Strategies in Fracture Treatments

Peter Biberthaler · Sebastian Siebenlist
James P. Waddell *Editors*

Acute Elbow Trauma

Fractures and Dislocation Injuries

ASSOCIATION FOR RATIONALE TREATMENT OF FRACTURES
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Strategies in Fracture Treatments

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This series provides a clearly structured and comprehensive overview of fracture treatments based on the most recent scientific data. Each book in the series is organized anatomically, so the surgeon can quickly access practical aspects, examples, pearls and pitfalls of specific areas. Trauma and orthopaedic surgeons worldwide who are searching for a current knowledge of new implants, therapeutic strategies and advancements will be able to quickly and efficiently apply the information to their daily clinical practice. The books in the series are written by a group of experts from the Association for the Rationale Treatment of Fractures (ARTOF) who aim to provide an independent, unbiased summary of fracture treatments to improve the clinical and long term outcomes for patients.

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Preface

The main therapeutic target of complex elbow trauma is a narrow path between stiffness and instability. In this regard, the elbow joint is one of the anatomic regions that saw the biggest changes in therapeutic concepts during the last decade. Over a long period, this joint was recognized as "the forgotten" joint since its complexity of bony and soft tissue structures orchestrating a highly sophisticated mobility concept of flexion/extension and pro-/supination overstrained the armamentarium of classical surgical implant technologies. Hence, a functional bow of flexion/extension between 30° and 130° was described as a sufficient therapeutic target tipping the scales towards stiffness. Due to the intensive research of several dedicated surgeons and the development of several highly specific implant series, therapeutic options were significantly improved during the last decade. Moreover, the thorough understanding of soft tissue structures and their contribution to elbow joint function induced a whole series of new surgical techniques to stabilize complex elbow injuries sufficiently. This approach allowed to control the instability problem more and more and extended the posttraumatic function consecutively towards a more and more original functional ability.

Hence, the intention of this book was to gather those innovative technologies in a comprehensive piece of knowledge. It is clear that such an ambitious goal can only be achieved by the concentrated work of leading international experts. Therefore, I would like to express my deep thanks to all authors of this book who shared their precious knowledge with the reader to the benefit of our patients.

This book is part of the ARTOF (Association for the rational treatment of fractures) trauma series published by Springer Nature. ARTOF (www.artof-online.org) is an independent scientific society dedicated to a strict scientific approach of the best therapeutic concept of fractures.

More volumes are
Proximal Humerus Fractures
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Simple Elbow Dislocations

1

Sebastian Siebenlist and Peter Biberthaler

Epidemiology

Regarding major human joints, the elbow is the second most commonly dislocated joint in adults following the shoulder [1]. By definition, a simple elbow dislocation is described as one without concomitant fractures (apart from small periarticular bony avulsions of 1 mm or 2 mm in diameter) [2]. Several authors reported on the incidence of simple elbow dislocations ranging from 3 to 9 per 100.000 individuals referred to different periods of life [1, 3–5]. Male adults are the group at highest risk. They are more likely to suffer from an elbow dislocation injury following sports or accidents. Women are likely to suffer from dislocations during a fall from standing height with daily activities.

Over the last decades, good functional outcomes have been reported after non-operative treatment in most patients. However, a small proportion of patients complains of recurrent instability, stiffness or pain if treated non-operatively and do require operative intervention in the sequel [3, 6, 7]. Due to better understanding of injury patterns and developments in soft tissue repair techniques the discussion of standard treatment for simple elbow dislocation has arisen again in recent years [8].

Classification

To this day, no validated classification exists for simple elbow dislocations. There is consensus to descriptively grade the injury according to the direction of dislocated forearm related to the humerus (Fig. 1.1). The most common direction of elbow dislocation is posterior and posterolateral respectively. Divergent and anterior dislocations are extremely rare and usually occur in paediatrics or in association with concomitant fractures.

