

## RESEARCH ARTICLE

# The Prevalence of Calcifications at the Origin of the Extensor Carpi Radialis Brevis Increases with Age

Matthew Tarabochia, BSc<sup>1</sup>; Stein J. Janssen, MD<sup>1</sup>; Paul T. Ogink, MD<sup>1</sup>; David Ring, MD, PhD<sup>2</sup>; Neal C. Chen, MD<sup>1</sup>

Research performed at Massachusetts General Hospital, Boston, MA, USA

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## Abstract

**Background:** Enthesopathy of the extensor carpi radialis brevis origin [eECRB] is a common idiopathic, non-inflammatory disease of middle age that is characterized by excess glycosaminoglycan production and frequently associated with radiographic calcification of its origin. The purpose of our study was to assess the relationship of calcification of the ECRB and advancing age.

**Methods:** We included 28,563 patients who received an elbow radiograph and assessed the relationship of calcifications of the ECRB identified on radiograph reports with patient age, sex, race, affected side, and ordering indication using multivariable logistic regression.

**Results:** Calcifications of the ECRB were independently associated with age (OR:1.04;  $P<0.001$ ); radiographs ordered for atraumatic pain (OR2.6;  $P<0.001$ ) or lateral epicondylitis (OR5.5;  $P<0.001$ ); and Hispanic ethnicity (OR1.5;  $P<0.001$ ) and less likely to be found at the left side (OR0.68;  $P<0.001$ ). Similarly, incidental calcifications of the ECRB, those on radiographs not ordered for atraumatic pain or lateral epicondylitis, were independently associated with age (OR1.03;  $P<0.001$ ) and Hispanic ethnicity (OR1.5;  $P<0.024$ ) and less likely to be found on the left side (OR0.71;  $P<0.001$ ).

**Conclusion:** We observed that about nine percent of people have ECRB calcification by the time they are in their sixth decade of life and calcifications persist in the absence of symptoms which supports the idea that eECRB is a common, self-limited diagnosis of middle age.

**Level of evidence:** II

**Keywords:** Calcification, Enthesopathy, Extensor carpi radialis brevis, Lateral epicondyle, Lateral epicondylitis, Radiograph, Prevalence, Tennis elbow

## Introduction

Tennis elbow and lateral epicondylitis are two common terms that refer to enthesopathy of the extensor carpi radialis brevis origin (eECRB). eECRB is an idiopathic, non-inflammatory disease that presents with pain over the lateral elbow. The condition occurs primarily in patients 35 to 54 years of age and is self-limited (1-4). On histology eECRB is characterized by excess glycosaminoglycan production (mucoi-

degeneration) (5-7). Calcification of the extensor carpi radialis brevis [ECRB] origin at the lateral epicondyle is common with eECRB and these calcifications might be permanent (5, 8-11).

Given that eECRB is common and often associated with calcifications, radiographic calcification of the extensor carpi radialis brevis (ECRB) might be expected to accumulate with age. In this sense the prevalence of

**Corresponding Author:** Stein J. Janssen, Hand Service, Department of Orthopedic Surgery, Massachusetts General Hospital, Massachusetts, Boston, USA  
Email: steinjanssen@gmail.com



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calcification of the ECRB origin with age may serve as a surrogate for the cumulative lifetime prevalence of eECRB.

Our study tested the primary null hypothesis: the prevalence of ECRB calcifications is not associated with age accounting for other factors. Secondly, we tested the null hypothesis: the prevalence of incidental calcifications of the ECRB is not related to age accounting for other factors.

## Materials and Methods

### Study design and population

After obtaining IRB approval, we searched the patient data registry of two tertiary care hospitals for all patients who had an elbow radiograph with at least two views (CPT codes 73070 and 73080) between January 1, 2005 and January 1, 2015. We included every patient greater than 18 years old who received an elbow radiograph at one of the two institutions. All patients with cancelled radiographs, radiographs completed at an outside institution, incomplete radiograph reports or radiographs ordered for a clinical mass or malignancy were excluded. All 28,563 eligible patients were included in this study. We only included the first elbow radiograph report for each patient to comply with the statistical assumption of independence.

