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Classification of non-unions of the proximal humerus

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Abstract A classification of non-unions of the proximal humerus is proposed based on a group of 21 cases. Suggestions for treatment are given.

Résumé Une classification de la pseudarthrose du col de l'humérus est proposée basé sur un groupe de 21 cas. Les suggestions pour les options du traitement sont données.

Introduction

Non-union of the proximal humerus may result from the type of fracture, infections, interposition of soft tissue, synovia fluid at the site of fracture, aggressive rehabilitation, bad patient compliance, and many other causes. What all these different situations have in common is an impairment of the stability and/or blood supply to the area [8, 11, 13].

There is no fixed time to develop non-union after fractures. However, Norris et al. [8] consider those fractures of the proximal humerus that have not healed in 3 months as non-unions, and treat them accordingly.

A wide variety of treatments for this condition have been proposed. They include conservative treatment, ORIF (with or without bone grafting), hemiarthroplasty or total shoulder joint replacement, and resection arthroplasties [1, 2, 4, 5, 8, 9, 10, 13].

The few authors with greater experience and a significant number of cases seem to agree about the morbidity, and the difficulties of treating this complication [2, 5, 9, 10, 13]. The majority of reports emphasise the possible treatment options and the results. Nonetheless, it is hard to compare such results since there is no clear classification for non-union of the proximal humerus. Motivated by this difficulty a retrospective study on non-union of the proximal humerus was carried out and the results suggest that patients could be divided into four distinct groups. An appropriate classification has been devised.

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Material and methods

From January 1990 to February 1996, 21 shoulders in 20 patients with non-union of the proximal humerus were treated at our Institution, and in a retrospective study the patients could be divided into four distinct groups (Fig. 1).

Group 1: High, 2-part non-union

This non-union is secondary to 2-part fractures of the surgical neck of the humerus and it resembles fractures of the anatomical neck with a very small proximal fragment. It includes cases of fractures in three parts where the greater or lesser tuberosity is consolidated, presenting a displacement of less than 5 mm [6, 7] (Fig. 2a).

Group 2: Low, 2-part non-union

This non-union is also secondary to 2-part fractures of the surgical neck of the humerus. Non-union occurs between the lesser tuberosity and the insertion of the pectoralis major tendon, and the proximal fragment is larger than in the previous group. It also includes 3-part fractures where the greater or lesser tuberosities have consolidated with a displacement of less than 5 mm [6, 7] (Fig. 2b).

Group 3: Complex non-union

This non-union is secondary to 3-part, 4-part or split head fractures of the surgical neck of the humerus (with or without necrosis of the humeral head) and with a displacement of the tuberosities greater than 5 mm (consolidated or not) [6, 7] (Fig. 2c,d).

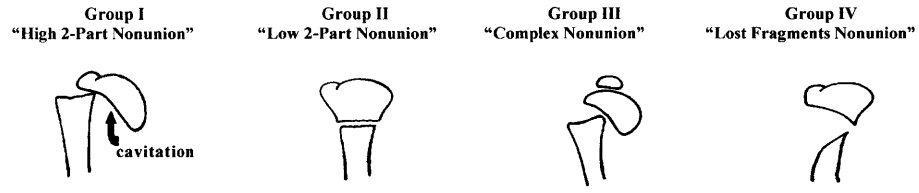

Fig. 1 Proposed classification for non-unions of the proximal humerus

Fig. 2 **a** AP view of the left shoulder showing a "high 2-part non-union" of the proximal humerus. Three months interval from the time of fracture to the diagnosis of non-union. **b** AP view of the left shoulder showing a "low 2-part non-union" of the proximal humerus. **c** AP view of the left shoulder showing a "complex non-union" of the proximal humerus resulting from a 4-part fracture. **d** AP view of the right shoulder showing a "complex non-union" of the proximal humerus resulting from a head-split fracture. **e** AP view of the right shoulder showing a "lost fragment non-union" of the proximal humerus

Group 4: Lost fragment non-union

This usually occurs after open fractures and/or post-traumatic osteomyelitis of the proximal humerus (Fig. 2e).

Ten of the 20 patients were males and 10 were females. One male presented with bilateral lesions. The mean age of the patients was 55.3 years (range 29–77 years). The dominant arm was affected in 8 patients and only 1 patient had a neurological lesion on the affected side (axillary nerve palsy).

The average period of time which had elapsed between the fracture and treatment of non-union was 14.1 months (range 3–48 months). All patients complained of pain and functional impairment.

Fig. 3 AP view of the right shoulder showing a "low 2-part non-union" of the proximal humerus with malunion of the greater tuberosity and displacement of less than 05 mm

Fig. 4 AP view of the right shoulder showing a non-union lower the insertion of the pectoralis major tendon

Results

According to our proposed classification, 7 shoulders were classified as 'high 2-part non-union', 6 as 'low 2-part non-union', 7 as 'complex non-union' and 1 as 'lost fragments non-union' (Fig. 2a–e).

