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Original article

Normal range-of-motion of trapeziometacarpal joint

Détermination des amplitudes normales de l'articulation trapézométacarpienne

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Abstract

Purpose. – The range-of-motion of the trapeziometacarpal joint is difficult to assess clinically. The purpose of our study was to constitute a range-of-motion database from normal active trapeziometacarpal joints.
Material and methods. – Two hundred hands from 101 healthy subjects (50 female and 51 male) with a mean age of 23.1 years (range: 22 to 35 years) have been evaluated. An optoelectronic device (Polaris®) was used to analyse the thumbs range-of-motion. Splints were fitted so as to isolate the trapeziometacarpal joint and retroreflective markers were placed both on the splints and on the thumb. After active flexion–extension, abduction–adduction, axial rotation and circumduction, the different range-of-motion parameters were calculated.
Results. – The mean range-of-motion of the trapeziometacarpal joint was 41° for flexion–extension, 51° for abduction–adduction and 21° for axial rotation. Comparisons between female and male subjects showed significant differences concerning flexion–extension, abduction–adduction axial rotation and circumduction. No significant differences were noted between right and left hands except for the abduction–adduction movement.
Discussion and conclusion. – One hundred and one healthy subjects were analysed for the development of a database of normal active range-of-motion parameters of the trapeziometacarpal joint, with an in vivo protocol. This database should allow comparing the range-of-motion of patients with osteoarthritic trapeziometacarpal joint and assessing surgical outcome.

Keywords: Trapeziometacarpal joint; Kinematics; In vivo; Range-of-motion; Optoelectronic; Biomechanics

Résumé

Objectifs. – L'évaluation des amplitudes articulaires de l'articulation trapézométacarpienne est difficile en pratique clinique courante. L'objectif de notre étude était de réaliser une base de données à partir de sujets sains, concernant les amplitudes de l'articulation trapézométacarpienne in vivo.
Matériels et méthodes. – L'analyse cinématique de 101 sujets sains (50 femmes, 51 hommes), soit 200 mains, a été réalisée à l'aide d'un système optoélectronique. Des attelles ont été placées sur la main et le poignet afin de ne mesurer que les mobilités trapézométacarpiennes. Les mouvements de flexion–extension, d'abduction–adduction, et de circumduction ont été étudiés.
Résultats. – Les mobilités moyennes de l'articulation trapézométacarpienne étaient de 41° en flexion–extension, de 51° en abduction–adduction, et de 21° en rotation axiale. La comparaison des sujets masculins et féminins montre une différence significative concernant les mobilités de flexion–extension, d'abduction–adduction, de rotation axiale et de circumduction. Aucune différence significative n'était notée entre les mains droites et gauches en dehors du mouvement d'abduction–adduction.
Discussion et conclusion. – L'analyse de 101 sujets sains a permis d'élaborer une base de données concernant les paramètres cinématiques de l'articulation trapézométacarpienne. Cette base de données permettra de comparer les mobilités de sujets atteints d'arthrose afin d'évaluer une éventuelle modification. De plus, la comparaison de patients ayant subi une intervention chirurgicale et des sujets sains pourra être réalisée, afin d'évaluer un éventuel bénéfice.

Mots clés : Articulation trapézométacarpienne ; Cinématique ; In vivo ; Optoélectronique ; Biomécanique

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1. Introduction

The trapeziometacarpal (TMC) joint is important for the thumb's range-of-motion [1]. However, its anatomy is very complicated. The shape of the trapezium and the first metacarpal articular surfaces is described as a double saddle with concave and convex surfaces. Moreover, many ligaments have been described to be present in the TMC joint [2], but their function remains unclear. Nevertheless, tendons, muscles action and capsular laxity may change the kinematics of the TMC joint.

The range-of–motion of the TMC joint is clinically difficult to assess accurately. The Kapandji score measures the entire thumb motion and gives no accurate data on TMC joint range-of-motion [1]. Goniometers can not be easily used in this joint. Many studies have described ex vivo kinematics of the TMC joint [3–12], which are definitely helpful for the understanding of TMC joint kinematics. However, these analyses did not include the active function of muscles and tendons in the study of joint kinematics.

In vivo studies are currently developed and various systems have been produced to analyse in vivo kinematics. X-rays analysis may be considered dangerous for the patients because of radiation exposure [8]. MRI analysis allows static study in different positions. Some studies have analysed the TMC joint using optoelectronic or electromagnetic devices [13,14]. These studies validated a kinematics protocol but no publication to our knowledge has ever presented a database of TMC joint range-of-motion in healthy subjects.

The purpose of our study was to validate an active TMC kinematics analysis and to collect data from TMC joint range-of-motion, in different specific patterns of movements, so as to obtain a panel of values for normal TMC joint.

