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RESEARCH ARTICLE

Tendinopathy of the Distal Biceps Tendon is a Common Incidental Finding on Magnetic Resonance Imaging of the Elbow

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Abstract

Objectives: The prevalence of tendinopathic changes of the distal biceps tendon (DBT) is not clear, in both the general population and patients with symptoms that may be related to distal biceps tendinopathy. The purpose of this study is to retrospectively determine the prevalence of distal biceps tendinopathy in symptomatic and asymptomatic patients undergoing an MRI of the elbow. A secondary aim is to assess the association between age and the prevalence of incidental distal biceps tendinopathy.

Methods: We assessed 1,180 MRI-reports describing the elbow region and calculated prevalence of incidental and symptomatic DBT tendinopathies. Symptomatic DBT tendinopathy was defined as patients that had complaints of anterior elbow pain. With a multivariate logistic regression analysis we tested whether age, sex, and race were independently associated with DBT tendinopathy.

Results: 276 of 1,180 (23%) of the distal biceps tendons showed signal changes on the MRI. Only 114 (10%) showed DBT tendinopathy, of which60 (5% of all tendons, 53% of tendons with tendinopathy) were incidental. The prevalence peaked between 40-49.9 years (37%) and 50-59.9 years (30%). There was no significant association between increasing age and incidental DBT tendinopathy (P= 0.935). However, there was a significant association between increasing age and tendinopathy, whether the tendinopathy was incidental or symptomatic (P< 0.001).

Conclusion: Signal changes in the DBT are common on MRI scans, however 53% of detected tendinopathies are incidental. There is no association between increasing age and prevalence of incidental DBT tendinopathy, though there is a significant association between increasing age and DBT tendinopathy.

Level of evidence: II

Keywords: Biceps, Distal, Elbow, Incidental, MRI, Prevalence, Tendinopathy, Tendon

Introduction

It is unclear what the natural history is regarding tendinopathy of the distal biceps tendon (DBT). The distal bicep attachment has a relatively low vascularity, which some suspect leads to intrinsic degeneration from hypoxic tendinopathy.[1–3] In addition, extrinsic factors such as impingement at the radial tuberosity may contribute to tendinopathy as well.[3–6] Microscopic analysis of distal bicep tendinopathy appears to be similar to rotator cuff tendinosis or lateral epicondylitis, characterized by fibroblast proliferation, focal hyaline degeneration and mucopolysaccharide infiltration.[7,8]

Distal biceps injuries primarily occur in middle aged men.[3,9–12] Injuries of the DBT are usually described as partial or total rupture.[13] It is unclear to what degree tendinopathy plays a role in rupture of the DBT, but similar to the rotator cuff or patellar tendon, it is likely that intrinsic pathology of the tendon is contributory. It is clear that not all DBT

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tendinopathy is symptomatic; some findings on MRI may be incidental.[14] Secondarily, it is unclear what is the prevalence of symptomatic versus asymptomatic tendinopathy.

Some insight to the prevalence of DBT tendinopathy can be inferred from existing MRIs of the elbow obtained for all pathologies. DBT tendinopathy appears as heterogeneous signal in the distal bicep tendon on magnetic resonance imaging (MRI).[14] Various prior studies report incidental imaging abnormalities in the rotator cuff or extensor carpi radialis brevis (ECRB).[15–17] these prior studies help contextualize MRI findings of tendinopathy and help inform treatment decisions. For similar reasons, it is important to characterize the prevalence of DBT tendinopathy.[18]

In light of this, the purpose of this study is to retrospectively determine the prevalence of distal biceps tendinopathy in symptomatic and asymptomatic patients undergoing an MRI of the elbow.

Materials and Methods

Ethics statement

The protocol for this study was reviewed by the Institutional Review Board at our institution and ethical approval was granted under protocol number 2019P001025.

