Incidental signal changes in the extensor carpi ulnaris on MRI

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Abstract

Background Magnetic resonance imaging (MRI) commonly finds musculoskeletal abnormalities incidental to the reason for ordering the test. The purpose of this study was to determine if the prevalence of extensor carpi ulnaris (ECU) signal changes on MRI varies between patients undergoing upper extremity MRI for assessment of clinically suspected ECU tendinopathy and those undergoing upper extremity MRI for other indications. Our secondary null hypotheses were that the prevalence of ECU signal changes on MRI does not vary based on patient age or sex and that the prevalence of ECU signal changes on MRI does not vary among other indications for MRI.

Methods We searched MRI reports of all patients undergoing MRI of the hand, wrist, or arm at our institution between 2001 and 2014 for signal changes in the ECU. The medical record was reviewed to determine the indication for the MRI and the presence of clinically suspected ECU tendinopathy.

Results ECU signal changes (overall prevalence of 13 %) were more common in patients undergoing MRI for a working clinical diagnosis of ECU tendinopathy or ulnar-sided wrist pain compared to patients evaluated for nonspecific pain and other indications. Age was independently associated with ECU signal changes on MRI. MRI signal changes are uncommonly associated with symptomatic tendinopathy (low positive predictive value).

Conclusions ECU signal changes on MRI are common and often asymptomatic.

Introduction

Magnetic resonance imaging (MRI) finds musculoskeletal variations and abnormalities (e.g., rotator cuff tear, triangular fibrocartilage [TFCC] lesions, ganglions, meniscus tears, and intervertebral disk protrusions) in asymptomatic patients, incidental to the reason for ordering the test [1–8]. As a consequence, MRI risks inappropriate diagnoses and unnecessary treatments [9]. Wrist pain is common, and it is often difficult to identify discrete, objective pathophysiology that accounts for the symptoms. In particular, pain on the ulnar side of the wrist is so vexing that some refer to it as "the back pain of the wrist" [10].

It is our impression that asymptomatic signal abnormalities of the extensor carpi ulnaris (ECU) are a common incidental finding on MRI [2]. If this impression proves true, it would inform patients with this finding on MRI that: (1) they have a benign problem and can be optimistic that their wrist will be dependable without treatment and (2) there is a substantial probability that the symptoms are not caused by this signal abnormality and treatment directed at this radiological finding might be unnecessary or unhelpful.

Our primary null hypothesis was that the prevalence of ECU signal changes on MRI does not vary between patients undergoing upper extremity MRI for assessment of clinically suspected ECU tendinopathy and those undergoing upper extremity MRI for other indications (e.g., nonspecific or ulnar-sided wrist pain, fracture or suspected fracture, arthritis, ganglion, de Quervain tendinopathy, and Kienböck disease). Our secondary null hypotheses were that the prevalence of ECU signal changes on MRI does not vary based on patient age or sex and that the prevalence of ECU signal changes on MRI does not vary among other indications for MRI.

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Materials and Methods

Study Design

This retrospective study was approved by our institutional review board, and a waiver of informed consent was granted. We included all patients undergoing MRI of the hand, wrist, or arm at our institution between April 18, 2001 and March 17, 2014 in the study (n=4301). If a patient underwent multiple MRIs during this time, only their first hand, wrist, or arm MRI was included in the study. Of the 4301 patients, 48 % (2076) were men, the average age was 44 years (standard deviation [SD]±18), and 13 % (556) demonstrated ECU signal changes on MRI.

The presence of radiological ECU signal change was determined by searching the radiology report text for "extensor carpi ulnaris" and synonyms as well as terms indicating signal change or any abnormality (Appendix 1). Signal abnormalities in the ECU on MRI were subsequently manually verified. Clinic notes were reviewed to determine the number of patients with a suspected clinical diagnosis of ECU tendinopathy prior to their MRI.

Explanatory variables were age, sex, and the indication for MRI. The indication was extracted based on information given by the ordering provider (Appendix 2). Fifty-four ([54/4301] 1.3 %) patients had a working clinical diagnosis of ECU tendinopathy prior to their MRI. Among these 54 patients, 31 had ECU signal changes and 23 did not. We categorized their indications for MRI as ulnar-sided wrist pain (n=35), nonspecific pain (n=17), and mass or tumor (n=4). The indication for MRI was not mentioned in 104 (2.4 %) patients; these MRIs were included as two separate groups: those who had skin markers placed by radiology at the time of imaging (n=34, 0.8 %), and those without any indication or skin marker (n=70, 1.6 %).

Statistical Analysis

In bivariate analysis, the rate of ECU signal change per indication was compared using the Fisher exact test. Differences in ECU signal changes among demographic variables were compared using the Fisher exact test for sex and the t test for age.

