Motion deficit of the thumb in CMC joint arthritis

Sebastian V. Gehrmann, MD1, Jie Tang, MS1, Zong-Ming Li, PhD1, Robert J. Goitz MD1, Joachim Windolf, MD2, Robert A. Kaufmann., MD1

1 Hand Research Laboratory, Department of Orthopaedic Surgery, University of Pittsburgh, Pittsburgh, PA 15213
2 Department of Trauma and Hand Surgery, University of Duesseldorf, Germany

Introduction
The unique anatomic configuration of the first carpometacarpal (CMC) joint determines the multidimensional motion capabilities of the thumb [1]. Idiopathic osteoarthritis of the thumbs CMC joint (CMC OA) is a common and disabling disease causing pain as well as strength and motion loss. There are few studies describing the multidirectional loss of motion in CMC OA of the thumb [2]. A compensatory hyperextension of the first metacarpophalangeal joint is described in cases of severe CMC OA of the thumb. So far, there exists no quantitative data regarding this mechanism. The aim of our study was to characterize the multidimensional motion capability of the thumb CMC joint in a group with severe CMC OA compared to a control group without arthritic change.

Methods
Fifteen subjects (mean age 56 ± 8 years) with stage III and IV CMC osteoarthritis according the Eaton/Littler classification and 15 control subjects (mean age 37 ± 14 years) were included in the study. The Cochin score was administered to assess symptom severity (1.57 ± 1.07 for the CMC OA group). The task consisted of 5 maximum circumduction movements of the thumb. A motion analysis system based on surface markers was used to quantify the maximum boundary of the thumb circumduction envelop (Fig. 1). A custom made Matlab program calculated Euler angles based on the hand coordinate system for the quantification of the 3D angular motion of the thumb. We calculated the following outcome measures: 1. The area enclosed by the angular circumduction envelop, 2. the ranges of motion (ROM) in multiple directions for the thumb CMC, MCP and interphalangeal (IP) joints. One-way analysis of variance (ANOVA) with statistical significance at p = 0.05 was used to analyze outcome measures.

Results
The circumduction envelops of the thumb CMC joint can be characterized as a “kidney-shape” with a convex palmar and a concave dorsal boundary (Fig. 2). Thumb osteoarthrits of the CMC joint stage III and IV resulted in a significantly smaller ROM in Flexion/Extension (45° ± 11° for the CMC OA group and 59° ± 10° for the controls), Abduction/Adduction (37° ± 6° for the CMC OA group and 63° ± 13° for the controls) and Pronation/Supination (49° ± 10° for the CMC OA group and 62° ± 11° for the controls) (p < 0.01). When analyzing the motion directions in Flexion/Extension and Abduction/Adduction separately, there was only a loss of Extension and Adduction (p < 0.01). The ROMs of the MCP or IP joint of the thumb were not significantly different between the two groups (p > 0.08).

Conclusions
Severe stages of CMC OA of the thumb cause an asymmetrical motion deficit with decreased ROM in extension and adduction leading to a decreased opening capability of the hand. A compensatory hyperextension of the MCP joint was not found in the patient group. A potential applications of this study is an objective functional assessment after operative and conservative treatment of CMC OA.

References