Patient selection

We identified all MRI reports of MRIs performed between 2004 and 2019 at two urban academic medical centers, using the Current Procedural Terminology (CPT®) Codes as presented in [Appendix A]. This search yielded 23,472 patients with 20,954 MRI reports of the upper extremity. Only reports of patients who underwent a dedicated elbow MRI scan were included, for either trauma or other pathology, resulting in 1,322 patients with 1,498 MRI reports. For each patient we only included the first MRI report to avoid over-counting. Patients aged less than 18 years were excluded. This resulted in a total number of 1,180 MRI reports. MRIs were performed with variable magnet strengths and imaging techniques; 152 scans were 1.5T, while 322 scans were 3T. The other reports did not mention the number of Tesla of the given MRI. Fifty-nine reports did specifically mention that they were performed in the flexed abducted supinated position (FABS).

Outcome measures

Our primary outcome measure was the presence of signal changes in the distal biceps tendon (DBT) insertion. The remaining 1,180 MRI reports were manually reviewed to confirm the presence of a DBT signal change and to identify the type of signal change. Signal changes were identified as (1) any DBT signal change, but not tendinopathy, and (2) tendinopathy. Tendinopathy was defined as either (1) distal biceps tendinopathy mentioned as such in the MRI report or (2) thickening or hyper-intense signal changes of the DBT. Any questionable cases were discussed with a fellowship-trained orthopedic upper extremity surgeon. We reviewed the medical charts of all patients to identify the symptoms and indications that resulted in acquiring MRI imaging. For patients with tendinopathy we also assessed whether the tendinopathy was an incidental finding and what other symptoms might be present. We considered tendinopathy of the DBT to be an incidental finding if the patient's medical chart did not mention the presence of anterior elbow pain.

Explanatory variables

Explanatory variables were age at the time of imaging, sex, and race. For patients that were found to have signs of DBT tendinopathy we also assessed whether *anterior elbow pain* (either pain at the area of the distal biceps tendon itself or over the distal aspect of the muscle belly) was present. Pain over the proximal biceps and shoulder area (i.e. close to the proximal biceps tendons) was not regarded as *anterior elbow pain*. Other indications or symptoms that we assessed as potential reasons to perform the MRI were *any elbow pain*, *lateral elbow pain*, *medial elbow pain*, *pain at other location in the arm*, *mass or swelling*, *limited movement*, *instability or ligament tear*, *trauma or fracture*, *inflammation, neuropathic symptoms*, and *suspicion of infection*. Data on these variables were collected using manual chart review. Patients could have multiple signs and symptoms that served as indications for undergoing an MRI; however, the presence of anterior elbow pain in conjunction with tendinopathic signal changes to the DBT were required to classify a patient as having a symptomatic tendinopathy of the DBT.

Statistical Analysis

Statistical analysis was performed using Stata/SE 16.1 for Mac (StataCorp, College Station TX). Categorical variables were presented as frequencies and percentages and continuous variables as the mean with the standard deviation (SD). Based on their age, we divided the patients into six groups: (1) 18 to 29.9 years, (2) 30 to 39.9 years, (3) 40 to 49.9 years, (4) 50 to 59.9 years, (5) 60 to 69.9 years, and (6) 70 years and older. For each group we determined the proportions of the following types of signal change: (1) MRI report showing no changes in the DBT, (2) any signal change in the DBT that were not tendinopathy, (3) incidental tendinopathy, or (4) symptomatic tendinopathy. Potential changes that could be found in the second group are signs of prior repair, signs of infection, or various types of ruptures of the DBT. A logistic regression model was used to assess the potential association between increasing age and incidental tendinopathy of the DBT, with a p-value of <0.05 being interpreted as statistically significant. Similarly, a logistic regression analysis was performed for an association between increasing age and any tendinopathy of the DBT (i.e. incidental or symptomatic). For these analyses, age was treated as linear data rather than categorical. The age at the time of MRI was available for all patients.

Results

We included 1,180 patients in the study with a mean age of 45.9 years (SD: 16.2), and of which 829 (70%) were men [Table 1]. The majority (83%) of patients were Caucasian (n=975). Of the 1,180 patients, 904 (77%) showed no changes in the DBT. Of the 276 patients (23%) for which the MRI demonstrated signal changes in the DBT, 114 (9.7%) had changes that were identified as isolated tendinopathy. Fifty-four patients (4.6%) had symptomatic tendinopathy and 60 (5.1%) had asymptomatic tendinopathy [Table 2]. Of the patients that had isolated tendinopathic changes of the DBT, 60 of 114 (53%) were asymptomatic.

