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# Association Between Acromion Morphology and Non-Traumatic Rotator Cuff Injury Among Young Adult Filipinos in a Tertiary Hospital: Cross-sectional Study

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1 **Association Between Acromion Morphology and Non-Traumatic Rotator Cuff Injury**  
2 **Among Young Adult Filipinos in a Tertiary Hospital: Cross-sectional Study**

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15 **ABSTRACT**

16

17 **Introduction**

18 Rotator cuff injury (RCI) is among the most common shoulder pathologies, significantly  
19 affecting quality of life. Acromial morphology has been implicated as a predisposing factor, but  
20 limited local data exist. The Bigliani-Kitay classification defines four acromion types: flat (I),  
21 curved (II), hooked (III), and convex (IV). MRI is the preferred modality for assessing both  
22 acromial morphology and RCI.

23 **Objective**

24 To assess the association between acromion morphology and RCI among patients undergoing  
25 shoulder MRI at Makati Medical Center, a tertiary hospital in the Philippines.

26 **Methods**

27 A retrospective review of shoulder MRI scans performed from January to December 2019 was

28 conducted. Patients with shoulder pain were included as cases. Acromion morphology and  
29 presence of RCI (tendinosis, partial, or full-thickness tears) were documented. Images were  
30 interpreted by radiologists accredited by the Philippine College of Radiology.

### 31 **Results**

32 Of 132 patients (mean age:  $31.2 \pm 5.4$  years), 65.9% were male. The period prevalence of RCI  
33 was 58.3% ( $n = 77$ ). There was no significant sex-based difference in RCI prevalence ( $p =$   
34  $0.4036$ ). RCI was significantly associated with Type II (70.5%,  $p < 0.00001$ ) and Type III  
35 (100%,  $p = 0.00158$ ) acromion morphologies. No significant association was found for Types I  
36 and IV.

### 37 **Conclusion**

38 Type II and Type III acromial morphologies are significantly associated with higher prevalence  
39 of RCI. Recognition of these morphologies on MRI may help identify patients at increased risk  
40 and allow for early intervention.

### 41 **Keywords**

42 Acromion; Rotator Cuff; Rotator Cuff Injuries; Cross-Sectional Studies; Philippines

### 43 **Advances in knowledge**

44

- 45 • Confirms a statistically significant association between Type III (hook-shaped) acromion  
46 and rotator cuff injury (RCI) in a Filipino young adult population.
- 47 • While associated with RCI as well, type II acromion is most prevalent in the study  
48 population.
- 49 • This is among the first studies in the Philippines to characterize acromial types in relation  
50 to documented RCI.

51

### 52 **Application to patient care**

53

- 54 • Early identification of type III acromion may support clinical suspicion for rotator cuff  
55 pathology, improving diagnostic accuracy.
- 56 • Patients with type III acromion may benefit from earlier referral to physical therapy or  
57 orthopedic evaluation.

- Incorporating acromial morphology in radiology reports may enhance multidisciplinary communication between radiologists, primary care providers, and orthopedic surgeons.

60

## 61 **Introduction**

62

63 Rotator cuff injuries (RCI) are among the most common shoulder pathologies, yet their  
64 precise etiology remains incompletely understood.<sup>1</sup> While both intrinsic factors (*e.g.*, age-  
65 related degeneration, reduced vascularity, and collagen abnormalities) and extrinsic factors  
66 (*e.g.*, subacromial impingement and repetitive overhead activity) have been implicated,  
67 relatively few studies have focused on the role of specific acromion morphologies in  
68 predisposing individuals to RCI. Of these, the hook-shaped type III acromion has been most  
69 consistently associated with rotator cuff pathology.<sup>2</sup>

70

71 Mechanical impingement is a leading extrinsic cause of rotator cuff injury, implicated in up  
72 to 95% of tears.<sup>3</sup> It results from repetitive compression of the tendons under the acromion,  
73 contributing to tendon degeneration. Acromioplasty, which addresses this impingement, has  
74 become increasingly common. Early diagnosis and management of mechanical factors are  
75 associated with better outcomes, emphasizing the need to identify structural contributors,  
76 such as acromial morphology.

