

**RESEARCH ARTICLE**

# The Prevalence of Unanticipated Hamate Hook Abnormalities in Computed Tomography Scans: A Retrospective Study

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## Abstract

**Background:** It is possible that some hamate hook fractures are not diagnosed or treated, thereby affecting the study of their natural history. Study of the prevalence of incidental hamate hook fractures, nonunions, and other abnormalities on computed tomography (CT) ordered for another reason could document a subset of undiagnosed and untreated hamate hook fractures which might change our understanding about the natural history.

**Methods:** Reports of 2489 hand, wrist, and forearm CT scans for hamate hook abnormalities were searched. We excluded 19 patients with anticipated hamate fractures and 1 patient that had a hamate hook excision. Twenty-eight patients had an unanticipated hamate hook abnormality.

**Results:** There was a significant difference in the prevalence of incidental hamate hook abnormalities by sex but not by age. Among the 28 unexpected hamate hook abnormalities, there were 16 fractures of the base (12 acute, 1 nonunion, and 3 of uncertain age), 5 acute oblique fractures, and 7 tip abnormalities/ossicles. The patient with an incidental nonunion had a CT scan for wrist pain and was diagnosed with gout.

All fractures involved a direct blow to the hand (distal radius or scaphoid fracture, or crush injury). The 7 patients with a hamate tip abnormality had a CT scan for a distal radius or metacarpal fracture, crush injury or wrist pain. Five acute fractures were treated operatively with excision and the other 23 fractures were treated nonoperatively.

**Conclusion:** Hamate fractures can be diagnosed incidental to other hand and wrist problems on CT.

**Keywords:** Computed tomography, Hamate hook fracture, Nonunion, Prevalence

## Introduction

Hamate hook fractures are typically associated with a direct blow to the hand, particularly during sport (e.g., from a tennis racket, golf club, or baseball bat) (1). The wrist nearest the base of the handle is at greater risk for fracture (2). An acute hook of hamate fracture can also occur with a direct blow during a fall onto an outstretched hand—for example among patients with fracture of the distal radius (3)—and likely with other falls on the hand (4).

It seems safe to assume that the pain typically associated with a hook of hamate fracture is less than that typically associated with an unstable fracture of the distal radius. Given that most displaced fractures of the distal radius

are managed without computed tomography (CT), it seems possible that many fractures go undiagnosed (5). It also seems likely that a substantial percentage of patients with a direct blow injury from sport do not seek medical attention for a hook of hamate fracture.

There is a sense that fractures of the hamate hook might have a high rate of nonunion, even with immobilization or protection. Some speculate that the tenuous blood supply of the hamate could lead to limited healing capacity and a high rate of nonunion, even with immobilization or protection (6). If the hook of the hamate is prone to nonunion and a subset of fractures go undiagnosed we might find hamate hook nonunions as an incidental

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finding on CT scans obtained for another indication. Knowledge of the prevalence of unexpected/incidental hamate hook fractures and nonunions would inform study of the natural history of these fractures.

We studied the prevalence of incidental hamate hook fracture, nonunion, and other abnormalities in a population of patients who had a CT scan that was not ordered for a suspected hamate hook fracture or nonunion. The objectives of this retrospective study were: (1) Are there differences in the prevalence of incidental hamate hook abnormalities by sex or age? (2) What are the types of hamate hook abnormalities? (3) What is the setting for each type of abnormality? (4) What treatment was selected?

## Materials and Methods

### Study design and setting

Using an Institutional Review Board approved protocol, we retrospectively searched the reports of 2489 hand, wrist, and forearm CT scans performed at one institution between January 2000 and March 2013 for the keyword "hamate". Scans of the hand and the forearm routinely include the hook of the hamate at our institution. To be sure that "hamate" wasn't misspelled we also looked for "hama". All radiology reports that mentioned the hamate and their corresponding CT scans were reviewed in detail.

### Study subjects

The indication for the CT scan was recorded. Among the 126 reports that mentioned the hamate the indication was trauma in 83 wrists (44 with normal radiographs and 39 to better characterize fractures seen on radiographs including 3 of the articulation of the hamate with the small finger metacarpal) and 43 to evaluate pain (including 20 suspected hamate hook fractures).

Fractures of the hamate body or articular surface were excluded if there was not also an abnormality of the hook. We also excluded CT scans when a hamate hook fracture was suspected. Among 2489 CT scans in 1968 patients, 15 of 20 (75%) ordered for a suspected hamate hook fracture confirmed that diagnosis, and 28 of 2469 (1.1%) ordered for another reason identified an abnormality of the hamate hook. The 20 CT scans that were done because of a suspected hamate hook fracture included one misdiagnosis by a radiologist and one patient who had a hamate hook excision as part of multiple procedures for ongoing hand pain, but no radiological evidence of a fracture.

