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REVIEW ARTICLE

Decision-making for complex scapula and ipsilateral clavicle fractures: a review

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Abstract

Introduction Complex scapula with ipsilateral clavicle fracures remains a challange and treatment recommendations are still missing. This review provides an overview of the evolution of the definition, classification and treatment strategies for complex scapula and ipsilateral clavicle fractures. As with other rare conditions, consensus has not been reached on the most suitable management strategies to treat these patients. The aim of this review is twofold: to compile and summarize the currently available literature on this topic, and to recommend treatment approaches.

Materials and methods Included in the review are the following topics: biomechanics of scapula and ipsilateral clavicle fractures, preoperative radiological evaluation, surgical treatment of the clavicle only, surgical treatment of both the clavicle and scapula, and nonsurgical treatment options.

Results A decision-making algorithm is proposed for different treatment strategies based on pre-operative parameters, and an example of a case treated our institution is presented to illustrate use of the algorithm.

Discussion The role of instability in complex scapula with ipsilateral clavicle fractures remains unclear. The question of stability is preoperatively less relevant than the question of whether the dislocated fragments lead to compromised shoulder function.

Keywords Floating shoulder · Complex scapula and ipsilateral clavicle fractures · Open reduction and internal fixation

Introduction

The combination of complex scapula and ipsilateral clavicle fractures is a rare condition, which is often associated with high energy trauma and multiple injured patients. When Ganz and Noesberger first described this combination of fractures in 1975 [1] they used the term “floating shoulder”. This term was later broadened to include “double disruption” of the superior shoulder suspensory complex (SSSC) [2], an osseo-ligamentary ring consisting of the glenoid, coracoid process, coraco-clavicular ligament, distal clavicle, acromioclavicular joint and acromion. In response to this change to the definition, debates arose in the literature about what constitutes a “floating shoulder” and the appropriate treatment strategies.

While single disruption of the SSSC is relatively common and does not cause instability, a double disruption occurs in only 0.1% of all trauma patients [3] and is considered an unstable condition [3–5]. In contrast to earlier definitions in which the combined ipsilateral clavicle and scapular neck fracture was defined as “floating shoulder”, instability only occurs in a complete double disruption of the SSSC [6]. A study using biomechanical analyses [7] showed that instability is present only in combination with concomitant coracoacromial and acromioclavicular ligament disruption. However, the degree of instability of such complex fractures continues to be a point of disagreement [8]. Furthermore, the classifications of scapular fractures do not systematically include concomitant ligamentous injuries of the shoulder girdle [9]. Ligamentous disruptions cannot be sufficiently assessed preoperatively to determine the stability of the injury. Conventional radiographs and/or CT scans are often the only means from which decisions can be made to treat conservatively or operate.

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Some authors have attempted to answer this question of stability from a clinical or biomechanical perspective [7, 10]. But given the rarity of these cases and limited research on this type of injury pattern, recommendations for the most appropriate treatment strategy have not yet been agreed upon. Moreover, most studies on the topic were published 10–20 years ago and include small numbers of heterogenic patients. There are, however, more recent publications describing findings from studies with larger numbers of patients [11–14] using clinical and radiological outcomes following conservative and operative management. The aim of this review is to compare and summarize the currently available body of knowledge on combined scapula and ipsilateral clavicle fractures, and to propose treatment strategies based on preoperatively assessable parameters.

Materials and methods

The U.S. National Library of Science database, MEDLINE®, was used to search for all relevant publications from January 1997 to December 2017. Inclusion criteria for this review were as follows: all published reports of original retrospective or prospective studies describing treatment for complex scapula and ipsilateral clavicle fractures, including clinical and/or radiological outcomes. Case series on this topic were also included. Single case reports and review articles were excluded. No limitations were assigned with regard to the age of the patients, but the study must have included at least four patients. Since findings from most investigations with adequate numbers of patients were published in the last 10–20 years, we focused the review on relevant literature covering the previous 21 years. No original articles pertinent to this review were available in English since 2016. The most recent studies, Gilde et al. [13] and Lin et al. [14], were published in 2015. Using two key terms—"scapula fracture" or "floating shoulder"—we identified 687 and 107 articles, respectively. All abstracts of these articles were screened by two of the authors. Full-length versions of potentially suitable articles were then assessed by the same reviewers. Of the 794 abstracts screened for inclusion, 13 articles fulfilled the criteria.

