Journal of Plastic, Reconstructive & Aesthetic Surgery (2016) 69, 341—345

JPRAS
An International Journal of Surgical Reconstruction
www.JPRASurg.com

# Evaluation of the first web-space narrowing in congenital anomalies with Z-deformity

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Received 9 July 2015; accepted 21 October 2015

**KEYWORDS**
First web;
Z-deformity;
Congenital anomaly;
Arthrogryposis multiplex congenita

**Summary** *Background:* In patients with congenital anomalies of the thumb, the metacarpophalangeal joint often undergoes radial deviation to compensate for a narrow first web space. In this study, we evaluated the relationship between the thumb and index finger in patients with arthrogryposis multiplex congenita (AMC), by measuring the thumb—index angle on radiographs taken while the patient held a styrene foam cone.
*Methods:* Investigation was carried out on nine patients (13 cases: four bilateral and five unilateral) with AMC. The average patient age was 4.4 years (range, 2.6—7.2 years). Overhead radiographs were obtained while the patient held a styrene foam cone. The radiographs were used to evaluate the apparent thumb—index web angle, the thumb to index finger metacarpal angle (1—2MCA), and the first metacarpophalangeal angle (1MPA).
*Results:* In the five unilateral cases, significant differences were seen on the affected versus unaffected sides in 1—2MCA and 1MPA. All 13 cases were treated surgically, and significant differences were observed between the groups before surgery and 2 years after surgery in the 1—2MCA and 1MPA. In addition, the mean postoperative 1MPA in the bilateral cases was significantly smaller compared with the unilateral cases.
*Conclusions:* This radiographic technique enabled us to evaluate the severity of the thumb—index web-space narrowing and the radial instability of the thumb metacarpophalangeal joint in patients with AMC. The bilateral cases tended to show better rehabilitative improvement compared with the unilateral ones, probably because the latter patients could use their unaffected hand.


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http://dx.doi.org/10.1016/j.bjps.2015.10.038

## Introduction

To compensate for a narrow first web space, radial deviation of the metacarpophalangeal (MCP) joint often occurs in patients with congenital anomalies. However, no consistent method has been reported to evaluate the first web space and thumb function in these anomalies.

To evaluate thumb function, Takagi et al. devised a method in which an overhead radiograph was obtained while the patient held a foam cone at a position where the first web space was expanded, using the radiographs to measure the thumb-to-index-finger metacarpal angle and the first metacarpophalangeal angle.[1] They assessed the usefulness of this evaluation in patients with hypoplastic thumbs, and they found that these patients had a smaller thumb-to-index metacarpal angle with a larger thumb metacarpophalangeal angle than patients with normal hands; these differences were greater in more severe cases of hypoplastic thumb. After surgery, the thumb-to-index-finger metacarpal angle increased, and the thumb metacarpophalangeal angle decreased.

In this study, we assessed the usefulness of this technique in patients with arthrogryposis multiplex congenita (AMC), a typical congenital anomaly with a Z-deformity, including a narrow first web space. We also evaluated the differences between bilateral and unilateral AMC cases. We found that the deformities improved after surgery, and that bilateral cases tended to show more rehabilitative improvement than unilateral ones, probably because the latter patients could use their unaffected hand for gripping.

## Materials and methods

### Patients

Between 2008 and 2012, nine patients with thumb instabilities caused by AMC were referred to our hospital. The average age of the patients when the preoperative radiographic films were taken was 4.4 years (range, 2.6—7.2 years). There were seven boys and two girls; four cases were bilateral, and five were unilateral. To widen the first web space, we performed a five-flap Z-plasty procedure on six hands[2] and then opponensplasty was performed[3] to stabilize the thumb MCP joint, in which the abductor digiti minimi tendon was passed underneath the extensor pollicis longus tendon and sutured to the adductor pollicis tendon on the ulnar side of the thumb MCP joint. A Spinner flap was performed on seven hands where a triangular flap based proximally on the dorso-radial aspect of the index finger was transposed into the first web with a split-thickness skin graft to cover the defect,[4] to improve the narrow first web, which was then followed by opponensplasty.[3] We also evaluated radiographs of these hands 2 years after surgery and collected the data retrospectively.

### Imaging procedure

Takagi et al. developed and evaluated a procedure for performing radiography while the patient holds a styrene foam cone (base diameter, 10 cm; height, 25 cm).[1] While still maintaining circumferential contact, the patient held the styrene foam cone with the thumb and index finger maintaining as large a circumference as possible. The cone was held with the thumb and index finger in a horizontal line, and an overhead radiograph was obtained. We evaluated the following three angles in the images: (1) the apparent first web angle (1WA; formed by the line between the centers of the index-finger carpometacarpal (CMC) and MCP joints and the line between the centers of the thumb CMC and MCP joints), (2) the thumb-to-index finger metacarpal angle (1—2MCA, formed by the line between the centers of the index-finger CMC and MCP joints and the line between the centers of the thumb CMC and interphalangeal (IP) joints), and (3) the first metacarpophalangeal angle (1MPA, formed by the line between the centers of the thumb MCP and CMC joints and the line between the centers of the thumb MCP IP joints). To obtain the measurements, the images on film were digitized.

### Assessment of the first web of the normal hand: comparison of affected and unaffected sides

In the five unilateral cases with AMC, we evaluated 1WA, 1—2MCA, and 1MPA on both the affected and the unaffected sides and compared the values of the two sides. In addition, the values on the unaffected side revealed the normal angles.

### Evaluation of improvement with surgery

By assessing the 1WA, 1—2MCA, and 1MPA before surgery and 2 years after surgery, the validity of the present imaging approach was evaluated for all 13 cases of AMC. In addition, the five unilateral cases (five hands) were compared with the four bilateral cases (eight hands) of AMC with respect to these three parameters before and after 2 years of surgery.

### Statistical analysis

All values were expressed as the mean and standard error of the mean. Statistical significance was determined as $P < .05$, using the Bonferroni multiple comparison test. Student's *t*-test was used to compare continuous data between the groups. Each angle was compared before surgery and 2 years after surgery using the paired *t*-test.

## Results

In the five unilateral AMC cases, no significant difference in 1WA was detected between the unaffected and affected sides. However, there were significant differences in 1—2MCA and 1MPA between the two sides (Figure 1) (Table 1).

We performed both five-flap Z-plasty/Spinner flap and opponensplasty to treat the 13 AMC cases. No significant difference was detected in 1WA between the groups before and 2 years after surgery. However, significant differences in 1—2MCA and 1MPA were observed (Figure 2) (Table 2): In