Table 1. Demographics	
Variable	**N=1,180**
Age in years, mean (SD)	45.9 (16.2)
Men, n (%)	829 (70.3)
Race	
African American, n (%)	32 (2.71)
Asian, n (%)	27 (2.29)
Caucasian, n (%)	975 (82.7)
Hispanic, n (%)	33 (2.80)
Other/unknown, n (%)	112 (9.50)

SD: standard deviation

Table 2. Prevalence of distal biceps tendon signal changes in 1,180 patients who underwent magnetic resonance imaging of the elbow

Variable	Age group in years						Total, n (%)
	18-29.9	***30-39.9***	***40-49.9***	***50-59.9***	***60-69.9***	***≥70***	
Elbow MRIs, n	240	159	260	313	136	72	1,180
Proportion of MRIs showing no changes in the DBT, n (%)	235 (97.9)	125 (78.6)	164 (63.1)	220 (70.3)	103 (75.7)	57 (79.2)	904 (76.6)
Proportion of MRIs showing DBT signal changes, n (%)	5 (2.10)	34 (21.4)	96 (36.9)	93 (29.7)	33 (24.3)	15 (20.8)	276 (23.4)
Any change, but no tendinopathy, n (%)	2 (0.83)	24 (15.1)	57 (21.9)	57 (18.2)	14 (10.3)	8 (11.1)	162 (13.7)
Tendinopathy, n (%)	3 (1.25)	10 (6.28)	39 (15.0)	36 (11.5)	19 (14.0)	7 (9.72)	114 (9.66)
Incidental, n (%)	2 (0.83)	5 (3.14)	22 (8.46)	16 (5.11)	10 (7.35)	5 (6.94)	60 (5.08)
Symptomatic, n (%)	1 (0.42)	5 (3.14)	17 (6.54)	20 (6.39)	9 (6.62)	2 (2.78)	54 (4.58)

MRI: magnetic resonance imaging

In this cohort, symptomatic DBT tendinopathy was only found once in the age category of 18-29.9 years. The age distribution for incidental tendinopathy showed a bimodal pattern, with the highest prevalence of incidental findings being found in the age group 40-49.9 years (8.5%) and 60-69.9 years (7.4%) [Figure 1].

