

Treatment of Geriatric Proximal Humerus Fractures: Indications and Outcome

Léčení geriatrických zlomenin proximálního humeru: indikace a výsledky

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SUMMARY

Treatment algorithms of proximal humerus fractures are still controversially discussed. The enthusiasm towards operative treatment after the introduction of locking implants, has not been justified by the functional results in the elderly population. The majority of those fractures in the geriatric patients can be successfully treated conservatively. Thorough clinical and radiological examination for fracture analysis, dynamic stability control with the use of an image intensifier, and meticulous reduction, in addition with the appropriate orthosis for its retention and rehabilitation, are the keys for the successful treatment of the proximal humerus fracture in the elderly patient. The present review reports on the main treatment aspects of proximal humerus fractures in the geriatric population and proposes a treatment algorithm.

Introduction

Fractures of the proximal humerus (PHF) constitute 4–5% of all fractures with an estimated incidence of 70/100,000 per year. Despite this relatively high incidence, which is even higher in the geriatric population, their treatment remains controversial, with unanimously accepted guidelines still missing (2).

PHF is the third most common fracture in patients above 65 years (14). Low-energy injuries, occurring mainly in elderly osteoporotic women, are most often the case (4, 18). Due to the demographic shift, with an aging – but still active – population, the incidence of geriatric PHFs is further expected to rise (23). The presence of osteoporosis may influence the choice of treatment, as complication rates of up to 35% after open reduction and internal fixation have been reported (22).

Despite the fact that the majority of PHF can be successfully treated conservatively with a good clinical outcome (8), the percentage of fractures treated with internal fixation continues to rise (28). This may be the result of advanced surgical techniques and improvements in implant technology (e.g. locking plate fixation, cement augmentation techniques) that enable early functional rehabilitation, thus promising improved functional outcomes. To date, none of these new techniques succeeded to provide indisputable superiority in the elderly population over the conservative treatment (21). Overall, the existing body of literature regarding the indications of conservative vs. surgical treatment has not taken into account the patient's age, co-morbidities and the quality of bone stock.

Considering the relatively high complication rate of surgical treatment (23), particularly in the osteoporotic cases (10), the treatment of geriatric PHF fractures needs to be critically evaluated.

This review aims to summarize the current knowledge about the treatment of geriatric PHF and provide a therapeutic algorithm focusing on the geriatric population.

Get to know your patient

The initial step for choosing the right treatment for your geriatric patient with PHF is an assessment of the medical history. Co-morbidities with special focus on vascular and neurological diseases, medication and the biological age of the patient are relevant parameters (17). The pre-fracture functional status of the shoulder and the general level of daily activity are highly relevant information. Furthermore, the patient's functional expectations should be assessed and documented (16). The clinical examination, with special focus on neurovascular injuries completes the initial assessment of the patient. Based on this information a risk-benefit analysis has to be performed to define the best treatment option for the patient.

Get to know the fracture

Standardized conventional X-rays of the affected shoulder are the first diagnostic step. The trauma-series after Neer includes three plains (AP, axial and Y-scapula-view), with the axial view not being possible in some patients because of pain (abduction of the shoulder is required). However, conventional X-rays are not always enough for fracture analysis (32), and an additional CT-scan is needed. The possibility of multiplanar reconstructions, including 3D views, (Fig. 1), that are freely rotatable facilitate the identification of the number and degree of displacement of all fragments (22). Although the CT-scan provides necessary information

