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# A systematic review: Of acromion types and its effect on degenerative rotator cuff tear

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**Abstract**
**Background:** Shoulder joint pain is commonly seen in primary care. Were many of them diagnosed with rotator cuff disease especially involvement of supraspinatus tendon of rotator cuff. The progression of disease leads to tear of rotator cuff and the etiology is multifactorial. However, characteristic changes of acromion morphology appear as major risk factor for rotator cuff tear. According to an ancient classification of acromion type I (flat), type II (curved), or type III (hooked) introduced by Bigliani *et al*. also documented that incident of rotator cuff tear highly increased with type III (hooked) acromion. Continue study over acromion shape a rare new type IV (convex) acromion also discovered. Many studies have attempted to correlate acromion characteristic with rotator cuff tears. But result still we attempted to determine the rotator cuff tear in association with different shape of acromion through a systemic review of appropriate studies.
**Methods:** Pubmed, Scopus and Baidu scholar database engine searched, limiting results to those published in the *English* language without limiting year. The key search terms utilized were "acromion morphology"/"rotator cuff tear" and "shoulder joint" / "impingement syndrome". Over 150 abstract reviewed and 20 literatures were analyzed for quality and relevance study.
**Conclusions:** On the base of previous published article, the different types of acromion shape distribution is not equally seen in population. The most common type II acromion appears large in number with or without rotator cuff disease. Those with type III acromion more than 70% found with degenerative changes or tear of rotator cuff. Current evidence suggests that pathological changes or tear of rotator cuff arise from a multivariare etiology. It increasingly evident that type III acromion plays greater role to rotator cuff tear than other type I and type II of Bilgiani acromion classification.

**Keywords:** Acromion, rotator cuff tear, type III acromion, impingement syndrome, supraspinatus tear

## 1. Introduction
Shoulder joint pain commonly seen in primary care, where most of them are diagnosed with musculoskeletal diseases of shoulder joint. After spine and knee, 16% of the musculoskeletal diseases appear in patients with shoulder joint pain [1]. In the musculoskeletal disease in patient with chronic shoulder pain, the degeneration or tear of rotator cuff tendon is most commonly involved. The etiology of rotator cuff tear (RCT) is multifactorial and remains poorly understood. However, degenerative changes of rotator cuff most likely increases the chances of cuff tear in over head worker, athletes and old age are equally affected. The factor leads to injuries of the tendon are categorized in intrinsic, extrinsic and traumatic causes [2-6]. Intrinsic factor of rotator cuff injuries usually associated with age of patient, decrease vascularization of soft tissue, atrophy and fatty deposition or infiltration of muscle tendon [2, 3]. Most important extrinsic factor that influences the injury of cuff characteristically changes of acromial morphology [4], internal impingement [5], thoracohumeral kinetics [6]. The principle of extrinsic factor leads to mechanic compression of rotator cuff and its surrounding soft tissue causing external impingement syndrome.
In 1972 Neer described pathological interaction of anterior third of the acromial, coracoacromial ligament abutted against the tendinous portion of the rotator cuff leading to rotator cuff tearing over time so called "impingement syndrome" [7]. Many other authors and Numerous subsequent studies have supported Neer's theory of extrinsic impingement leading to cuff disease and combined the procedures of cuff repair and anterior acromioplasty [8-11].

