

Is the FABS view MRI more accurate than standard MRI in detecting distal biceps pathology?

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1 **Abstract**

2 **Background:** Partial biceps tendon pathology is difficult to diagnose. The Flexion Abduction
3 Supination (FABS) view MRI has been advocated to improve the accuracy of MRI investigation.

4 **Hypothesis:** The purpose of the present study is to evaluate the accuracy of the FABS view MRI in
5 the diagnosis of distal biceps tendon pathology.

6 **Study Design:** We compared sensitivity and specificity of the FABS view MRI and the standard MRI.

7 **Methods:** 50 patients with surgically confirmed distal biceps tendon pathology and 50 patients with
8 other elbow disorders were included. From both groups, half had standard elbow MRI (retrospective
9 review of previously obtained MRI data) and the other half FABS view MRI. These were evaluated by
10 two independent musculoskeletal radiologists. Sensitivity and specificity of the both MRI views were
11 determined. Tendinosis or grade of rupture were reported from MRI and then compared to surgical
12 findings.

13 **Results:** There was no significant difference in sensitivity and specificity in detecting partial distal
14 biceps injuries when comparing the FABS view MRI (sensitivity 84% and specificity 86%) and
15 standard MRI (sensitivity 76% and specificity 98%). The inter-observer reliability (IRR) was 92% for
16 the FABS view MRI with biceps pathology and 68% for standard MRI. In the control group the IRR
17 was 88% for the FABS view MRI and 96% for standard MRI. FABS MRI was significantly better
18 with regards to grade of injury.

19 **Conclusions:** No significant differences in sensitivity and specificity were found between the FABS
20 view and standard elbow MRI in the diagnosis of partial distal biceps tendon injuries with high
21 sensitivity and specificity for both views. Interrater reliability was better for FABS views and FABS
22 views were significantly more accurate in grading the extend of the pathology when compared to
23 surgical findings.

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25 **Key words:** MRI, elbow, distal, biceps, tendon, partial, rupture, FABS

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27 **Level of evidence:** IV

28

29 **Introduction**

30 The diagnosis of a complete tear of the distal biceps tendon is mainly based on clinical examination.^{10,}

31 ¹¹ A variety of clinical test have been described.^{8, 11} However, in a complete tear with an intact lacertus

32 fibrosus, partial tears, tendonitis or bursitis the clinical image may be less obvious.^{1, 3, 9, 12, 13}

33 Patients often complain of pain in the antecubital region, exacerbated with activity. Biceps strength is

34 usually good and resistance tests may be negative. This often results in a significant delay in

35 diagnosis, or it may be missed altogether.^{1, 3, 9}

36 MRI investigation has been proposed if the diagnosis is unclear. Although MRI has been proven to be

37 very sensitive for complete distal biceps tendon tears, the sensitivity for partial tears or other distal

38 biceps tendon pathology is significantly lower.^{2, 4-6} In 2004, Giuffrè et al. suggested the flexion

39 abduction supination view (FABS) to optimally view the distal biceps tendon from the

40 musculotendinous junction to its insertion, usually on a single image (in one or, at most, two

41 sections).⁷ (Figure 1) Although it was widely adopted in clinical practice, the sensitivity and

42 specificity of the FABS view for partial distal biceps tendon tears and other distal biceps tendon

43 pathology has not been studied.

44 The purpose of this study was to evaluate sensitivity, specificity and reproducibility of the FABS view

45 MRI to detect distal biceps tendon pathology and to compare this to standard elbow MRI

46 investigation.

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57 **Material and methods**

58 After internal review board approval, 100 patients with elbow pathology who underwent MRI
59 investigation were included. All patients were treated by the senior author and MRIs were performed
60 in a single institution. To be included in this study, biceps pathology had to be confirmed by biceps
61 endoscopic surgery. MRI images had to satisfy the following criteria: (1) the area proximal to the
62 biceps musculotendinous junction and distal to the radial tuberosity had to be viewable on the study;
63 (2) the MRI hardware needed a magnet strength of 1.5 T; (3) no contrast was used. The scanner in our
64 institution is a Siemens 1.5 T Magnetom Aera, and images before 2015 were taken by a Siemens 1,5T
65 Symphony. The standard MRI protocol uses a 15-channel knee coil and includes axial T2 TSE fatsat,
66 axial T1 TSE, coronal T1 TSE, coronal T2 TSE fatsat, sagittal T2 TSE fatsat. The patient is positioned
67 prone with the elbow extended above the head and thumb up (Superman position). Our radiologists'
68 FABS view protocol has the following specifications: a 16-channel shoulder coil, included axial
69 proton+T2 TSE fatsat, coronal T1 TSE and T2 fatsat, sagittal T2 TSE fatsat, axial and coronal 3D
70 DESS with water excitation. For the FABS view MRI, patient positioning is very different: the patient
71 lies prone with the arm in 'FABS' flexion-abduction-supination (Figure 1a) during the total scanning
72 time. Detailed resolution of all MRI sequences is presented in Table C. The Standard MRI images of
73 25 patients with distal biceps tendon pathology (Figure 2) and 25 patients with another elbow
74 problem, were retrospectively included from the surgeon's database. Clinical and surgical notes were
75 used to confirm the pathology. From 2018, 25 patients with distal biceps tendon pathology and 25
76 patients with another elbow problem were included prospectively and FABS views were obtained for
77 these 50 patients.