2. Material and methods

One hundred and one healthy subjects, 50 females and 51 males, were evaluated, with a mean age of 23.1 (range 22–35) years. Both hands were studied in 99 subjects and one hand in two. Two hundred hands were finally analysed. All subjects underwent a medical query in order to exclude those with a previous hand injury or any other kind of hand pathology.

Each examined hand was placed into a splint in order to immobilize the wrist. A small splint was used to fix the IP and MCP joints, so as to isolate the TMC joint for individual examination (Fig. 1).

An optoelectronic system (Polaris®, Northern Digital Inc, Ontario) was used to analyse the movements of the thumb with two fixed infrared cameras and retroreflective markers. Retroreflective markers were placed on the two splints (Fig. 1). A pen with markers was used to localize bony landmarks on the first metacarpal bone.

Four movements of the thumb were analysed: abduction–adduction, flexion–extension, axial rotation and circumduction. Circumduction, which is defined as the spatial motion of the first metacarpal of the thumb, was described by three parameters: υa, υb and β [13] (Fig. 2). The palm of the hand

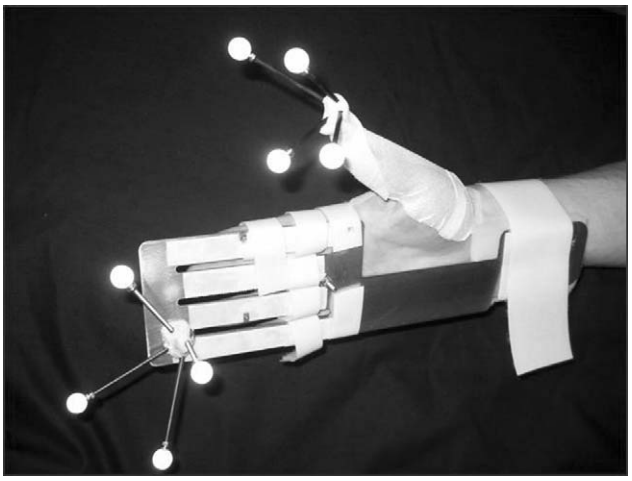

Fig. 1. Splints with retroreflective markers to immobilize all joints except the TMC joint.

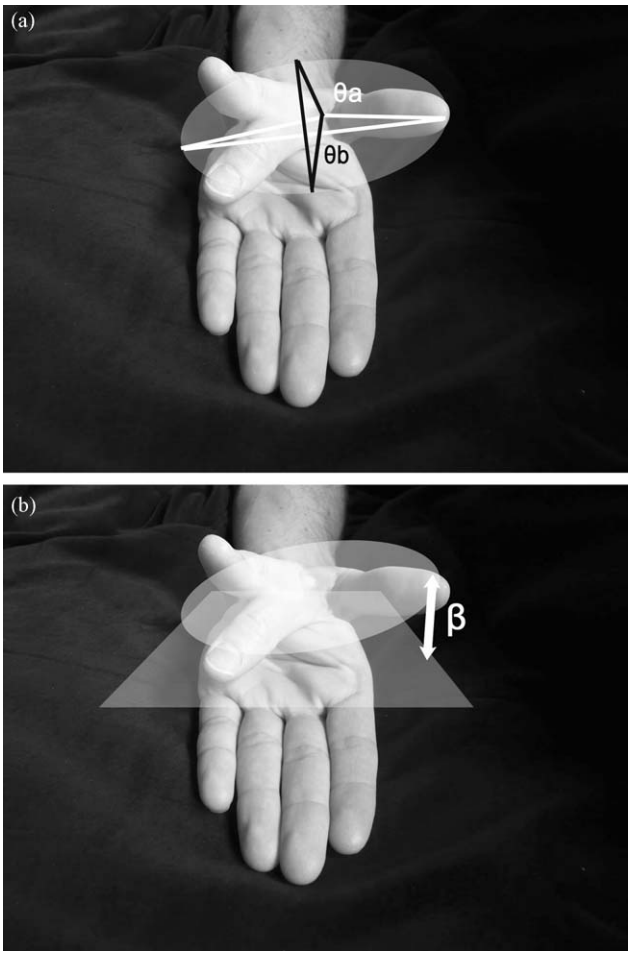

Fig. 2. a: circumduction is defined with the υa and υb parameters. υa is the angle between the higher and lower position of the first metacarpal in abduction–adduction (movement in the same plane as the thumb nail plane). Θb is the angle between the higher and lower position of the first metacarpal in flexion–extension (movement in the perpendicular plane to the thumb nail plane); b: the angle between the surface of circumduction (oval) and plane of the palm (square) is defined with the β parameter.