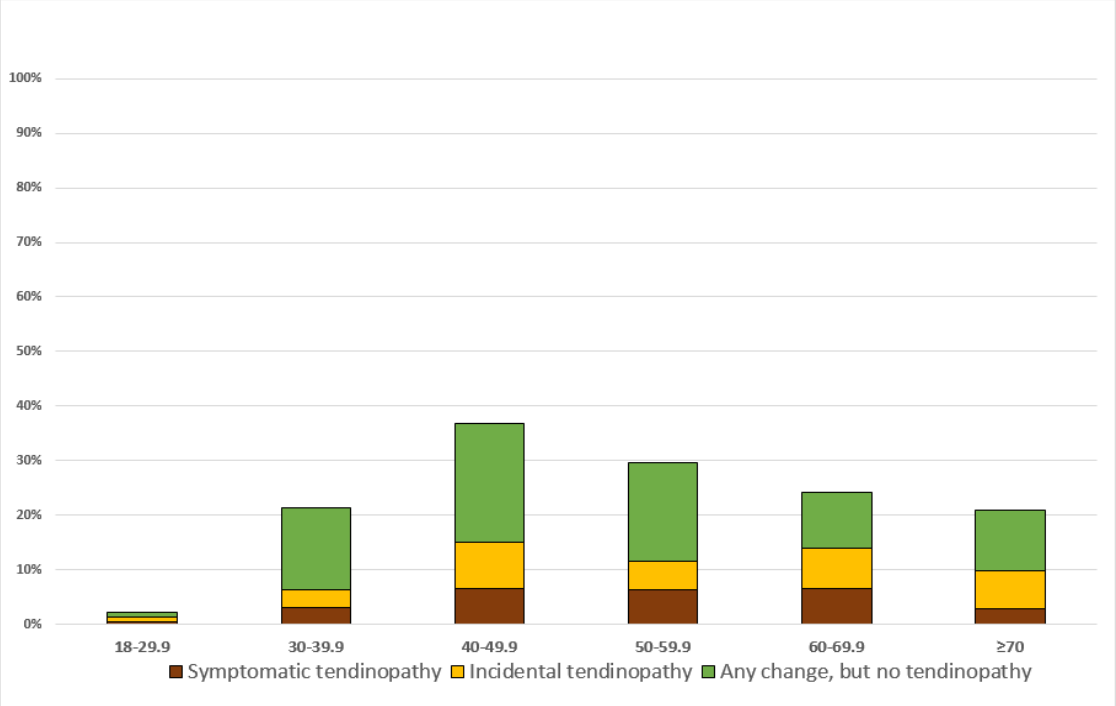

Figure 1. Signal changes in the distal biceps tendon on all elbow MRI scans (n=1,180) stratified by age group

The main indications for acquiring an MRI were anterior elbow pain (n=54, 47.5%), lateral elbow pain (n=28, 24.6%), and trauma or fracture (n=49, 43.0%) [Table 3]. DBT. The presence or absence of anterior elbow pain dictated whether tendinopathy on MRI was classified as either symptomatic or incidental. All patients in the symptomatic cohort were positive for 'any elbow pain' compared to 62.1% in the cohort of incidental tendinopathy (P<0.001). Limited movement was more commonly present in the symptomatic cohort (11.9 vs. 1.7%, P=0.03), as were traumatic events or suspicion of fracture (57.6 vs. 36.2%, P=0.02).

Table 3. Bivariate analysis of symptoms and indications for MRI in symptomatic or incidental tendinopathy

Present symptom or indication	Symptomatic tendinopathy	Incidental tendinopathy	P-value
Anterior elbow pain, n (%)*	59 (100.0)	0 (0)	N/A
Elbow pain, n (%)	59 (100.0)	36 (62.1)	<0.001
Lateral elbow pain, n (%)	5 (8.5)	6 (10.3)	0.73
Medial elbow pain, n (%)	5 (8.5)	4 (6.9)	0.75
Pain at other location in the arm, n (%)	2 (3.4)	2 (3.5)	0.99
Mass or swelling, n (%)	5 (8.5)	6 (10.3)	0.73
Limited movement, n (%)	7 (11.9)	1 (1.7)	0.03
Instability or ligament tear, n (%)	2 (3.5)	4 (6.9)	0.40
Trauma or fracture, n (%)	34 (57.6)	21 (36.2)	0.02
Inflammation, n (%)	7 (11.9)	11 (19.0)	0.29
Neuropathic symptoms, n (%)	2 (3.4)	4 (6.9)	0.39
Suspicion of infection, n (%)	0 (0)	2 (3.5)	0.15

* Anterior elbow pain along with tendinopathy on MRI was considered indicative for symptomatic tendinopathy of the distal biceps tendon
Patients could have multiple symptoms or indications for performing an MRI

Table 4 lists the results of a bivariate analysis of these symptoms and indications in all cohorts [Table 4]. Anterior elbow pain was also present in 41.4% of patients with non-tendinopathic DBT changes on MRI, and 5.2% of patients without any DBT changes on MRI. Both lateral (15.1%) and medical (19.2%) elbow pain were most frequent in patients without any DBT changes (P=0.003 and P<0.001, respectively). Instability or suspected ligament tear was also most common in patients without DBT changes (19.2%, P<0.001), while a traumatic indication or suspicion of fracture was least commonly present in that cohort (20.4%, P<0.001).

Logistic regression analysis demonstrated a correlation between increasing patient age and all tendinopathy (incidental and symptomatic combined) (P<0.001, beta 0.027, pseudo R^2 0.025). However, no statistical correlation was observed in our logistic regression analysis (P=0.935) between incidental DBT tendinopathy and increasing patient age.

