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Novel finding of a radial sesamoid stress fracture of the thumb metacarpophalangeal joint: A case report in a vegan female

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Abstract

This case report explores the incidence of a stress fracture in the radial sesamoid bone of the thumb metacarpophalangeal joint (MCP) in a 24-years-old vegan woman. The patient's distinctive dietary choices raise intriguing questions about potential relationship between nutritional factors and bone health. Through analysis of this case, we aim to contribute valuable insights into the diagnosis, management, and prevention of such rare occurrences, further highlighting the importance of a well-balanced vegan diet in maintaining musculoskeletal health.

After reviewing the literature, we did not find any previous publication on radial sesamoid stress fractures of the thumb in vegan patients.

Case: Sesamoid bone fractures of the thumb are rare. We report a case of a patient with a fracture of radial sesamoid at the MCP joint of the thumb without any preceding trauma.

Context: A 24-years-old female, vegan sports instructor.

Keywords: Sesamoid fracture; Vegan; Thumb fractures; Stress fracture; First MCP joint.

Abbreviations: MCP: Metacarpophalangeal Joint; MRI: Magnetic Resonance Imaging; BMD: Bone Mineral Density; BMI: Body Mass Index.

Background

Sesamoid fractures of the thumb are a rare injury, typically caused by hyperextension of the thumb or less commonly by direct trauma [1]. Sometimes these fractures are associated with volar plate ligament tears of the Metacarpophalangeal (MCP) joint [2].

We report a case of a stress fracture of the radial sesamoid bone in a young, vegan female without any evident preceding trauma. We performed a literature review of sesamoid thumb fractures and the influences of nutritional status on fractures.

The patient provided informed consent for her medical data to be published.

Case report

A 24-year-old vegan woman in good general health, with a past medical history relevant for oral contraceptive use, reported progressively worsening pain in the right thenar eminence

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over a two- week period in the absence of any discernible trauma.

The discomfort was notably aggravated during thumb-related activities, sparking significant concern as she was a sports instructor whose daily job involved extensive work with children and frequent manual tasks, e.g., leaning on her hands.

Clinical examination revealed tenderness, swelling, and the absence of a hematoma at the first MCP joint, thus prompting further investigation.

Her social history revealed a vegan diet and thus a complete absence of meat, fish, and all animal- based product intake (i.e., milk, eggs, and cheese).

Radiographic imaging demonstrated a non-displaced radial sesamoid fracture while Magnetic Resonance Imaging (MRI) confirmed the fracture's non-displacement and revealed soft tissue edema of surrounding structures as well as localized reactive inflammation of the palmar aspect of the thenar eminence (Figures 1-4).

Importantly, MRI confirmed the integrity of the surrounding tendon-ligament structures (i.e., no rupture of the ulnar collateral ligament complex), hence providing a comprehensive understanding of the injury's anatomical implications.

The initial management strategy included four weeks of thumb spica immobilization and analgesia, followed by a pivotal shift towards active rehabilitation with occupational therapy. The efficacy of our chosen therapeutic approach was evident during the patient's four-month follow-up in which she exhibited noteworthy pain reduction and complete restoration of thumb function.

Long-term follow-up by the senior author 3 years later revealed sustained clinical benefit, with the patient describing her condition as pain free and unrestricted by any kind of motion.

Table 1: Patient's blood tests and reference values.		
	Patient's values	Reference values
Vitamin D (nmol/L)	56 mol/L	≥75 nmol/L
Serum proteins (g/L)	64.7 g/L	64-83 g/L
Albumin (g/L)	42 g/L	34-48 g/L
Corrected calcium (mmol/L)	2.2 mmol/L	2.20-2.55 mmol/L
Folate (nmol/L)	4.5 nmol/L	>10 nmol/L
CBC, ESR, CRP, liver assessmer range	nt, tP1NP, TSH, PTH	were within normal

Biochemical assessment conducted two months post-trauma offered valuable insight into potential contributing factors. Despite her overall healthy state, the patient exhibited clinically significant vitamin D and folate deficiencies as well as a calcium value at the lower end of normal (Table 1). Vitamin D supplementation was initiated and combined with dietary recommendations aimed at achieving a daily calcium intake of 1000 mg over the subsequent six months.

The comprehensive treatment approach that was adopted in this case spanned orthopedics, nutritional counselling, and rehabilitation, thus highlighting the importance of holistic treatment for optimal patient care and recovery.



Figure 1: RX thumb PA: Subtle displacement of lateral fragment.



Figure 2: RX thumb LAT: Aspect of fragmentation of the upper pole.



Figure 3: Thumb MRI seq T1 PD Dixon FSE cor.: Fracture nondisplaced of upper aspect of the radial sesamoid with oedema of surrounding soft tissues.



Figure 4: Thumb MRI seq T1 PD Dixon FSE sag: The fracture with intraosseous oedema.