Even before Neer, in 1949 Armstrong *et al*. postulated that a subacromial space lead to narrowing by compression of bursa undersurface of the acromion. Thus, leads to rotator cuff injuries [12] mainly to the superaspinatus (SSP) tendon. Further study described rotator cuff pathology in landmark book "The Shoulder Rupture of the Supraspinatus Tendon and Other Lesions in and about the Subacromial Bursa" [44]. The author purposed that, the changes over acromial are secondary to degenerative changes of rotator cuff itself and initiate rotator cuff tears as intrinsic process. The specific etiology of degenerative changes on the rotator cuff and further injuries due to acromial morphology remain in controversy. On the other hand, many different radiological parameters has been introduced and already being use in clinical practice to predict the RCT. Predictive RCT parameters like acromion morphology, acromion index(AI), critical shoulder angle (CSA) and lateral acromion angle (LAA) are strongly support the extrinsic factor [8, 13, 14]. Especially acromion involvement is most likely factor was suggested for rotator cuff degeneration. In 2006, Nyffeler *et al*. described a more lateral extension of the acromion measured by the AI in patients with a rotator cuff tear [13]. Recently, in 2013 B.K Moor introduced the CSA, were the angle combines the lateral extension of the acromion and the incitation of the glenoid as a risk factors for RC tear [14]. The measurement of these all radiological parameter is depends on the acromial shape.

The best known acromion shape classification first described by Bigliani in 1986, the acromion can be classified as Type I: flat (fig.1), Type II: curved (fig. 2) or Type III: hooked (fig. 3). Some author found that in cadavers with a hooked acromion, there was a 70% incidence of rotator cuff tears [8]. In a subsequent clinical study, similar findings were reported and considered acromial morphology (type III) as a risk factor for degenerative RCT [8, 15]. The acromial shape appears as highly important factor not just to predict RCT but also for surgical treatment in patient with rotator cuff tear. Continues study over acromial shape in 1993, Gagey *et al*. discovered a new convex shaped type-IV acromion (fig. 4) [16]. This type of acromion again revealed by Vanarthos *et al*. in 1995 & study suggest the incidence of this type of acromion is uncommon in population [16, 17]. Further study of Bigliani acromion classification system was questioned because of reported poor inter-observer reliability and the difficult in standardized radiographs measurement [13, 18, 19]. Despite mounting controversial evidence, Bigliani classification of acromion morphology is still widely used in clinical practice and plays a large role in the consideration for acromioplasty to achieve type I (flat) shape to decompress the subacromioal space. Therefore our purposes of study to revise the previous literature to know characteristic changes of acromion types and its relationship to the degenerative rotator cuff tear.


**Fig 1:** Flat undersurface


**Fig 2:** Curved undersurface


**Fig 3:** Hooked shape

**Fig 4:** Upward or superior convexity of inferior border

## 2. Materials and Methods

For this study we used PubMed, Scopus and Baidu scholar search engine by giving search term "acromion morphology"/"rotator cuff tear" and "shoulder joint"/ "impingement syndrome" without limiting published year to avoid any related information. There were numerous literatures found which are previously published. Specific aim of ongoing prospective study regarding study of RCT due to acromion morphology 350 abstract was revised. To include study we focused on rotator cuff degenerative change or RCT based on acromion morphology with or without trauma, arthroscopic or surgical finding and radiological evaluation of

cuff tear and acromial morphology were selected. We have excluded many articles which were linked to animal experiment, biomechanics and other journal identified those not applicable to the study. About 60 studies were thought to be appropriate for analysis and as well thoroughly reviewed. Following revision of all articles we exclude articles which had data of RCT due to shoulder implant, lesion and purpose to surgical technique. On the basis of Bigliani *et al*. classification of acromion shape described in 1986 and their relationship with RCT also briefly described. Since, then many authors used verity of method to clarify relationship of acromion with RCT for example, radiological and ultrasound evaluation [20-25], cadavers specimen experiment [10, 26-28] and arthroscopic and surgical finding [29, 30]. After all detail of evaluation 49 literatures concluded those are correlated acromion morphology and impingement syndrome or rotator cuff tear.

## 3. Results

After given a related term on Pubmed, Scopus and Baidu scholar there were 350 literatures found and finally 60 articles were selected. To specify our study we excluded seven articles which had poor evidence and finally 49 applicable literatures selected. From these studies 20 literatures were finally selected for analysis those are able to reflect the details of acrmion morphology and its effect on rotator cuff tear. From these literatures some author described the distribution of acromion morphology were other authors specifically explained each type of acromion and their influence on degenerative rotator cuff tear.