### Outcomes

Our primary outcome measure was calcific enthesopathy around the lateral epicondyle. We searched the first elbow radiograph report of every eligible patient for mention of calcifications, enthesopathy, the lateral epicondyle or the common extensor tendon, including synonyms and common misspellings: 4,983 (17%) reports were flagged and 1,236 (4.3%) of these patients had probable calcifications or changes at the lateral epicondyle not likely caused by trauma, inflammatory diseases, and/or arthritis. We then manually reviewed the complete report text of all 1,236 patients with probable changes in the extensor tendon and found that 958 patients had an impression of calcification of the extensor tendon, 220 had findings consistent with calcifications of the extensor tendon, and 58 did not have calcifications within the extensor tendon. To assess the accuracy of our text search we randomly sampled 100 patients identified as not having calcifications of the extensor tendon at the lateral epicondyle and manually reviewed the report text for each patient. None of the 100 patient reports we reviewed had mention of extensor tendon calcification within their reports. To assess the accuracy of the radiology reports, two research fellows reviewed the elbow radiographs of 100 randomly selected patients with reported calcifications of the ECRB and 100 patients without reported calcifications. Of the 100 patients with calcifications in their report, 81 patients had calcifications about the lateral epicondyle on their radiograph. Of the 100 without calcifications noted in the report text, 8 patients had calcifications on their radiographs.

Our secondary outcome measure was incidental

(i.e. non-symptomatic) common extensor tendon calcifications, which included all radiographs not ordered to assess lateral epicondylitis or atraumatic elbow pain.

Our explanatory variables were age as a continuous variable, and sex, race, affected side, and the primary ordering indication for the radiograph as categorical variables. We identified patient age, sex, and race from the medical record and extracted the indication from the radiology report text.

The primary ordering indication for an elbow radiograph was determined by searching the "indications" section of each elbow radiograph report. When the primary ordering indication was unclear ( $n = 36$ ), the indication was manually reviewed. We identified patients who had an indication of lateral epicondylitis or atraumatic elbow pain to determine which calcifications were incidental or asymptomatic. We included patients with primary ordering indications of arthritis, tendinopathies, other painful conditions or isolated stiffness and/or swelling in a group called atraumatic pain. There were 16,564 (58%) radiographs ordered to assess trauma or follow-up of a surgery for trauma; 10,154 (36%) radiographs were ordered to assess atraumatic elbow pain; 949 (3.3%) radiographs did not have an ordering indication in the report, 522 (1.8%) were ordered for lateral epicondylitis or a synonym; and 374 (1.3%) radiographs were ordered for a diagnosis that did not fit into another category, e.g. – foreign body, evaluation of dialysis fistula, neuropathy [Table 1].

### Statistical analysis

We report frequencies with percentages for categorical variables and mean with standard deviation (SD) for continuous variables.

We used multivariable logistic regression analysis to assess the association between each explanatory variable and the response variables while adjusting for potential confounding. We report the odds ratio (OR), standard error (SE), and p-value for the regression analyses; a two-tailed p-value below 0.05 is considered significant.

### Baseline characteristics

The eligible patients averaged 50 (SD=18) years of age; 52% were men; and 75% were white. Radiology reports addressed the right elbow in 13,568 (48%) patients, the left elbow in 12,716 (45%) patients, and in 2,279 (8%) patients the report did not identify a side or described bilateral elbows. The most common ordering indication was trauma [Table 1]. Symptomatic and incidental calcifications peaked in prevalence when patients were 60 to 80 years of age. In our study population, 1,178 of 28,563 patients (4.1%, 95% confidence interval [95% CI], 3.9 – 4.4) had elbow radiograph reports describing elbow calcifications within the extensor tendon. When we excluded all patients with radiographs ordered for lateral epicondylitis or atraumatic pain (37% [10,676 out of 28,563]) we found that 486 of 17,887 patients had incidental extensor tendon calcifications identified on radiograph (2.7%, 95% CI, 2.5 – 3.0; Table 2).

