Cuff Disorders

11

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Introduction

Bony anatomy and rotator cuff (RC) integrity are fundamental for a proper shoulder function, which is often impaired after humeral head fracture. In the last decades functional outcome after proximal humeral fractures was mainly brought in line with restoration of the bony anatomy. Little attention was paid to already preoperative existing or due to trauma developed rotator cuff lesion. As current studies on conservative and surgical treatment show a significant correlation between rotator cuff tears (RCTs) and poor clinical outcome, these pathologies should be considered carefully before final treatment decision regarding proximal humerus fractures [1–3]. Furthermore the option of anatomic or reverse arthroplasty for complex fractures of the proximal humerus in the elderly patients requires detailed information about the status of the RC [4, 5]. The following chapter accordingly focuses on preoperative diagnostics and considerations regarding pre-existing and concomitant RCTs in case of proximal humeral fractures to allow for an individual treatment decision for satisfying clinical results:

Etiology of Concomitant RCTs

The prevalence of asymptomatic RCTs increases with age so that in patients younger than 50 years less than 5 % of RCTs were found whereas patients older than 80 years show an asymptomatic RCT in up to 80 % [6]. Accordingly in the elderly patients a preexisting RCT is supposed to be more frequent (Fig. 11.1). But also trauma associated lesions of the rotator cuff are described in case of proximal humeral fractures [1, 7, 8]. In the era of open surgery a tear of the rotator interval (longitudinal or complex shape) has been described as the most common traumatic tear pattern besides bony avulsions [2]. However, arthros-

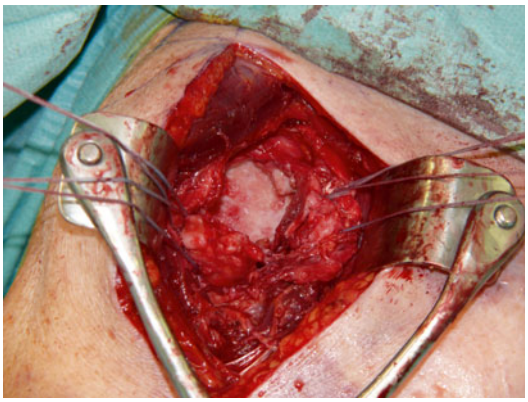

Fig. 11.1 Intraoperative situs of a chronic massive RCT in a humeral head fracture (Courtesy of Dr. V. Braunstein, Munich)

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copy revealed a higher incidence of intraarticular lesions which have not been diagnosed in open surgery due to the limited exposure from the bursal side [9, 10]. A progression of the preexisting tear size or combined injuries are also described in proximal humeral fractures so that in some cases uncommon tear patterns may result.

Preoperative Diagnostics

A detailed acquisition of history of shoulder complaints (pain, weakness, active deficit in range of motion (ROM), instability, previous surgery) may provide a first hint to pre-existing rotator cuff pathologies. But in the elderly patient a proper evaluation of pre-traumatic shoulder function might be difficult due to reduced practice of the arm and altered pain perception. According to the increasing prevalence of RCTs with age the patient's age gives an idea of the overall tear probability [6, 11].

Clinical examination of the acute injured patient is mainly limited due to pain. But a careful inspection of the periscapular muscle status may already reveal an atrophy of the fossa supraspinata and/or infraspinata as a sign of a large chronic RCT (see Fig. 11.2). Significant haematoma or soft tissue swelling complicate this assessment. Traumatic lesions of the suprascapular nerve often combined with high velocity trauma and fractures of the scapula are also difficult to examine clinically. If due to the trauma mechanism a nerve injury is suspected additional neurologic diagnostics are indicated.

Fig. 11.2 Clinical sign of a chronic postero-superior RCT: Atrophy Fossa supra-/infraspinata right shoulder

Imaging

Plain radiographs of the shoulder are accepted as basic diagnostics for suspected proximal humeral fractures. For a standardized evaluation at minimum two planes ("true ap" and axial view/Velpeau) are required, an additional "outlet view" gives further information. Due to the inability to be visualized directly on plain radiographs, soft tissue structures have been neglected during initial evaluation of proximal humeral fractures. Nevertheless there are secondary signs of chronic rotator cuff insufficiency that are displayed on plain radiographs. The most obvious changes are seen in advanced cuff arthropathy with changes of the shape of the glenoid and acromion (acetabularisation) [12]. In early stages subchondral sclerosis of the acromion and cystic changes in the footprint of the rotator cuff might be evitable (see Fig. 11.3). An advanced osteoarthritic deformation of the head (fragments) or a posterior osteoarthritic glenoid bone loss gives no evidence of rotator cuff insufficiency.