### Statistical analysis

The demographic and clinical characteristics of patients were described with frequencies and percentages for categorical variables and with mean  $\pm$  standard deviation and range for continuous variables. Pearson Chi-Square test was used to assess the relationship between categorical variables and the difference in means of continuous variables between two groups was determined using the Mann-Whitney U test.

### Demographics, description of study population

The final cohort for analysis consisted of 28 wrists in 28 patients with hamate hook abnormalities that were not anticipated or mentioned prior to ordering the CT scan. Demographic information was retrieved from the medical record. There were 22 men and 6 women with an average age of 44 years (range, 21 to 95 years). Concomitant distal radius fractures were classified according to the Arbeitsgemeinschaft für Osteosynthesefragen (AO) classification, and volar or dorsal displacement was recorded.

### Results

There was a significant difference in the prevalence of incidental hamate hook abnormalities by sex ( $P=0.014$ ) but not by age ( $P=0.096$ ) [Table 1].

Among the 28 unexpected hamate hook abnormalities, there were 16 fractures of the base (12 acute fractures [Figure 1A-B], 1 old nonunion [Figure 2A-B], and 3 fractures that followed a fall, but had limited documented tenderness and were felt to be potentially old), 5 oblique fractures (5 acute [Figure 3A-B]), and 7 tip abnormalities that looked like ossicles or anatomical variations [Figure 4A-B], but could not be definitively distinguished from old or new fractures of the tip of the hook of the hamate.

The patient with an incidental nonunion of the base of the hamate hook had a CT scan for wrist pain and was diagnosed with gout. All of the acute hamate hook fractures were incidental injuries in patients that were injured in either a fall onto the outstretched hand (distal radius and/or scaphoid fracture) or in a crush injury. Among the 15 patients with unexpected acute base fractures, the indication for CT scan was a fracture of the distal radius in 8 (with concomitant scaphoid fracture in 2), fracture of the scaphoid in 3, and a crushed hand in 4 patients. Six of the 8 distal radius fractures were AO

| Table 1. Bivariable Analysis |                            |                         |         |
|------------------------------|----------------------------|-------------------------|---------|
|                              | No Hamate Hook Abnormality | Hamate Hook abnormality | n=1968  |
| Parameter                    | Mean (SD)                  | Mean (SD)               | P Value |
| Age                          | 44 (3.7)                   | 47 (0.44)               | 0.35    |
| Parameter                    | Number (%)                 | Number (%)              |         |
| Sex                          |                            |                         |         |
| Women                        | 802 (99.3%)                | 6 (0.74%)               | 0.039   |
| Men                          | 1166 (98.1%)               | 22 (1.9%)               |         |

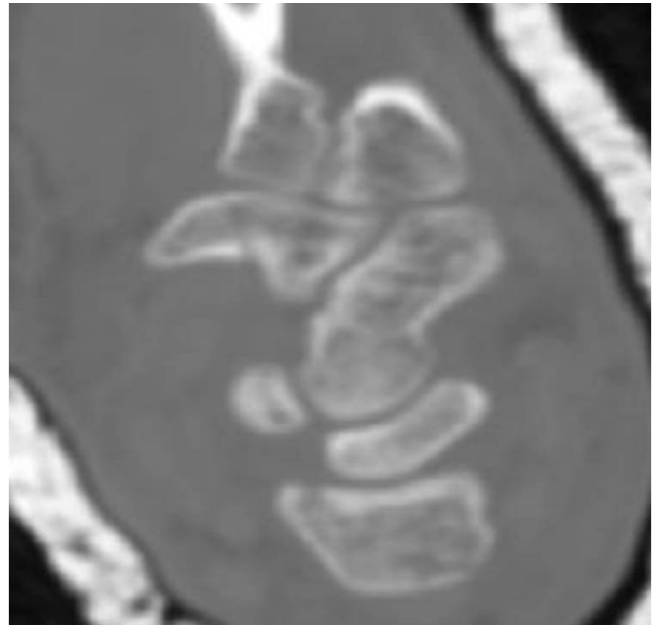
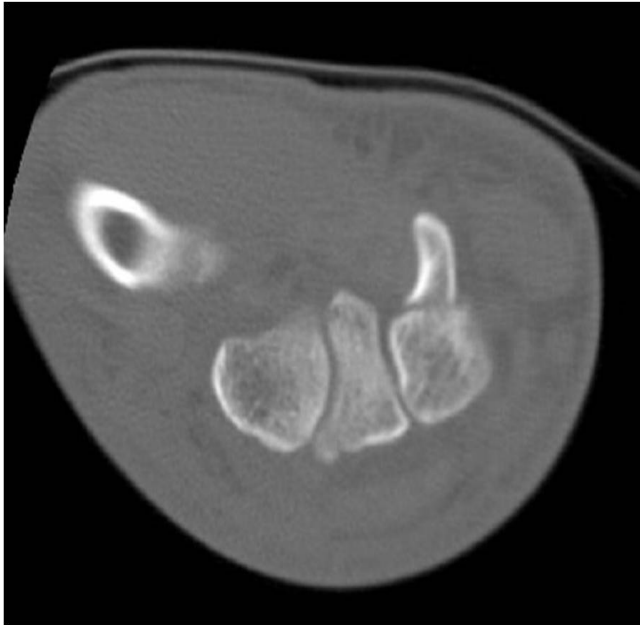


