Trauma Case Reports 47 (2023) 100905

Contents lists available at ScienceDirect

Trauma Case Reports

journal homepage: www.elsevier.com/locate/tcr

Case Report

Locked thumb metacarpophalangeal joint due to sesamoid bone entrapment: A case report and review of literature

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ARTICLE INFO

Keywords:
Case report
Locked MCP joint
Sesamoid entrapment
Radial sesamoid
The locked thumb

ABSTRACT

Locked thumb metacarpophalangeal (MCP) joint has been known as a relatively rare condition. We present a case of a 25-year-old male presented with a traumatic locked thumb MCP joint of the right hand. Clinical presentation showed the joint was in a hyperextention position and resistant to active flexion and extension. The radial sesamoid was distally displaced on X-ray film and entrapped into the joint on CT scan. The mechanism of the locked MCP joint was thought as a "pull-hook lock" between the pointed proximal edge of the sesamoid and the deformed volar groove on the cartilaginous surface of the metacarpal head. Surgical treatment included partially releasing the insertion of the abductor pollicis brevis (APB) and flexor pollicis brevis (FPB) muscles to move the entrapped radial sesamoid, and resurfacing the deformed metacarpal head.

Introduction

The locked thumb metacarpophalangeal (MCP) joint has been known as a relatively rare condition and seldom reported in literature. The condition was early reported by Tsuge and Watari in 1974 [1], and then by most Japanese authors [2]. Because of its rarity, most studies about it just stayed in case report or case series.

It was impossible to reproduce an actual MCP joint locking in the laboratory setting despite considerable effort. There were several hypotheses of the causal mechanism such as volar plate incarcerated into the MCP joint, fracture fragment /loose body entrapment, and morphological abnormality of the first metacarpal head. The cause of most cases was attributed to the entrapment of radial sesamoid into the volar aspect of the deformed metacarpal head [3]. Lack of global understanding about the variation of thumb MCP anatomy, the rarity of the condition and controversies of the locking mechanism have made it difficult for inexperienced orthopedic surgeons to properly diagnose and manage.

We present a clinical case of entrapped radial sesamoid bone with successful operative treatment. We also concisely summarize the mechanism, pathoanatomy and treatment of the condition.

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https://doi.org/10.1016/j.tcr.2023.100905
Accepted 12 August 2023
Available online 15 August 2023

Presentation of case

A 25-year-old male presented at the ED in the condition that his right thumb was in severe pain and swelling, and couldn't move. His thumb was in hyperextension when he used it to push a middle-hole chair to ground. He was admitted to a local hospital on the same day. Closed reduction was attempted several times by either hanging his right thumb under weight for 15–20 min or manual stretching and flexing the MCP join. Unfortunately, any attempt failed, and he left the hospital with his hand put in a dorsal extension splint.

He presented to our hospital 7 days later with severe pain and moderate swelling on the volar aspect of the thumb MCP joint. The MCP joint was in 30° of hyperextension and the IP joint in slight flexion (Fig. 1). He was unable to actively flex and extend the MCP joint. Passive ROM of the MCP joint was 70° of flexion and 55° of extension. Bony crepitus could be audible on the MCP joint during passive flexion and extension of the joint. It was also in varus-valgus stability. Varus and valgus tests were negative. A lateral radiograph showed the hyperextension of the thumb MCP joint and distal displacement of the sesamoid bone (Fig. 2). Three-dimensional CT scans identified the displacement of the radial sesamoid that rode on the radial side protrusion of the metacarpal head (Fig. 3). Signs of collateral ligament injuries were not founded on MRI.

We unsuccessfully tried closed reduction under general anesthesia. Open reduction was performed with a 5-cm vertical incision along the radial edge of the MCP joint. At first exploration, we recognized that one pole of the radial sesamoid bone got stuck in the volar cartilaginous groove of the metacarpal head- a proximal head deformity (Fig. 4). We managed to release the entrapped sesamoid bone out of the groove by partially cutting the insertions of the APB and FPB muscles to reduce the significant tension of their tendons. Finally, resurfacing the radial cartilaginous deformity of the metacarpal head was performed to avoid the recurrence of the locking. The thumb was splinted in a neutral position with an Iselin splint for 2 weeks. However, the patient was encouraged to start active flexion and extension right after the operation. He achieved free-pain full range of motion of MCP joint with little complaint of instability at the point of 2-week and 4-week follow-up.