The validity of the combination fracture pattern/dislocation and rotator cuff tear is discussed controversially. Biomechanically a typical fracture dislocation (greater tuberosity – postero-superior, lesser tuberosity – antero-inferior)

Fig. 11.3 Preexisting early cuff arthropathy (Hamada II) with reduced acromio-humeral distance, subchondral sclerosis of the acromion and cystic changes of the greater tuberosity [12]

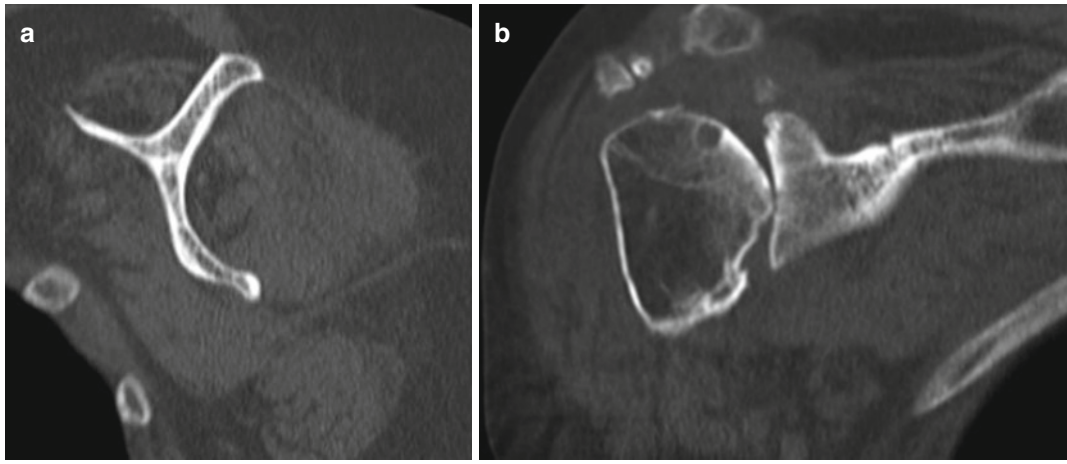

Fig. 11.4 CT-Scan (**a**) parasagittal reconstruction with a Grade III/IV fatty infiltration of SSP/ISP according to Goutallier et al. [14] (**b**) coronary reconstruction with significant fatty infiltration of the SSP muscle belly and cranialisation of the humeral head

concludes intact tension vectors (RC) and might be seen as a sign for functional integrity of the rotator cuff. But smaller rotator cuff tears may not be evident for changes in tension vectors. On the other hand two current studies show a positive correlation between severity/displacement of the fracture and prevalence of RCTs [1, 7]. But these differences might be due to different fracture mechanisms and age of the patients. In massive RCTs especially fracture patterns with compression fractures between acromion and humeral head are described.

In complex fractures a computed tomography (CT) scan enhances the consistency in understanding these fractures [13]. Additionally the fatty infiltration of the rotator cuff muscles can be evaluated in the parasagittal reconstruction according to Goutallier et al. [14]. In the elderly patient a generalized mild fatty infiltration in all parts of the RC is a common finding due to muscle inactivity whereas a localized fatty infiltration degree III/IV according to Goutallier is a certain sign for a biomechanically relevant chronic RCT (see Fig. 11.4a, b).

Besides the muscle structure also the muscle volume especially of the supraspinatus muscle can be estimated in CT according to the Thomazeau MRI classification in the parasagittal reconstruction, but changes in the cross-sectional area due to retraction of the musculo-tendinous junction have to be considered [15].

Additional ultrasonographic examination can give further information about the status of the rotator cuff. In traumatic or degenerative RCTs ultrasonography showed a sensitivity and specificity of 85–91 % regarding a detection of RCTs when compared to MR-arthrograms of the shoulder or arthroscopic findings of the shoulder at time of surgery [16]. But this accuracy is strongly dependent on the experience of the investigator. In fracture cases the examination accuracy is additionally limited due to haematoma and fracture dislocation of the RC insertion so that it cannot be recommended as standard diagnostic tool in dislocated multifragmentary fractures. Besides regarding the evaluation of the continuity of the RC some studies show the possibility of evaluating fatty infiltration but haematoma and investigator's experience may limit this technique [17, 18].

In daily clinical practice Magnetic resonance Imaging (MRI) diagnostics are performed only in few cases of proximal humeral fracture due to its availability and often misinterpretation of bony defect areas (bone bruise). But non- or minimally-displaced humeral head fractures are often not recognized until MRI reveals the fracture. In current radiological studies MRI showed information on fracture morphology comparable to CT but due to the above mentioned reasons it has not found the way to regular clinical practice yet. But in cases of persisting pain after conservative treatment MRI is accepted as standard diagnostic tool besides x-ray.

