



Review Article

Impacted valgus fractures of the proximal humerus[☆]



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ABSTRACT

Impacted valgus fractures of the proximal humerus are considered to be a special type fracture, since impaction of the humeral head on the metaphysis with maintenance of the posteromedial periosteum improves the prognosis regarding occurrences of avascular necrosis. This characteristic can also facilitate the reduction maneuver and increase the consolidation rate of these fractures, even in more complex cases. The studies included were obtained by searching the Bireme, Medline, PubMed, Cochrane Library and Google Scholar databases for those published between 1991 and 2013. The objective of this study was to identify the most common definitions, classifications and treatment methods used for these fractures in the orthopedic medical literature.

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Fratura impactada em valgo do úmero proximal

RESUMO

A fratura impactada em valgo do úmero proximal é considerada um tipo especial de fratura, pois a impactação metafisária da cabeça umeral, com manutenção do periosteio pósteromedial, melhora seu prognóstico quanto à ocorrência de necrose avascular. Essa característica pode, ainda, facilitar a manobra de redução e aumentar o índice de consolidação dessas fraturas, mesmo nos casos mais complexos. Os estudos incluídos foram pesquisados nas bases de dados Bireme, Medline, PubMed, Cochrane Library e Google Scholar publicados de 1991 a 2013. O objetivo deste estudo foi identificar a definição, classificação e os métodos de tratamento dessas fraturas mais usados na literatura médica ortopédica.

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Introduction

Impacted valgus fractures of the proximal humerus have been defined and classified using different concepts in the orthopedic medical literature, and different treatments have been described. The angular parameters used for defining the diagnosis (Fig. 1) and the management applied have differed in most studies.¹⁻⁵ This lack of consensus in the literature may give rise to failure in prognostic evaluations on these fractures and influence the choice of treatment method.

These fractures have received attention that differentiates them from other complex fractures of the proximal humerus, because of their better prognosis with regard to surgical reduction, consolidation and occurrences of avascular necrosis.¹⁻¹⁴

The mechanism for these fractures consists of axial trauma to the abducted upper limb, with direct impaction between the humeral head and the glenoid cavity, and consequent impaction and posteromedial displacement (dorsal tilting of the head) because of its physiological anatomical conformation in retroversion.^{1,2,8,10,12} In this specific type of fracture, with metaphyseal bone impaction, the posteromedial periosteum of the humeral head (i.e. the medial hinge) may be maintained. Consequently, the posterior humeral circumflex artery (which passes through this region) may also be maintained. The blood supply to the humeral head may be preserved (Fig. 2).^{1-3,6,8-13} This may give rise to avoidance of the most frequent complication of complex fractures of the proximal humerus: avascular necrosis. The incidence of this complication is 21-75% in four-part fractures and 8-26% in situations of

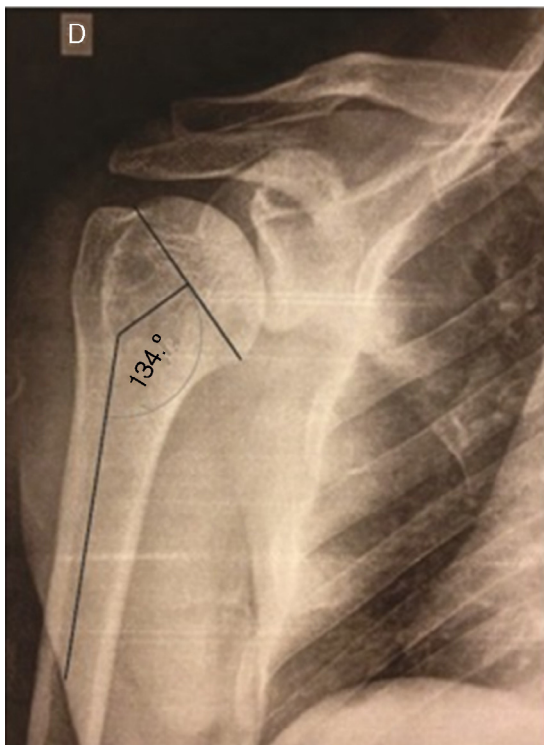


Fig. 1 – Radiograph showing measurement of the cervicodiaphyseal angle of the proximal humerus, i.e. the angle between the anatomical neck and the axis of the humeral diaphysis.

