Cuff Tear Arthropathy: Classifications

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6.1 Introduction

Rotator cuff tear arthropathy is a term coined by Neer in 1983, and it encompasses a broad spectrum of pathology [1]. All patients with rotator cuff tear arthropathy possess at least three critical features: (1) rotator cuff insufficiency, (2) degenerative changes of the glenohumeral joint, and (3) superior migration of the humeral head [2].

The glenohumeral joint lacks substantial intrinsic osseous restraints, and thus the joint's stability relies heavily on the rotator cuff's ability to center the humeral head within the glenoid fossa [3, 4]. This key concept has been coined concavity-compression. Through this mechanism, the shoulder musculature—including the rotator cuff—becomes the primary stabilizer of the glenohumeral joint as the arm moves through positions in which the capsule ligamentous structures are lax [3, 5].

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Patients with a massive rotator cuff tear may present with a clinical pattern of combined loss of active elevation and external rotation (CLEER) [6]. Their daily activities may be reversely limited due to a muscle imbalance in both the horizontal and vertical planes.

In particular, activities involving external rotation (eating, drinking, brushing teeth, etc.) may be impossible and lead to a severe handicap in daily life. In such situation, the absence of the rotator cuff causes the head of the humerus to ride upward.

The definition of an irreparable rotator cuff varies widely. At one extreme some surgeons argue that all rotator cuff tears are reparable. Others consider tears with a chronic acromiohumeral distance (AHD) less than 7 mm [7] or atrophy greater than grade 2 [8] irreparable. Fatty degeneration is irreversible even with repair and leads to reduced function of the rotator cuff musculature [9]. If associated with preoperative supraspinatus tendon length of less than 15 mm, MRCT (massive rotator cuff tear) with Goutallier Stages 2 to 3 MRCT fails to completely heal in up to 92% of cases [10]. Acetabularization of the acromion and femoralization of the humeral head are preoperative factors reflecting significant chronic static instability and are a contraindication for repair.

Once a MRCT is identified, it can be further classified according to Collin et al. [11]. In this classification, the rotator cuff is divided into five components: supraspinatus, superior sub-

scapularis, inferior subscapularis, infraspinatus, and teres minor (Fig. 6.1).

Rotator cuff tear patterns can then be classified into five types: type A, supraspinatus and superior subscapularis tears; type B, supraspinatus and entire subscapularis tears; type C, supraspinatus, superior subscapularis, and infraspinatus tears; type D, supraspinatus and infraspinatus tears; and type E, supraspinatus, infraspinatus, and teres minor tears (Fig. 6.2) [11].

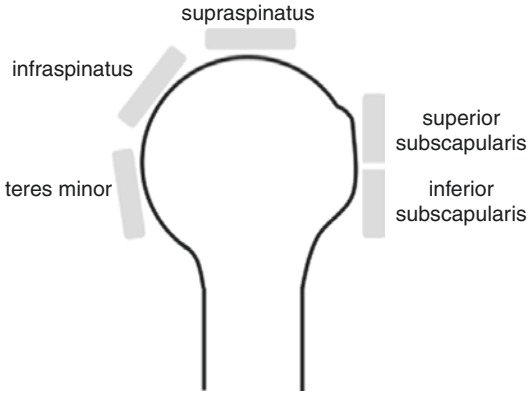

Fig. 6.1 The rotator cuff is divided into five components: supraspinatus, superior subscapularis, inferior subscapularis, infraspinatus, and teres minor (Reproduced from Collin P, Matsumura N, Lädermann A, Denard PJ, Walch G (2014). Relationship between massive chronic rotator cuff tear pattern and loss of active shoulder range of motion. J Shoulder Elbow Surg 23(8):1195–202. doi:https://doi.org/10.1016/j.jse.2013.11.019)

This classification not only subclassifies massive tears but has also been linked to function, particularly the maintenance of active elevation [11].

6.2 Cuff Tear Arthropathy Classification

A concise definition of cuff tear arthropathy would probably be glenohumeral osteoarthritis with a concomitant massive rotator cuff tear and rotator cuff dysfunction. The spectrum of cuff tear arthropathy ranges from superior migration of the humeral head with only regional chondromalacia to collapse of the humeral head with full-thickness cartilage defects. Numerous radiologic classification schemes have been proposed [12].