Results

General literature overview

Biomechanics of scapula and ipsilateral clavicle fractures

The term "floating shoulder" was originally used to describe the combination of scapular neck and ipsilateral clavicle fractures [1] and it was defined as an unstable fracture pattern. Concomitant ligamentous injuries were not addressed in this original definition. When Goss et al. introduced the concept of the SSSC and its double disruption, a variety of shoulder injuries sharing a common biomechanical basis were then included under one definition, even though important differences existed. For example, single disruption of the SSSC are common and do not produce instability, but a double disruption may require surgical stabilization due to its loss of function and integrity [2]. Problems with the coracoacromial ligament were not factored into Goss' description of the SSSC, even though this ligament is an important stabilizer in scapular neck fractures [7]. Findings from a biomechanical study by Williams et al. [7] demonstrated that the coracoacromial ligament provided approximately 40% of medial stability. According to these results, a "floating shoulder" only occurs when all attachments of the distal fragment (scapula neck fracture) to the proximal fragment and the axial skeleton have also been disrupted. However, based on assessments with cadavers, several dynamic factors, such as the deltoid muscle, rotator cuff force and trapezius muscle, were missing from the study by Williams et al. In conclusion, the role of stability in complex scapula fractures and ipsilateral clavicle fractures continues to be disputed, and the lack of evidence in the literature leaves this important point unresolved.

Preoperative radiological evaluation

Complex shoulder fractures are most often the result of a high energy trauma. Clinical and radiological evaluations are first done using the Advanced Trauma Life Support (ATLS®) guidelines. To diagnose a scapula and ipsilateral clavicle fracture, radiographic evaluation is necessary and should include a shoulder trauma series (true anteroposterior, scapular lateral and axillary lateral view). A CT scan is not always indicated but is often done at some point during the treatment of a multiple injured patient.

Acromioclavicular ligament disruptions are usually easy to diagnose both clinically and radiologically, but diagnosing a disruption of the coracoacromial ligament is more difficult. Scapular neck fractures with complete disruption of all attachments to the proximal fragment are more likely displacements rather than fractures with intact coracoacromial and acromioclavicular ligament disruption. However, the degree of displacement may only be an indirect sign of concomitant ligamentous injuries and not considered reliable radiological evidence. The two methods currently used to measure the amount of angular displacement of the scapular neck fragment on radiographs are the glenopolar angle (GPA) [15, 16] and the inclination angle of the glenoid [17].

A wide range of definitions are found in the literature concerning a dislocated fracture of both the clavicle and scapula. Some authors state that a displaced scapula fracture must have an angulation of > 40° and > 1 cm of medial translational displacement of the glenoid surface [18–20]. Others define displacement of the glenoid as > 5 mm or > 10 mm of the clavicle [21]. Nevertheless, there seems to be agreement that a certain degree of displacement leads to instability and poorer clinical outcomes. A recent study by Lin et al. [14] showed a high negative correlation between GPA and DASH, and a high positive correlation between GPA and Constant Score. In addition, Kim et al. [22] described a significantly improved Constant Score in patients with a GPA > 30° at a mean follow-up of 24 months. Romero et al. [15] defined a GPA of < 20° as severe glenoid rotational malalignment. Yadav et al. [12] did not find any significant correlation between GPA and the Herscovici score in either the conservatively treated or the operative group. The authors state that the GPA may be corrected by fixation of the clavicle but it does not correlate with the clinical outcome because the glenoid may dislocate in any direction and may not be compared with a two-dimensional model. Furthermore, in a systematic review Morey et al. [23] was unable to show a difference in outcomes depending on the GPA in conservatively and operatively treated (ORIF clavicle alone and both ORIF of clavicle and scapula) patients. In conclusion, the amount of instability can only be estimated, not proven or reliably assessed, at the preoperative stage.

Surgical approaches

Different invasive and less invasive approaches to treat scapula fractures have been described in the literature over the last 50 years [24–26]. Key aspects to consider when selecting the approach include the location and complexity of the fracture, and length of time between fracture and surgery [27]. In cases where the anterior glenoid rim needs to be addressed (fractures involving the superior aspect of the glenoid or involving the coracoid process), the approach should be anterior. Nevertheless, most scapula neck fractures are surgically treated using a posterior approach [28]. The most frequently practiced types are the extensile Judet approach [24], the modified Judet approach [26] and the minimally invasive approach [25].

In complex scapula fractures or fractures in which the operative procedure was delayed and callus formation would have been likely, the extensile Judet approach was most often used. The advantage of this approach is to adequately visualize and reduce fragments. The deltoid muscle is mobilized from the scapular spine and the muscle flap, which includes the teres minor and infraspinatus muscle, and must be elevated [24]. Special attention ought to be given to the suprascapular nerve when the flap is done laterally, nerve excursion does not allow exposure of the joint without overstretching the neurovascular bundle [29].