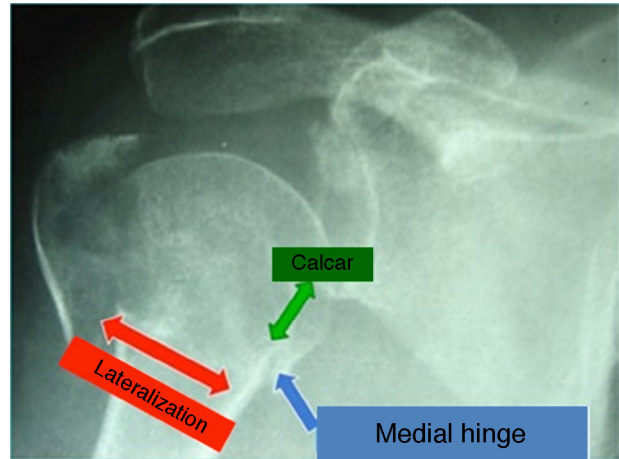


Fig. 2 – Anteroposterior radiograph of the right shoulder showing valgus impacted fracture of the proximal humerus.

valgus impact.¹¹ Maintenance of this medial hinge may also help in fracture reduction, since it serves as a support point (fulcrum) for the humeral head to return to its varus position, without losing contact with the metaphyseal region of the diaphysis.^{1-3,6-8} These characteristic factors may lead to a higher consolidation rate for these fractures, compared with other complex fractures of the proximal humerus.^{1,2,6,7}

In deciding between conservative and surgical treatment for valgus impacted fractures of the proximal humerus, the following important factors need to be taken into account: physiological age, comorbidities, work activities, sports activities, demand, smoking, osteoporosis, patient cooperation, time elapsed since the fracture, surgeon's experience and the fracture pattern described.^{1,2,5,11} Among the surgical treatments, the options that have been described are: closed reduction with percutaneous fixation, open reduction with internal fixation using a locked plate (Fig. 3), screws, metal wires and/or nonabsorbable threads and arthroplasty.¹⁻¹³

Furthermore, regarding surgical treatment, in reducing these impacted fractures, significant bone failure may occur below the humeral head. The cavity that thus forms can be filled with repositioned tubercles from this bone or by means of an autologous, autogenous or synthetic bone graft, in order to avoid loss of reduction.^{1-3,7,11}

The aim of this study was to identify the definitions, classifications and treatment methods for valgus impacted fractures of the proximal humerus that have been most used in the orthopedic medical literature.

Methods

A review of the orthopedic medical literature was conducted in the Regional Medical Library (Biblioteca Regional de Medicina, Bireme), Medline, PubMed, Cochrane Library and Google Scholar databases. This review covered articles published between 1991 and 2013, and it used combinations of the following search terms: fracture of the proximal humerus, valgus impaction, classification and treatment. Studies were selected