In newer times, the complex interactions among the different elbow stabilizers have been better understood due to improvements of biomechanical knowledge, and therefore current surveys deal with systemizing this “simple” injury [9, 10]. An exhaustive and practical classification is still highly difficult to create because numerous and different parameters are to be considered. However, eminent elbow surgeons have described the elbow instability based on the following criteria: timing (acute, chronic, recurrent), injured ligaments and soft tissues, articulations involved (radio-ulno/humeral or proximal radioulnar),

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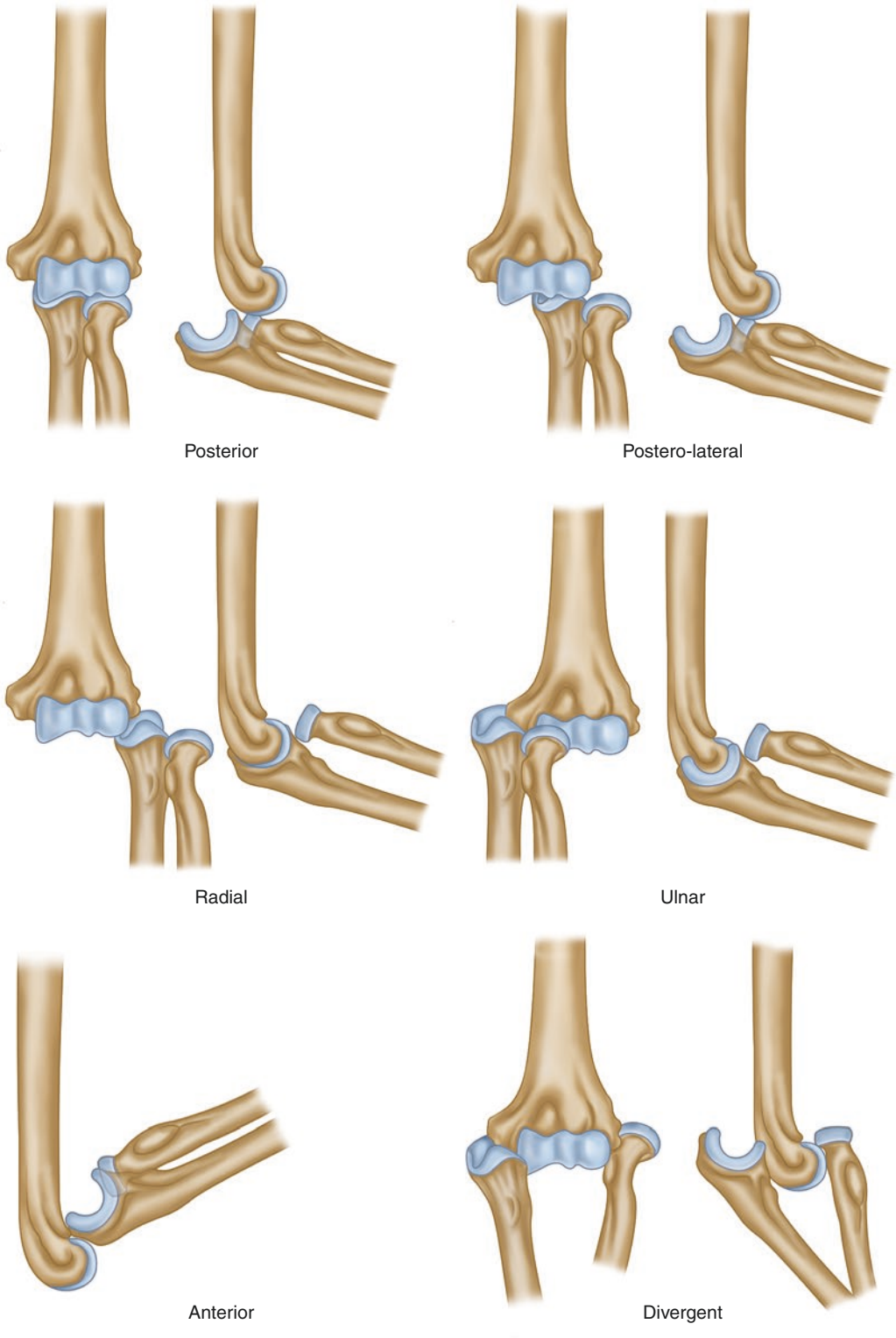

Fig. 1.1 Directions of elbow dislocation

direction (valgus, varus, anterior, posterolateral), degree (subluxated, perched, dislocated) and according to associated fractures (radial head, coronoid, olecranon, distal humerus) [11–15].