Figure 1. Axial (A) and sagittal (B) computed tomography images of a fracture of the base of the hook of the hamate.

Type B, volar shearing partial articular fractures, 2 were distal shearing. Among the 5 acute oblique fractures, the indication for CT scan was fracture of the distal radius in 2 patients (both AO Type B, volar shearing fractures),

fracture of the scaphoid in 2 patients, and a crush injury of the hand in 1 patient. Among the 7 patients with a hamate tip abnormality, the indication for a CT scan was a fracture of the distal radius in 4 patients (3 AO Type C

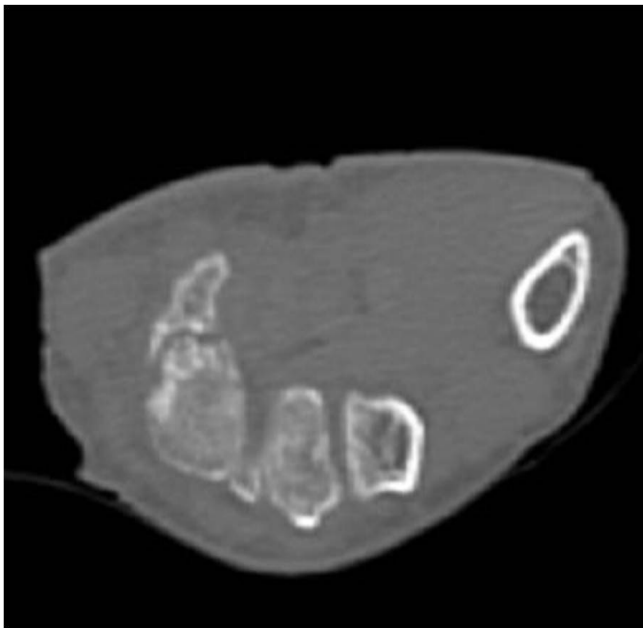


Figure 2. Axial (A) and sagittal (B) computed tomography images of an old nonunion of the base of the hamate.



Figure 3. Axial (A) and sagittal (B) computed tomography images of an oblique fracture of the hook of the hamate.

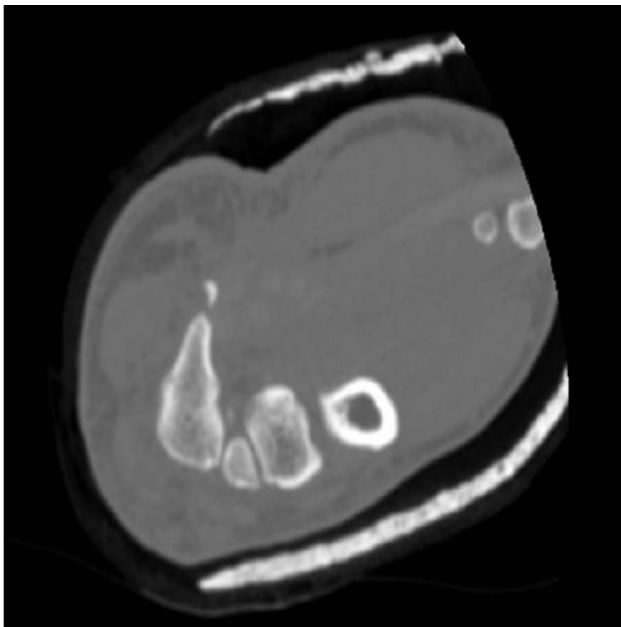


Figure 4. Axial (A) and sagittal (B) computed tomography images of an ossicle or fracture of the tip of the hook of the hamate.

and 1 AO Type B, volar shearing fracture), a fracture of a metacarpal, non-traumatic pain in the wrist, and a crush injury of the hand. None of these hamate abnormalities were visible on radiographs.

