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# ACROMION MORPHOLOGY AND ITS RELATIONSHIP WITH SUB ACROMIAL IMPINGEMENT

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### Abstract

**Background And Objectives:** Shoulder pain due to Impingement syndrome is a common clinical entity. The cause of which are generally supported by typical changes in Acromion morphology on standard radiographs. We Evaluated 5 commonly used radiographic parameters of acromial morphology and assessed the association between different radiographic characteristics on the one hand and sub-acromial impingement on the other.

**Methods:** Measurement of acromial type (Bigliani), acromial Slope (AS), acromial tilt(AT), Lateral acromial angle (LAA), and acromion index (AI) were done on standard radiographs of 100 patients with sub acromial impingement and 100 controls without sub-acromial pathology.

**Results:** The acromial type III according to Bigliani was associated with Impingement, A statistically significant difference between controls and impingement patients was found for AS. AT of controls was significantly smaller than that of impingement patients. LAA of controls was not significantly different from that of impingement patients. AI of controls was significantly lower than of impingement patients. A good correlation was found between acromial type and AS.

**Interpretation And Conclusions:** A low lateral acromial angle and a large lateral extension of the acromion are associated with a higher prevalence

of Impingement. Type II Acromion is most common type whereas Type III is a risk factor for Impingement. Higher degrees of Acromion slope and lower degrees Tilt are found in Impingement syndrome.

**Keywords:** Acromion, Impingement, Bigliani

## Introduction:

The shoulder is a complex joint consisting of four joints, two spaces, numerous stabilizing ligaments and more than thirty muscles and their respective tendons. There needs to be a synchronized movements to function properly with acromion process being an important structure.<sup>1,4</sup> Movements of the human shoulder represent the result of a complex dynamic interplay of structural bony anatomy and biomechanics, static ligamentous and tendinous restraints and dynamic muscle forces, injury to one or more of these components through overuse or acute trauma disrupts this complex inter-relationships and places shoulder at risk. Shoulder pain causes significant morbidity being the 3<sup>rd</sup> most prevalent Musculoskeletal complaint, the common causes of shoulder pain being rotator cuff disorders,<sup>2,17</sup> Impingement syndromes gleno-humeral disorder, acromio-clavicular joint diseases and referred pain from neck, with rotator cuff disorders being most common cause.<sup>8</sup> The morphology of acromion has been considered as the main cause of sub-acromion disease as in impingement syndrome, tendinitis and cuff-rotator tears.<sup>3,7,16</sup> The predominant theory for Impingement syndrome classifies the contributing factors as anatomical and functional, anatomical includes shape and inclination of acromion, the slope and length of acromion and height of the arch is more closely associated with degenerative changes. The morphology of acromion as first described by Bigliani based on radiography into Type I- Flat, Type II-Curved, Type III-Hooked and later on Type IV-convex was added.<sup>4,5</sup> Neer outlined the stages of impingement stage I-Included inflammation, oedema and haemorrhage of conjoint

tendon, usually affecting people below 25 years of age, stage II is a continual process of stage I but symptoms are consistent and usually affects patients between 25 to 40 yrs.<sup>12</sup>

In 1931, Codman originally described degenerative changes of the tendons that initiate rotator cuff tears (Codman and Akerson 1931).<sup>6</sup> On the other hand, Armstrong suggested in 1949 that compression of the bursa and rotator cuff tendons under the acromion causes the supraspinatus syndrome (Armstrong 1949).<sup>2</sup> Later on, Neer (1983) stated that 95% of cuff tears are caused by mechanical impingement and reported successful treatment by anterior acromioplasty (Neer 1972).<sup>12</sup> However, acromioplasty is still the standard operative treatment for impingement lesions, and there has been a substantial increase in its incidence in the United States (Vitale et al. 2010).<sup>25</sup> Although the indication for acromioplasty is based on clinical evaluation of the patient, it is generally supported by typical changes in acromial morphology on standard radiographs (Neer 1972, Aoki et al. 1986, Bigliani et al. 1986, Zuckerman et al. 1992, Banas et al. 1995, Toivonen et al. 1995, Tetreault et al. 2004).<sup>1,4,20</sup> In some studies, a type-III acromion has been found to be associated with a higher prevalence of rotator cuff tears (Bigliani et al. 1986, 1991, MacGillivray et al. 1998) whereas not all authors have found this (Ozaki et al. 1988, MacGillivray et al. 1998).<sup>10,15</sup> Several attempts have been made to classify the acromial morphology. Bigliani et al. (1986) and Kitay et al. (1995) described the acromial slope (AS; Figure 1A), and Kitay et al. (1995) and Aoki et al. (1986) described the acromial tilt (AT; Figure 1B).<sup>9</sup> Other authors have