Table 1. Baseline characteristics		n = 28,563
		<b>Mean (SD)</b>
<b>Age</b>		50 (18)
		<b>n (%)</b>
<b>Patients with no calcifications at the lateral epicondyle</b>		27,385 (96)
<b>Patients with calcifications at the lateral epicondyle</b>		1,178 (4.1)
<b>Indication*</b>		
Trauma		16,564 (58)
Atraumatic pain*		10,154 (36)
No indication		949 (3.3)
Lateral epicondylitis		522 (1.8)
Other		374 (1.3)
<b>Sex</b>		
Men		14,757 (52)
Women		13,806 (48)
<b>Race</b>		
White		21,290 (75)
Hispanic		2,072 (7.3)
Black		2,028 (7.1)
Unknown		1,308 (4.6)
Other		1,004 (3.5)
Asian		829 (2.9)
Native American		32 (0.11)
<b>Affected Side</b>		
Right		13,568 (48)
Left		12,716 (45)
Not specified		2,279 (8.0)

\*Atraumatic pain includes all radiographs ordered for elbow pain, painful conditions and/or stiffness and swelling.

Table 2. Prevalence of calcifications of the ECRB with age.										
Age (years)	10 - 20	20 - 30	30 - 40	40 - 50	50 - 60	60 - 70	70 - 80	80 - 90	90 +	0 - 90
Calcifications (%)	0.00	0.37	0.80	3.5	5.8	8.7	6.4	5.6	4.2	4.1
Incidental calcifications* (%)	0.00	0.30	0.59	2.1	3.9	5.6	5.0	4.5	3.2	2.7

\* Incidental calcifications are defined as calcifications at the lateral epicondyle in the absence of atraumatic pain or lateral epicondylitis as an ordering indication; all patients with atraumatic pain or lateral epicondylitis were therefore excluded from these analyses.

## Results

Age (OR 1.04;  $P < 0.001$ ; 4% increase in likelihood per year over age 18); radiographs ordered for atraumatic pain (OR 2.6;  $P < 0.001$ ) or lateral epicondylitis (OR 5.5;  $P < 0.001$ ); and Hispanic ethnicity (OR 1.5;  $P < 0.001$ ) were independently associated with calcifications of the ECRB. The left elbow (OR 0.68;  $P < 0.001$ ) was less likely to have calcifications of the ECRB [Table 3 and

Figure 1].

Age (OR 1.03;  $P < 0.001$ ; 3% increase in likelihood per year over age 18) and Hispanic ethnicity (OR 1.5;  $P < 0.024$ ) were independently associated with incidental calcifications of the ECRB. Incidental calcifications were less likely to be found in the left ECRB (OR 0.71;  $P < 0.001$ ; Table 3 and Figure 1).

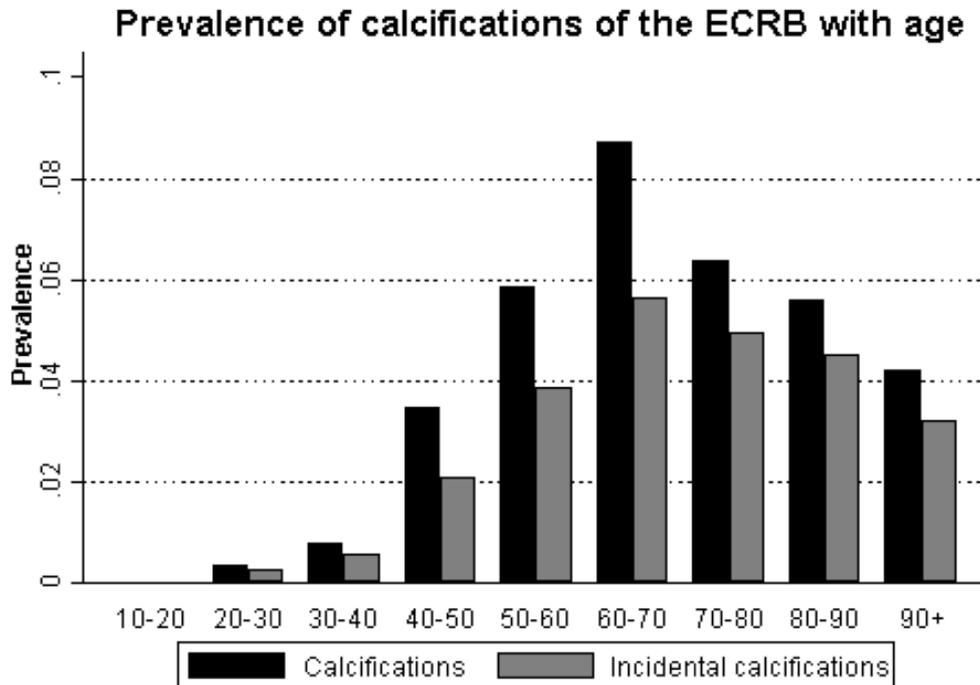


Figure 1. Prevalence of calcification of the extensor carpi radialis brevis and incidental calcifications of the extensor carpi radialis brevis versus age.