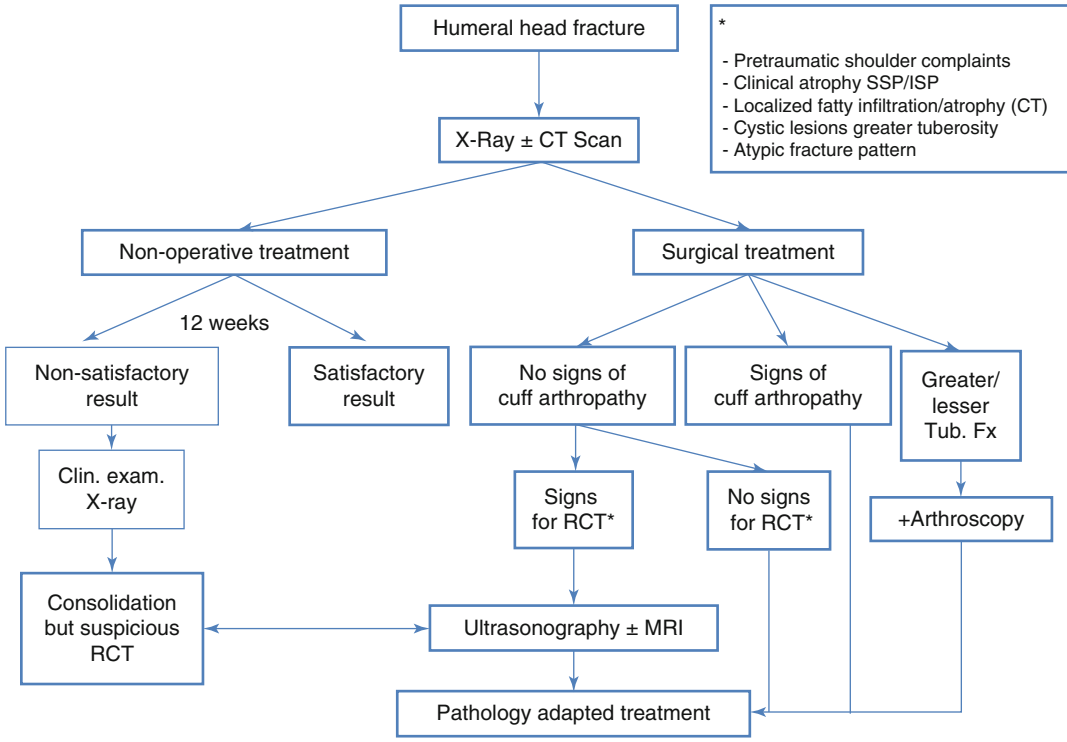

Fig. 11.5 Algorithm for imaging rotator cuff tendons in the setting of proximal humerus fractures

Arthroscopy

Diagnostic arthroscopy may reveal especially intraarticular lesions of the RCT and pathologies of the long head of the biceps tendon. But arthroscopy ahead of open refixation is technically limited to 2-Part fractures or minor dislocated fracture patterns. In comminuted or massive dislocated fractures the joint capsule continuity is completely destroyed so that an intraarticular visualisation cannot be achieved [9, 10]. As disadvantage prolonged arthroscopic diagnostics or treatment can cause massive periarticular swelling due to joint capsule interruption and complicate the open surgery itself. So the extent of arthroscopic diagnostics and treatment should be planned carefully.

Algorithm for Diagnostics

Already in 2009 Gallo et al. presented a simple algorithm based on the number of fragments and displacement of the greater tuberosity for additional diagnostics in proximal humeral fractures [19]. However the data about the relevance of fracture displacement remains unclear and especially preexisting lesions are not considered in the published algorithm. In fact the indication for additional diagnostics remains an individual decision. The following algorithm should provide a guideline for clinical practice (see Fig. 11.5).

Clinical Data and Treatment Considerations

The aforementioned additional diagnostic tools support the surgeon in his preoperative and also intraoperative considerations [20].

Preoperative considerations are mainly focussed on treatment modality (surgical vs. conservative treatment) and surgical technique. In most of the cases the indication of treatment modality (surgical vs. conservative) is not influenced by additional diagnostics because the osseous status (X-ray/CT scan) mostly defines the treatment. But specific intraoperative diagnostics

