

## Experience in the Treatment of Complex Fractures of the Proximal Humerus

a report by

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### Introduction

Fractures of the humeral head account for about 4% to 5% of all fractures in adult patients. Since osteoporosis is one of the main predisposing factors, the majority of patients with humeral head fractures are female. The male-to-female ratio varies from 1:2 to 1:5 in different publications. The overall incidence is about 50–100 fractures per 100,000, with an exponential increase from the fifth decade of life onward.

As far as the mechanism of injury is concerned, high-energy injuries are the exception, since it is mostly elderly people who are affected. In younger patients who sustain such fractures, they are the result of high-energy accidents in the majority of cases, while, in older patients, domestic accidents are a more frequent cause. A fall onto the outstretched arm or a direct impact on the affected shoulder is typically reported. Owing to the high-energy impact involved in younger patients, this group has a significantly higher incidence of dislocation fractures. Force analysis makes it possible to distinguish compression fractures from shear fractures and from bending fractures. This distinction and accurate classification of the fracture are extremely important for the prognosis, especially against the background of the vascularisation characteristics of the humeral head. The blood supply to the proximal third of the humerus comes from the anterior and posterior circumflex humeral arteries that branch off from the axillary artery. Fractures within the region of the anatomical neck of the humerus, multiple fractures of the calotte that result in large bone fragments while the outline of the bone remains essentially unchanged and dislocation of the medial column by more than 1cm are usually associated with substantial damage to the vascularisation of the humeral head and are therefore likely to increase the risk of osteonecrosis of the humeral head. The risk of AVN increases with the number of fracture fragments. In patients with three-fragment fractures, the risk of AVN is approximately 3% to 14%, while AVN is observed in 26% to 75% of patients with four-fragment fractures. Various prognostic scores have been elaborated to allow more accurate estimates of

the risk that humeral head necrosis will develop. Accepted risk factors, in addition to a four-fragment fracture, are angular displacement of the head, the degree of displacement of the tuberosity, glenohumeral dislocation and possibly humeral head-split components.

The high risk of osteonecrosis is not the only reason why the treatment of complex fractures of the humeral head continues to test the trauma surgeon's skill. The range of therapeutic options is wide and subject to some controversy; it includes conservative treatments, various forms of minimally invasive osteosynthesis (such as K-wire osteosynthesis), various intramedullary nailing systems, conventional and fixed-angle plating systems and even primary shoulder arthroplasty. Finding the optimal treatment to suit each individual patient is crucial to his/her subsequent quality of life.

### Diagnosis

The standard procedure for the diagnosis of fractures in the region of the proximal humerus is conventional radiography at two levels. In addition to a true arthroplasty exposure for visualisation of the humeral head and evaluation of the glenohumeral joint gap with no overlap, a supplementary radiograph with the X-ray beam directed axially is helpful for evaluation of the fracture's complexity. If severe pain makes this impossible – as is frequently the case immediately after an accident – an exposure with the X-ray beam directed through the thorax in addition to the arthroplasty exposure is another option that can yield more information about the fracture. For this examination, the patient adopts a standing or sitting position, with the shoulder that is to be X-rayed facing towards the squared screen. The arm being investigated is allowed to hang down. The arm further away from the X-ray source is placed above the head. The patient positions the 'good' side so that it is turned a little further back. The radiographer centres on a point on the front axillary line about a hand's breadth below the glenoid cavity on the opposite side. The radiation path is perpendicular to the cassette, passing through the humeral head on the side facing the source and continuing on to the centre of the cassette. The

proximal upper arm is seen between the spinal column and the sternum. It is impossible to select the most appropriate treatment procedure without optimal pre-operative diagnostic investigations. Especially in the case of dislocated fractures of the humeral head, it is important for surgeons to understand the entire complex anatomy of the fracture and to integrate their knowledge of it into the further therapy planning. For this reason, we believe routine computed tomography (CT) investigation of fractures in this region is generally advisable.