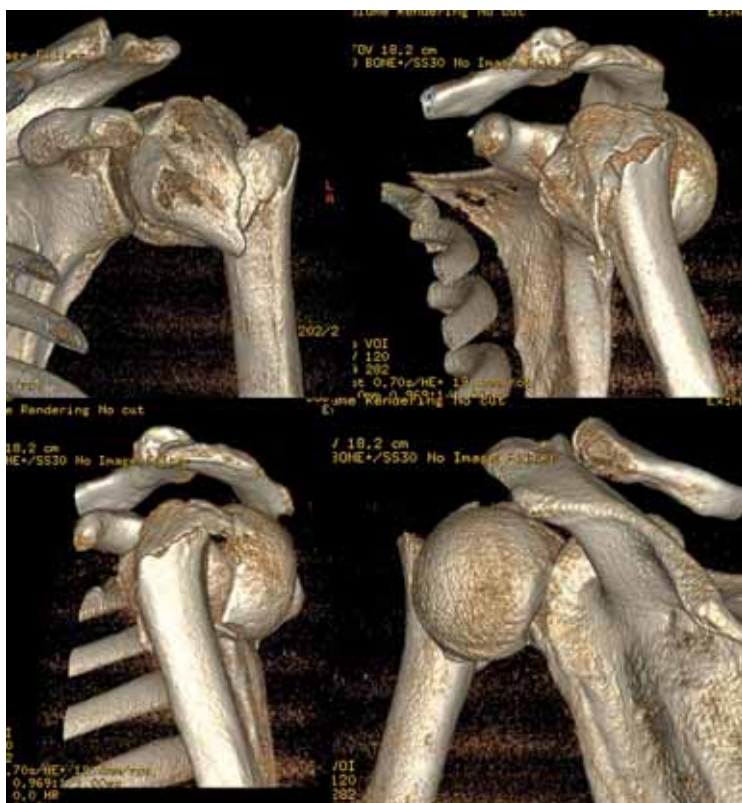


Fig. 1. Dislocated proximal humerus fracture in a 65-year-old patient shown from a ventral, dorsolateral, ventrolateral and dorsal point of view (AO-Classification 11 C3.2). CT-scans with 3D-reconstructions are valuable for the estimation of the fracture severity and classification.

regarding the osseous structures only, additional MRI examination for rotator cuff injuries are a rarity.

The risk of avascular necrosis is mainly present in complex multifragmentary fractures (24). Blood supply to the proximal humerus is ensured through the anterior and posterior circumflex arteries which arise from the axillary artery (19). They enter the humerus at the anatomic neck medio-dorsally; this is the reason for the increased necrosis rate (up to 50%) after fractures of the anatomic neck compared to surgical neck fractures (12). The posterior humeral circumflex artery provides 64% of the blood supply to the humeral head (15). The anterior circumflex artery gives a branch called the arcuate artery, which then goes into the sulcus intertubercularis. Displaced fractures of the minor tubercle can set this artery in risk.

Neither time to surgery, nor patient age seem to influence the development of avascular necrosis, in contrast to the number of fragments that proportionately increase the risk (1). More specifically, the rupture of the periosteum seems to be a pivotal risk factor – when the medial hinge is more than 6mm displaced, the blood supply to the humeral head is considered to be at risk for avascular necrosis (22). This complication is reported to be significantly higher in patients treated with a plate osteosynthesis (14, 33). Nevertheless, this merits critical attention, as plate osteosynthesis is usually used for more complex fractures.

Operative treatment

There are several options for the surgical treatment of PHF available: angular stable locking plate systems (e. g. proximal humeral interlocking system [P.H.I.L.O.S.], Synthes, Umkirch), intramedullary nailing systems, K-wires, tension-band techniques or even prosthetic replacements, especially in the geriatric population. However, it is still unclear which of the above-mentioned options should be applied to what patient. Most of the existing studies could not find significant differences between the groups treated with a plate osteosynthesis or an intramedullary locking nail in terms of outcome, while the populations included were inhomogeneous in terms of age, fracture severity and co-morbidities.

The indications for surgical treatment regardless of age are significant fracture-dislocation and head-split components, pathological fractures, open fractures, concomitant neurovascular injuries and a non-reducible shaft-displacement of >50% of the shaft diameter. The original criteria for surgical treatment according to Neer (25) were refined over the last years (23) (Table 1).

However, these criteria for decision making were based on data from younger patients. Thus, they should be applied with caution in cases of geriatric fractures.

IM-nailing and locking plate fixation are the most common surgical procedures for the treatment of PHF. Lill et al. compared both types of fracture fixation (22), and they recommended IM-nailing for two-part and plate osteosynthesis for three-part fractures with medial support. No recommendation was made for four-part fractures. Regarding the geriatric population (beyond 75 years of age), the partial arthroplasty with refixation of the tubercula was recommended, depending on the intraoperative condition of the rotator cuff. A reverse-arthroplasty of the shoulder could serve as an alternative in cases of rotator-cuff insufficiencies in the elderly (6).

