Dorsal Wrist Pain in the Extended Wrist-Loading Position: An MRI Study

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Abstract

Background The etiology of dorsal wrist pain associated with loading of the wrist in extension has not been clearly identified in the literature.

Purpose Many exercise disciplines incorporate upper extremity weight-bearing exercises in an extended wrist posture, for example push-ups, plank position, and various yoga and Pilates poses. This study evaluates patients with dorsal wrist pain in the extended wrist-loading position and identifies anatomic abnormalities in the wrist using magnetic resonance imaging (MRI).

Methods A retrospective chart review was performed comparing MRI of patients who complained of dorsal wrist pain while performing weight bearing in a wrist extension position with a control group of patients who complained of ulnar-sided wrist pain. The primary MRI outcome was dorsal wrist pathology, including occult dorsal ganglion cyst, scapholunate ligament tear or degeneration, and dorsal capsulitis.

Results Dorsal wrist pathology was significantly more prevalent in patients with dorsal wrist pain (84%) than in the patient cohort with ulnar-sided wrist pain (12%). Occult dorsal ganglion cysts were the most common sources of pathology (76%).

Conclusion MRI demonstrated an identifiable dorsal abnormality in 84% of patients with dorsal wrist pain associated with weight bearing on the extended wrist. Occult dorsal ganglion cysts are the most common cause of dorsal wrist pain, followed by partial scapholunate tears. When patients complain of dorsal wrist pain during specific extended loading wrist positions such as push-ups, yoga, or Pilates poses, an MRI may be warranted to help identify anatomic abnormalities that may help guide treatment choices.

Level of Evidence Diagnostic, Level III.

Keywords

- ▶ dorsal wrist pain
- ▶ wrist loading
- ▶ dorsal ganglion
- ▶ imaging

The etiology of dorsal wrist pain associated with loading of the wrist in extension has not been clearly identified in the literature. Dorsal wrist pain is often a presenting complaint in patients who train or perform weight-bearing exercises on their wrists in the extended posture (e.g., push-ups, plank position, and various yoga and Pilates poses).¹ There is

evidence of relocation of force transmission through the radiocarpal and intracarpal joint as the wrist transitions from neutral to extended load position.^{2–6} Majima et al reported that the force of an extended load on the radiocarpal joint significantly shifts radially, from lunate to scaphoid. This causes the scapholunate intercarpal ligaments to

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sustain the majority of the tensile force.⁴ Pathologies such as occult dorsal ganglion cysts or partial tears of the scapholunate ligament are common conditions believed to cause pain during these maneuvers.⁷⁻⁹

The purpose of this study is to identify the prevalence of occult dorsal wrist pathology diagnosed on magnetic resonance imaging (MRI) in patients with dorsal wrist pain when the wrist is loaded in extension. The null hypothesis was that there would be no difference in dorsal wrist pathology reported on MRI between two cohorts: one with a history of dorsal wrist pain and one with a history of ulnar-sided wrist pain.

Methods

Approval from the authors' institutional review board was obtained prior to start of study. A retrospective chart review was performed comparing patients who complained of dorsal wrist pain during weight bearing in the extended wrist position (push-up) with a control group of patients who complained of ulnar sided wrist pain. Inclusion criteria included adults older than 18 years and an MRI examination of the wrist on the hospital's PACS (picture archiving and communication system). The inclusion criteria for the dorsal wrist pain cohort (dorsal) consisted of a chief complaint of dorsal wrist pain when weight bearing on the wrist in the extended position, and a clinical examination demonstrating dorsal wrist tenderness to palpation. Specific activities cited included push-ups, planks, yoga, or Pilates poses, or pain when pushing heavy objects with the wrists in the extended position (e.g., heavy door, furniture). Inclusion criteria for the ulnar wrist pain cohort (ulnar) consisted of a chief complaint of ulnar-sided wrist pain and a clinical examination demonstrating ulnar-sided tenderness or a positive impaction test. Patients with traumatic hand injury, inflammatory disease, prior hand surgery, or a palpable dorsal cyst were excluded. The primary outcome was dorsal wrist pathology as demonstrated by MRI, including occult dorsal ganglion cyst, scapholunate ligament tear, scapholunate ligament degeneration, or dorsal capsulitis.

ICD 9 codes for wrist pain, wrist sprain, ganglion, triangular fibrocartilage complex (TFCC) tear, and current procedural terminology (CPT) codes for ganglion excision, wrist arthroscopy, and TFCC debridement were utilized to identify the patients from the database of two surgeons.

Imaging and Diagnosis

MRIs were performed in 1.5-tesla (T) units (GE Healthcare, Waukesha, WI) with pulse sequences consisting of coronal three-dimensional (3D) gradient-echo; coronal inversion recovery; and coronal, sagittal, and axial proton density fast spin echo (FSE) sequences. The MRIs were retrospectively evaluated by a single musculoskeletal radiologist blinded to the patients' symptoms and diagnosis. Ganglion cysts were defined as focal lesions in the soft tissues with signal isointense to fluid. Scapholunate ligament degeneration was defined as any loss of normal signal intensity of the ligament, and scapholunate ligament tear was defined as linear hyperintense signal disrupting the normal architecture of the

ligament or frank absence of the ligament. Capsulitis was diagnosed when increased signal intensity or edema was seen in the synovial lining of the joint on either the inversion recovery or proton density FSE pulse sequences.