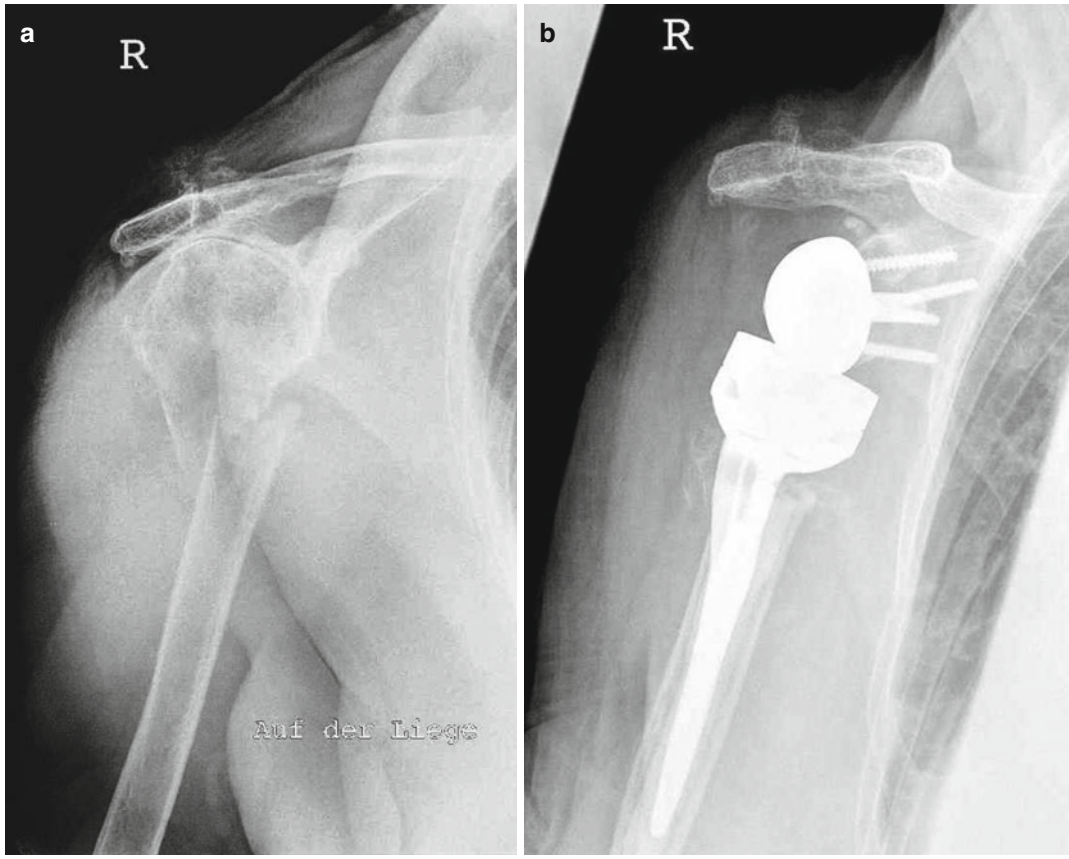

Fig. 11.6 Reverse Arthroplasty in a proximal humeral fracture (86 years, female) with a pre-existing rotator cuff arthropathy (Tornier, Aequalis reversed shoulder fracture stem with Bio RSA glenoid augmentation) (**a**) preoperative X-ray a.p. view (**b**) postoperative X-ray a.p. view (Courtesy of Dr. V. Braunstein, Munich)

(e.g. careful visualisation of parts of the RC) and technical decisions can be lead by detailed knowledge of the RC status. Current literature states the importance of the intact RC function for satisfying clinical results in all treatment modalities [1, 3, 21]. Wilmanns et al. evaluated 39 patients with proximal humeral fractures 6 months postoperatively clinically and with ultrasound. Patients with RCT showed a significantly inferior clinical outcome [3]. Bahrs et al. confirmed this conclusion in a larger series of 302 patients with a follow up of 53 months [1].

The most important information of additional preoperative imaging besides tear pattern and localization is the estimation of reparability of the tear. With both surgical approaches (osteosynthesis vs. anatomic shoulder arthroplasty) current case series show satisfying clinical outcome with additional rotator cuff reconstruction [4, 22]. But further studies of higher evidence levels are still missing.

In the case of prosthetic replacement the choice of implant defines the importance of rotator cuff integrity. While in anatomic shoulder replacement a dysfunction of the RC (tear, resorption of the tubercula) correlates with inferior clinical results [21] the shoulder function in reverse shoulder arthroplasty (RSA) is less dependant on RCT integrity. RSA gains growing interest in the treatment of the elderly patient with a complex fracture situation. Early clinical studies show satisfying postoperative results [5, 23]. In rotator cuff arthropathy an improved clinical outcome is found in patients with a remaining force couple, so that a stable refixation of the tubercula is strongly recommended. For the indication of RSA the sudden loss of function after 10–12 years postoperatively has to be considered especially in patients younger than 70 years [24] (Fig. 11.6).

Summary

Rotator cuff integrity is fundamental for a satisfying shoulder function after proximal humeral fractures. Patients' history, clinical examination and additional radiologic diagnostics (e.g. x-ray/CT) give information about the status of the RC and may influence the chosen treatment option. In all surgical techniques continuity of the RC (RSA – infraspinatus/teres minor/subscapularis) should be one important goal of the treatment as clinical studies report herewith improved outcomes.

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