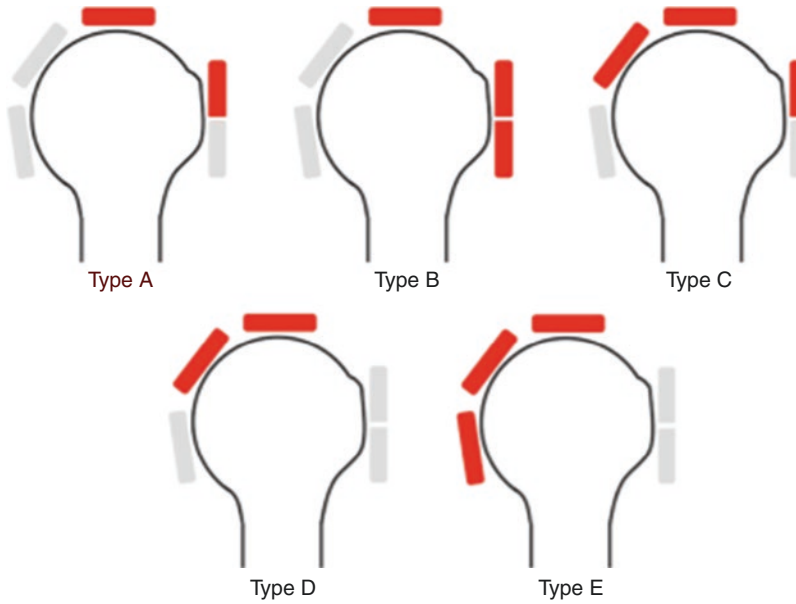

Fig. 6.2 Rotator cuff tears classified by the involved components: type A, supraspinatus and superior subscapularis tears; type B, supraspinatus and entire subscapularis tears; type C, supraspinatus, superior subscapularis, and infraspinatus tears; type D, supraspinatus and infraspinatus tears; and type E, supraspinatus, infraspinatus, and teres minor tears (Reproduced from: Collin P, Matsumura N, Lädermann A, Denard PJ, Walch G (2014). Relationship between massive chronic rotator cuff tear pattern and loss of active shoulder range of motion. J Shoulder Elbow Surg 23(8):1195–202. doi:https://doi.org/10.1016/j.jse.2013.11.019)

Classification systems applicable to rotator cuff tear arthropathy include the Hamada system [13] and the Seebauer system [14].

- The *Hamada classification* [13] grades the acromion humeral distance, morphologic alterations of the acromion and humeral head, and glenohumeral joint space narrowing. This system divides massive rotator cuff tears into five radiographic stages, with successive stages demonstrating findings consistent with progression of the rotator cuff tear arthropathy. In Stage 1, the acromiohumeral interval is >6 mm. In Stage 2, the acromiohumeral interval is <5 mm. In Stage 3, the acromiohumeral interval is <5 mm and acetabulization of the coracoacromial arch is present. In Stage 4, the glenohumeral joint is narrowed, either without acetabulization (Stage 4a) or with acetabulization (Stage 4b). In Stage 5, humeral head osteonecrosis results in collapse (Fig. 6.3).
- The *Seebauer classification* system [15] is a biomechanical description of rotator cuff tear arthropathy, in which each type is distinguished on the basis of the degree of superior migration from the center of rotation and the amount of instability. The amount of decentralization seen on radiographs is dependent on "the extent of the rotator cuff tear, the integrity of the coracoacromial arch, and the degree and direction of the glenoid bone erosion," and thus this classification system is intended to be a radiographic correlate of the underlying pathology seen in rotator cuff tear arthropathy (Fig. 6.4).
- The *Favard classification* of cuff tear arthropathy is shown in Fig. 6.5.
  - Group 1: this group is characterized by upward migration of the humeral head, superior glenohumeral joint space narrowing, an acromion changed in shape due to the imprint of the humeral head and subacromial arthritis.
  - Group 2: this group is characterized by central glenohumeral joint space narrowing and with little alteration in the shape of