Review of the current literature

Sesamoid bone function and fractures

Presence of the sesamoid bone in the hand shows considerable anatomical variability in the general population; however, it is noteworthy that 99.5% to 100% of individuals have two sesamoid bones in the volar aspect of their thumb MCP joint [3-5].

Sesamoid bones act as pulleys [5]. A sesamoid bone develops within a tendon, where the tendon passes over a joint, essentially forming a focal point of ossification within the tendon itself, thus acting as a protective mechanism and altering the tendon's direction around a joint. Within the thumb MCP joint, sesamoid bones are intricately integrated into the volar plate. The radial sesamoid facilitates the insertion of the flexor pollicis brevis muscle, while the ulnar sesamoid serves as the insertion site of the adductor pollicis.

Sesamoid bones are strategically located in common areas of tendon compression and trauma where they play a crucial role in shielding the tendons from undue wear and tear. Their function likely involves pressure modification, friction reduction, and occasionally the alteration of muscle pull direction [5,6].

Traumatic thumb sesamoid fractures are a rare occurrence. As described by various authors, these mechanisms predominantly involve falls or sports-related incidents, defined by hyperextension injuries of the MCP joint in young and active patients. Occasionally, they may result from direct trauma [3,4,7-9].

Localized swelling, pain, and restricted thumb motion may result following injury [9]. Surgical interventions, though, should be reserved solely for cases of painful nonunion [8].

Traditionally, the anteroposterior and oblique X-ray views are considered the most effective in identifying sesamoid fractures. However, these fractures often remain undiagnosed since oblique views are not routinely performed, and the fragments are usually small. Although CT scans and MRIs are highly reliable diagnostic tools, they have certain disadvantages such as limited immediate availability and high costs [4,9].

Stress fractures

Stress injuries encompass a wide diagnostic spectrum ranging from periostitis (a stress reaction characterized by bony edema), to microfractures, to complete cortical breaks (i.e., stress fractures). Stress injuries are frequently encountered in overuse injuries amongst all levels of athletes resulting from prolonged repetitive loading without sufficient rest; they are often specific to the sport being practiced in patients with normal bone mineral density (BDM) [10,11]. These injuries are commonly found in the lower extremities (e.g., femoral neck, patella, medial malleolus, talus, navicular bone, 5th metatarsal, and hallux sesamoid) as opposed to the upper extremities [10].

Stress fractures are typical of sites subjected to maximum tensile load and in regions with compromised blood supply [11]. They commonly manifest with an insidious onset of pain lacking any specific traumatic event [10]. Risk factors can be stratified into intrinsic (e.g., female sex, hormonal disorders, reduced bone and muscle density, and anatomical/biochemical anomalies) and extrinsic factors (e.g., excessive training intensity, low caloric intake, inadequate vitamin D and calcium intake, and smoking) [10,12].

To date, no similar case to ours has been mentioned in the literature. Nonetheless, cases of sesamoid stress injuries of the big toe were previously described and managed conservatively with immobilization and rest [10].

Regarding our case, following a meticulous analysis of the patient's hand movements as a sports instructor, we found a trend consistent with frequent prone positioning with repeated hand support on the ground. Consequently, this has resulted in an increased chronic mechanical load on the hand and subsequent hyperextension of the MCP joint, causing an imbalance between bone remodeling and abnormal stress on the bony architecture.

Fractures in a vegan patient and osteoporosis

Veganism is a lifestyle choice defined as complete abstinence from all animal-derived products both in personal and dietary consumption. This includes abstaining from eating meat, fish, eggs, and dairy products [13-15].

Veganism can be described as a subset of vegetarianism, ranging from a strict vegan diet as described above (i.e., no animal-derived products at all), to lacto-vegetarianism (i.e., including dairy products but excluding eggs), to ovo-lacto-vegetarianism (i.e., incorporating both dairy products and eggs into the diet), to an omnivorous diet which occasionally adopts elements of veganism [13].

Although veganism is gaining global popularity, it remains a contentious topic of debate mainly due to its implicated health concerns [14]. Vegetarian foods typically contain lower levels of saturated fats and cholesterol while offering increased dietary fiber and various phytochemicals (e.g., flavonoids, carotenoids, polyphenols, and saponins) [13].

A strict vegan diet may lead to numerous nutritional deficiencies, including deficiencies in calcium, selenium, zinc, iron, iodine, long-chain omega-3 fatty acids, and vitamin B12. Moreover, protein intake is typically lower in a vegan diet than in an omnivorous diet, with calcium bioavailability further restricted in plant-based foods [14].

Previous research has identified vegans as having statistically significantly lower calcium intake compared to other dietary groups. This was hypothesized to be due to their strict avoidance of dairy, which is a primary source of dietary calcium. Furthermore, both vegans and vegetarians exhibited lower protein intakes on average. Within the human body, 99% of calcium is found in the bones and teeth in the form of hydroxyapatite. In cases of calcium deficiency, hydroxyapatite may be resorbed to maintain metabolic calcium homeostasis, potentially leading to osteoporosis if adequate external calcium restoration fails to occur [16].