Gradt et al. suggested that two- and three-part fractures should be treated with IM-nailing since it leads to better functional outcomes compared to locking plate fixation. While the overall complication rate was higher (up to 28%) in the locking-plate group, major complications with need for surgical revision were mostly observed in the IM-nailing group (major complications being se-

Table 1: Criteria for surgical treatment after Neer (25) and after Lill (23).

Neer et al. 1987	Lill et al. 2012
Axis deviation >45°	Axis deviation >20°
Displacement of the head >1cm	Displacement of the head >5mm
Displacement of the tubercula >5mm	Displacement of the tubercula >2mm

condary fracture displacement with implant failure, osteonecrosis, rotator-cuff lesions and glenohumeral joint screw protrusion over 1 mm) (11). A retrospective study of 43 patients treated with IM-nailing demonstrated that a malreduction of either $>15^\circ$ in both planes or of $>20^\circ$ in one plane resulted in a significantly worse clinical outcome (31). Another study reported significantly more implant failures in the IM-nailing group (pullout of interlocking screws) and higher rates of subacromial impingements, when compared to the plate group. On the contrary, the plate group suffered more postoperative infections and type I complex regional pain syndrome (3).

Biomechanical analyses demonstrated locking plating endures torsional forces longer before transmitting deformation to the bone. The IM-nail has a higher rigidity and is more resistant to deformation. Based on these findings, Foruria et al. suggested that the plate may be superior for patients who are impaired, since it endures more spontaneous loads before transformation (7).

In any case, both locking plates and intramedullary nails seem to provide the necessary stability for the treatment of osteoporotic fractures in the elderly. The overall reported complication rate seems to be similar between the two techniques and is mostly due to incorrect surgical technique (20). Nevertheless, based on the increased rate of major complications of the IM-nail and the better biomechanical behavior of the locking plates towards torsional forces, locking plate osteosynthesis seems to be the first choice in geriatric cases, if surgery is needed.

Conservative treatment

About 13–16% of all fractures are three- and four-parted and 20% of them are displaced (3). This leaves almost 70% of fractures that are suitable for conservative treatment.

Since the pioneering reduction and treatment algorithms published by Böhler (1951), the principles of conservative treatment of PHF have not changed: reduction followed by a stable retention and early rehabilitation.

In unclear cases, the dynamic examination of fracture stability under the image intensifier presents a valuable option. In our department, in fractures that do not explicitly fulfill surgical criteria, we perform this procedure (Fig. 2).

The advantages of the conservative treatment are the absence of additional surgical trauma and of possible surgical complications. (21, 26)

Yüksel et al. analyzed retrospectively 18 patients with three- and four-part fractures that refused surgery or could not undergo surgery because of medical conditions. They were all treated conservatively with the same pro-