Discussion

In terms of anatomy, the thumb MCP joint, like other digital joints, is a diarthrodial condyloid joint with flexible motions. However, the thumb consistently possesses its two sesamoid bones including radial and ulnar ones, unlike other metacarpophalangeal joints [4]. The sesamoid bones are stable in a complex system contributed by proper and accessory collateral ligaments, volar and dorsal plates, and muscular aponeuroses [5]. Being one of the insertions of FPB and APB muscles, they serve as force transmission to perform the corresponding grasping and pinching action of the thumb [6].

It was widely accepted that hyperextension force resulted in the distal displacement of the sesamoid bone and made it entrap into the joint. The radial sesamoid was reportedly involved in most of the cases. However, authors didn't know exactly how it was locked in the MCP joint. Inoue and Tsuboi et al. noted that the morphology of the thumb metacarpal head remarkably contributed to the pathology of locking, especially which one has the radial protrusion and the deformed volar groove [7]. Kojima et al. and Cheng Sze-Chung noted that incarceration of the sesamoid bone was anatomically impossible in their fresh cadaver but they believed the real cause was the incarceration of the proximal volar plate. Chia-Chin Tsai et al. described no injuries of the volar plate or proper collateral ligaments could be found in their two cases [6–8]. Some authors believed that displaced radial sesamoid served as a block to joint motion, hence no passive and active joint movement could be found [2]. Contrary to this belief, G. Xiong found the locked MCP joint

Fig. 1. MCP joint in hyperextension and the IP joint in flexion position.

Fig. 2. Lateral X-ray showed the hyperextension of the thumb MCP joint along with distal displacement of the sesamoid bone.

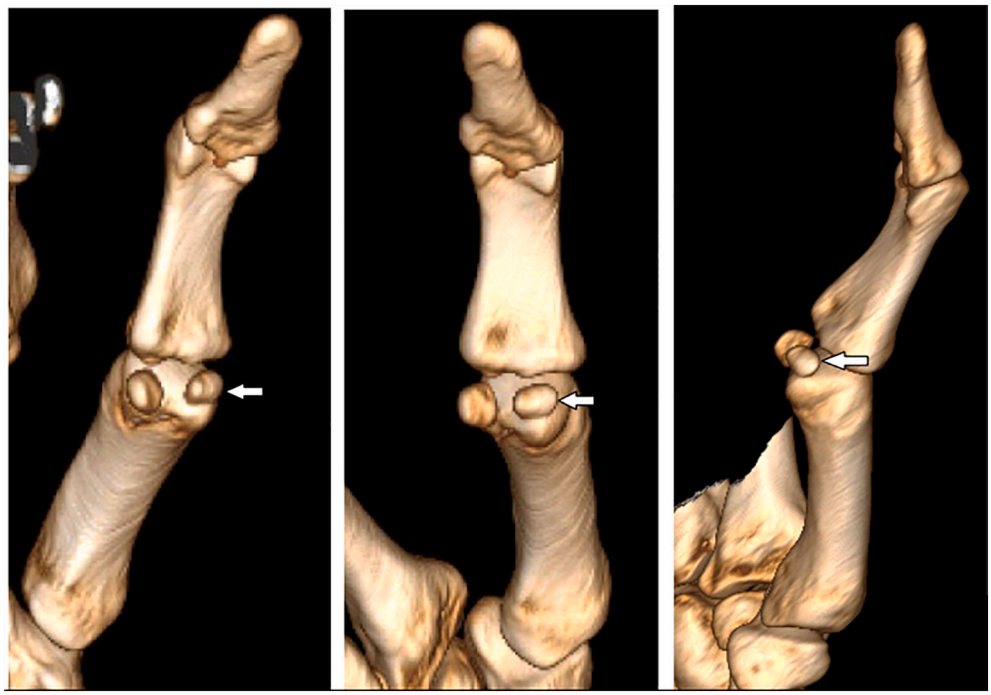

Fig. 3. The radial sesamoid (white arrow) rode on the volar protrusion of the metatarsal head.

retained the ability to passive flexion. The authors postulated that the displaced sesamoid did not impede the movement of the MCP joint but it moved and locked at the distal and radial side of the metacarpal head instead [3].

