Cadaveric Study of Locked Thumb Metacarpophalangeal Joint Caused by Entrapment of Radial Sesamoid Bone

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ABSTRACT

Purpose: To identify the anatomical basis of entrapment of radial sesamoid bone of thumb into intercondylar notch of first metacarpal head and to reproduce radiographic “overlapping sign” on sesamoid subluxation.

Methods: Ten human cadaveric hands were dissected to measure the anthropometric parameters of radial sesamoid bone and intercondylar notch of first metacarpal head. Radiographs were taken to identify and to reproduce “overlapping sign” on sesamoid subluxation into intercondylar notch.

Results: Intercondylar notch of first metacarpal head was consistently larger than radial sesamoid bone, which allowed the entrapment. Radiographic “overlapping sign” was reproducible when such subluxation occurred.

Conclusion: This anatomical study identifies sesamoid subluxation into intercondylar notch as the cause of first metacarpophalangeal joint rotary subluxation. Radiographic “overlapping sign” is diagnostic of this clinical entity and is an important consideration for open reduction.

中文摘要

目的：確認拇指橈端籽骨陷入拇指掌骨間關口的解剖依據及重建X射線照片中在種籽骨半脫位的疊重徵兆。

方法：解剖並設置10隻人類拇指的橈端籽骨和第一個掌骨間關口的參考。使用X射線照片確認及重複在種籽骨半脫位進入掌骨間關口的“疊重徵兆”。

結果：拇指掌骨間關口遠大於橈端籽骨，能讓種籽骨陷入其中。當此半脫位發生時，X射線照片中“疊重的徵兆”可重複的。

總結：這項解剖研究確認橈端籽骨半脫位陷入拇指掌骨間關口，可成為拇指橈關節旋轉式半脫位的起因。X射線照片中之重疊徵兆是重要的臨床診斷手段及考慮手術復位的關鍵。

Introduction

Injury of the metacarpophalangeal joint (MCPJ) of the thumb is not uncommon. However, this injury associated with a locked thumb by the entrapment of the sesamoid bone is infrequently reported (Figure 1).1-3 Hyperextension injury of volar plate complex, which resulted in arthritis of the sesamoid articulation, was reported.3 Anatomical study was also carried out.4 However, the mechanism by which the sesamoid bone subluxed into intercondylar notch, resulting in locking, was not completely understood. The aim of this anatomical study was to investigate the anatomical basis of subluxation of radial sesamoid bone into the intercondylar notch of 1st metacarpal bone and the reproducibility of radiographic “overlapping sign” after the entrapment of the sesamoid bone.

Methods

Dissection of 10 cadaveric hands was carried out by two authors. All anatomical specimens were embalmed cadavers from a regional hospital. All ligaments and tendons of the thumb were preserved during the dissection. One 2-mm-diameter Kirschner wire was

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inserted into the base of proximal phalanx and another one into the neck of the metacarpal bone of the thumb (Figure 2A). Traction force was applied to the distal Kirschner wire by a weighing device, whereas pronation force was added simultaneously to create sesamoid subluxation (Figure 2B). The anthropometric data of sesamoid bone and intercondylar notch were obtained using a thickness gauge with ball tips, measurable to 0.05 mm (Centrostyle, Reference 04955, Italy) (Figure 3). The results of mean dimension were compared by Student t test using SPSS version 11.0 (SPSS Inc., Chicago, IL, USA). The anatomical hands were then brought under an image intensifier to document the "overlapping sign" and to measure the subsesamoid joint space.

Results

The mean dimensions of intercondylar notch of the 1st metacarpal bone were: height, 5.6 (4.6–7.1) mm; width, 5.4 (4.6–7.4) mm; and depth, 3.2 (2.7–5.0) mm. The mean dimensions of radial sesamoid bone were: height, 5.0 (4.2–5.6) mm; width, 4.7 (4.1–6.2) mm; and depth, 2.7 (2.3–3.5) mm (Table). The size of the intercondylar notch was consistently larger than that of the radial sesamoid bone, although this set of data failed to reach statistical significance. "Overlapping sign" was present in all radiographs when the sesamoid bone was subluxed into the intercondylar notch of 1st metacarpal bone (Figure 1). The mean force applied to achieve subluxation was 12.3 kgf, during which the mean degree of pronation of thumb was 35.5.

Discussion

The thenar sesamoids are present in all human hands. The radial sesamoid bone lies within the radial margins of the palmar plate. It is situated at the origin of the fibrous tunnel of flexor pollicis longus. Surrounding it are several ligaments and muscular structures. They include the accessory collateral ligaments that insert into lateral margins of sesamoids. Tendon of adductor pollicis inserts on ulnar sesamoid bone, whereas tendon of flexor pollicis brevis inserts on radial sesamoid bone.

There was no study on the anthropometric data of sesamoid bone of the thumb, which might fit snugly into intercondylar notch of metacarpal bone with its soft tissue attachments. Yamanaka et al described the patho-mechanism of dislocation of 1st MCPJ in 1985.
They reproduced the locked thumb by forced hyperextension of 1st MCPJ in irreducible position in cadaveric hands. Close reduction was successful in seven, but the other 16 required open reduction. In the latter group, they found that the proximal palmar ligament was ruptured transversely, with its distal part riding over the volar prominence of the radial condyle of the metacarpal bone together with the accessory collateral ligament. This dislocated part of the ligament formed a constricting bundle on the distal joint surface of the condyle that prevented closed reduction.7 On the contrary, there was a case report on MCPJ rotary subluxation because of sesamoid bone entrapment into intercondylar notch, without rupture of palmar ligament or volar capsule.2

In our study, the subluxation of the radial sesamoid bone into the intercondylar notch of 1st metacarpal bone was reproducible. In clinical practice, this condition presented as rotary subluxation of 1st MCPJ.2 The subluxed sesamoid bone gave a consistent “overlapping sign” by obliterating the subsesamoid joint space. This sign could be an important clinical clue to suggest open reduction for the subluxation of sesamoid bone.

However, there was bias in this study. First, the embalmed anatomical specimens posed technical difficulty regarding soft tissue condition and handling, which might not reflect in vivo circumstances. Second, measurement error of anthropometric data could occur though the interobserver error was minimised by taking all measurements by a single author. Finally, the sample size was too small to reach any statistical significance.

This anatomical study sheds light on the subluxation of the sesamoid bone into the intercondylar notch of 1st metacarpal bone and its subsequent management. Radiographic “overlapping sign” is reproducible. Whenever a thumb cannot be flexed at the MCPJ after injury, with radiographic “overlapping sign”, it implies entrapment of the radial sesamoid bone into the intercondylar notch, which is an indication for open reduction.

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