focused on the lateral rather than the anterior extension of the acromion (Banas et al. 1995, Tetreault et al. 2004, Nyffeler et al. 2006).<sup>14</sup> Banas et al. (1995) described the frontal plane slope of the acromion on MRI and found a lower lateral acromial angle (LAA; Figure 1C) in patients with rotator cuff disease. Nyffeler et al. (2006) observed that the acromion of patients with a rotator cuff tear appeared to have a more lateral extension than that of patients with an intact cuff, and described the acromion index (AI; Figure 1D).<sup>14</sup> Despite the numerous studies that have been carried out in an attempt to support or refute Neer's original theory of extrinsic mechanical impingement as the primary etiology of rotator cuff disease, the role of the acromion is still unclear.<sup>11</sup> We therefore evaluated 5 commonly used parameters of acromial morphology (acromial type, acromial slope, acromial tilt, lateral acromial angle, and acromion index) and their relationship to subacromial impingement and rotator cuff tears.

## Materials and Methodology:

It was a cross sectional study conducted at Department of Orthopaedics Victoria Hospital Bangalore from August 2018 to April 2019. Case subjects included 100 patients presented with Shoulder pain and was clinically diagnosed with Sub acromial Impingement according to Neer and Hawkins's tests, Control subjects included 100 patients with Symptoms of shoulder pain unrelated to impingement and was ruled out by Neer and Hawkins's tests and did not have any weakness in rotator cuff tests (starter test, Jobe test, internal and external rotation, belly-press test, and liftoff test). Study

and control groups were subjected to radiography of shoulder joint, For the true anteroposterior radiograph, the patient was positioned with the scapula adjacent to the X-ray cassette.<sup>14</sup> The arm was held in neutral position with the elbow extended and the thumb aiming anterior. Beam alignment was 20° caudal. For the outlet-view radiograph, the affected shoulder with the arm hanging was turned 30° away from the X-ray stand. Beam alignment was tangential to the scapula, 10–15° caudo-cranial.<sup>13</sup> The following characteristics of Acromion were assessed

**Acromial type:** The acromial type was classified according to Bigliani et al (1986). Type I -Flat, Type II -Curved, and type III -Hooked, Type IV-Convexon outlet-view radiographs.

**Acromial slope:** The acromial slope (AS) was measured on outlet-view radiographs according to Bigliani et al. (1986) and Kitay et al. (1995). One line was drawn connecting the most anterior point of the inferior acromion and the midway point on the inferior acromion. Another line was drawn connecting the most posterior point of the inferior acromion with the same midway point. The angle ( $\delta$ ) formed by these 2 lines represented the AS.

**Acromial tilt:** The acromial tilt (AT) was measured on outlet-view radiographs as described by Kitay et al. (1995) and Aoki et al. (1986). One line was drawn connecting the most posterior point of the inferior acromion to the most anterior point of the inferior acromion. Another line was drawn connecting the same most posterior point of the inferior acromion to the inferior tip of the coracoid process. The resulting angle ( $\beta$ ) represented the AT.%

**Acromion index**<sup>24</sup>: The acromion index (AI) was measured on true anteroposterior radiographs according to Nyffeler et al. (2006). The distance from the glenoid plane to the acromion (GA) was divided by the distance from the glenoid plane to the lateral aspect of the humeral head (GH). The larger the extension of the acromion, the higher the AI.