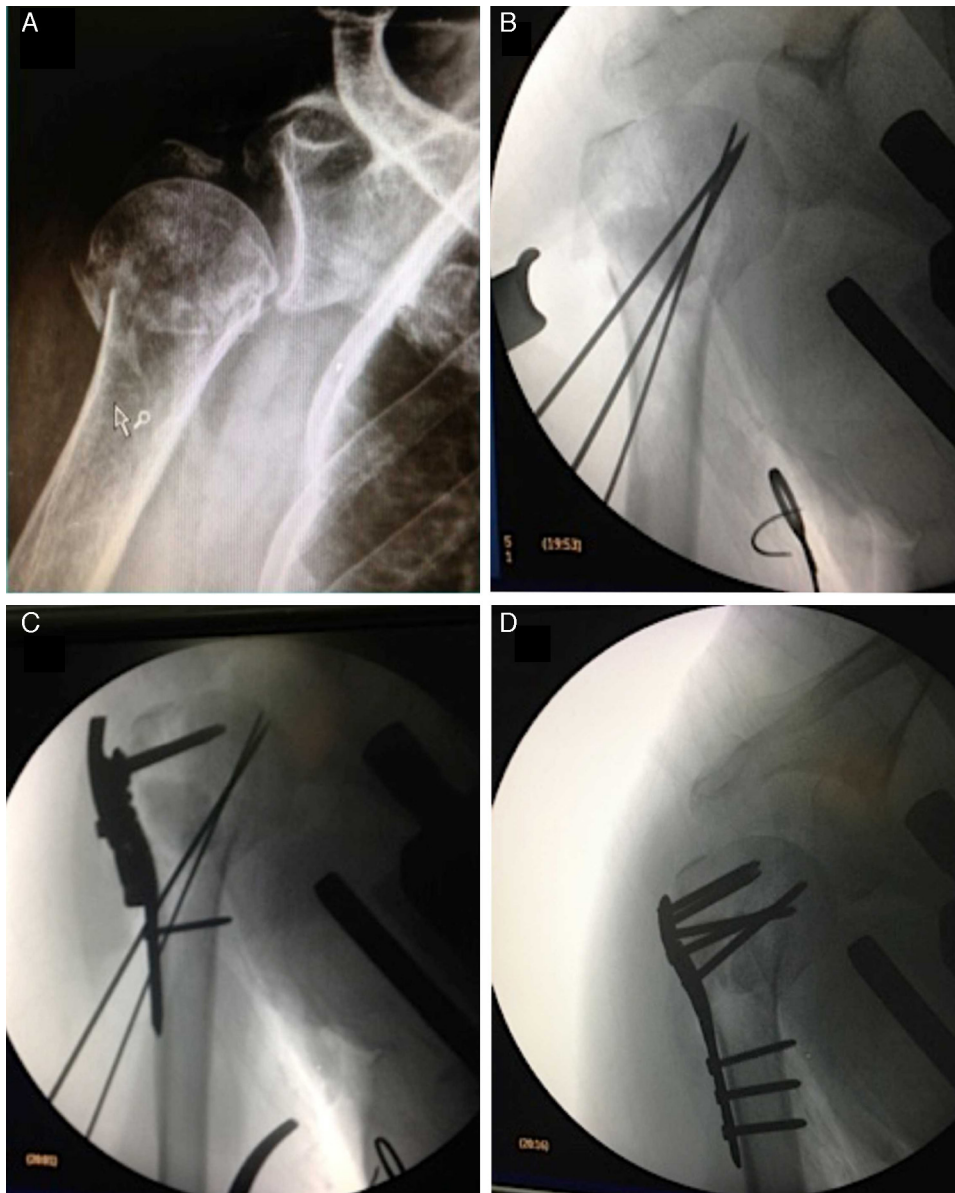


Fig. 3 – (A) Anteroposterior radiograph of the right shoulder showing valgus impacted fracture of the proximal humerus. (B) Intraoperative fluoroscopy showing fracture reduction, synthetic graft and provisional fixation with metal wires. (C) Fixation using locked plate. (D) Final osteosynthesis.

if they dealt with valgus impacted fractures of the proximal humerus, with descriptions in the English or Portuguese languages.

Results

Jakob et al.⁷ considered valgus impacted fractures of the proximal humerus to be a specific type of fracture that was not mentioned initially in Neer's classification.¹ They defined them as four-fragment fractures with varying displacement of the tuberosities and valgus impaction of the humeral head. They used the AO/ASIF classification and reported that they had 16 patients in 11C2.2 and three in 11C2.1, who were all treated surgically. They found that 74% of the results were

satisfactory and concluded that these valgus impacted fractures were angled and not translated, which favored a better prognosis. Their unsatisfactory results were due to avascular necrosis of the humeral head.

Robinson et al.^{1,2} defined valgus impacted fractures of the proximal humerus as situations in which the cervicodiaphyseal angle was greater than or equal to 160° . They used the Neer and AO/ASIF classifications. During the operations, the tubercles were separated and the humeral head was reduced to its original position. In the cavity formed by impaction of the humeral head, a synthetic graft was used to aid in maintaining the surgical reduction. The tubercles were then brought to their anatomical positions and were bound up using non-absorbable threads. A fixed-angle plate was used for fracture fixation.

