

Prevalence of Os Styloideum in National Hockey League Players

Harry G. Greditzer IV, MD,^{*†} Ian D. Hutchinson, MD,[‡] Christian S. Geannette, MD,[†] Robert N. Hotchkiss, MD,[§] Bryan T. Kelly, MD,^{||} and Hollis G. Potter, MD[†]

Background: Os styloideum describes an accessory carpal ossicle between the trapezoid, the capitate, and the second and third metacarpals. Injuries to this tissue have been described as part of the carpal boss syndrome. While the etiology of os styloideum remains uncertain, it may represent a physiologic response to altered loading forces in the wrist, similar to the development of cam-type deformity in the hips of ice hockey players or the Bennett lesion in the shoulders of baseball pitchers.

Hypothesis: Professional hockey players will have a higher prevalence of os styloideum compared with the general population.

Study Design: Case series.

Level of Evidence: Level 4.

Methods: A retrospective review of 16 professional hockey players from 4 different National Hockey League (NHL) teams who underwent unilateral imaging of the wrist was performed. Seventeen wrists were reviewed for the presence of os styloideum.

Results: Thirteen of 16 players (81%) had an os styloideum, representing an increased prevalence compared with the general population. Previous clinical and cadaveric studies estimated a general prevalence of up to 19% ($P < 0.001$). For the 10 players who had their leading wrist scanned, 9 had an os styloideum (90%). Ten of 11 (91%) players demonstrated a bone marrow edema pattern within the metacarpal and the os styloideum on magnetic resonance imaging. There was no significant association between the presence of an os styloideum and the player's position, leading wrist, or years in the league.

Conclusion: There appears to be an increased prevalence of os styloideum among NHL players, and team physicians should consider this finding while formulating a differential diagnosis for dorsal wrist pain.

Clinical Relevance: This study identified NHL players as having an increased prevalence of os styloideum compared with the general population. By doing so, these findings represent an opportunity to enhance our understanding of the etiology, clinical significance, and treatment of os styloideum.

Keywords: sports medicine; os styloideum; wrist; hand; MRI; ice hockey

Os styloideum is an accessory immobile carpal ossicle between the trapezoid, the capitate, and the second and third metacarpals.⁶ In contrast, the carpal boss was described by Fiolle⁵ as an immobile dorsal protuberance at the base of the second and third metacarpals. Fiolle⁵ further stated that the carpal boss might represent degenerative osteophyte formation, a fused os styloideum, or both. Consequently, injuries

of the os styloideum have been reported as part of the "carpal boss syndrome," which makes differentiation between the 2 entities somewhat confusing.⁷ However, the terms *carpal boss* and *os styloideum* should not be considered synonymous. A more current description of the finding of a bony dorsal protuberance reserved the term *carpal boss* in reference to an osseous protuberance connected to the capitate, third

From the [†]Department of Radiology & Imaging, Hospital for Special Surgery, New York, New York, [‡]Tissue Engineering, Regeneration & Repair Program, Hospital for Special Surgery, New York, New York, [§]Department of Orthopedic Surgery: Hand & Upper Extremity Service, Hospital for Special Surgery, New York, New York, and ^{||}Department of Orthopedic Surgery: Sports Medicine & Shoulder Service, Hospital for Special Surgery, New York, New York

*Address correspondence to Harry G. Greditzer IV, MD, Department of Radiology & Imaging, Hospital for Special Surgery, New York, NY 10021 (email: tategred@gmail.com).

The following author declared potential conflicts of interest: Bryan T. Kelly, MD, is a paid consultant for Arthrex and A3 surgical and has stock/stock options in A3 surgical.

DOI: 10.1177/1941738117707914

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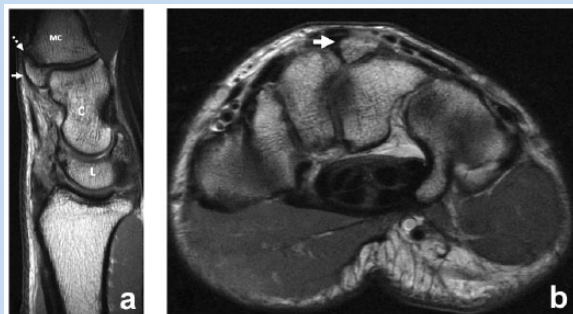


