges of movements of each joint.

In our study, flexion of the IPJ was consistent, while extension of the IPJ was very variable with results as high as 45° and as low as 0° . This could be due to simple

variation in joint laxity; however, there was a correlation between IPJ extension and MCPJ extension, whereby restriction in MCPJ extension was associated with an increase in IPJ extension and vice versa, indicating that when the MCPJ extends less, the IPJ will extend more. The body thus compensates for a reduced range in one joint by increasing the range in another to achieve the widest span possible. The variability of the IPJ extension is markedly greater than any other range of movement.

The MCPJ range of movement is very varied although the total range was never more than 70° . It was the arc of movement that varied. As with the correlation between the MCPJ and the IPJ, there is a correlation between CMCJ radial abduction and MCPJ extension, whereby a restriction in CMCJ radial abduction was associated with an increase in MCPJ extension and vice versa. No other movements of the CMCJ demonstrated a correlation with movements of the MCPJ or IPJ.

The range of Kapandji grade is exceedingly narrow with almost all being grade 9 or 10. This reflects the insensitivity of this measuring scale; however, it is the only measure there is available for this complex movement and it is universally used.

The reliability and reproducibility of the results show significantly favourable inter-observer and intra-observer reliability coefficients indicating that this method could be used by any health professional to accurately record the range of movement of the CMCJ. However, CMCJ thumb adduction was difficult to measure due to the described movement pushing the stationary arm of the goniometer off the index finger, thus leading to inaccurate readings. This will require a different method of measurement to be employed and assessed clinically for reliability and reproducibility in a further study.

The limitations of this study include the number of individuals used as test subjects and the number of professionals performing the measurements. We would anticipate using a larger sample group and a larger number of professionals performing the measurements. Another limitation of this study was the difficulty measuring adduction and a more reliable method of measurement will have to be adapted.

We have also demonstrated that a change in the range of movement of one joint of the thumb does affect the other joints of the thumb. This will be the basis of a future study looking at pathological conditions affecting the thumb. A further follow-up study would be useful to observe those patients with larger ranges of movement, to see if they are more prone to developing degenerative arthritic conditions.

Conflict of Interest The authors declare that they have no conflict of interest.

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