Checchia et al.⁷ emphasized that valgus impacted fractures of the proximal humerus presented lower rates of avascular necrosis than the four-part fractures traditionally described by Neer. In their sample, when the displacement of the medial cortical bone of the humerus was greater than 5 mm, there was a higher rate of avascular necrosis of the humeral head. They used the surgical technique of open reduction, fixation with metal wires and suturing of the tubercles with non-absorbable thread, which was the same technique as described by Jakob et al.⁶ and modified by Resh et al.⁸ They obtained good results from 75% of their cases. Autologous grafts were used in 62.5% of the patients. They found the following postoperative complications: avascular necrosis, infection, pseudarthrosis, heterotopic ossification and adhesive capsulitis.

Atalar et al.³ defined valgus impacted fractures of the proximal humerus as those with a cervicodiaphyseal angle greater than 170°. They used Neer's classification. They defined the type of treatment during the operation, according to the degree of blood reflux (backflow), after perforation of the humeral head. When bleeding occurred in the perforations, osteosynthesis was performed. If it did not occur, arthroplasty was performed. The osteosynthesis was performed after open reduction of the humeral head to its anatomical position and fixation of the tubercles using non-absorbable thread and metal wires. They used autologous or allogeneic bone grafts in all their cases. They observed that the rate of avascular necrosis of the humeral head in these fractures was lower than in other four-part fractures, especially when the displacement of the medial hinge was less than 2 mm.

Resh et al.⁸ used Neer's classification but subdivided the fractures into varus (due to separation or impaction) and valgus, which might or might not have lateral displacement of the humeral head. In the valgus impacted fractures, the tubercles could be in their original positions, since they were connected to the diaphysis by the periosteum. The humeral head was reduced with the aid of the medial hinge as a support, until satisfactory alignment with the tubercles was achieved. Fixation was done using metal wires or screws.

Hertel et al.⁹ developed a new binary classification system (LEGO®), with 12 possible types of fractures of the proximal humerus: six that divided the humerus into two fragments, five that divided it into three fragments and a single fracture pattern in four fragments. From this, they defined some predictors of ischemia of the humeral head: fracture extent in the metaphysis less than 8 mm, displacement of the medial hinge greater than 2 mm, basic pattern of joint fracture (anatomical neck or head split), angular displacement of the humeral head greater than 45°, fractures in three or four parts, displacement of tuberosities greater than 1 cm and glenohumeral displacement. They observed that there was a 97% risk of avascular necrosis of the humeral head when a fracture of the anatomical neck occurred in association with injury to the medial hinge and a calcar with metaphyseal length less than 8 mm.

Panagopoulos et al.¹⁰ defined valgus impacted fractures of the proximal humerus as humeral joint fragments (anatomical neck) impacted against the metaphyseal region, with separation of the tuberosities and minimal lateral deviation of the humeral head. The mean cervicodiaphyseal angle of humeral impaction among the patients involved in their study was 42° (range: 37–48°) and the mean lateral displacement was

1 mm (range: 0–7 mm). All the cases were treated by means of open reduction and internal fixation, with binding of the tubercles using non-absorbable thread and sutures using tension bands. They concluded that during the open reduction of these fractures, it is important to maintain the medial hinge of the impacted fragment, since a large part of the vascular supply of the humeral head comes to be through the anastomoses of the posterior capsule, supplied by the posterior circumflex humeral artery, which may diminish the risk of avascular necrosis. There were no reports of use of grafts.

Solberg et al.⁴ used two methods for evaluating the risk of avascular necrosis: the direction of the displacement of the humeral head (varus or valgus) and the length of metaphyseal continuation, which could be measured by making comparisons with the intact contralateral side, by means of radiography or tomography. They concluded that when this metaphyseal length of the humeral head was greater than 2 mm, there would be lower risk of avascular necrosis. The Neer and AO/ASIF classifications were used. After reduction of all of the cases of valgus impacted fractures, a fixed-angle plate was used, without a graft.