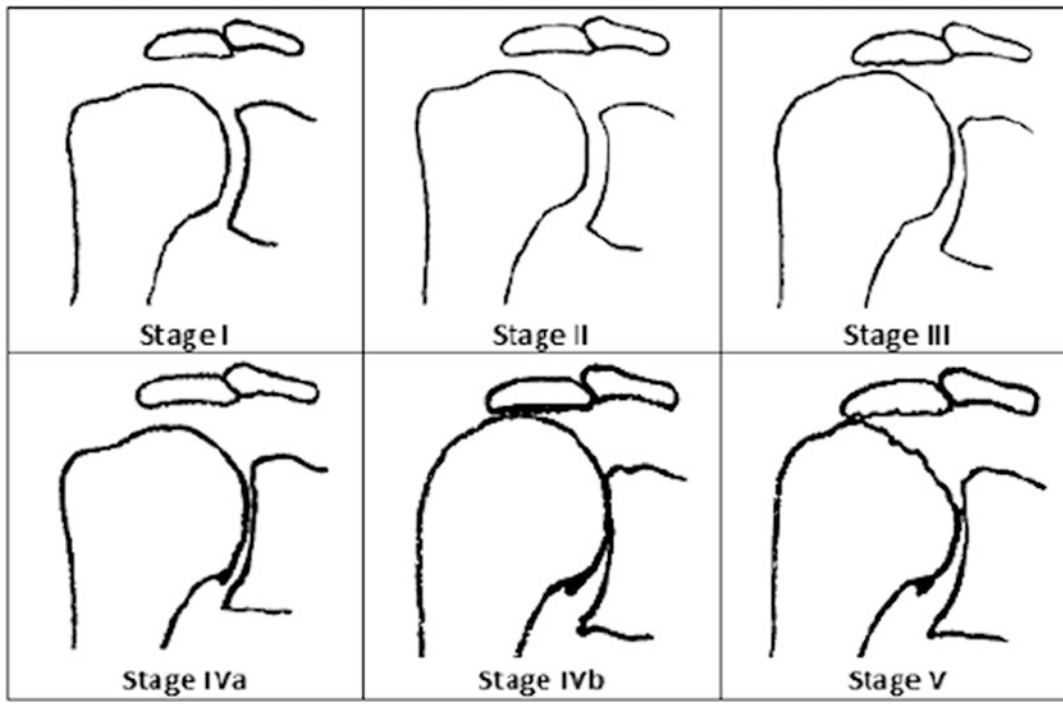

Fig. 6.3 Hamada classification system according to the acromiohumeral interval and progression of arthropathy (Reproduced from Hamada K, Fukuda H, Mikasa M, Kobayashi Y. Roentgenographic findings in massive rotator cuff tears. A long-term observation. Clin Orthop Relat Res. 1990; 254:92–6)