Figure 1. (a) Sagittal and (b) axial proton-density magnetic resonance images of the wrist in 24-year-old National Hockey League player demonstrating an os styloideum (arrow) at the base of the long finger metacarpal. The dashed arrow in Figure 1a demonstrates the fibrous union with the base of the second metacarpal. The player presented for a triangular fibrocartilage injury and was asymptomatic. C, capitate; L, lunate; MC, metacarpal.

metacarpal, or both.² Specifically, an os styloideum was defined by the authors as either a separate bony ossicle or an ossicle that maintains a fibrous union with the carpus or metacarpal bones (Figure 1). A carpal boss is defined as a bony protuberance fused to the base of the metacarpal bones (Figure 2).

The frequency of carpal boss and os styloideum has been well defined in the literature. In the 1950s, a review of 450 radiographs of the hand reported a prevalence of 1% to 4%.³ However, subsequent cadaveric studies evaluated the incidence of carpal boss with a much higher rate of occurrence of 18% to 19%.¹ There was no clear distinction between carpal boss and os styloideum in the study by Alemohammad et al,¹ and this is likely an overestimate. Currently, the etiology and clinical significance of the os styloideum remains uncertain. Os styloideum may represent a physiologic response to altered loading forces in the wrist; repetitive microtrauma to the skeletally immature carpus or the metacarpal base may lead to reactive bone formation to the immature carpus or the metacarpal base.

The aim of this study was to investigate the prevalence of os styloideum in a retrospective series of professional hockey players who underwent unilateral imaging of the wrist. Given the potential association with sports that expose the wrist to increased repetitive loading in extension, it was hypothesized that the prevalence of os styloideum is greater in professional ice hockey players.

METHODS

This study was performed under an institutional review board-approved protocol. We performed a retrospective review of a consecutive series of 17 wrists in 16 professional ice hockey players. Inclusion criteria included any professional ice hockey player who underwent imaging of the wrist, at our institution, from 2014 to 2016.

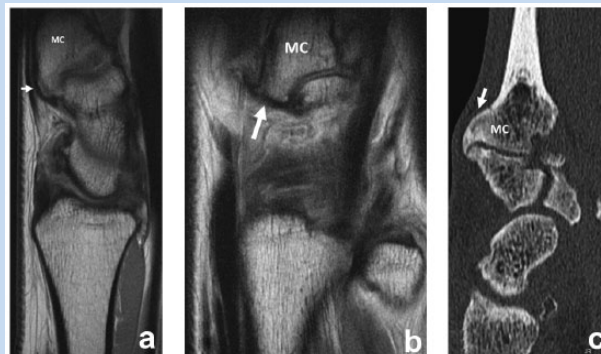


Figure 2. (a) Sagittal and (b) coronal magnetic resonance images of the wrist demonstrating a carpal boss (arrows) with medullary continuity with the base of the second metacarpal in a 40-year-old man who was asymptomatic with regard to his os styloideum. (c) Sagittal reformatted computed tomography image of the wrist demonstrates the appearance of a large carpal boss with osseous remodeling. MC, metacarpal.

The magnetic resonance imaging (MRI) studies were conducted with coronal 3-dimensional (3D) gradient-recalled echo, short-tau inversion recovery, and coronal, sagittal, and axial fast spin echo techniques. MRI was performed with a 3.0- or 1.5-T system and an 8-channel, receive-only, phased-array wrist coil (Invivo). The imaging protocol involved a 3D gradient-recalled echo sequence (repetition time/echo time [TR/TE], 40/20 ms; flip angle, 10°; field of view [FOV], 80 mm; slice thickness, 1 mm), proton-density fast spin echo sequences (TR/TE, 3500-6000/28-38 ms; FOV, 90-100 mm; slice thickness, 2.3-3 mm), and inversion recovery sequences (TR/TE, 3200-6800/15-18 ms; FOV, 90-100; slice thickness, 2.3-3 mm). Radiographic views obtained of the wrist included posteroanterior (PA), lateral, and oblique projections. Computed tomography (CT) scans were performed with the following standardized imaging and reformatting protocol: slice thickness, 2.5 mm retrospectively reconstructed to 0.625 mm; pitch, 0.531:1; resolution, 512 × 512; kVp, 120; mAs, 400; acquisition algorithm, bone; and reformation algorithm, standard.