78 Patients were divided into four groups. The first group had FABS view images with distal biceps
79 tendon pathology, surgically confirmed and graded during biceps endoscopy. A low-grade partial tear
80 was defined as less than or equal to a 25% tear of the width of the distal biceps tendon attachment. An
81 intermediate-grade tear was defined as a 25% to 50% tear of the width and a high-grade partial tear
82 was defined as a greater than 50% tear of the width of the distal biceps tendon attachment.

83 The second group included FABS views from patients with various elbow pathologies other than
84 distal biceps tendon problems, such as lateral epicondylitis, ulnar nerve pathologies and medial

85 epicondylitis. Patients did not complain of anterior elbow and forearm pain and clinical tests for distal
86 biceps tendon pathology were negative.

87 The third group included patients with surgically confirmed distal biceps tendon pathology and
88 preoperative standard MRI studies.

89 Finally, the fourth group consisted of standard MRI investigations from patients with other elbow
90 pathologies than distal biceps tendon problems.

91 All investigations were blinded, randomized and evaluated by two independent radiologists, highly
92 experienced in musculoskeletal imaging, with 8 and 22 years of practice respectively. The radiologists
93 participating in this study were not involved in the original care of any patient in this study and did not
94 receive any clinical information. They were asked to provide a general diagnosis, and if the MRI
95 proved positive for distal biceps tendon pathology, to specify according to the following criteria (1)
96 partial tear: characterize as either a high-grade, intermediate-grade or low-grade tear, using the
97 definition provided earlier; (2) presence of tendinosis or (3) bicipital bursitis.

98 MRI interpretations were then correlated to the intraoperative findings and results were statistically
99 analyzed (SPSS Software, Chicago, IL). Comparison of FABS and standard MRI was evaluated using
100 t-test and significance level was set at 0.05. Values reported for sensitivity, specificity, positive
101 predictive value, and negative predictive value were calculated. Furthermore, we evaluated the inter-
102 observer reliability (IRR). For biceps pathology, the IRR in group 1 (FABS view) and group 3
103 (standard MRI) was based on the different types of distal biceps tendon pathology, as described above.
104 The IRR for the other elbow pathologies was calculated on patients with either medial or lateral
105 epicondylitis, as these were similarly distributed in group 2 (FABS view, 13 patients) and group 4
106 (standard MRI, 15 patients).

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108 **Results**

109 A total of 100 MRIs were included for review. Group 1 and 3 each included 25 surgically confirmed
110 distal biceps tendinitis or partial ruptures. Group 2 and 4 each contained 25 MRIs of non-biceps
111 pathologies. The mean ages in group 1 and 3 were 55 (range, 36-77 years) and 59 years (range, 34-87
112 years), respectively. In group 2 and 4 the mean ages were 48 years (range, 31-60 years) and 53 (range,

113 26-73 years). Group 1 consisted of 6 women and 19 men. In group 2, 8 women and 17 men were
114 included. In the third group there were 8 women and 17 men and in group 4, 13 patients were women
115 and 12 men. In both group 1 and 2, the dominant elbow was involved in 60% of patients. In group 3
116 and 4, the dominant elbow was involved in 56% and 68% respectively.

117 In group 1, endoscopic findings included tendinosis or bicipital bursitis (12%), low-grade (20%),
118 intermediate (12%) and high-grade (56%) partial distal biceps ruptures (Table A). In group 3, there
119 were no cases of tendinosis or bicipital bursitis and partial tears were divided into 60% low-grade, 8%
120 intermediate and 32% high-grade tears (Table B).

121 In the biceps pathology groups 1 and 3, MRI interpretations were compared to intraoperative findings.
122 Biceps pathology was correctly reported from FABS view MRI's in 84%, and in 76% on standard
123 MRI's (p=0.32).