If scapular body exposure is not necessary, the modified Judet approach may be the most suitable approach. As a result, elevation of the teres minor and the infraspinatus muscle can be avoided. This technique can be performed in less complex fractures involving the scapula neck and fractures without callus formation. Alternatively, the minimally invasive approach is a viable method for preventing extensive soft tissue dissection [25, 27].

With regard to clavicle fractures, the most commonly used methods for ORIF are the superior and anterior inferior plating techniques. Some authors use intramedullary nailing techniques for the clavicle, which has been shown to be a feasible method in simple mid-shaft fractures [11]. In comminuted fractures or patients with respiratory insufficiency, plating is a viable method for achieving more rigidity and stability of the fracture. According to a recently published meta-analysis by Ai et al. [30], the anterior inferior plating technique may reduce blood loss, and operation and union time. However, no differences were detected in the Constant Scores, or the complication, infection or non-union rates.

Findings of review of treatment strategies

Tables 1 and 2 present a summary of the 13 studies included in this review, which are organized chronologically and according to treatment strategy performed. Although understanding of the double disruption of the SSSC has greatly improved and recently published findings from studies with higher levels of evidence and larger sample sizes are available [12–14], definitive treatment strategies are still unclear. As previously mentioned, this is a rare injury pattern, definitions have been modified over the years, and measurement technique/outcome parameters vary. For these reasons, establishing general treatment guidelines has been a challenge and may not always be applicable to each case.

Nonsurgical treatment

Using a non-invasive approach, overall morbidity can remain low, and soft tissue damage and neurovascular injuries can be avoided. Most publications report only fair-to-good results with this approach, though. In a prospective randomized study, Lin et al. [14] described a series of 13 conservatively treated patients. When compared to the surgically treated patients [open reduction and internal fixation (ORIF) of the clavicle and scapula], the GPA was significantly lower and was associated with a poorer clinical outcome (Constant Score, DASH). In a prospective study comparing conservative and operative outcomes, Yadav et al. [12] described better clinical results in the operative group than in the non-surgical group, yet there was no significant correlation with the GPA. Earlier studies, in particular, recommend conservative

Table 1 List of studies on conservative management of "floating shoulder"

Study	Year	No. of patients	Mean FU* (months)	Clinical outcome	Radiological outcome	Recommendation	Evidence level
Lin et al. [14]	2015	13/39	24	CSS = 62.35 (aCSS = 64.86), DASH = 20.81 (aDASH = 16.28)	GPA = 25.23°	C/S	I
Yadav et al. [12]	2013	13/25	24	Herscovici score = 10.4 (3 months)/13.0 (24 months)	GPA = 20.7	C	II
Kim et al. [22]	2008	7/32	32	CSS = 64.7	GPA = 16–27	–	III
Labler et al. [31]	2004	8/17	86	n = 5 (CSS = 92–100) n = 3 (SCC = 67–81)		C/S or conservative	III
Oh et al. [32]	2002	3/13	20	Rowe = 77		C/S	IV
van Noort et al. [17]	2001	28(31)/35	35	n = 6 (caudal displacement glenoid, CSS = 42), n = 22 (without caudal displacement glenoid, SCC = 85), n = 14 (dropping shoulder, CSS = 76), n = 14 (normal contour, CSS = 81)		Conservative	III
Egol et al. [33]	2001	12/19	53	DASH = 52.7, ASES = 80.2		–	III
Edwards et al. [21]	2000	20/20	28	Herscovici score 17 excellent, 3 good Rowe score 95 (18 excellent, 1 good, 1 fair) CSS = 96		Conservative	IV
Ramos et al. [34]	1997	13/13	90	Hersovici score, 11 excellent, 1 good, 1 fair		Conservative	IV

CSS constant-Murley shoulder outcome score; *aCSS* adjusted constant-Murley shoulder outcome score; *DASH* disabilities of the arm, shoulder and hand score; *aDASH* adjusted disabilities of the arm, shoulder and hand score; *ASES* American shoulder and elbow score; *GPA* glenopolar angle after consolidation; C/S, recommendation for ORIF clavicle and scapula; C, recommendation for ORIF only of the clavicle

*Follow-up

treatment, but many studies simply lack clear recommendations for treatment.