Theoretically, we focus on several steps of locking mechanism, which might relate to treatment. Firstly, hyperextension injury distally displaces the radial sesamoid bone. Secondly, the APB and FPB muscles embedding the radial sesamoid bone produce a tension force in the proximal part of these muscles, which makes the sesamoid bone horizontally forward rotated and proximally pulled. Thirdly, the proximal pole of the sesamoid bone serves as a hook that engages the groove of the deformed MC head. The triple interaction of trapped sesamoid bone, deformed head groove, and tension of APB and FPB muscles is globally viewed as the mechanism

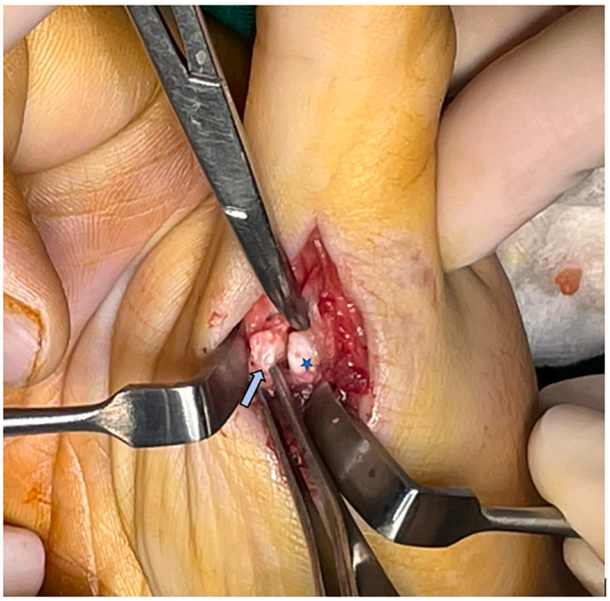

Fig. 4. Radial sesamoid bone (arrow) was entrapped in the deformed metacarpal head. The deformed groove of the metacarpal head was found (star).

of the "pull-hook lock" (Fig. 5).

As a rarity, the clinical presentation of the locked MCP joint could be unfamiliar thereby neglection and inappropriate treatment of the condition might be inevitable. Clinical suspicion about the locked joint should be taken when locking deformities are found in the thumb MCP joint. The locking deformity is described as mild-to-moderate hyperextension of the MCP joint with the restriction of active flexion and localized tenderness [2,6,9]. The locking mechanism is mostly ascribed to the entrapment of the radial sesamoid bone, however, many mechanical causes were reported, including fracture fragment/loose body entrapment, and morphological abnormality of the first metacarpal head [3]. Imaging studies including X-ray and CT scans should be indicated to confirm the diagnosis as well as to rule out other mechanical causes.

Most authors considered closed reduction as an initial treatment. However, how to reduce is still under debate. Both hanging the thumb under weight and manually stretching with flexion of the MCP joint were unsuccessfully applied in our case. Theoretically, these maneuvers made the sesamoid bone more horizontally forward rotated (Fig. 6). When the MCP joint should be in overextension, the bone would be horizontally backward rotated, and then escape from the deformed groove. Thereafter, the joint was passively flexed under axial pressure with radial and ulnar deviations to obtain the bone in its normal position (Fig. 7) [2]. Applying the manner, Yamanaka et al., G. Xiong et al., and Yoshifumi Harada et al. succeeded in 7 of 23 patients, 4 of 10 patients, 7 in their 11 patients, respectively [2,3,10]. However, G. Xiong et al. suggested another method to manage the locking. The patients were asked to repeat several times of nail-cutting actions like abduction and flexion of the thumb MCP joint. The authors reported three locked thumbs were successfully unlocked by the simple method. They assumed the APB and FPB pulled the sesamoid out of the groove-like depression [2,3].

In our opinion, it is very hard to unlock the radial sesamoid bone from the deformed groove unless the insertion of APB and FPB muscles to the sesamoid bone is partially released. The sesamoid bone should be retained or else it would lead to postoperative instability and weakness of the thumb. The radial cartilaginous protrusion of the metacarpal head should be trimmed to eliminate its groove without concern about the MCP subluxation in thumb flexion. Cutting any proper or accessory collateral ligaments is unnecessary. The patient should be encouraged to move the thumb as soon as possible in order to recover the functions and prevent joint stiffness.

Conclusion

Sesamoid bone entrapment into a groove of the deformed MP head should be first thought of when dealing with a locked thumb metacarpophalangeal (MCP) joint. Imaging investigations would be done to confirm the condition. Partially releasing APB and FPB insertion, meticulously removing the groove and early moving the MCP joint may be the key to achieving full recovery of functions.

Sources of funding

None.