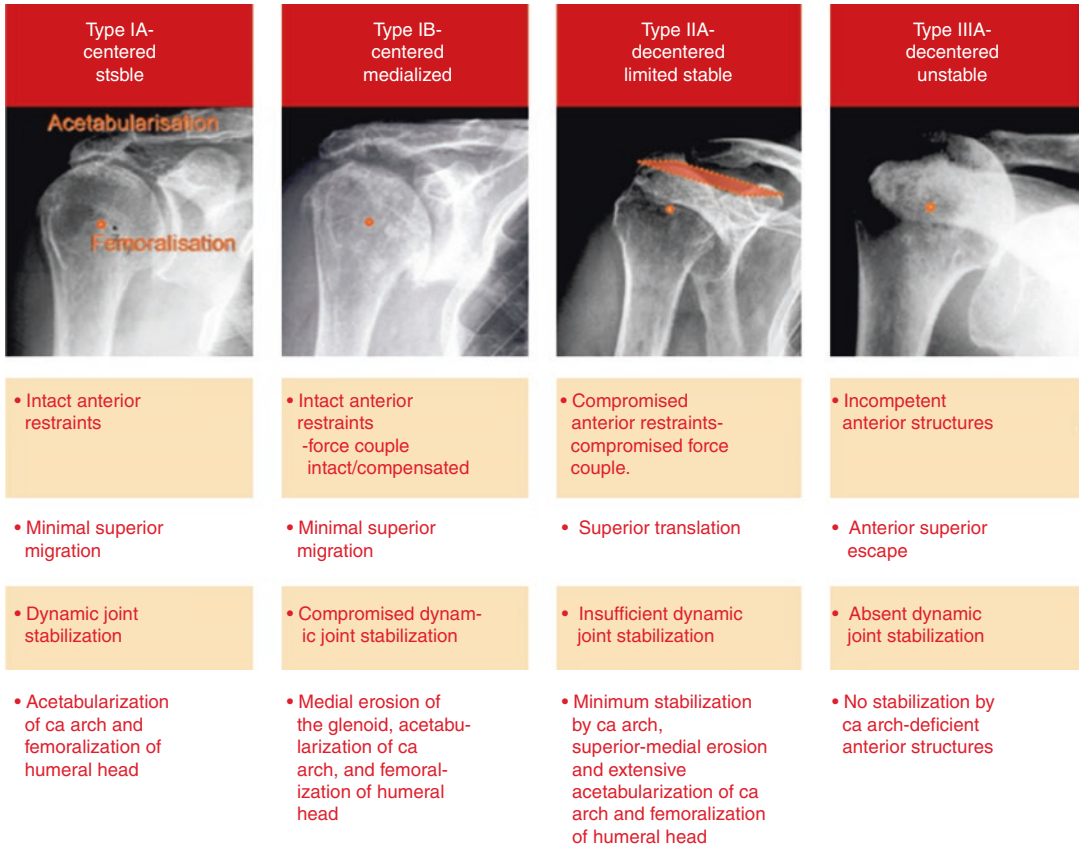

Fig. 6.4 The Seebauer classification system is a biomechanical description of rotator cuff tear arthropathy based on clinical and radiographic parameters (Reproduced from Visotsky JL, Basamania C, Seebauer L, Rockwood CA, Jensen KL. Cuff tear arthropathy: pathogenesis, classification, and algorithm for treatment. J Bone Joint Surg Am. 2004;86)

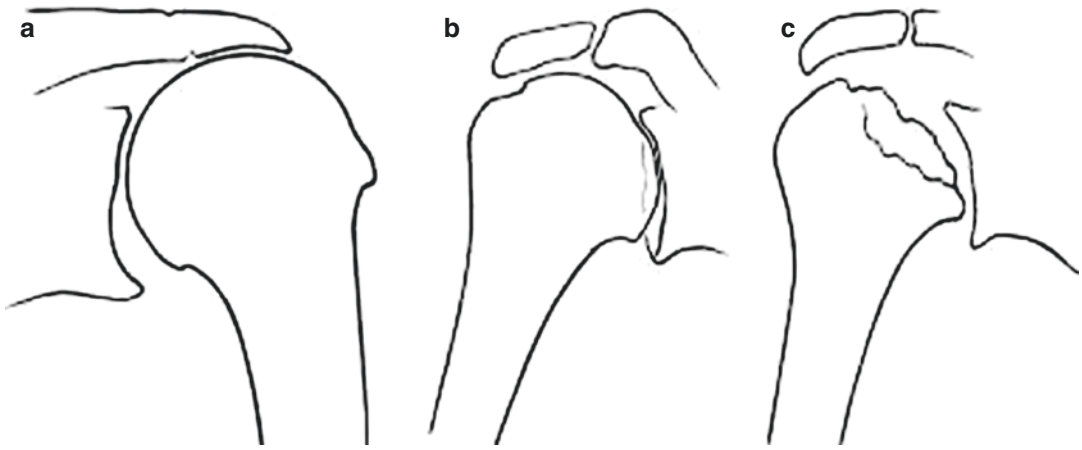

Fig. 6.5 Favard classification of cuff tear arthropathy (Reproduced from Favard et al., OA with massive RCT: the limitations of its current definitions. In: The Cuff, edited by Gazielly D, Elsevier, 1997)

the acromion which does not have a humeral head imprint.
- Group 3: this group is characterized by signs of bony destruction in the form of lysis of either the head or the acromion. The bony elements not affected by the lysis do not undergo any modification in their shape, for example, the greater tuberosity is not eroded and the acromion does not have a humeral head imprint. Glenohumeral joint space narrowing is either minimal or nonexistent.