Surgical treatment of the clavicle only

Surgical treatment limited to the clavicle only has led to satisfactory outcomes. In two recent published studies, Lin et al. [14] and Gilde et al. [13] described good-to-excellent results when fixing just the clavicle. Lin et al. [14] described better clinical results (DASH score and Constant Score) in the group with clavicle fixation only compared to the conservatively treated group. The GPA of clavicle fixation alone revealed no cases of total realignment of the glenoid in relation to the scapular body, and no secondary correction of the GPA occurred after ORIF of the clavicle. Yadav et al. [12] found a significant improvement in GPA in patients with clavicular fixation alone, but no effect on the clinical outcome. Kim et al. presented satisfactory results when only fixing the clavicle and concluded that the glenoid angulation was not influenced by stabilization of the clavicle. Nevertheless, they reported significantly better results in patients with a GPA > 30° than with a GPA < 30°. Oh et al. compared patients with only clavicle fixations to patients with ORIF of both clavicle and scapula. They found better results in patients with additional scapular reconstruction than in fixing the clavicle alone, and found poorer results in patients with a scapular neck fracture displacement of > 1 cm.

Table 2 List of studies on operatively managed "floating shoulders"

Study	Year	No. of patients	Mean FU* (months)	Clinical outcome	Radiological outcome	Recommendation	Evidence level
A. Stabilization of clavicle and scapula							
Lin et al. [14]	2015	13/39	24	CSS = 76.57 (aCSS = 75.22), DASH = 1.22 (aDASH = 2.49)	GPA = 35.54°	C/S	I
Labler et al. [31]	2004	2/17	85	Case 1 CSS = 86, case 2 CSS = 100		C/S or conservative	III
Oh et al. [32]	2002	5/13	20	Rowe = 90		C/S	IV
Egol et al. [33]	2001	7/19	36	DASH = 46.1, ASES = 88.7		–	III
B. Stabilization of clavicula alone							
Lin et al. [14]	2015	13/39	24	CSS = 65.52 (aCSS = 64.51), DASH = 23.24 (aDASH = 26.52)	GPA = 28.23	C/S	I
Gilde et al. [13]	2015	13/13	16	Herscovici score = 12.9, VAS 1–3 ($n = 11$), VAS 4–6 ($n = 1$), VAS 7–10 ($n = 1$)		–	III
Yadav et al. [12]	2013	12/25	24	Herscovici score = 13.9 (3 months)/14.9 (24 months)	GPA = 22.9	C	II
Izadpanah et al. [11]	2012	16/16	35.7	Plate OS: CSS = 78.2, ASES = 79.1 TEN OS: CSS = 82.4, ASES = 85.7	Plate GPA = 36.8, TEN GPA = 34.6	–	IV
Kim et al. [22]	2008	9/16	32	CSS = 73.6	GPA = 17–37	–	III
Labler et al. [31]	2004	7/9	86.3	$n = 4$ (CSS 93–98) $n = 3$ (CSS 0–86)		C/S or conservative	III
Hashiguchi et al. [35]	2003	5/5	57.4	UCLA = 34.2, satisfactory outcome in all patients		–	IV
Oh et al. [32]	2002	5/13	20	Rowe = 88		C/S	IV
van Noort et al. [17]	2001	4(7)/35	35	Overall CSS = 71, 3 patients with persistent caudal glenoid displacement (CSS = 62)		conservative	III
Low et al. [36]	2000	4/4	40	Rowe score, 3 excellent, 1 good		C	IV

CSS constant-Murley shoulder outcome score; *aCSS* adjusted constant-Murley shoulder outcome score; *DASH* disabilities of the arm, shoulder and hand score; *aDASH* adjusted disabilities of the arm, shoulder and hand score; *ASES* American shoulder and elbow score; *VAS* visual analogue scale; *UCLA* UCLA shoulder rating scale (modified); *GPA* glenopolar angle after consolidation; C/S, recommendation for ORIF clavicle and scapula; C, recommendation for ORIF only of the clavicle

*Follow-up

Surgical treatment of clavicle and scapula

As reflected in more recent publications, surgical treatment has become more widely accepted and practiced. Reports indicate that this strategy results in immediate restoration of stability and early functional mobilization. Furthermore, understanding of the shoulder girdle and its possible dysfunction due to malalignment of the glenoid (Table 2) has improved over the years. Many surgeons report that stabilizing the clavicle is sufficient to prevent displacement and malrotation of the glenoid [36, 37]. Consequently, there is a limited amount of studies addressing treatment of both the clavicle and scapula. Lin et al. [14] found the most promising clinical results in patients with ORIF of both the clavicle and the scapula compared to ORIF of the clavicle alone or a conservatively treated "floating shoulder". As mentioned above, they found a negative correlation between GPA and DASH, and a positive correlation between GPA and Constant Score. Studies with elderly populations [31–33] reported good-to-excellent results in stabilization of the clavicle and the scapula.