Catalano et al.⁵ defined valgus impacted fractures of the proximal humerus as those with a cervicodiaphyseal angle greater than 160°. The criteria for surgical indication that they used were the fracture pattern, degree of displacement and bone quality. The techniques that they used were open reduction, internal fixation with metal wires and implantation of synthetic grafts.

De Franco et al.¹¹ used the Neer and AO/ASIF classifications and defined valgus impacted fractures of the proximal humerus as those that were classified as 11C2.1 and 11C2.2. They used either conservative treatment or surgical treatment consisting of open or percutaneous osteosynthesis and arthroplasty. In implementing treatment consisting of osteosynthesis, they reported that when the humeral head was reduced from valgus to its original position, the tubercles returned to their anatomical position because of the possible integrity of the periosteum in these fractures. For fixation, they used Steinmann pins, cannulated screws, suturing with non-absorbable thread and/or plates and screws. When necessary, they used grafts to support the humeral head.

Neer¹² reviewed his classical classification, which had not prescribed treatments or made prognoses. In this study, he divided the evaluation of fractures into those with two parts (anatomical neck or surgical neck), which could be impacted, non-impacted or comminuted; those in which open reduction and internal fixation or arthroplasty was performed; and those with four parts, which could be true or have valgus impaction. He reported that in four-part fractures with valgus impaction, with a minimum inclination of 45°, without displacement or with minimal lateral displacement of the joint surface in relation to the humeral diaphysis, the medial periosteum remained intact, which could maintain the vascular supply of the humeral head, with better prognosis regarding avascular necrosis.

Ogawa et al.¹³ studied four-part fractures of the proximal humerus with valgus impaction and used the Neer and AO/ASIF classifications. They defined these fractures as type 11C2.2, in which the humeral head presented valgus displacement, with an angular deviation of 45°, or when the top of the

greater tuberosity was higher than the vertex of the humeral head. Surgical treatment was indicated for all their patients. The reduction was performed with the first metal wire passing through the humeral head from a lateral to a medial location and the second metal wire for correcting the valgus. In elderly patients, a third metal wire was also used, in a retrograde manner, to aid in the reduction. If the reduction was not achieved, tension bands, screws and non-absorbable threads were used.

Court-Brown et al.¹⁴ analyzed 125 patients with valgus impacted fractures of the proximal humerus that presented the AO/ASIF classification 11B1.1 and for which conservative treatment was used. They observed that all of these fractures that they followed up in their study reached consolidation. They reported that these fractures presented a better prognosis also when treated conservatively, and that 80% of the results were good. They also concluded that these results depended directly on the initial degree of displacement of the fracture and on the patient's age.

Discussion

In the main studies in the orthopedic medical literature that were consulted¹⁻¹⁴ regarding valgus impacted fractures of the proximal humerus, a variety of definitions, classifications and treatment methods have been used.

Most of these studies used the definition of cervicodiaphyseal angle greater than 160°. They agreed that impaction of the metaphyseal region of the humeral head was an important characteristic of these fractures, which could favor maintenance of the integrity of the posteromedial periosteum of the calcar. This particular feature gave rise to a lower rate of avascular necrosis of the humeral head and a higher consolidation rate, in comparison with other complex fractures of the proximal humerus.

The classifications most used in the literature consulted were Neer and AO/ASIF.

The treatment method most used in these studies was surgical. The operations consisted of open reduction and internal fixation using metal wires, locked plates and/or non-absorbable thread.

A variety of grafts were used for filling the space that had formed in the impacted region, comprising synthetic, allogeneic and autogenous types. The indications for using grafts that were described in the literature consulted were variable and remained at the discretion of each surgeon.

Final remarks

Studies on valgus impacted fractures of the proximal humerus present variations in definitions, classifications and treatment methods used, but they are always concordant with each other

regarding the better prognosis for these fractures, in comparison with other complex fractures of the proximal humerus.

Conflicts of interest

The authors declare no conflicts of interest.

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