The variables with a P value below 0.10 in bivariate analysis were entered into a stepwise backward multiple logistic regression analysis to identify explanatory variables independently associated with ECU signal changes. Odds ratios (OR), the ratio of the odds of ECU signal changes occurring in patients with the explanatory variable compared to the odds in the reference group with 95 % confidence intervals (CI), are provided to quantify the association of explanatory variables with the outcome ECU signal change. We ran further multivariable analysis limited to those patients without ulnar-sided

pain or a working clinical diagnosis of ECU tendinopathy. A two-sided P value of less than 0.05 is considered significant.

Results

In bivariate analysis, we found a difference in the rate of ECU signal changes on MRI between groups of indications (P<0.001): 31 of the 54 patients (57 %) with a working clinical diagnosis of ECU tendinopathy, 87 of the 211 patients (41 %) with ulnar-sided wrist pain, 98 of the 629 patients (16 %) with nonspecific pain, and 331 of the 3,303 patients (10 %) with other indications for MRI (Table 1). There was no difference in the rate of ECU signal changes between men and women (P=0.52). Patients with ECU signal changes on MRI were slightly older on average (46 years, SD±16) than those without (44 years, SD±18) (P=0.025) (Table 2). Using clinical diagnosis of ECU tendinopathy as the reference standard, MRI had a sensitivity of 57 %, specificity of 88 %, positive predictive value of 6 %, negative predictive value of 99 %, and accuracy of 87 %. This is worth restating for emphasis and clarity: the prevalence of asymptomatic signal changes in the ECU makes MRI an unhelpful diagnostic test for illness related to ECU pathology. This is apparent in the low positive predictive value (only 31 of the 556 patients with ECU signal changes [6 %] had a clinical diagnosis of ECU tendinopathy) and the very high negative predictive value, in spite of the fact that nearly half of the patients with a clinical diagnosis of ECU tendinopathy had no signal changes on MRI.

Multivariable analysis of patients with any indication for MRI (n=4301) demonstrated that age (OR 1.01, 95 % CI 1.00–1.01, P=0.001) was positively associated with the presence of ECU signal changes, whereas the presence of multiple indications (OR 0.48, 95 % CI 0.32–0.73, P=0.001) was negatively associated. Relative to patients with a working clinical diagnosis of ECU tendinopathy, assessment of ulnar pain (OR 0.51, 95 % CI 0.28–0.94, P=0.030), arthritis (OR 0.21, 95 % CI 0.099–0.44, P<0.001), nonspecific pain (OR 0.16, 95 % CI 0.087–0.28, P<0.001), other indications (OR 0.11, 95 % CI 0.060–0.19, P<0.001), no indication or marker (OR 0.053, 95 % CI 0.018–0.15, P<0.001), mass or tumor (OR 0.041, 95 % CI 0.023–0.075, P<0.001), and infection (OR 0.015, 95 % CI 0.0054–0.43, P<0.001) were negatively associated with the presence of ECU signal changes.

Among patients who did not have ulnar-sided pain or a working clinical diagnosis of ECU tendinopathy (n=4036), age (OR 1.01, 95 % CI 1.00–1.02, P=0.002) was positively associated with the presence of ECU signal changes, and the presence of multiple indications (OR 0.46, 95 % CI 0.29–0.74, P=0.002) was negatively associated. Relative patients with other indications, assessment of arthritis (OR 2.0, 95 % CI 1.2–3.3, P=0.009) and nonspecific pain (OR 1.5, 95 % CI 1.1–2.0, P=0.004) were associated with a higher rate of ECU

Table 1 ECU signal changes on MRI per indication

	ECU signal changes on MRI		No ECU signal changes on MRI		$n=4301$ P value
	N	%	N	%	
All patients with wrist MRI					
Working diagnosis of ECU tendinopathy	31/54	57	23/54	43	
Ulnar-sided pain	87/211	41	124/211	59	**<0.001**
Nonspecific pain	98/629	16	531/629	84	
No indication for imaging provided, skin marker present	4/34	12	30/34	88	
Other indications for MRI[a]	331/3303	10	2972/3303	90	
No indication for imaging provided and no skin marker present	5/70	7	65/70	93	
Variation among other specific indications for MRI					
Assessment of any arthritis	38/162	23	124/162	77	**<0.001**
Assessment of de Quervain tendinopathy	3/13	23	10/13	77	
Assessment of Kienböck disease	5/32	16	27/32	84	
Assessment of trauma or fracture	118/791	15	673/791	85	
Assessment of ganglion cyst	39/253	15	214/253	85	
Assessment of mass or tumor	89/1470	6	1381/1470	94	

Significant P values in bold

[a] Included all those patients with a specific indication that was not nonspecific pain or ulnar-sided pain

signal changes, whereas assessment of mass or tumor (OR 0.39, 95 % CI 0.30–0.52, $P<0.001$) and infection (OR 0.15, 95 % CI 0.060–0.36, $P<0.001$) were associated with a lower rate (Table 3).