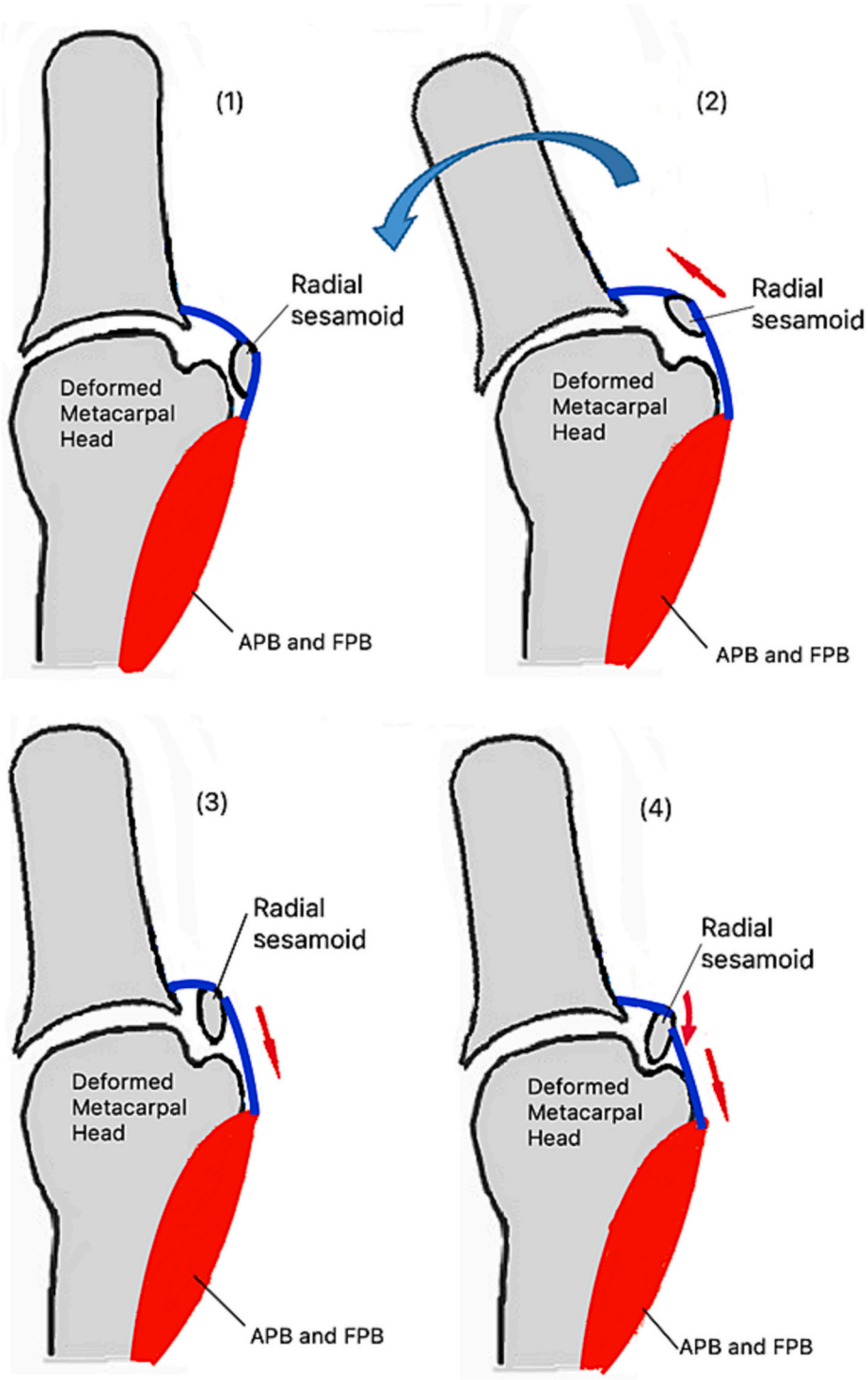

Fig. 5. The picture describes the "pull-hook lock" mechanism of the radial sesamoid. The radial sesamoid normally resides out of the deformed metacarpal head (1). The hyperextension force distally displaces the bone through ligamentotaxis (2). The APB and FPB muscles produce a tension (3). The radial sesamoid becomes horizontally forward rotated and proximally displaced, otherwise its proximal pole serves as a hook locking in the deformed metacarpal head (4).