Radiological studies were identified and examined by 2 fellowship-trained musculoskeletal radiologists who independently confirmed the presence of os styloideum. Player demographics were reviewed to describe the patient's presenting complaint, position, shooting side (leading wrist), age at the time of imaging, and years of professional hockey played (Table 1; see also the Appendix, available in the online version of this article).

Statistical Analysis

Statistics were undertaken using STATA statistical software, release 11. A binomial test was performed to evaluate prevalence in our sample size, assuming an incidence of os

Table 1. Player demographics

	With Os Styloideum	Without Os Styloideum	Overall <i>P</i> Value (n = 17)
Age, y, mean ± SD	28.3 ± 1.3	28.0 ± 0.9	0.9
Years in NHL, mean ± SD	7.9 ± 1.3	8.8 ± 0.9	0.72
Position, n, center/wing/defense/goalie	4/5/3/1	0/1/3/0	0.45
Leading wrist imaged, n (%) (10/16 players)	9/10 (90)	1/10 (10)	0.25
Presented with dorsal wrist pain, n (%)	3/3 (100)	0/3 (0)	0.54

NHL, National Hockey League.



Figure 3. (a) Coronal inversion-recovery magnetic resonance image (MRI) of the left hand in a 22-year-old National Hockey League player demonstrating bone marrow edema pattern (arrow) within the long finger metacarpal bone after getting hit with the puck. (b) Sagittal proton-density MRI demonstrates a large os styloideum (arrow) with a ganglion cyst (dashed arrow), which represents an incidental finding in this case. C, capitate; MC, metacarpal.

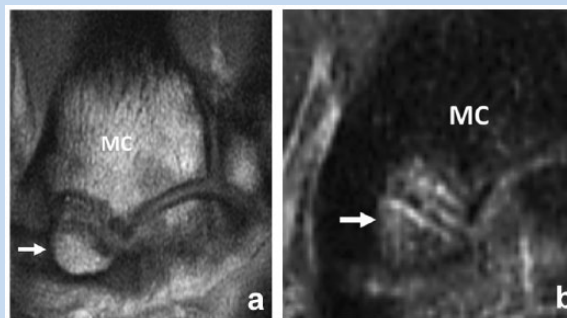


Figure 4. (a) Coronal proton-density magnetic resonance image (MRI) demonstrating an os styloideum (arrow) at the base of the long finger metacarpal in a 26-year-old National Hockey League center with dorsal wrist pain referable to the area. (b) Coronal inversion recovery MRI demonstrates a bone marrow edema pattern (arrow) on both sides of the articulation. MC, metacarpal.

styloideum in the general population to be 19% (upper limit of the cadaveric study).¹ Group comparisons for categorical variables were conducted using Fisher exact tests. Comparisons of continuous variables (age and years in the National Hockey League [NHL]) were examined using the Student *t* test.

RESULTS

Thirteen of 16 players (81%) demonstrated os styloideum amounting to a significantly increased prevalence ($P < 0.001$) compared with the general population, as stated by Alemohammad et al.¹ No player demonstrated a carpal boss by its contemporary definition.

A total of 17 wrist unilateral radiological examinations from 16 professional ice hockey players of 4 different NHL teams were analyzed, and the indications are summarized in the Appendix

(1 patient had bilateral imaging on separate occasions). The most common diagnosis was a fracture as a result of a player's getting hit with a puck (Figure 3). All 3 patients who were scanned for atraumatic dorsal wrist pain had an os styloideum (Figure 4).

For those players who underwent MRI, 11 of 13 (85%) had an os styloideum, and of these, 10 of 11 (91%) players demonstrated a bone marrow edema pattern within the metacarpal and the os styloideum. Only 1 player was diagnosed with an os styloideum on CT compared with 5 players (62.5%) on radiographs of the hand or wrist (Figures 5 and 6).

In our study, no statistically significant associations were evident between os styloideum and a player's position, leading wrist, age, or years in the league. A sample-size analysis performed using the generated data indicated that 46 patients would be needed to examine the association between leading wrist and the presence of an os styloideum, computed to require unilateral "standard of care" imaging.



Figure 5. (a) Posteroanterior radiograph of the wrist in a 24-year-old National Hockey League player with a prior triangular fibrocartilage complex injury and repair at follow-up. Os styloideum is not typically seen in this view and is not appreciated here. (b) Lateral radiograph demonstrates a large os styloideum (arrow).