Table 4. Bivariate analysis of symptoms and indications for MRI among all groups

Present symptom or indication	Symptomatic tendinopathy	Incidental tendinopathy	Non-tendinopathic DBT changes	No changes to DBT	P-value
Anterior elbow pain, n (%)*	59 (100.0)	0 (0)	67 (41.4)	54 (5.2)	<0.001
Elbow pain, n (%)	59 (100.0)	36 (62.1)	114 (70.4)	787 (75.5)	<0.001
Lateral elbow pain, n (%)	5 (8.5)	6 (10.3)	8 (4.9)	157 (15.1)	0.003
Medial elbow pain, n (%)	5 (8.5)	4 (6.9)	6 (3.7)	200 (19.2)	<0.001
Pain at other location in the arm, n (%)	2 (3.4)	2 (3.5)	11 (6.8)	46 (4.4)	0.53
Mass or swelling, n (%)	5 (8.5)	6 (10.3)	17 (10.6)	182 (17.5)	0.03
Limited movement, n (%)	7 (11.9)	1 (1.7)	10 (6.2)	74 (7.1)	0.19
Instability or ligament tear, n (%)	2 (3.5)	4 (6.9)	7 (4.3)	200 (19.2)	<0.001
Trauma or fracture, n (%)	34 (57.6)	21 (36.2)	103 (63.6)	213 (20.4)	<0.001
Inflammation, n (%)	7 (11.9)	11 (19.0)	13 (8.0)	157 (15.1)	0.07
Neuropathic symptoms, n (%)	2 (3.4)	4 (6.9)	6 (3.7)	80 (7.7)	0.20
Suspicion of infection, n (%)	0 (0)	2 (3.5)	3 (1.9)	31 (3.0)	0.48

* Anterior elbow pain along with tendinopathy on MRI was considered indicative for symptomatic tendinopathy of the distal biceps tendon
Patients could have multiple symptoms or indications for performing an MRI

Discussion

The purpose of this study was to determine the prevalence of distal biceps tendinopathy on elbow MRI exams, and then evaluating that prevalence in context of reported symptoms. Overall, the prevalence was found to be 9.7% across all elbow MRIs. Of the identified cases of DBT tendinopathy, more than half were incidental findings in patients that underwent an MRI for reasons that did not indicate anterior elbow pain.

There was an association between increasing age and tendinopathy of the DBT in the overall cohort. Thus, it seems

that tendinopathic changes may indeed persist over time, irrespective of the presence of symptoms. In a similar study that assessed ECRB signal changes there was a relationship with asymptomatic patients and increasing age.[15] However, we did not observe our hypothesized association between increasing age and the prevalence of incidental DBT tendinopathy on MRI. This may reflect that distal bicep tendinopathy is not as prevalent as ECRB tendinopathy and a larger cohort may be needed to understand the relationship between incidental tendinopathy and age. We also found a higher prevalence of incidental tendinopathy in middle-aged patients, the majority of whom were male. This is in line with results of earlier studies.[3,9–12] Overall, we observed that DBT peaks in patients aged 40-49.9 years before gradually decreasing in older patients. This may be either due to (1) the signal changes that are commonly found in patients aged 40-49.9 years dissipate without lasting changes in the ensuing years or (2) there are different populations undergoing an MRI exam of the elbow at specific ages and may represent some selection bias. Potentially, the discrepancy of age and its association with changes to the ECRB and DBT may be explained by changes to the ECRB accumulating over time, but we did not observe a similar pattern in the distal bicep tendon.

In this cohort, the prevalence of DBT tendinopathy was 9.7%. Distal bicep tendinopathy has a relatively lower prevalence compared to medial or lateral epicondylosis, which ranges from 5.7% to 16% with a correlation between prevalence and increasing patient age.[15] Because there is a relatively small number of patients who undergo elbow MRI compared to other joints, even if tendinopathic changes persist over time, we may not observe the association of incidental tendinopathy with age because of sampling error. Interestingly, a modest but significant association between increasing age and all tendinopathic changes (symptomatic and asymptomatic combined) was found in the current cohort.