### Fracture Type Classification

It is generally accepted that humeral head fractures should be classed as one-, two-, three- and four-fragment fractures. One special type is that of valgus-impacted comminuted fractures of the calotte. Neer elaborated the four-segment classification system further, developing a classification that takes into account not only the number of fragments, but also the degree of dislocation. The 'Arbeitsgemeinschaft für Osteosynthesefragen' (AO) has introduced a complex and sophisticated classification system for long bones, but, in the case of the humeral head, the AO classification has little relevance to prognosis. In attempts to make more accurate estimates of prognosis possible, alternative classification systems have been suggested, but most of these have not become widely accepted; some are still so new that they have yet to be tested for clinical relevance. The number of classification systems available reflects their low level of both reliability and clinical significance. As a general rule, however, we can say that the prognosis worsens with increasing number of fracture fragments. We find the classification introduced by Codman helpful, since it is based not only on the degree of dislocation of the fracture fragments, which is difficult to estimate, but also on the instability of the fragments involved.

### Conservative Therapy

Conservative treatment should be considered, especially when there is only minimal dislocation of the fracture fragments and stability is good. This applies both to fractures of the humeral head and to subcapital fractures of the proximal humerus. Before conservative therapy is definitively decided upon, the stability of the fracture must be evaluated with the aid of image amplification with a mobile X-ray apparatus. This involves abducting the arm affected under radiographic control and then judging whether passive abduction leads to movement of both the proximal and the distal fracture components. In cases in which stability can be documented, we recommend immobilisation of the affected shoulder in a Gilchrist bandage. There is still some controversy about how long such immobilisation should be continued, since the published data is contradictory. In a prospective

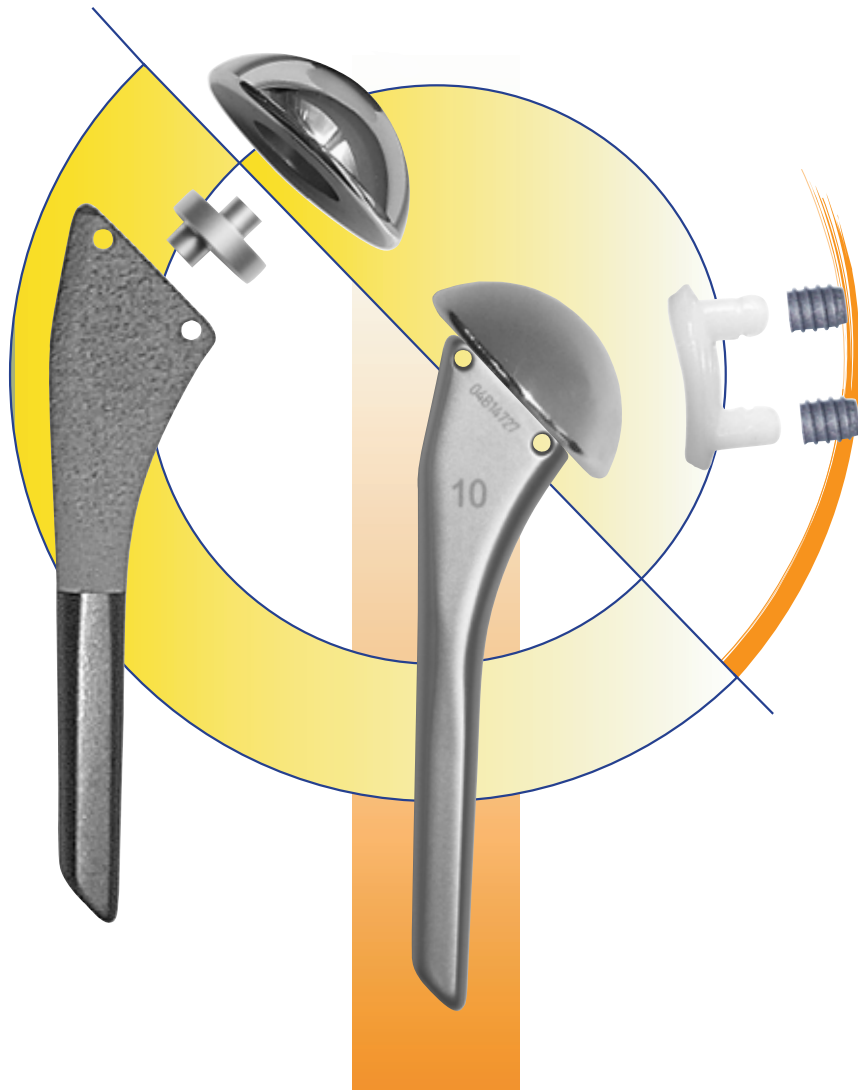
randomised controlled study, Kristiansen's group found no significant differences in outcome between patients with immobilisation with a Gilchrist bandage for only one week and patients in whom such immobilisation was continued for three weeks. In our hospital, we recommend beginning with pendulum-swing exercises after three to four days. Passive exercise of the shoulder joint is possible 14 days after Gilchrist bandage immobilisation. Overall, we recommend that the bandage be left in place for three weeks. Full exposure to normal movement should not be allowed for six weeks, but physiotherapy is allowed after week three, subject to limitation by pain. In our opinion, especially in older patients, an early start of physiotherapy and the earliest possible recovery of a full range of motion in the affected shoulder are of outstanding importance to the clinical outcome. In older patients, a restriction of the active or passive movement of the affected shoulder is one of the complications seen most frequently, even though, from the traumatological aspect, fracture healing seems to be satisfactory in many of these patients.