## Discussion

Calcifications about the lateral epicondyle are associated with eECRB and thought to be permanent (5, 8-11). The prevalence of calcification on elbow radiograph may reflect the cumulative lifetime incidence of clinical eECRB. We found that each year of age increases the odds of having ECRB calcifications. We also found that calcifications are more common on the right lateral epicondyle and in people of Hispanic ethnicity.

Our study has certain limitations. First, our retrospective cohort study design can only identify a relationship between age and calcification; it cannot address the specific cause of calcification. Second, we relied on reports written by the radiologists at the two institutions we reviewed. In the reports we reviewed, the calcifications of the ECRB were not systematically described with the same language as all radiologists from our two institutions were included. To ensure we captured all reports mentioning calcification of the ECRB, we included search terms for calcification or the ECRB and all synonyms and any common misspellings.

Third, we relied on searching report texts to identify the affected side and radiograph ordering indication. Based on manual review of the identified reports we are confident our search terms accurately identified indication and the affected side listed in the reports. However, we believe our estimate of incidental calcifications is conservative because we excluded all patients with atraumatic pain or epicondylitis as an indication. The one-word ordering indication "pain" was very common and we had no

way of knowing what part of the elbow the ordering provider referred to so we assumed all radiographs ordered for "pain" could represent eECRB. This may have led to exclusion of patients with symptomatic medial epicondylitis or ulnar neuropathy with incidental calcific enthesopathy. Fourth, we relied on radiologists reporting calcifications in each radiograph and there may be inter-radiologist variability of which we are unaware. The text descriptions were reasonably accurate on manual review of the radiographs, but there is some degree of error introduced by variation of radiographic interpretation. Some radiologists may omit commenting on calcifications which would decrease the prevalence. In addition, when double-checking radiographs, we used a different software system to view the DICOM images than the radiologists. It is possible that the radiologists were able to see calcifications that we could not see because they had a superior DICOM viewing platform. We do not anticipate that any over or under call would be significantly different than other institutions and or bias the prevalence based on age, side, race or ordering indication. Fifth, there may be differences in the quality of the radiographs read by radiologist in this study as our cohort includes patients who received radiographs over a ten-year period. Sixth, the majority of our cohort was white and lived in the Northeastern United States and therefore these results might not be generalizable to all populations or geographical regions. However, these limitations are counterbalanced by the number of

**Table 3. Predictors of common extensor tendon calcifications**

	All ordering indications (n = 28,563)			Incidental calcifications** (n = 17,887)		
	Multivariate Analysis			Multivariate Analysis		
	Odds ratio	Standard Error	P-value	Odds ratio	Standard Error	P-value
<b>Age</b>	1.04	0.0018	<0.001	1.03	0.0025	<0.001
<b>Indication</b>						
Trauma	ref.	ref.	ref.	ref.	ref.	ref.
Atraumatic pain*	2.6	0.17	<0.001	n/a	n/a	n/a
No indication	1.0	0.21	0.96	1.01	0.21	0.98
Lateral epicondylitis	5.5	0.80	<0.001	n/a	n/a	n/a
Other	1.3	0.41	0.38	1.3	0.40	0.43
<b>Sex</b>						
Women	ref.	ref.	ref.	ref.	ref.	ref.
Men	0.96	0.059	0.49	1.02	0.097	0.84
<b>Race</b>						
White	ref.	ref.	ref.	ref.	ref.	ref.
Black	0.93	0.12	0.59	0.95	0.19	0.80
Hispanic	1.5	0.18	<0.001	1.5	0.27	0.024
Asian	1.0	0.20	0.93	1.5	0.39	0.14
Native American	2.0	1.5	0.35	2.6	2.7	0.37
Other	0.97	0.19	0.89	0.96	0.29	0.88
Unknown	1.0	0.15	0.80	1.0	0.22	0.93
<b>Affected Side</b>						
Right	ref.	ref.	ref.	ref.	ref.	ref.
Left	0.68	0.044	<0.001	0.71	0.069	<0.001
Not specified	0.96	0.10	0.70	0.90	0.16	0.56

ref. = reference group. n/a = not applicable.