Statistical Analysis

A sample size analysis was performed. Using an α value of $p = 0.05$ and a clinically relevant 50% effect size, a sample size of 50 patients was calculated to provide 80% power to detect a statistically significant difference in dorsal wrist pathology between groups. Differences in occurrence on the basis of age or sex were evaluated using a chi-square test.

Results

From the 889 charts reviewed, 25 patients were identified in each cohort. Average age of the patients was 39.8 years (range: 11–65). There were 29 males and 21 females (►Table 1); 41 of the 50 patients were right handed and

Table 1 Selected patient characteristics

	Dorsal pain		Ulnar pain	
	n (%)		n (%)	
Age	37.4		41.7	
Sex				
Male	13	(52)	16	(64)
Female	12	(48)	9	(36)
Hand dominance (right)	20	(80)	21	(84)
Affected hand (right)	16	(64)	14	(56)
Occupation				
Marketing/sales/secretary	3	(12)	4	(16)
Health care/research	6	(24)	4	(16)
Finance/law	6	(24)	5	(20)
Homemaker	2	(8)	0	(0)
Executive	1	(4)	1	(4)
Artist/designers/musician	4	(16)	4	(16)
Academia/student/librarian	1	(4)	5	(20)
Labor (i.e., construction)	0	(0)	0	(0)
Not reported/unemployed	2	(8)	2	(8)
Activity causing pain				
Extended wrist loading/push-up	25	(100)	0	(0)
Weight lifting	0	(0)	4	(16)
Activities of daily life	0	(0)	8	(32)
Computer use	0	(0)	4	(16)
Pronation/supination	0	(0)	5	(20)
Twisting/ulnar pain	0	(0)	4	(16)
Dorsal pathology				
Yes	21	(84)	3	(12)
No	4	(14)	22	(88)

Fig. 1 Dorsal wrist pathologies identified using MRI in patient cohort reporting dorsal wrist pain with extended lead-bearing wrist position.

the dominant side was affected in 23 patients. No significant differences were found when groups were stratified by sex or age ($p = 0.41$ and 0.23 , respectively). Occupations reported were varied, and no one reported a labor-intensive occupation (►Table 1).

Significantly more patients were identified with dorsal wrist pathology on MRI in the dorsal cohort (21 of 25 [84%]) than the ulnar cohort (3 of 25 [12%]) ($p < 0.001$). Of the 21 patients with dorsal wrist pathology, occult dorsal ganglion cysts were seen in 16 wrists (76%) and were the most frequently identified underlying pathology on MRI (►Figs. 1, 2). Excluding one dorsal ganglion originating from the distal radiolunar ligament, every dorsal ganglion identified on MRI arose from the dorsal band of the scapholunate ligament. Scapholunate ligament injury was identified in three patients and dorsal capsulitis in two patients (►Fig. 3).

Fig. 3 MRI coronal inversion recovery image of the right wrist of a 40-year-old man shows a tear (arrow) of the membranous portion of the scapholunate ligament.

Of the 25 patients in the ulnar pain cohort, 3 (12%) were diagnosed with dorsal wrist pathology: 2 cases of dorsal ganglion cysts and 1 case of dorsal capsulitis (►Fig. 4).

Discussion

The inherent strength and elasticity of the wrist's capsule-ligamentous structures protect the wrist in moderate exercise load and frequency.¹⁰ Crisco et al reported that carpal ligaments relax during repeated wrist extension loading (push-up and grip), thus reducing the loads borne by the intrinsic wrist ligaments.¹¹ Further, ligaments were found to recover from laxity after a short duration away from the sports activity.

Fig. 2 MRI coronal inversion recovery (A) and axial proton density (B) images of the right wrist of a 35-year-old man shows a large ganglion cyst measuring up to 21 mm in greatest dimension within the dorsal soft tissues arising from the dorsal band of the scapholunate ligament. L, lunate; S, scaphoid, and arrows point to the cyst arising from the scapholunate ligament.

Fig. 4 Dorsal wrist pathologies identified using MRI in patient cohort reporting ulnar wrist pain.

Another recent *in vivo* 3D kinetic study by Rainbow et al reports that during midrange extension of the wrist, the scaphoid and capitate rotate proportionately. However, during extremes of wrist extension, the scaphoid rotates 25% less than it does during midrange extension.⁶ Based on these findings, the authors present the idea that restriction of scaphoid during extreme wrist extension results in higher-than-usual load application on the periscaphoid ligament complex and articular cartilage. Most relevant to our own study's findings, the frequency of scapholunate ligament pathology (24%) and dorsal wrist ganglia (76%) may be explained by the notion that the repetition of high tensile forces and mechanical impingement of the scapholunate ligament in the extended weight-bearing position result in inflammation, degeneration, and mechanical trauma.¹¹

Weaknesses of our study include the small cohort size and retrospective nature of the investigation. Given this limitation, we were precluded from incorporating analysis of assessment of frequency or duration in activities associated with dorsal wrist pain. While a prospective study would strengthen the claim that the dorsal pathology identified on MRI is associated with dorsal wrist pain, the control group in

our study was included to account for possible incidental findings of dorsal wrist pathology.

Dorsal wrist pain associated with weight bearing on the wrist in the extended position was associated with a statistically increased prevalence of dorsal pathology on MRI, when compared with a matched cohort with ulnar-sided pain. Occult dorsal ganglion cysts (76%) were the most common finding. Based on the finding of a significant increase in prevalence of dorsal wrist pathologies in the dorsal patient cohort, we recommend diagnostic MRI to identify occult anatomic abnormalities in patients with pain during wrist loading in the extended position.

Conflict of Interest

None.

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