**Lateral acromial angle:** The lateral acromial angle (LAA) was measured on true anteroposterior radiographs according to Banas et al. (1995). One line was drawn along the superior- and inferior-most lateral points of the glenoid and represented the glenoid surface. Another line was drawn parallel to the acromion undersurface. The angle between these 2 lines (a) represented the LAA.

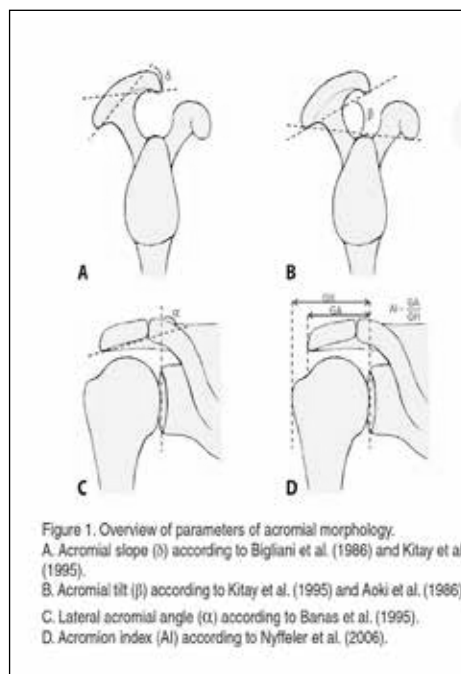
The appropriateness of the radiographs was evaluated by 2 independent examiners. Only when

both examiners were convinced about the quality of the radiographs were they used for the study. Measurements were made according to agreement by both examiners who were unaware of the underlying clinical symptoms.

**Statistics:** Acromion type according to Bigliani, AS, AT, LAA, and AI were tested for correlation to each other and to sex, side, and age using the Pearson correlation coefficient (PCC), which was graded as excellent (0.81–1.00), good (0.61–0.80), moderate (0.41–0.60), fair (0.21–0.40), or poor (0.00–0.20). The means for age, AS, AT, LAA, and AI from each group were compared using the Mann-Whitney U test. The significance level was set to  $p < 0.05$ . Calculations were done using SPSS software version 13.0. The study was reviewed and approved by the local ethics committee.

**Table 1 : Frequencies**

Groups	Sex		Bigliani shape			
	Males	Females	I	II	III	IV
1 (controls)	74	26	18	62	20	0
2 (Impingement)	68	32	20	42	36	2



**Table 2 :Descriptive studies**

Group 1	Mean	Range	SD
Age in Years	52	40-80	12
Acromion Slope	25°	8°-47°	9
Acromion Tilt	38°	20°-45°	8
Lateral acromion angle	81°	74°-92°	8
Acromion index	0.62	0.50-0.94	0.2
Group 2			
Age in years	48	40-78	10
Acromion Slope	29°	8°-46°	13
Acromion Tilt	36°	25°-45°	8
Lateral Acromion angle	80°	74°-92°	8
Acromion Index	0.68	0.5-0.96	0.2

**Table 3:Correlations**

	Age	Bigliani type	Acromion slope	Acromion Tilt	Lateral acromion angle	Acromion Index
Age						
PCC		<0.001	-0.006	0.09	-0.34 <sup>a</sup>	0.24 <sup>a</sup>
P-Value		1.0	0.8	0.4	<0.001	0.01
Bigliani						
PCC	<0.001		0.74 <sup>a</sup>	-0.24 <sup>a</sup>	0.077	-0.078
P-Value	1.0		<0.001	0.01	0.4	0.3
Acromion Slope						
PCC	-0.006	-0.74 <sup>a</sup>		-0.17 <sup>a</sup>	0.069	0.056
P-Value	0.8	0.01		0.04	0.4	0.5
Acromion Tilt						
PCC	0.09	-0.24 <sup>a</sup>	-0.17 <sup>b</sup>		-0.26 <sup>a</sup>	0.24 <sup>a</sup>
P-Value	0.4	0.01	0.004		0.001	0.003
Lateral Acromion angle						
PCC	-0.34 <sup>a</sup>	0.077	0.07	-0.26 <sup>a</sup>		-0.49 <sup>a</sup>
P-Value	<0.001	0.4	0.4	0.001		<0.001
Acromion Index						
PCC	0.24 <sup>a</sup>	-0.078	-0.056	0.24 <sup>a</sup>	-0.49 <sup>a</sup>	
P-Value	0.01	0.3	0.5	0.003	<0.001	

**PCC:** Pearson correlation coefficient which was graded as excellent (0.81-1.00), good (0.61-0.80), moderate (0.41-0.60), fair (0.21-0.40), or poor (0.00-0.20).