77

78 Acromial morphology is a key anatomical determinant of subacromial impingement.<sup>4,5</sup> The  
79 most widely used system for classifying acromion types is the Bigliani classification, later  
80 refined by Kitay et al., which describes four morphological types based on the shape of the  
81 inferior acromial surface: flat (Type I), curved (Type II), hooked (Type III), and convex  
82 (Type IV).<sup>6</sup> Magnetic Resonance Imaging (MRI) has since emerged as the most accurate  
83 modality for assessing both acromion shape and rotator cuff integrity.

84

85 Several studies have examined the relationship between acromion type and impingement or RCI.  
86 While many report an association between Type III (hooked) acromion and non-traumatic  
87 RCI,<sup>2,7-11</sup> others have found no significant relationship.<sup>12,13</sup> Such conflicting results demonstrate  
88 the ongoing uncertainty in the role of acromial morphology in RCI pathogenesis. Notably, nearly

89 all of these studies were conducted among middle-aged and older adults, leaving a gap in  
90 understanding of how acromial morphology relates to RCI in younger populations. Moreover,  
91 there is a lack of local data from the Philippines on this issue. Hence, the primary objective of  
92 this study was to assess the association between acromial morphology and non-traumatic rotator  
93 cuff injury among young adult Filipinos (<40 years old) using MRI-based classification.

94

95 RCIs are known to reduce quality of life to levels comparable with chronic conditions such as  
96 heart failure, diabetes, and depression. Treatment costs can accumulate rapidly, and delays in  
97 appropriate management can result in poorer outcomes. Early identification of anatomical risk  
98 factors, particularly in younger adults, may aid in preventive strategies and more tailored  
99 treatment approaches.<sup>11</sup>

100

## 101 **Methods**

102

103 This cross-sectional study retrospectively reviewed the MRI results of all patients (ages 25 to 50  
104 years) of Makati Medical Center who underwent shoulder MRI from January 1, 2019 to  
105 December 31, 2019 as interpreted by radiologists accredited by the Philippine College of  
106 Radiology and fellows of the CT-MRI society of the Philippines. This study included as cases all  
107 patients with RCI, either tendinosis, partial or full thickness. We excluded individuals with (1)  
108 previous shoulder surgery, (2) fractures and/or dislocation, (3) infections or tumors of the  
109 shoulder, and (4) presence of acromial spurs. Asymptomatic patients with intact rotator cuff were  
110 also included to serve as control.

111

112 All scans were performed using a 1.5-Tesla MRI scanner (Siemens). A shoulder array coil was  
113 used. The patients were positioned supine with their arms on the sides of their body in partial  
114 external rotation. Coronal oblique, sagittal oblique and axial images were obtained. The coronal  
115 oblique plane were selected parallel to the course of the supraspinatus tendon for ideal image  
116 acquisition of the tendon. The sagittal oblique image was used to identify acromion morphology.

117

118 The main outcome was the presence of rotator cuff injury was determined by radiologic report.

119 Complete rotator cuff tears were identified as a hyperintense signal area within the tendon on

120 T2W and fat-suppressed images, seen in two planes. Complete tears are described as T2/PD  
121 signals extending from the articular or bursal surface, which most commonly affect the  
122 supraspinatus tendon. Fluid signal within the tendon defect is highly suggestive of rotator cuff  
123 injury.<sup>14</sup>

124

125 Partial tears were defined as T2/PD signals that extend in either, not both, the bursal or articular  
126 surface. Partial tears are also seen within the tendon substance, hence the term, intrasubstance  
127 partial tear. Radiologists use tendinosis as an all-encompassing term to indicate all tendon  
128 pathology. Also, they may use it to suggest a chronic tendon disease that does not resolve.<sup>15</sup>

129

130 The primary exposure was acromion morphology, classified using the Bigliani system by a  
131 single radiologist (T.B.). Information on age and sex were collected as well. MRI reports and  
132 images of all patients who underwent shoulder MRI were retrieved from the Novarad radiology  
133 information system (NovaRIS) and picture archiving and communication system (NovaPACS) of  
134 the Department of Radiology. The data were tabulated using Microsoft Excel-based data  
135 abstraction tool.