\*Atraumatic pain includes all radiographs ordered for elbow pain, painful conditions and/or stiffness and swelling.

\*\* Incidental calcifications are defined as calcifications at the lateral epicondyle in the absence of atraumatic pain or lateral epicondylitis as an ordering indication; all patients with atraumatic pain or lateral epicondylitis were therefore excluded from these analyses.

patients in our research database. The large number of patients, radiologists, and institutions mitigates variation of radiographic interpretation and reporting. In addition, the large number of patients allows for a more robust statistical analysis than studies with smaller patient cohorts.

We found all calcifications of the ECRB were predicted by advancing age, the right elbow and Hispanic ethnicity. Previous studies were set up to suggest that calcifications of the ECRB are related to symptomatic eECRB. For instance, Edelson et al documented calcification on CT scans in 3 of 20 patients with no elbow symptoms and 6 of 10 patients with long-standing elbow symptoms ( $P=0.003$ ), but there was no difference in patients with symptoms for less than one year ( $P=0.73$ ) (9). Similarly,

Levin et al compared ultrasound images of 25 elbows with symptoms of eECRB to 32 asymptomatic elbows and found calcifications of the common extensor tendons (OR 6.2;  $P<0.05$ ) and adjacent bone irregularity (OR 4.8;  $P<0.05$ ) were associated with symptoms. However, patients with symptomatic elbows were significantly older than asymptomatic elbows (10). It is difficult to compare our radiographic prevalences to prevalences based on symptoms such as Hamilton et al., (twice as common on the right side; similar numbers of men and women) (1) and Owens et al (fewer black patients) (12). In our opinion, the racial findings are likely spurious because most of the patients were white.

Secondarily we found that incidental calcifications of the ECRB were predicted by advancing age, the

right elbow and Hispanic ethnicity. The association of age with calcification supports the theory that the pathophysiological changes persist and accumulate in aging populations even as the symptoms resolve [Table 2 and Figure 1]. This is supported by other studies of the extensor tendon. Zeisig et al who found persistent changes in 13 of 20 sonograms of the extensor origin after resolution of symptoms (11). Jaén-Díaz examined the common extensor tendon using ultrasound in 240 patients and noted that 48% with changes remembered symptoms consistent with eECRB compared to 2% in patients with normal elbows ( $P<0.001$ ) (13). Van Leeuwen et al studied MRI signal changes of the ECRB and found that age was independently associated with ECRB enthesopathy (OR 1.04;  $P<0.001$ ) and that the prevalence of signal changes increases to 16% in patients over age 71 (14). MRI changes are likely more often detected than calcifications and this is probably a more accurate reflection of the prevalence of eECRB.

The observation that about nine percent of the population have calcifications of the ECRB origin by the time they are in their sixth decade of life supports the idea eECRB is a common, self-limited disease of middle age (1, 2, 9, 11, 13). Combined with similar MRI data and the weight of current best evidence, patients can be counseled that evidence to date support the concept that eECRB is common and self-limiting.

**Conflicts of interest:** One of the authors (DR) certifies

that he, or a member of his immediate family, has or may receive payments or benefits, during the study period, an amount less than USD 10,000 from Wright Medical (Memphis, TN, USA); an amount less than USD 10,000 from Skeletal Dynamics (Miami, FL, USA); an amount less than USD 10,000 from Biomet (Warsaw, IN, USA); an amount less than USD 10,000 from AO North America (Paoli, PA, USA); and an amount less than USD 10,000 from AO International (Dubendorf, Switzerland).

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Matthew Tarabochia BSc<sup>1</sup>

Stein J. Janssen MD<sup>1</sup>

Paul T. Ogink MD<sup>1</sup>

David Ring MD PhD<sup>2</sup>

Neal C. Chen MD<sup>1</sup>

<sup>1</sup> Hand Service, Department of Orthopedic Surgery, Massachusetts General Hospital, Massachusetts, Boston, USA

<sup>2</sup> Department of Surgery and Perioperative Care, Dell Medical School, The University of Texas at Austin, Austin, Texas, USA

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