Symptoms and Diagnostics

With special respect to the mechanism of injury a detailed case history interview and an accurate physical examination should be performed. In most cases the history gives a lead to the diagnosis. However, the dislocation mechanism (arm position at time of impact) has to be determined as precisely as possible to receive information about the dislocation pattern (→ *subchapter injury pattern!*). Some patients report self- or spontaneous reduction and just complain about pain and swelling, but no deformity. These patients should be exactly interviewed about a history of a clicking event, deformity at the time of injury or a feeling of elbow instability. The elbow has to be evaluated for open wounds as well as for neurologic or vascular disturbances that are described in rare cases [16].

Patients with a dislocated joint at time of presentation frequently report strong pain in the elbow in a typically, slightly flexed position. Prior to reduction, anteroposterior and lateral radiographs are performed to confirm dislocation, to determine direction of dislocation and to exclude associated fractures as well. If the diagnosis is confirmed an immediate closed reduction should be performed by using a gentle reduction maneuver [17]. Subsequently the elbow is immobilized in a posterior plaster cast (→ *subchapter non-operative treatment!*). Again the postreduction neurovascular examination is mandatory and has to be documented. Following reduction radiographs have to be reviewed for joint congruency and to rule out previously unrecognized, concomitant fractures. A CT scan can be necessary for questionable associated fractures or bony avulsions (especially at the coronoid tip!).

During the next days after reduction the physical evaluation should focus on medial or lateral bruising after removing any cast or dressing. An edema and hematoma formation medially and/or laterally points to an extensive soft tissue disruption including the tough muscular fascia (Fig. 1.2). In the acute injury the stress testing for ligament integrity is very often not sufficiently feasible due to pain inhibition. In any case the patient should be instructed to actively move his elbow to verify muscular joint centering and stabilization (→ *subchapter injury pattern!*). In the author's experience a reluctance to actively move the injured elbow is highly suspicious of a grossly joint instability based on substantial soft tissue injury. Many of these patients also describe apprehension of recurrent dislocation. Finally, the examination should also include the ipsilateral shoulder and wrist not to miss further injuries.

Fig. 1.2 The massive hematoma at the medial elbow indicates an extensive soft tissue injury (disruption of the flexor mass and muscular fascia) following simple dislocation

Anteroposterior and lateral radiographs should be repeated within the first week after reduction to secure a concentric reduction. An initial drop sign (= ulnohumeral distance >3–4 mm) caused by effusion has to be diminished within this time. Otherwise reasons for its persistence like incarcerated ligamentous tissue or loose cartilage bodies have to be detected [18].

Not only for that reason, a MRI examination (ideally obtained within the first week post injury) has to be recommended after any simple elbow dislocation. Using MRI scans Hackl et al.

specified cutoff points for radiocapitellar incongruity and axial ulnohumeral incongruity in patients with posterolateral rotatory instability [19]. To provoke joint incongruencies it is crucial to perform the MRI examination in the nearly extended elbow. Only then the MRI illustrates the integrity of the static ligamentous constraints and of the dynamic muscular stabilizers as well (→ *subchapter injury pattern!*). The MRI scans therefore should be screened with special respect to the lateral ligament complex (LCL), the anterior bundle of the medial collateral ligament (MCL), the flexor–pronator origin, and the common extensor origin (Figs. 1.3 and 1.4). However, it has to be clearly stated that the MRI findings should not be overemphasized and have be assessed in relation to the whole clinical presentation.