The various types of method described in the literature for the identification of acromion types and factors behind rotator cuff disease were as follows; dried scapulas, cadaveric scapulas and living subjects. Dried and cadaveric Scapulas were examined either visually [26] or by radiographs [27, 28]. While other authors examined some patient or volunteers to evaluate shoulder condition and related factors by using radiograph [8, 15, 25, 30-34, 37] and MRI [9, 16, 17, 21, 35].

### 3.1 Distribution of acromion types in general population

Clinical importance of the standard ancient classification acromial type I (flat), type II (curved) and type III (hooked) described in 1986 by Bigliani *et al*. on the basis of his classification of acromoin types some authors focused on to understand characteristic appearance of acromion types in literature [8-9, 15-17, 21, 25-28, 30-33, 35-38].

In the literature, the percentages of acromial types vary to a great extent: 5.4%–67.7% for type I, 24.2%–83% for type II, 0%–42.4% for type III, and 1.6%–13.3% for type IV. On the basis of following data type I and III acromion was appear in large number after most common type II acromion. While, Gagey *et al*. discovered new type of acromion type IV after that some author also found type IV acromion in very least number [16-17, 35]. These findings are compared in Table 1. Differences may reflect the subjective nature of the classification method, the type of sample, and the method used for the examination.

### 3.2 Characteristic presence of acromion types in patient with or without degenerative RCT.

Considering rotator cuff disease due acromion shape firstly Bigliani *et al*. [8] and Morission & Bigliani *et al*. [15] found close relationship 70% and 80% Rotator cuff tear（RCT）associated with acromial type III (hooked). During review we choose six literature for our final study by Balke *et al*. [4], Epstein *et al*. [9], Hirano *et al*. [21], Mohamed *et al*. [23], Toivonen *et al*. [25] and Farley *et al*. [35]. These authors also suggest high prevalence of impingement syndrome and Rotator cuff tear associated with acromial type III (hooked). In detail findings are,

According to above table 2, types of acromion was divided according to their presence in a group of sample with normal rotator cuff and degenerative RCT. This table reflects the presence of all type of acromian in every group except type IV found none in number with degenerative cuff disease group. While, most common type II acromion appear equally about 50% in each group of patients with impingement or RCT and with normal rotator cuff [4, 9, 23]. Therefore, type II acromion statistically found no significant ($p>0.05$) for any group including healthy rotator cuff, impingement or partial tear of cuff and rotator cuff tear. Second common type I acromion were also presented in large number in all patients group with non-significant and less viability. On the table type III acromion were highly associated in patients with degenerative partial rotator cuff and complete rotator cuff tear. Bigliani *et al*. (1986) found 66% type III acromions among 33 cadavers with RCTs, although this type of acromion was present in only 38.6% of all specimens. The majority of studies have subsequently confirmed this correlation [4, 9, 23, 21, 25, 35]. Previous study in patients with RCT hooked acromion were presented in range from 20%-62% comparing non pathological cuff with presence of hooked acromion (2%-25%). In the study patients with RCT had significantly increased prevalence of type III acromion compare to non-pathological group ($p<0.05$).