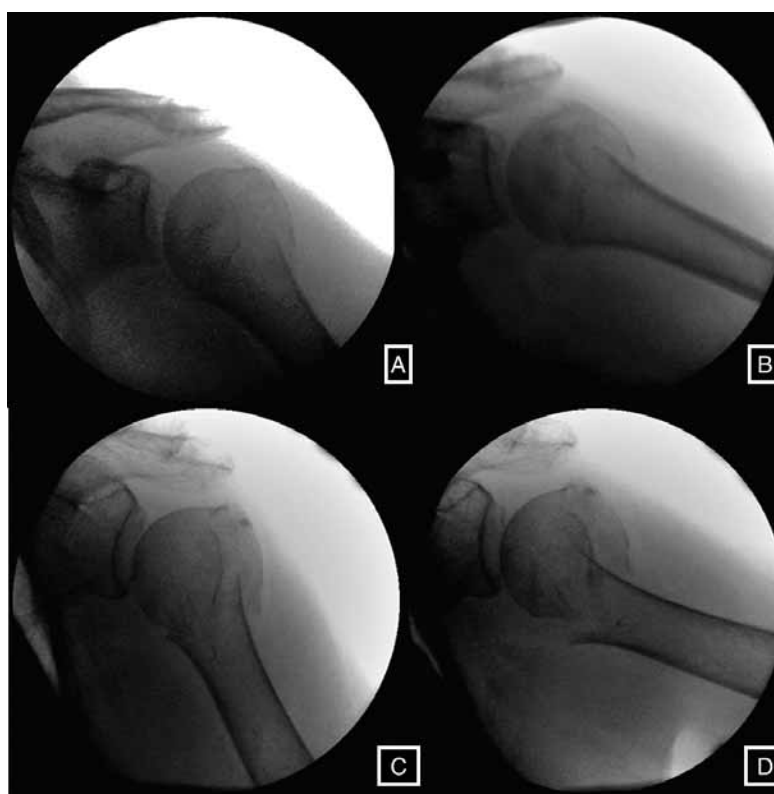


Fig. 2. Examination of fracture stability with an image intensifier in 0° abduction (A) and in 45° abduction (B) in a stable AO B1.2 surgical neck fracture with metaphyseal impaction. The lower pictures show an unstable complex neck and tuberositas fracture AO C1.2 in 0° abduction (C) and an increase of displacement in 45° abduction (D).

ocol. The functional outcome was better in patients below the age of 65 years with three-part fractures; in all other cases the Constant Murley Score did not show any significant differences regarding fracture type and age. Five of the eighteen patients developed an osteonecrosis which did not seem to have any influence on their functional results (34). Torrens et al. examined 70 patients treated conservatively with a PHF between 60 and 85 years of age with regard to their functional outcome and quality-of-life.

All fractures consolidated, and the functional outcome was inversely proportional to the number of fragments. Although the patient subgroup >75 years scored lower in the Constant score, there was no correlation to the quality-of-life measurement (30).

Additionally, a prospective study of conservatively treated PHF in elderly patients reported that 80.6% of the patients had excellent to good results, with the quality of outcome being mainly dependent on patient age and fracture displacement (5). Nevertheless, surgery does not seem to improve the outcome in the elderly patient (5).

The conservative treatment of stable fractures (after dynamic examination under an image intensifier) consists of functional immobilization and additional passive motion with flexion and abduction of less than 90° during the first 2 weeks after trauma. Assisted physiotherapy can begin at day 14 with free ROM passively or



Fig. 3. Conservative treatment algorithm in our institute for stable and unstable proximal humerus fractures.

with active assistance. After six weeks the joint can be loaded freely up to the limit of pain. The treatment for unstable fractures is more restricted. Treatment is initiated with absolute immobilization over three weeks, followed by passive mobilization up to 90° flexion/abduction. Assisted physiotherapy may only start after X-ray control follow-up (Fig. 3).

X-ray controls should be performed at day 3, 7, 14 and after week 3 and 6. In case of secondary displacement, the indication for surgery may be reconsidered (21).

The type of immobilization depends on the fracture type. In the case of isolated or combined fractures of the major tubercle, the upper extremity should be immobilized in external rotation. If the minor tubercle is fractured, the humerus should be immobilized in internal rotation. In case of varus deviation, the upper arm should be immobilized in abduction (Fig. 4). With respect to the medial shaft displacement below 50% the use of a proximal reel is possible (21).

Operative vs. conservative treatment

The geriatric patient bears certain differences in terms of therapeutic outcome, when compared with young individuals. The surgical criteria of Neer and Lill may not

necessarily apply to this group of patients, as in many cases they can be considered quite aggressive. Surgery does not necessarily result in better outcome in geriatric patients, as the iatrogenic soft tissue damage and revision surgery can complicate the situation (13, 29). However, studies demonstrating a higher complication rate due to osteoporotic bone stock are still missing (22). Most authors suggest, that complication rates rise as a function of age with all its implications (comorbidities, physical weakness, etc.). A major limitation in the comparison of the literature available is the varying inclusion criteria and methods of analyses. Most studies do have one thing in common: they fail

to demonstrate the superiority of either one of the treatment options studied. Lill et al. is not the only one who supports that there is no functional difference between the conservative and the operative treatment (21, 22, 30, 34). While the conservative treatment seems to result in lower objective functional outcomes and a reduced range of motion, this did not seem to have any effect on the quality of life of the patients (30). Olerud et al. compared 60 patients with 2-/3-part fractures, who were either treated conservatively or with an locking plate osteosynthesis. The results indicated an advantage in functional outcome and a higher life quality in favor of the locking plate group but at the cost of additional surgery in 30% of patients (26). Additionally, a meta-analysis of Song et al. showed that conservative treatment can effectively reduce the risk of additional surgeries and complications and that there is also no statistical difference between operative and non-operative treatment in terms of clinical outcome in elderly patients (27).