124 In the FABS view MRI group, 83% of tendinosis cases, 50% of low-grade tears, 67% of intermediate
125 grade cases and 57% of high-grade partial tears were correctly identified (Table A). In the standard
126 MRI group 23% of low-grade cases, none of the intermediate grade cases and 6% high-grade partial
127 tears were correctly identified (Table B). There was a significant difference between FABS and
128 standard MRI when comparing grading of the tears (p=0.002)

129
130 In the control groups 2 and 4, non-symptomatic biceps tendinosis was reported in 14% of cases on
131 FABS view MRI's and in 2% on standard MRI.

132 The overall sensitivity in detecting distal biceps tendon pathology for the FABS view MRI was 84%,
133 while the specificity was 86%. The standard MRI had an overall sensitivity and specificity in detecting
134 distal biceps tendon pathology of 76% and 98%, respectively. There were no significant differences
135 between FABS and standard MRI views in sensitivity (p=0.32) or specificity (p=0.31). The positive
136 predictive value for the FABS view MRI was 86% and the negative predictive value was 84%. For
137 standard MRI the positive and negative predictive values were 97% and 80%, respectively.

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139 The inter-observer reliability (IRR) was 92% for the FABS view MRI's with biceps pathology, while
140 for the standard MRI's with biceps pathology the IRR was 68%. In control groups the IRR was 88%
141 for the FABS view MRI's and 96% for the standard MRI's. (Table 1)

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143 **Discussion**

144 Partial ruptures of the distal biceps tendon are relatively uncommon injuries. Diagnosis is difficult
145 since symptoms and clinical examination are often vague and aspecific.^{1, 3, 9, 12, 13} Literature has shown
146 magnetic resonance imaging (MRI) of the elbow to be a useful tool in the diagnosis of distal tendon
147 pathology.^{4, 6} However, most studies evaluate complete ruptures of the distal biceps tendon. A study
148 that compared the effectiveness of standard elbow MRI for complete and partial ruptures, found the
149 sensitivity of MRI to be only 59% for partial tears, compared to 100% for complete ruptures.⁵ The
150 sensitivity (76%) of standard MRI views in the present study is higher than the previous reported
151 sensitivity of 59%.⁵

152 To improve the accuracy of MRI diagnosis of distal biceps tendon pathology, the flexion abduction
153 supination view (FABS), was described by Giuffrè in 2004.⁷ Although it has been used clinically, no
154 specific research on the accuracy of the FABS view MRI had been published. Our data did not show a
155 significant difference in sensitivity and specificity for FABS view MRI compared to standard MRI in
156 the detection of distal biceps injuries.

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158 The advantage of present study is that the radiologists were blinded to the purpose of this
159 investigation. Only after the first distinction they were told to grade the distal biceps tendon ruptures
160 as described before. In previous studies, the investigators were told that the MRI was
161 suspected of distal biceps pathology.¹⁴

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163 There are several limitations to present study. Firstly, standard MRI and FABS MRI were not
164 directly compared from the same patient. However, since the radiologists were not aware that

165 they were evaluating distal biceps tendon pathologies in either group, we believe that the
166 results of the study were not influenced. Secondly, we did not consider the chronicity of the
167 tears. Previous research evaluated this and saw no influence on the results.⁵ Our FABS view
168 MRI protocol included coronal and axial 3D sequences with slice thickness of 1.5 mm while
169 the standard elbow MRI protocol had a slice thickness of 3 mm. Accuracy and consistency of
170 the MRI examination may have been influenced in favor of the FABS view by using thinner
171 slice thickness compared to the standard MRI protocol.
172 Lastly, grading of the tear was based on surgical findings. This may have introduced an error
173 but we feel this was the most accurate way possible.

174

175 In conclusion, the FABS view has shown to be a valuable tool in the diagnosis of partial distal
176 biceps tendon injuries. No significant difference was found in sensitivity and specificity, when
177 comparing FABS and standard views but interrater reliability was higher with FABS views and FABS
178 views were significantly more accurate in grading the extent of the pathology when compared to
179 surgical findings.

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222 **Legend of Figures:**

223 **Figure 1a:** Flexion abduction supination view (FABS) positioning with shoulder abduction and elbow
224 flexion-supination.

225 **Figure 1b:** MRI image from a patient in the FABS position. The entire tendon can be viewed from
226 insertion to musculotendinous junction in one single image. A tendinosis was diagnosed in this
227 patient.

228 **Figure 2:** Standard MRI view of a distal biceps tendinosis. Notice that, when compared to a FABS
229 image, only a small portion of the tendon can be seen per image.

230

231 **Tables:**

232 **Table 1:** Accuracy of the FABS view and standard MRI view of partial distal biceps tendon ruptures.

233 PPV: positive predictive value, NPV: negative predictive value, IRR: inter-rater (observer) reliability.