If conservative treatment is carried out consistently, it can lead to good functional results, even in dislocated fractures of the humeral head. In the late 1990s, a Scandinavian group reported equally good clinical and functional results both after conservative therapy and after surgical stabilisation in patients with dislocated three-fragment fractures of the humeral head, but with a decidedly lower complication rate after conservative treatment.

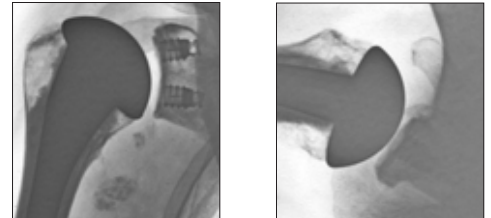
This should be borne in mind particularly when treatment plans are set up for older patients with substantial co-morbidities. At the same time, however, the Scandinavian studies have shown that this observation applies only in the case of three-fragment fractures, and not for dislocated four-fragment fractures, of the humeral head. It is still generally accepted that a four-fragment fracture usually requires operative intervention. Whether conservative therapy will continue to be accepted as so valuable in dislocated three-fragment fractures of the humeral head even now that more modern osteosynthesis procedures, such as fixed-angle osteosynthesis, have been introduced must be investigated in appropriate studies. Up to now, few results obtained with the fixed-angle proximal humerus plate or with some of the promising modern shoulder prosthesis systems have been published. Initially, we shall have to wait and see whether the theoretical advantage of better anchorage of fixed-angle implants, especially in bones affected by osteoporosis, will also lead to improved clinical results. ■

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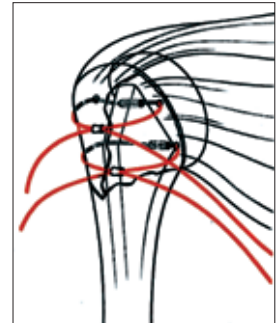
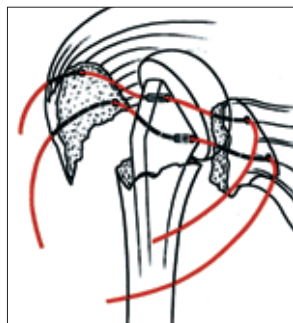
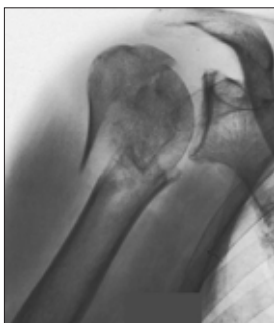


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