However, age alone should not be the only parameter to define the optimal treatment strategy (9). Decision making should be performed individually. Even unstable displaced fractures with a high risk profile can lead to a conservative treatment cascade.



Fig. 4. A – conservative treatment with immobilization in external rotation of major tubercle fractures; B – immobilization in internal rotation for the conservative treatment of minor tubercle fractures; C – immobilization in abduction for the conservative treatment of varus deviated humerus head fractures.

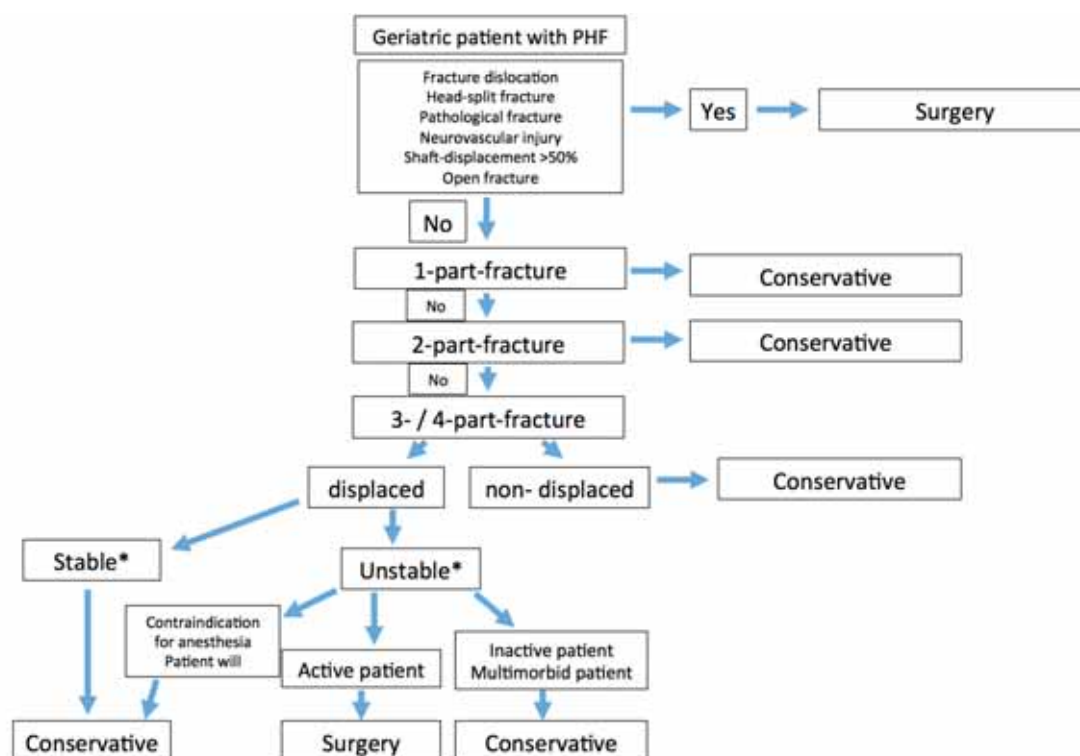


Fig. 5. Treatment algorithm and decision making (conservative vs. operative) of geriatric patients with proximal humerus fractures. (*=dynamic examination of fracture stability with the use of image intensifier).

On the contrary, one has to take into consideration that conservative treatment of these fractures leads to temporary immobilization, which may be restrictive in biologically younger, active patients. In order to guide the decision making process in cases of geriatric PHF, we propose a treatment algorithm, combining the above mentioned characteristics and factors (Fig. 5).

Conclusions

Fractures to the proximal humerus in the geriatric population are a common injury that can be potentially treated conservatively. The enthusiasm towards operative treatment of those fractures even in the elderly population after the introduction of locking implants has not been justified by the functional results. Conservative treatment in the geriatric population should be considered frequently, since long term outcome is comparable or even superior according to the current state of literature. The decision-making process based on fracture type and stability, as well as, patients risk profile should be performed individually. In case of conservative treatment adequate immobilization and rehabilitation are the key steps for optimal functional outcome and acceptable quality of life.

Conflict of interest statement

Each author certifies that he or she has no commercial associations (e.g. consultancies, stock ownership, equity interest, patent/licensing arrangements, etc.) that might pose a conflict of interest in connection with the submitted article

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