Five of the acute fractures were treated in our hospital operatively with excision (presumably because the surgeon felt the fracture was at high risk for nonunion), and the other 23 fractures (acute and old) were treated

nonoperatively and have given no trouble to date as far as we know.

### Discussion

Hamate fractures can be diagnosed incidental to other hand and wrist problems on CT (7). The hamate fracture is typically treated nonoperatively and occasionally was not noticed or treated by the treating surgeons. It is not clear whether hamate fractures that occur in this context have a different prognosis from the typical isolated hamate hook fracture associated with a direct blow to the hand.

This study should be interpreted in the context of its shortcomings. This was not a review of 2489 CT scans in detail, it was a database study using a computer search for key words with careful review of the subset of patients with hamate abnormalities noted in the report. It is possible that other hamate abnormalities were either undiagnosed or unrecorded and therefore overlooked using this strategy. We could not determine the precise indication for CT scan from the database, which makes it difficult to define the convenience sample used in this study including the percent ordered for traumatic or nontraumatic conditions. Consequently, we can conclude that all incidental fractures occurred in the setting of trauma, but we cannot determine the prevalence of incidental fractures among all CT scans obtained to evaluate trauma. Furthermore, it's safe to assume that there are many crush injuries and distal radius and scaphoid fractures that are not evaluated with CT scans. We cannot be certain of the age of the hamate findings, and the distinction between acute and chronic is-in part-speculative. Acute fractures were based on appearance and context (a recent injury), but some of them might have been incidental old fractures or accessory ossicles. The one hamate hook base nonunion was clearly old. We did not examine the patients or repeat the CT scan so we don't know if the untreated incidental hamate hook base fractures healed or whether they were associated with symptoms. The best we can say is that patients with fractures of the scaphoid and distal radius were evaluated for several months or years and never developed problems in the palm of the hand that were recorded in the medical record.

To our knowledge population-based data are not available on the prevalence of hamate hook fractures. The actual prevalence of hamate hook fractures in the general population might very well be higher than reported in this study because hamate hook fractures do not necessarily cause symptoms and they can go unnoticed on radiographs and CT scans (8, 9). In one patient that had two CT scans, an incidental fracture was not diagnosed by the radiologist on the first CT scan, but in retrospect, was visible on both scans.

Most of the suspected old or preexisting hamate abnormalities were abnormalities of the tip and might represent accessory ossicles or a bipartite hamate hook (10). There are many accessory ossicles described in the carpus with an estimated incidence of 1.4% (11). In our patients we found 7 ossicles that could also represent an acute or ununited fracture of the tip of the hamate

hook. There may be many more of these that were not mentioned in radiology reports and therefore not noted by us. We found a prevalence of 0.28% incidental ossicles (7 ossicles in 2489 scans) that were mentioned in the radiologist's report.

The indications for the CT scan where an incidental hamate fracture is diagnosed usually involve a direct blow to the hand (crush injury, distal radius and/or scaphoid fracture), as has been previously described (1, 3, 4). It is notable that most of the distal radius fractures are volar shearing fractures.

The finding of 15 unexpected base of hook fractures and only one nonunion among 28 incidental hamate hook abnormalities on nearly 2500 CT scans of the wrist and hand suggests that hamate hook base fractures sometimes go undiagnosed (particularly when associated with a fracture of the radius or scaphoid) and might heal without diagnosis or treatment. Specifically, if the base of the hamate hook is sometimes fractured and likely often goes undiagnosed, we might expect to find more nonunions if it generally has trouble healing. Ideally, we would study 1) A very large cross section of healthy people representative of the general population with CT scan of the hamate to determine the prevalence of unhealed hamate hook fractures; and 2) A large consecutive series of patients with hand and wrist trauma to identify incidental hamate hook fractures and study their natural history (e.g., healing and symptoms without treatment).

Although not the focus of this study, the observation that 15 of 20 (75%) CT scans ordered to confirm a hamate base fracture or nonunion were positive suggests that the symptoms and signs of suspected hamate hook fractures are characteristic, but not foolproof and there is value to confirming the diagnosis with a CT scan.

All authors (SAS, SJEB, MGJSH, and DR) declare that they have no conflict of interest to disclose related to this study. All procedures performed in studies involving human participants were in accordance with the ethical standards of the institutional and/or national research committee and with the 1964 Helsinki declaration and its later amendments or comparable ethical standards. Informed consent was waived for this study.

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