<sup>a</sup> - Correlation is significant at the 1% level (2- tailed)

<sup>b</sup> - Correlation is significant at the 5% level (2- tailed)

**Discussion:**

Total of 52% of study population had Type II Acromion. As high as 36% of Impingement Group had type III Acromion as compared to 20% in the control group. Acromion of type II was common in both impingement and control groups without any significant differences. Like other authors, we did not find any significant correlation between acromion type

and age (Banas et al. 1995, Vahakari et al. 2010).<sup>24</sup> The acromial slopes of controls were generally small than impingement patients, they did not differ significantly in this respect. The slope angle showed a good correlation with the Bigliani classification (Table 3). The average AS being related to acromial type is in accordance with the results of Toivonen et al. (1995).<sup>21</sup> Tuite et al.<sup>23</sup> (1995) found a mean AS

angle of 25° in patients with an intact rotator cuff and 29° in patients with Impingement. Thus, whereas the AS and the Bigliani classification are not useful for prediction of the likelihood of a cuff tear in most shoulders, the rare occurrence of a very high slope angle corresponding to an extremely hooked acromion appears to give a hint of rotator cuff disease even in younger patients. In our patients the tilt angle in the controls was Higher than in pathological shoulders. A statistically significant correlation between the LAA and Impingement (Table 3). The LAA showed fair correlation with age in our study (Table 3), and there was moderate correlation (PCC = 0.46) in the original study by Banas et al. (1995). Like these authors, we did not find a significant correlation between LAA and acromion type according to Bigliani (Table 3). In our opinion, the LAA can help differentiate on the one hand between controls and Impingement. Regarding the acromion index (AI), the findings by Nyffeler et al. (2006) and Torrens et al. (2007) are supported by our study.<sup>22</sup> We found a significantly lower AI in controls than in Impingement. The average AI in our study was similar to that in the study by Nyffeler et al. (2006), which speaks for the consistency of the measurement technique. As mentioned by Hamid et al., the contrary findings might in part be explained by subtle differences in the methods of radiographic assessment.<sup>8</sup> Taking into account the similarity of the results by us, by Nyffeler et al. and by Torrens et al., we are convinced that the AI can help differentiate between healthy shoulders and shoulders with subacromial pathology. This latter differentiation appears to be possible using the LAA. In the present study, the patients with subacromial impingement were the

same age as the controls, showing no increase with age (Banas et al. 1995, Yamaguchi et al. 2006).<sup>26</sup> Regarding the different classifications and their correlation with age, we only found fair correlations for LAA and AI. This supports the findings by Vahakari et al. (2010) who evaluated routine outletview radiographs in different age groups and did not find any statistically significant differences. The present study had some limitations. Suboptimal radiographs may influence the different measurements (Prato et al. 1998, Stehle et al. 2007).<sup>18</sup> Although 2 experienced orthopedic surgeons who were blinded regarding the diagnoses evaluated the radiographs, we did not test the reliability of our measurements. As some radiographic parameters also correlate with age, this again might have caused bias. Because this correlation was at best fair, we still believe in the significance of our results. Patients presenting with a “bruised shoulder” at a trauma department served as controls. We excluded patients with fractures, tumors, previous surgeries, rotator cuff tears. The latter was only excluded by clinical examination, but we did not check for asymptomatic rotator cuff tears (e.g. by MRI or ultrasound). Thus, we might have accidentally included patients with asymptomatic cuff tears in our control group. In summary, low lateral acromial angle and a large lateral extension of the acromion are associated with a higher prevalence of Impingement. Type II Acromion is most common type whereas Type III is a risk factor for Impingement. Higher degrees of Acromion slope and lower degrees Tilt are found in Impingement syndrome.

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