More than half of MRIs which demonstrated tendinopathy of the DBT (52.6%) occurred in patients without complaints of anterior elbow pain who were thus regarded as incidental DBT tendinopathy. In the sub cohort of patients that were ≥70 years old, we found that 71.4% of the identified DBT tendinopathy was incidental. It remains unclear whether a larger cohort would reveal an association between increasing age and the prevalence of incidental tendinopathy of the DBT on MRI. Regardless, the considerable proportion of incidental findings in all age groups emphasizes the important Bayesian concept that prior probabilities are important to inform the interpretation of diagnostic studies, which may lead to potential over-diagnosis and unnecessary burdens to both patients and healthcare providers. This is also important in order to optimally indicate patients for invasive treatment, which may greatly vary in invasiveness and results depending on technique and the involved tendon-based pathology.[19–23]

One of the limitations of this study is that we did not assess the indications for all MRI scans, but only for those patients that were found to have tendinopathy of the DBT. Our findings could therefore not be compared to patients who might have similar symptoms without (detected) DBT tendinopathy. Due to the cross-sectional nature of our study, we cannot comment upon the proportion of patients with incidental tendinopathy who develop symptoms over time. A longitudinal study would be required to determine whether incidental findings of DBT tendinopathy on MRI may be predictive of future symptoms or potentially even complete ruptures. A second limitation is that in this study, we agglomerated multiple descriptions of DBT pathology as "DBT tendinopathy". It is possible that some MRI findings are associated with more severe symptoms.[24–26] Also, this study does not investigate psychological characteristics such as resilience and their effect on symptoms, which however has been explored in other upper extremity conditions.[27,28]

A recent publication by Van Melkebeke et al. investigating the prevalence of DBT tendinopathy in 1,191 MRI scans that included the elbow.[29] A comparison was made between blinded MRI assessments by two physicians in orthopedic surgery and clinical assessment (including physical examination), with the latter being the reference standard. They found that 18% of patients who underwent an MRI due to clinical suspicion of DBT tendinopathy did not have DBT signal changes in the report by the radiologist. However, only 0.7% of patients without a clinical diagnosis of DBT tendinopathy had signal changes in the DBT upon review, compared to 52.6% in our cohort (i.e. patients with incidental DBT tendinopathy). The conclusion by Van Melkebeke et al. is that MRI can be used to exclude the presence of DBT pathology in cases of negative MRI results, due to its high negative predictive value of 99%. Based on our results, MRI interpretation may be more complicated and not as definitive as suggested. Notably, our MRIs were read by radiologists rather than orthopedic surgeons, which may reflect differences in interpretation of images. In our study we found that over half of the patients with radiologic DBT changes had no clinical diagnosis of DBT tendinopathy, compared to only 5.6% (8 out of 143) in the study by Van Melkebeke et al. However, in the current cohort, anterior elbow pain was also present in 41.4% of patients without DBT findings.

In our cohort, MRI indications of trauma or limited movement were associated with symptomatic DBT tendinopathy. Although our findings differ from Van Melkebeke et al., one conserved principle is the importance of Bayesian pre-test probabilities in interpretation of the MRI findings. Because changes to the DBT are noted in about 10% of all elbow MRIs, careful consideration of symptoms is needed to avoid overtreatment.

Conclusion

Tendinopathy of the DBT is finding that occurs in about 10% patients that undergo an MRI of the elbow, independent of symptomatology. We observed that the prevalence of DBT tendinopathy is associated with age. However, roughly half of these tendinopathies are incidental radiological findings without clinical symptoms. We observed that the prevalence of DBT tendinopathy

peaks at middle age in our cohort. We recommend that in clinical practice clinicians should be aware that signal changes in the distal bicep are common and may be suspect for over-interpretation and treatment.

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Declaration of Informed Consent: Informed consent was obtained from all individual participants included in the study. Questionnaires were completed in accordance with the ethical standards of the responsible committee on human experimentation (institutional and national) and with the Helsinki Declaration of 1975, as revised in 2013.

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Appendix

Appendix A - CPT codes
73221 – MRI Shoulder, Elbow, Wrist or Clavicle w/o Contrast
73222 – MRI Shoulder, Elbow, Wrist or Clavicle with Contrast
73223 – MRI Shoulder, Elbow, Wrist or Clavicle w/wo Contrast
73218 – MRI Upper Extremity w/o Contrast
73219 – MRI Upper Extremity with Contrast
73220 – MRI Upper Extremity w/wo Contrast
CPT: Current Procedural Terminology