Ultrasound examination can also provide valuable additional information when analyzing the collateral ligaments and the common flexor and extensors by dynamic testing. Nevertheless, especially in the acute injury this examination is heavily dependent on the patient's pain, swelling and compliance, but principally on the surgeon's experience.

Also, the fluoroscopy is valuable to dynamically assess the elbow under varus and valgus stress (in full extension and 30° of flexion) and to visualize the degree of stable functional arc. Some authors prefer the fluoroscopy to determine joint stability and to justify their treating protocol for nonsurgical or surgical management [20, 21]. In the anteroposterior view, the angle between the distal humeral joint line and the proximal ulnoradial joint line is measured under maximal varus and valgus stress. It seems probable that the bigger this angle can be opened during examination the more severe is the damage of soft tissue stabilizers on the medial and/or the lateral side (Fig. 1.5). This hypothesis is underlined by a current study of Adolfsson et al. showing that vast soft tissue injuries including both collateral ligaments and muscle origins lead to redislocation in nonsurgically treated simple elbow dislocations [22]. Consequently, it is obvious that an elbow that redislocates under fluoroscopic examination needs surgical intervention due to gross instability. The examination is ideally performed under anesthesia at time of reduction. However, the evaluation of stability using fluoroscopy requires adequate experience in elbow disorders management.

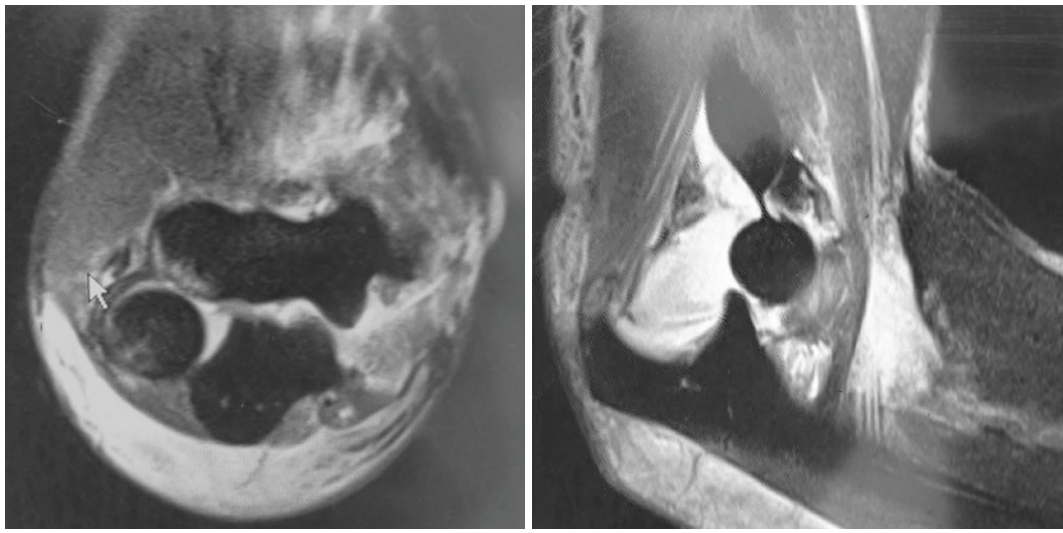

Fig. 1.3 51-year-old male patient after skiing accident: MRI showing re-dislocation of the elbow joint within the applied plaster cast. The brachialis muscle and the flexor-pronator-mass are totally ruptured

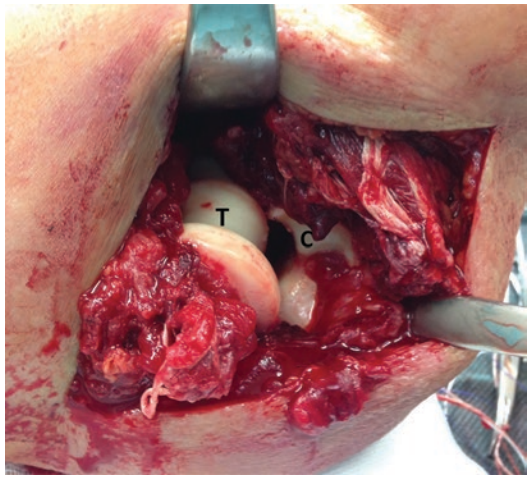

Fig. 1.4 Intraoperative situs of patient presented in Fig. 1.3: following skin incision at the medial elbow it's obvious that all soft tissue stabilizers (MCL complex, flexor-pronator mass and brachialis muscle) are stripped of the humerus (*T* humeral trochlea, *C* coronoid)