DISCUSSION

The goal of this study was to investigate the prevalence of os styloideum in professional hockey players compared with the general population. We accepted our hypothesis when the prevalence of os styloideum in our cohort of 16 professional ice hockey players, who underwent unilateral imaging (all except 1 patient), was 81%, significantly higher than the highest estimates in the general population.

Current literature suggests that symptomatic os styloideum is more commonly encountered by patients (including professional athletes) who engage in sports that demand relatively increased activity (and loading) with the wrist in extension, such as golf and racquet sports.¹⁰ Moreover, current literature suggests that symptomatic carpal boss is more likely to present in the wrist of the dominant hand.⁴ Maquirriain and Ghisi⁹ described a symptomatic os styloideum in an elite male swimmer who presented with dorsal wrist pain and swelling; their patient responded to semirigid wrist immobilization and nonsteroidal anti-inflammatory drugs with physical therapy, returning to preinjury level at 5 weeks. Similarly, Kissel⁸ described a symptomatic os styloideum in an elite ice hockey player who was treated with physical therapy and returned to preinjury play in 1 week.

In our study, all 3 professional ice hockey players who presented with isolated, nontraumatic dorsal wrist pain had an os styloideum; all were treated conservatively, and none missed more than 1 week in the league. Of those patients who did not have dorsal wrist pain, 10 of 13 patients (77%) had an os styloideum, with 91% of these patients demonstrating bone marrow edema on fluid-sensitive MRI sequences. Therefore, close clinical correlation to accurately identify an os styloideum as a symptomatic pain generator in the context of radiological findings is recommended. The presence of positive bone

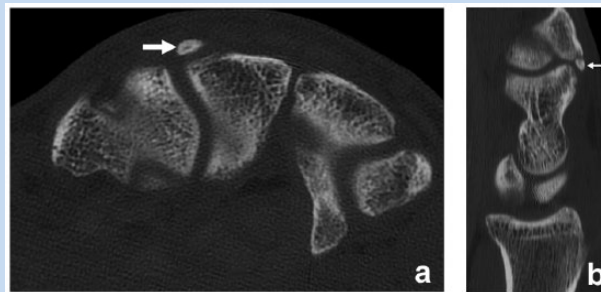


Figure 6. (a) Axial and (b) sagittal reformatted computed tomography images demonstrating a small os styloideum (arrow) in a 25-year-old National Hockey League player who underwent evaluation for a scaphoid fracture.

marrow edema pattern on MRI in the majority of elite hockey players with os styloideum (with or without symptoms) was also congruent with our hypothesis. Altered/increased loading and repetitive microtrauma in the wrists may lead to reactive bone formation similar to the development of cam-type deformity in the hips of ice hockey players or Bennett lesion in the shoulders of Major League Baseball pitchers.^{11,12} Interestingly, 90% of players who had their leading wrists scanned had an os styloideum; this was not significant in the context of insufficient power, but given the trends observed, our findings cannot be concluded to be random and warrant further investigation. Moreover, while discrete trends based on position in the NHL were observed, playing position during childhood and at more junior levels during wrist growth may be more influential.

Our study has limitations that warrant consideration. The study is retrospective, descriptive, and involves unilateral standard-of-care imaging for all but 1 patient. Therefore, it is possible with bilateral imaging that our prevalence may be even higher. Bilateral imaging would also influence our descriptive statistics with the exception of age and years in the NHL. Our sample of 16 patients was sufficient to answer our hypothesis; however, the study was underpowered to investigate specific associations between the presence of os styloideum and player characteristics.

CONCLUSION

The current study suggests that os styloideum is more prevalent in professional NHL players. All players who presented with dorsal wrist pain had an os styloideum and responded to conservative measures; however, symptomatic os styloideum only accounted for 18% of the lesions observed, so clinical correlation is important. While the exact etiology of os styloideum remains unclear, the enormous biomechanical demand placed on the wrist with extension loading during ice hockey, as evidenced by bone marrow edema on MRI, may drive adaptive changes at the base of the metacarpal or carpus, similar to the cam lesion in hockey players or the Bennett lesion

in pitchers. In this context, identifying a patient group with such increased incidence of os styloideum may be beneficial to improve our understanding of the pathophysiology and significance of this lesion on wrist function and symptomatology.

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