136

137 The sample size was computed with 95% confidence level, an acceptable margin of error at 5%,  
138 an estimated prevalence of rotator cuff injury in certain acromion morphology of 56%.<sup>12</sup> The  
139 computation for sample size suggested a need for at least 132 patients.

140

141 MRI reports and images of all patients who underwent shoulder MRI were retrieved from the  
142 NOVARAD RIS and PACS system of the Department of Radiology. The data were tabulated  
143 using Microsoft Excel-based data abstraction tool.

144

145 Descriptive statistics were used to describe the demographic characteristics (age and sex) of the  
146 participants. Qualitative and quantitative data were numerically expressed as frequencies,  
147 proportions and means  $\pm$  standard deviations (SD).

148

149 The prevalence of rotator cuff injury according to sex and acromion morphology were  
150 determined. For each acromion type, a 2 $\times$ 2 contingency table was constructed comparing the

151 number of patients with the given type versus all others, stratified by RCI status. Fisher's Exact  
152 Test was used for all comparisons due to the small sample sizes, particularly for Types III and  
153 IV. A  $p$ -value less than 0.05 was considered statistically significant. All statistical tests were  
154 conducted in R (v.4.5.0).

155

## 156 **Results**

157

158 A total of 155 Shoulder MRI studies of young adult patients were reviewed and 132 of them  
159 were included in the study due to presence of one of the following: injury of the rotator cuff,  
160 either tendinosis, partial or complete tear with no history of previous shoulder surgery, no  
161 associated fractures nor dislocation, infections or tumors of the shoulder nor presence of  
162 degenerative changes. Of the 155 studies, 20 were not included due to a history of trauma with  
163 fracture and/or dislocation; 5 were also not included due to the presence of degenerative changes  
164 as stated in the exclusion criteria above.

165

166 The mean ( $\pm$  SD) age of the participants is  $31.22 \pm 5.42$ . Of the 132 participants included in the  
167 study, there was a higher proportion of males compared to females (Table 1). The overall period  
168 prevalence of rotator cuff injury was 58.33% ( $n = 77$ ). There was higher prevalence of RCI  
169 among males, as opposed to females. There was no significant difference between the prevalence  
170 of rotator cuff injury among male subjects when compared to that of female subjects ( $p =$   
171 0.4036).

172

173 To determine which acromial shape was most associated with injury, we compared RCI  
174 incidence across types. Among all acromion types, Type II acromion, the most common variant,  
175 showed the strongest association with RCI ( $p < 0.00001$ ). Type III was also linked to higher RCI  
176 rates ( $p = 0.0158$ ). Although Type III acromion was present in only 5 patients, it was associated  
177 with a 100% rate of rotator cuff injury. Type II acromion, the most common variant, was also  
178 linked to higher RCI rates ( $p < 0.00001$ ), possibly due to its curved morphology. Fisher's exact  
179 test did not demonstrate a significant relationship between rotator cuff injury and the presence of  
180 type I acromion ( $p = 0.2041$ ) or type IV acromion ( $p = 0.5287$ ). Detailed frequencies are shown  
181 in Table 2.

182

183 **Discussion**

184

185 The most significant finding in this study is the significant association between acromial  
186 morphology and non-traumatic RCI. Only ~3% of the subjects had Type III acromion and  
187 although rare, all of them were associated with RCI ( $p = 0.00158$ ) compared to other acromion  
188 types. This results align with systematic review findings that Type III morphology nearly triples  
189 the odds of rotator cuff tear compared to Types I–II (OR = 2.82,  $p = 3e^{-6}$ ).<sup>11</sup> This association is  
190 probably due to shape of Type III acromion described as being hooked. A hooked acromion  
191 differs from the Type I and II due to its increased anterior and inferior extension of the acromial  
192 bony process, which is thought to decrease the subacromial space, thereby increasing the  
193 likelihood of extrinsic degeneration of the rotator cuff tendons.<sup>11</sup>