**Table 1:** Distribution of acromion types

| Author/ year | Classification Method | Acromion types (%) | | | |
|---|---|---|---|---|---|
| | | I | II | III | IV |
| Bigliani *et al.* (1986) | Radiographs | 18.6 | 42 | 38.6 | - |
| Morrison *et al.* (1987) | Radiographs | 18 | 41 | 41 | - |
| Epstein *et al.* (1993) | MRI | 29.7 | 37.8 | 32.5 | - |
| Gagey *et al.* (1993) | MRI | 27.5 | 58.8 | 12.1 | 1.6 |
| Farley *et al.* (1994) | MRI | 47 | 39 | 11 | 3 |
| Toivonen *et al.* (1995) | Radiographs | 5.4 | 62.5 | 32.1 | - |
| Vanarthos *et al.* (1995) | MRI | 40 | 36.7 | 10 | 13.3 |
| Yazici *et al.* (1995) | Visual inspection | 22.5 | 75 | 2.5 | - |
| Getz *et al.* (1996) | Visual inspection | 22.8 | 68.5 | 8.6 | - |
| Nicholson *et al.* (1996) | Radiographs | 32 | 42 | 26 | - |
| Wang *et al.* (1997) | Radiographs | 40.8 | 44.9 | 14.3 | - |
| Wang *et al.* (2000) | Radiographs | 6 | 66 | 28 | - |
| Speer *et al.* (2001) | Radiographs | 11.5 | 84.5 | 4 | - |
| Shah *et al.* (2001) | Visual inspection | 17 | 83 | | - |
| Hirano *et al.* (2002) | MRI | 36.3 | 24.2 | 39.6 | - |
| Worland *et al.* (2003) | Radiographs | 7.6 | 50 | 42.4 | - |
| Aydin A *et al.* (2011) | Arthroscopy | 13 | 53.3 | 33.3 | - |
| Balake *et al.* (2014) | Radiographs | 21 | 67 | 13 | - |

**Table 2:** Presence of acromion types in patient with normal rotator cuff and degenerative or full thickness RCT. Compare to type I and type II acromion in patient with pathological rotator cuff type III appear highly significant ($p<0.05$)

| Author/ year | Total patient | patient with normal rotator cuff Acromion types (%) | | | patient with full thickness RCT Acromion types (%) | | | patient with impingement syndrome/ partial RCT Acromion types (%) | | |
|---|---|---|---|---|---|---|---|---|---|---|
| | | Type I | Type II | Type III | Type I | Type II | Type III | Type I | Type II | Type III |
| Maurice Balke/2013 | 150 | 9(18%) | 40(80%) | 1(2%) | 14(28%) | 26(52%) | 10(20%) | 14(28%) | 26(52%) | 10(20%) |
| Robert E.Epstein/1993 | 111 | 20(43%) | 21(45%) | 6(13%) | 3(9%) | 10(29%) | 21(62%) | 10(33%) | 11(37%) | 9(30%) |
| Mako Hirano/2002 | 163 | 34(47.5%) | 14(19.5%) | 24(33%) | 33(36.3%) | 22(24.2%) | 36(39.5%) | - | - | - |
| Rainia E. Mohamed/2013 | 86 | 9(30%) | 13(43.3%) | 5(16.7%) | 16(28.6%) | 25(44.6%) | 13(23.2%) | - | - | - |
| David A. Toivonen/1995 | 91 | 3 (14%) | 17(77%) | 2(9%) | 0 | 18 （53%） | 16 （47%） | 13 （37%） | 15 （43%） | 7 （20%） |
| Farley T E。 / 1994 | 76 | 12 （39%） | 15 （48%） | 1 （3%） | 17 （38%） | 18(40%) | 8 （18%） | - | - | - |

Nature of acromion types present in pathological and non- pathological rotator cuff

## 4. Discussion

Bigliani classification is unanimously used in all articles, according to this method the acromial type was identified by radiograph and inspecting the lateral aspect of the acromion. Performing additional sagittal oblique MRI, Gagey *et al*. in 1993 originally described the fourth (convex) type of acromion in 3 out of 182 (1.6%) shoulders [16]. Later on some author also observed this type of acromion in the range(1.6%- 13%) concluding study from table 2 [17, 35]. In the current study, the incidence of type IV acromions was 2.6% and the incidence of this type of acromion suggested as uncommon type of acromion. Apart from percentage of acromial types, the prevalence of rotator cuff tear with convex type acromion was mentioned none. However, our goal is to clarify relationship between acromion morphology and RCT. There for we collect previous published study data and thoroughly analyzed. The acromion has been implicated in the pathogenesis of rotator cuff disease for many years. type I & type II acromion was presented in large number in all group according to table 1 but the only type III acromion characteristically found highly significant($p<0.001$) with degenerative RCT [25]. Over all, study also found 90% of shoulders with a type III acromion had partial or complete RCT [25].