Discussion

MRI finds incidental signal changes and asymptomatic or incidental pathophysiology. Such findings have a substantial effect on diagnostic performance characteristics and place patients at risk for unnecessary treatment and unnecessary restrictions/disability. We found that patients with pain (particularly ulnar-sided wrist pain) were more likely to have ECU signal changes on MRI than those with other indications but that incidental signal changes are present in 1 out of 10 patients and more common as we age. As a result of these

common incidental signal changes, MRI findings in the ECU must be interpreted with caution: on average, signal changes are common in the absence of clinical diagnosis, and nearly half of patients with a clinical diagnosis had no signal changes. The resulting positive predictive value (6 %) and negative predictive value (99 %) reflect the influence of a 10 % rate of incidental signal changes on diagnostic performance characteristics.

Our study had several limitations. First, we were limited to the indications given by providers in the radiology ordering system. Although some providers noted specific indications, indications were often generic and nonspecific. Second, while it seems safe to assume that most of the incidental signal changes in the ECU were asymptomatic, some patients may not have reported ulnar-sided pain in the setting of a nonpainful indication for MRI. Our study addressed incidental signal changes in the ECU among patients having MRI, not

Table 2 Variation in ECU signal changes among demographic characteristics

	ECU signal changes on MRI		No ECU signal changes on MRI		$n=4301$ P value
Sex	N	%	n	%	
Men	261/2076	13	1815/2076	87	0.52
Women	295/2225	13	1930/2225	87	
	Mean (± SD)		Mean (± SD)		
Age (years)	46 (±16)		44 (±18)		**0.025**

Dichotomous variables compared by the Fisher exact test; interval variables compared by t test. Significant P values in bold

SD standard deviation

Table 3 Multivariable analysis

Presence of ECU signal changes	Odds ratio (95 % confidence interval)	Standard error	P value	Pseudo R^2
Any indication ($n=4301$)				
Age (years)	1.01 (1.00–1.01)	0.0028	0.001	0.092
Presence of multiple indications	0.48 (0.32–0.73)	0.10	0.001	
Working clinical diagnosis of ECU tendinopathy	Reference group			
Ulnar pain	0.51 (0.28–0.94)	0.16	0.030	
Arthritis	0.21 (0.099–0.44)	0.078	<0.001	
Nonspecific pain	0.16 (0.087–0.28)	0.047	<0.001	
Other indications[a]	0.11 (0.060–0.19)	0.031	<0.001	
No indication, no marker	0.053 (0.018–0.15)	0.029	<0.001	
Mass or tumor	0.041 (0.023–0.075)	0.013	<0.001	
Infection	0.015 (0.0054–0.043)	0.0081	<0.001	
Among those without ulnar pain or working clinical diagnosis of ECU tendinopathy[b] ($n=4036$)				
Age (years)	1.01 (1.00–1.02)	0.0030	0.002	0.043
Presence of multiple indications	0.46 (0.29–0.74)	0.11	0.002	
Other indications[a]	Reference group			
Arthritis	2.0 (1.2–3.3)	0.53	0.009	
Nonspecific pain	1.5 (1.1–2.0)	0.22	0.004	
Mass or tumor	0.39 (0.30–0.52)	0.056	<0.001	
Infection	0.15 (0.060–0.36)	0.067	<0.001	

[a] Other indications included Kienböck, numbness, swelling, weakness, trauma/fracture, de Quervain, nerve compression, stiffness, AVN, ganglion cyst, and no indication w/ skin maker

[b] No indication, no marker dropped for $P>0.10$

asymptomatic changes in healthy patients. Many of the MRIs were ordered for unclear and seemingly unhelpful reasons (e.g., known arthritis, to confirm tendinopathy). We suspect that this was, in part, due to a large number of MRIs being ordered by nonspecialists. While the appropriate use of wrist MRI merits additional study, we are confident that our study reflects the routine use of MRI in our hospital.

ECU signal changes on MRI were more common in patients undergoing MRI for a suspected clinical diagnosis of ECU tendinopathy (57 %) or ulnar-sided pain (41 %) compared to patients having MRI for nonspecific pain (16 %) and other indications (10 %). One can conclude from this data that ECU tendinopathy is a common cause of pain on the ulnar side of the wrist. It is possible that the signal changes associated with ECU tendinopathy never completely normalize, contributing—among other factors—to a higher rate of incidental signal changes.