194

195 Type II acromion was also found to be associated with increased occurrence of RCI ( $p <$   
196  $0.00001$ ) which may be due to its curved shape which can also narrow the subacromial space to  
197 some extent. However, being the most common type, Type II acromion can therefore  
198 significantly instigate a high incidence rate of RCI among all of the acromion types and can  
199 notably influence the causal relationship between this certain type and incidence of injury.<sup>16</sup>

200

201 Majority of the subjects were male but there is no significant difference in the incidence of RCI  
202 between sexes. Studies in different populations similarly report no consistent sex-based  
203 differences in acromial morphology among rotator cuff tear cases.<sup>17,18</sup> Also, this study also shows  
204 similar results to studies conducted with different age cohorts, suggesting that Type III acromion  
205 is a risk marker regardless of age. For instance, in a multivariable analysis of surgical cases,  
206 acromial morphology (especially type III) remained significantly associated with RCI even after  
207 stratification by age.<sup>19</sup> But it is unknown whether these relationships are causal, or simply  
208 predictive in nature. Cross-sectional design limits causal inferences. Some investigators have  
209 found no significant correlation between acromion type and cuff tear, reinforcing uncertainty in  
210 the impingement hypothesis.<sup>12,17,20</sup>

211

212 These findings support using MRI-based acromial classification to identify individuals at

213 elevated risk for non-traumatic RCI. Early recognition through imaging may guide targeted  
214 intervention, such as referral to physical therapists, physiatrists or orthopedic surgeons.

215  
216 This study had some limitations. The analysis was not adjusted for many other extrinsic and  
217 intrinsic factors affecting the rotator cuff tendons' risk of injury. Also, the relationship of the  
218 severity/grade of rotator cuff injury and the acromion types was not taken into consideration.  
219 Future prospective studies incorporating multivariate modeling and grading of tendon pathology  
220 may be needed to clarify causality.

## 221 222 **Conclusion**

223  
224 This study corroborates previous findings that type III acromion, although rare, is associated  
225 with a high incidence of non-traumatic rotator cuff injury. Type II acromion was also associated  
226 with RCI but it also has the highest prevalence. No significant association was found between  
227 sex and rotator cuff injury. Identifying those patients at risk may potentially benefit from  
228 corrective or preventive measures to help prevent future injury. Future studies may benefit by  
229 examining a greater number of factors and including a better distribution of acromion types.

## 230 **ETHICS COMMITTEE APPROVAL**

231 Ethical approval was waived by the IRB of Makati Medical Center

## 232 **COMPETING INTERESTS**

233 The authors declare no competing interests.

## 234 **AUTHORS CONTRIBUTIONS STATEMENT**

235 Terence Burgo was responsible for Investigation, Resources, Supervision, Writing – Original  
236 Draft, and Writing – Review & Editing. Brian Pollo contributed to contributed to  
237 Conceptualization, Data Curation, Literature Review, Writing – Original Draft, and Writing –  
238 Review & Editing. Both authors approved the final version of the manuscript.

239

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301

302

303 **Table 1.** Association between sex and presence of rotator cuff injury.

	<b>(+) Rotator Cuff Injury (n = 77)</b>	<b>(-) Rotator Cuff Injury (n = 55)</b>	<b>Total (n = 132)</b>
<b>Male</b>	60.92% (n = 53)	39.08% (n = 34)	100% (n = 87)
<b>Female</b>	53.33% (n = 24)	46.67% (n = 21)	100% (n = 45)

304

305 **Table 2.** Association between acromion morphology and presence of rotator cuff injury.

<b>Acromion Type</b>	<b>(+) Rotator Cuff Injury (n = 77)</b>	<b>(-) Rotator Cuff Injury (n = 55)</b>	<b>p-value</b>
<b>Type I</b>	44.26% (n = 27)	55.74% (n = 34)	0.2041
<b>Type II</b>	70.49% (n = 43)	29.51% (n = 18)	p < 0.00001
<b>Type III</b>	100% (n = 5)	0% (n = 0)	0.00158
<b>Type IV</b>	40% (n = 2)	60% (n = 3)	0.5287

306

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