The 2001 EPICOxford study revealed an increased risk of selfreported fractures in women with a calcium intake below 525 mg/day compared to those consuming more than 1200 mg/day [16].

Several genetic and lifestyle factors contribute to BMD and fracture risk. Notably, physical activity and diet are considered the most relevant contributing factors of BMD. Regarding diet, certain nutrients including calcium and vitamin D are crucial for preserving bone health. Other nutrients, such as protein, vitamin B12, zinc, and n-3 fatty acids (which are predominantly sourced from animal-derived products), may also be associated with improved bone health, although their role is less clearly defined in the literature [14-16].

Interestingly, fracture risk remained elevated in vegans even after adjusting for dietary calcium and protein intake. Accordingly, this suggests that nutritional factors only partially account for the variation in fracture risk amongst diet groups and that other characteristics likely contribute to the perceived differences instead [16].

A 2021 review article and a 2020 meta-analysis conducted by Chuang [13] and Iguacel et. AI [15], respectively, aimed to investigate the impact of vegetarian and vegan diets compared to omnivorous diets on BMD and fracture rates. The findings indicated that both vegetarians and vegans exhibited lower BMD at the level of the lumbar spine and femoral neck than omnivores, with vegans in particular presenting with a higher fracture risk compared to omnivores. Furthermore, the observed decrease in BMD and increase in fracture risk were also more significantly emphasized in vegans than vegetarians [15,16].

Vegetarians and vegans, thus, may face an increased risk of lower BMD and fracture incidence compared to omnivores due to a potential deficiency of essential nutrients in their diets [15,16].

Subgroup analysis specified that the increased fracture risk was only statistically significant in the vegan group. This, in turn, suggests that certain nutrients-such as dietary calcium, high biological value proteins, vitamins B12 and D, and retinol-which are more abundant in animal-based foods, may play a crucial role in bone health. Whilst these nutrients are found in ovo-lacto-vegetarian diets, they are typically present in lower amounts in vegan diets [15].

Nevertheless, a recent meta-analysis of randomized controlled trials demonstrated that combined vitamin D and calcium supplementation as opposed to solitary vitamin D supplementation was effective in preventing fractures, thus illustrating calcium's importance. With regards to protein, the latest evidence points to a positive association between protein intake and bone health and contradicts previous studies that suggested a correlation between high protein intake and weaker bones due to increased calcium excretion. This positive association, however, may not necessarily translate into clinically tangible differences in fracture risk [16].

Body mass index (BMI) is also acknowledged as a significant factor in fracture risk. Namely, a recent study suggested that the lower BMD observed in American vegetarians may largely be explained by their lower BMI and smaller waist circumference. However, the association between BMI and fracture risk differs depending on fracture site, with a low BMI specifically associated with an increased risk of hip fractures but a decreased risk of ankle fractures [16].

Similarly, in a previous extensive cohort study, Appleby et al. [17] implied that vegans face an elevated fracture risk only when calcium intake fell below 525 mg/day.

Conversely, Tong et al. concluded that vegans had a higher total risk of fractures, including hip, leg, and vertebral fractures, than omnivores, whilst pescatarians and vegetarians exhibited an increased risk of hip fractures specifically. These differences in fracture risk were likely influenced by lower BMI and potentially reduced calcium and protein intake [16].

Treatment of thumb sesamoid's fractures

Our patient was diagnosed with an isolated sesamoid fracture and underwent conservative treatment consisting of analgesia and anti-inflammatory medication, as well as a wrist brace supporting the thumb. This treatment is supported by current guidelines which were informed by the results of traumatic fracture studies [4,7-9]. Physical therapy was administered for 3-4 months, resulting in the eradication of residual symptoms. Clinical functional assessment at 4 months post- injury revealed a pain-free, functional thumb with a normal range of movement.

Van der Naald et al. (2019) reported that 91% of patients (31 out of 34) achieved full recovery, with 50% (17 out of 34) recovering completely within 8 weeks of treatment. The follow-up duration, however, was unspecified in the study's other reports. Only one patient reported ongoing pain, while two patients were unable to fully flex their thumb at the final follow-up [8].

Conclusion

Sesamoid stress fractures of the thumb MCP joint are an injury that can significantly impact patients' health and quality of life. Often, symptoms such as localized swelling, tenderness to palpation, and functional limitations may develop in the thumb, prompting patients to seek medical treatment despite a lack of a clear history of previous trauma.

In this case, further imaging was crucial for accurate identification and management of the injury. Assessing the patient's lifestyle, dietary habits, and past medical treatments was equally important in determining the risk profile and making timely corrections.

Although our case report only describes a single case, we hope it will encourage further research into the subject and subsequent publications. This would allow for a more profound understanding of rare stress fractures of the thumb sesamoid and their multidisciplinary implications, lifestyle and dietary factors.

Declarations

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Conflicts of interests: The authors have no conflicts of interests to declare.

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