One in ten patients with a nonpainful indication for MRI had incidental signal changes in the ECU. This is consistent with prior studies of wrist MRI. One study of asymptomatic volunteers found an average of more than three MRI findings per wrist imaged [11] but did not comment on the ECU specifically. Another study of asymptomatic volunteers noted ECU signal changes on MRI in 22 of 26 patients [2]. Others have emphasized that the ECU tendon often has high signal intensity at baseline [12]. Burgess et. al., compared wrist

MRIs in computer users with chronic pain to asymptomatic controls. They demonstrated equal 58 % prevalence of ECU subluxation or dislocation among asymptomatic and symptomatic patients [13]. Another study noted that among 15 asymptomatic gymnasts, MRI identified signal changes in the tendons of the wrist in all patients, most commonly involving the ECU [14]. Other studies have demonstrated a much lower (4.3 %, $n=1/23$) rate of incidental ECU tendinopathy on MRI among volunteers with no hand or systemic musculoskeletal complaints [15].

The observation that patients with ECU signal changes on MRI tended to be older than those without ECU signal changes on MRI is consistent with other types of pathophysiology such as degenerative spinal disease and extra-spinal degenerative disease [5], TFCC abnormalities [6, 16], lumbar spine abnormalities [7], cervical spine abnormalities [8], trapeziometacarpal arthrosis [17], rotator cuff abnormalities [18], and meniscal tears [19], among others. The ECU may accumulate pathological changes with time, most of which are asymptomatic. Other studies have measured the incidental rate of signal changes. Lumbar spine MRIs have demonstrated changes in 52 % ($n=51/98$) of patients [7]. MRI of asymptomatic wrists has shown rates of TFCC changes varying from 38 % ($n=39/103$) [6] to 50 % ($n=35/70$) [20]. This rate is similar to that shown in a cadaveric dissection study showing a TFCC defect rate of 36 % ($n=141/393$) [21]. The

supraspinatus has a somewhat higher rate of changes: one study showed changes in 89 % (*n*=49/55) of asymptomatic patients [1]. Another study showed MRI changes in 79 % (*n*= 11/14) of throwing and 93 % (*n*=13/14) of nonthrowing shoulders in asymptomatic baseball players [22]. Finally, medial meniscus changes have been demonstrated on MRI in between 29 % (*n*=64/220) [23] and 67 % (*n*=33/49) [4] of asymptomatic controls. Our overall rate of incidental ECU signal changes is lower at 10 % (*n*=331/3303).

Our study identified incidental ECU signal changes in at least 10 % of wrists, higher in older patients with wrist pain and associated arthritis. This high rate of incidental changes makes it difficult to connect MRI findings with a patient's symptoms (poor diagnostic performance characteristics). Pending additional research, our opinion is that—due to a minimum 10 % incidence of incidental signal changes— MRI is not helpful in the management of ECU tendinopathy. One wonders why an MRI was even ordered in patients suspected of having ECU tendinopathy as it would not change management. Considering the more likely clinical scenarios or puzzling wrist pain or a tumor, while there is a chance that ECU tendinopathy is contributing to symptoms, it is highly likely that the ECU signal changes on MRI are unrelated to the patient's symptoms.

Appendix 1: terms indicating tendon signal change

Contusion
Degenerative change
Dislocation
Displacement
Enlarged
Fluid adjacent
Fluid collection
Fluid in the tendon sheath
Fluid surrounding

Fluid surrounds
Fluid within
Hyperintensity
Increased intrasubstance signal
Increased signal
Increased signal intensity
Inflammation
Intrasubstance signal abnormality
Mild subcutaneous fat stranding overlying
Perched
Perching
Soft tissue edema
Soft tissue thickening
Subluxation
Subluxed
Surrounding edema
Synovitis
Tear
Tearing
Tendinitis
Tendinopathy
Tendinosis
Tenosynovitis
Thickened
Thickening
Torn
Translation
Underlying enhancement and edema

Appendix 2: indications for MRI*

Arthritis
DJD
AVN
Necrosis
Carpal tunnel
Cubital tunnel
Cyst
Ganglion
Foreign body
Fracture
Infection
Abscess
Cellulitis
Necrotizing fasciitis
Osteomyelitis
Septic bursitis
Septic joint
Kienböcks
Mass
Adenoma
Bladder cancer

Breast cancer
Cancer
Carcinoma
Colon cancer
Growth
Hemangioma
Histiocytoma
Lesion
Lipoma
Lump
Melanoma
Mets eval
Neoplasm
Neurofibromatosis
Node
Nodule
Sarcoma
Schwannoma
Tumor
Nerve compression
Numbness
Paresthesia
Pain
Stiffness
Limited movement
Swelling
Edema
Tear
Rupture
Trauma
Dislocation
Fall
Injury
Laceration
Vascular occlusion
Weakness

*Nested terms were included within the search of the parent indication.

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