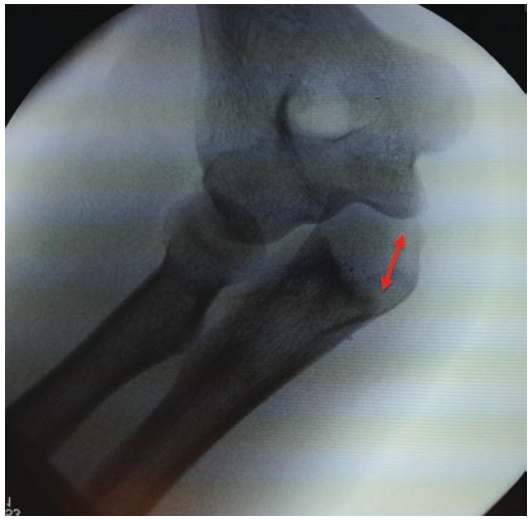

Fig. 1.5 Medial stability testing using fluoroscopy: a grossly openable joint (red arrow) point to severe damage of soft tissue stabilizers

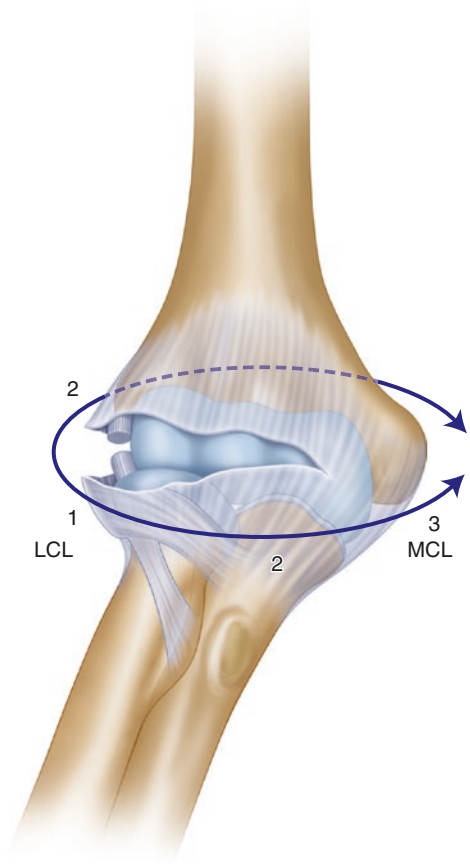

Fig. 1.6 The stages of 'Horii circle':
Stage 1: the partial or complete disruption of the LUCL on the lateral side results in posterolateral rotatory subluxation.
Stage 2: the disruption of the capsule both anteriorly and posteriorly leads to incomplete posterolateral dislocation.
Stage 3A: all the soft tissues except the anterior bundle of the MCL are disrupted. This leads to posterior dislocation of the elbow with pivoting around the MCL.
Stage 3B: the entire medial ligament complex is disrupted.
Stage 3C: the entire distal humerus is stripped of soft tissues including the flexor–pronator mass

Injury Pattern and Surgery Related Anatomy

The exact mechanism of elbow dislocation injuries is still the subject of debate in the current literature. The proposed posterolateral rotation theory of Shawn O'Driscoll – named the 'Horii circle' – is the most cited and accepted injury pattern (Fig. 1.6) [23, 24]. He described a soft tissue disruption from lateral to medial caused by a fall onto the outstretched hand. The soft tissue disruption subsequently results due to co-occuring