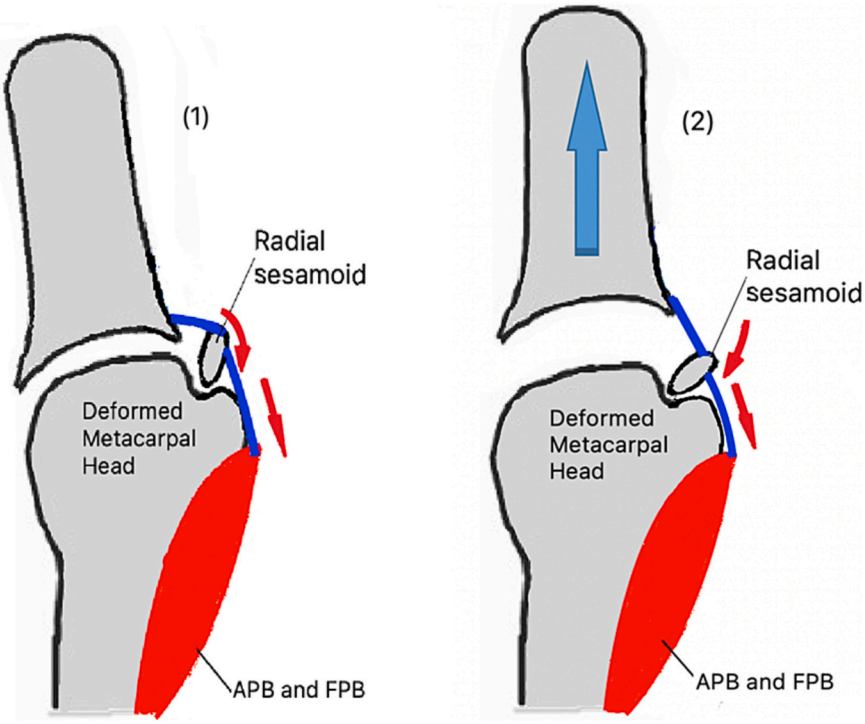

Fig. 6. If reduction of the locking is simply performed under a tension force, the entrapped sesamoid bone will be more horizontally forward rotated, and much more locked in the deformed metacarpal head.

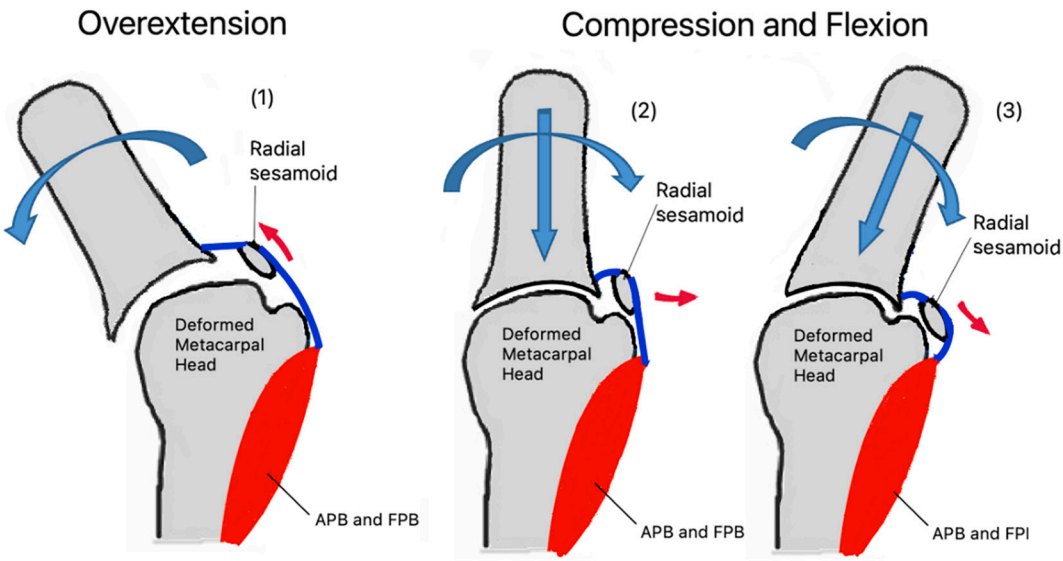

Fig. 7. Under overextension, the sesamoid will be horizontally backward rotated and then escape from the deformed groove (1). Gradual compression and flexion will transfer the sesamoid to its normal position (2) (3).

Ethical approval

This case series got ethical approval from our institution. The patient was given consent form before the surgery.

Consent

Written informed consent was obtained from the patient for publication of this case report and accompanying images. A copy of the written consent is available for review by the Editor-in-Chief of this journal on request.

Research registration

None.

CRediT authorship contribution statement

Hung Do Phuoc: conceptualising the plan for surgery, performing the surgery, follow up patient's recovery, writing the literature review for case report, reviewing the manuscript.
Vinh Pham Quang: reviewing the paper, assisting the surgery, prepare the neccessary equipments.
Hieu Nguyen Chi: Assisting the surgery, writing the literature review, taking note of postoperative function.
Phu Nguyen Hoang: taking note and data visualisation perioperatively.
Huy Hoang Quoc: Assisting in planning and in the surgery, writing the draft for case report.
Ngoc Nguyen: Analyzing the radiology and MRI.
Guarantor.
Hung Do Phuoc MD, PhD.

Declaration of competing interest

The authors declare that they have no known competing financial interests or personal relationships that could have appeared to influence the work reported in this paper.

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