Neers *et al*. described the mechanism of subacromial impingement and investigated the anterolateral acromion as a critical area, were supraspinatus tendon frequently get contact with acromion [7]. Considering non traumatic RCT appear as a final result of progressive degeneration or impingement of rotator cuff. The condition may aggravate by over use of rotator cuff and age related changes of cuff tendon [39-41]. Recently, Garber etc. introduced the instability ratio by calculating Joint reaction force [42]. were the study suggested that the low angle of active abduction of arm affect stability of joint and increase extra load over supraspinatus tendon to maintain the stability of shoulder joint. In the range between 6-$61^0$ of low angle abduction supraspinatus muscle required 33% additional load to maintain the joint stability [42, 43]. Following condition of SSP on low active abduction arm may get worse in patient with impingement syndrome or partial rotator cuff tear. According to previous evidence 70% of type III acromion was associated with the degeneration or tear of rotator cuff [8]. Type III acromion found highly correlated with RCT compare to type I & II acromion [4, 9, 21, 23, 25, 35]. Further cadaveric investigations showed a close relationship between acromial shape and rotator cuff disease [15]. On recently published article 20% of subacromial pathology is associated with Bigliani classification type III acromion and only 2% was presented in asymptomatic shoulder joint [4]. This indicates in patients with acromion type III and low active abduction of arm are prone to tear of rotator cuff.

The study also described the majority of RCTs are the result of subacromial impingement [19]. On the other hand, Codman believed that acromial changes were secondary to degeneration of the rotator cuff itself and that initiation of a RCT was an intrinsic process [44]. Nicholson *et al*. explained that Acromial morphologic condition as evaluated by outlet radiographs is independent of age and appears to be a primary anatomic characteristic [45]. The variations observed in acromial morphologic condition are not acquired from age-related changes and spur formation and thus contribute to impingement disease independent of and in addition to age-related processes [45].

Since, Neer's *et al* described the mechanism of impingement syndrome; based on his concept Parskevas *et al*. reported that the hooked acromion reduced the dimension of subacromial space [46]. This relation explains the factor more often leads to impingement of rotator cuff tendon and gradually to tendon tear. Study also proved the clinical significance of acromion shape anterior lateral relation to rotator cuff disease [46]. Supporting Neer's theory, many authors started to use partial anterior acromioplasty to treat rotator cuff disease. This procedure was introduced to decompress the desire subacromial space to prevent further damage of rotator cuff and the procedure was associated with good clinical result [47-49]. Bigliani's classification is still widely used to classify acromial morphology and play large role in consideration of acromioplasty.

Etiology of rotator cuff pathology is multifactorial and specific one is remain in debate. However, previous published evidence lead to support severity of rotator cuff pathology or tear higher with type III acromion independent of an addition with age related changes of rotator cuff. Except of this risk factors for rotator cuff tear, there were also low active abduction of arm was also result to increase the risk for RCT by increasing superaspinatous load to maintain the glenohumeral joint stability.

## 5. Conclusion

Based on mention literature above, Bigliani classification of acromion morphology anonymously used in different study. Were the study found most common type of acromion type II in population with or without pathological change of rotator

cuff. While, type IV found least common type of acromion. Following studies has been also expressed the details of acromion shape and its effect towards degenerative rotator cuff changes. The presence of acromial type III (hooked) in association with Rotator cuff tear (RCT) significantly higher than type I and type II. Review analysis of our study also led to support there is highly chances of degenerative change and RCT with acromial type III.

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