Classification of glenoid erosion in glenohumeral osteoarthritis with massive rupture of the cuff according to *Sirveaux* [16]: the authors defined four types of glenoid erosion. In type E0, the head of the humerus migrated upward without erosion of the glenoid. Type E1 was defined by a concentric erosion of the glenoid. In type E2 there was an erosion of the superior part of the glenoid, and in type E3 the erosion extended to the inferior part of the glenoid (Fig. 6.6).

There is no general agreement as to which classification system should be used. No comparison of radiographic classification schemes of cuff tear arthropathy has been attempted yet, nor has their reliability been determined yet. A classification scheme specifically for cuff tear arthropathy has to display three core characteristics: it has to be valid and to preferably allow treatment strategies to be derived from the stage of disease determined by the classification. In addition, it has to possess at least comparable reliability to classification schemes that were not specifically designed for cuff tear arthropathy.

Moreover, an improved understanding of the risk factors for radiographic progression of cuff tears may improve treatment paradigms for patients with degenerative cuff tears. Keener et al. [14] performed an analysis of risk factors for proximal humeral migration. These authors found it to be significantly greater in tears with symptoms, tears with involvement of the infraspinatus, and tears with larger size. In multivariate analysis, tear size was the strongest predictor

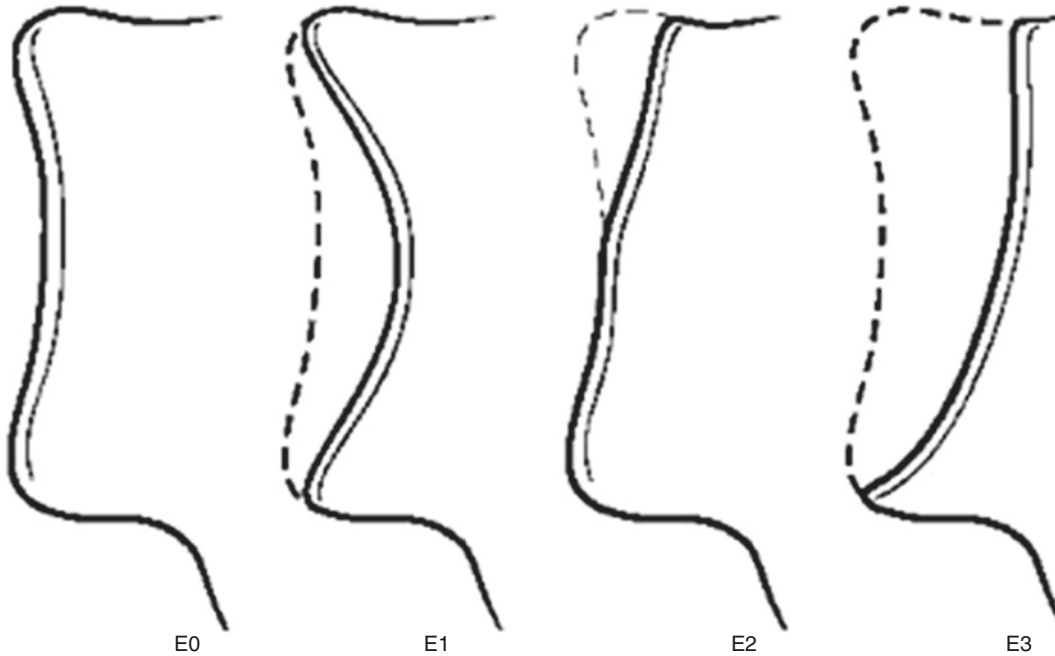

Fig. 6.6 Sirveaux classification of glenoid erosion in cuff tear arthropathy (Reproduced from Sirveaux F, Favard L, Oudet D, Huquet D, Walch G, Mole D. Grammont inverted total shoulder arthroplasty in the treatment of glenohumeral osteoarthritis with massive rupture of the cuff. Results of a multicentre study of 80 shoulders. J Bone Joint Surg Br 2004;86:388–95 (PMID 15125127))

of migration. Patients with small or medium size tears and minimal arthritic changes had low risk for arthritic progression. Those patients who present with larger tears and more advanced arthritic changes may have more accelerated progression.

Paxton et al. [17] reported no correlation between tear characteristics or clinical findings and the progression of rotator cuff tear arthropathy, although non-comparative series have suggested that large, irreparable recurrent tears have rapid progression rates.

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