In the group classified as 'complex non-union, 3 patients had 3-part fractures of the proximal humerus associated with fracture of the greater tuberosity, 1 patient had a 3-part fracture and fracture of the lesser tuberosity, 2 patients had 4-part fractures, and 1 patient had a split head fracture. None of these patients had pre-operative evidence of necrosis of the humeral head.

Discussion

In 1983 Neer [7] concentrated attention on the difficulties of treating non-union in cases with severe osteoporosis and bone resorption sometimes associated with bone cavitation and head collapse. The results of the treatment of non-union reported in the literature are somewhat disappointing. In 1990 Healy et al. obtained 52% unsatisfactory results in 25 patients [3]; in 1996 Duralde et al. found 45% unsatisfactory results in their series of 20 operated cases [1]. Neer [7] obtained consolidation of the non-union in 12 of 13 cases operated on using tension bands and intramedullary wires associated with bone grafting and prolonged external immobilisation. However, he does not refer to the functional results. Other authors such as Nayak et al. [4], Norris et al. [8], Healy et al. [3] and Duralde et al. [1] reported bad results with internal fixation of the non-union, and a high rate of complications and re-operations.

Walch et al. [12] obtained 95% satisfactory results in 20 patients with non-union treated with ORIF and bone grafting. However, unlike other authors he limited his cases to non-union occurring between the lesser tuberosity and the insertion of the pectoralis major tendon. This type of non-union was classified in the current study as 'low 2-part non-union' (Fig. 2b), and is quite different from more proximal non-union where rapid resorption of the cancellous bone occurs with cavitation of the humeral head. This latter type which also results from 2-part surgical neck fractures is here classified as 'high 2-part non-union' (Fig. 2a). In such cases internal fixation is very difficult to perform. According to Neer [7] the bone cavitation is secondary to communication between the fracture and the synovial fluid of the joint. In 1969 Razemon and Baux [9] had already reported this complication of fractures of the proximal humerus where resorption of bone takes place, and non-union seems to occur as far proximal as to the anatomical neck. Norris et al. [8] also called attention to this specific type of non-union with a small head fragment. In the current study it was found that bone cavitation may occur early in the course of the disease and it was noted that 2 patients from this group had as short an interval as 3 months between the time of fracture and a diagnosis of non-union (Fig. 2a).

A third group includes non-union secondary to 3-part, 4-part or split head fractures where the tuberosities have also developed non-union or mal-union with displacement greater than 5 mm. These should be grouped separately because there is bad positioning of one or both tuberosities which causes secondary disorganisation of the tendons of the rotator cuff (Fig. 2c,d). This type of non-union may also lead to avascular necrosis of the humeral head.

It is important to stress the fact that none of the patients in this study, including those with 4-part fractures, presented any pre-operative necrosis of the humeral head.

Walch et al. [12] state that all their cases of non-union due to 3-part fractures also had mal-union of the greater tuberosity, with a displacement of less than 5 mm. These cases should be included in the 'high 2-part non-union' group or the 'low 2-part non-union' group, depending on the degree of bone cavitation, and not in 'Complex non-union' as osteotomies and correction of the shortening of tendons of the rotator cuff is not necessary (Fig. 3). Neer [7] also excludes cases with displaced fractures of the greater and/or lesser tuberosities. The 'lost fragments non-union' corresponds to non-union secondary to high-energy trauma such as open fractures with loss of bone fragments, and/or post-traumatic osteomyelitis (Fig. 2e). Our series contained only one such case. Although Norris et al. [8] included 5 cases of non-union of the greater tuberosity in their series the current study did not include cases of non-union secondary to isolated fractures of the greater or lesser tuberosities in this classification. It is our opinion that such cases should be managed as chronic lesions of the rotator cuff. Consolidation of the non-union of the tuberosities is usually uneventful, while the difficulty lies in managing the tendon tears and retractions.

Contrary to Healy's [3] experience, in our study patients where the non-union gap was distal to the insertion of the pectoralis major tendon were also excluded as these lesions do not 'belong' to the anatomical neck of the humerus (Fig. 4). Our reason for proposing this classification was the difference encountered in the outcome of 'high 2-part non-union' and 'low 2-part non-union'. It seems clear that 2-part surgical neck fractures can develop non-union in distinct manners, and where the different quality of the bone necessitates different surgical techniques.

Thus, this classification was designed to allow a better assessment of these fractures and a comparison with the experiences of other authors. The classification may also aid in comparing methods of treatment used for this difficult complication.

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