Discussion

Treatment of complex scapula with ipsilateral clavicle fractures remains a challenge [6]. Most published studies include small numbers of patients treated over long periods, which is likely due to the infrequency of this fracture pattern. Given the changes in surgical techniques and rehabilitation regimes over the years, studies include a wide variety of scapular fracture types and therapies, which makes comparisons difficult. No widely accepted classification exists and the primary diagnosis of ligamentous injuries is difficult. The extent of lesions may only be detected in patients with distal clavicle fracture, acromion fracture or disruption of the acromioclavicular joint. Moreover, definitions of unstable fractures differ widely in the literature. It is still not possible to preoperatively determine if a scapula fracture combined with an ipsilateral clavicle fracture is unstable. Several studies provide evidence about the degree of instability of such complex shoulder injuries, but its application to clinical practice is limited [2, 7]. The combination of all these factors makes establishment of treatment recommendations complicated.

Decision-tree diagram for the treatment of "floating shoulder"

Using findings from studies currently available and experiences from our institution, we created a decision-tree diagram for selecting one of five different treatment strategies (Fig. 1). In light of the complexity of the topic, we present this diagram as a draft for consideration, a point of discussion and further development.

There is agreement in the literature that several preoperative radiological findings ought to be considered when choosing a treatment strategy. Recently, published prospective studies with large numbers of patients presented findings that are incorporated into these recommendations for

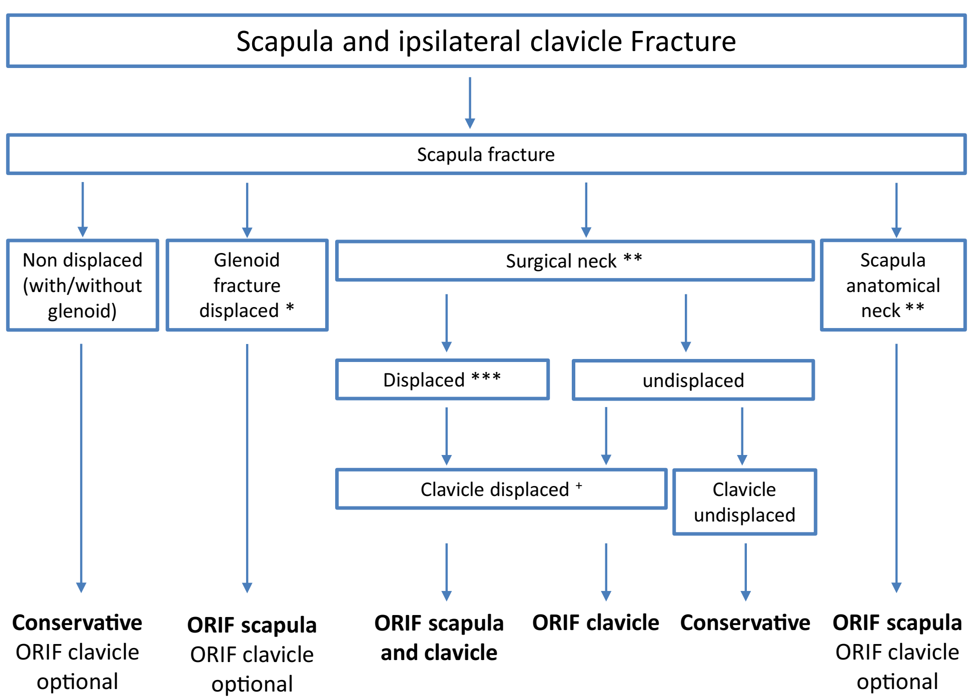

Fig. 1 Proposed decision-making algorithm for complex scapula and ipsilateral clavicular fractures. *Defined as displacement of (> 5 mm) only involving the glenoid rim with centered glenohumeral joint. Central fractures are defined as displaced if dislocation > 2 mm or gap > 5 mm. **Surgical and anatomical neck includes fracture types AO 09 A3.2/3.3 and B3.3.**Secondary dislocation, GPA < 20°. +Includes AO 06 A1-3 with displacement > 1 shaft width, all Type 06 B and C fractures, lateral fractures AO 07 B1-3, open fractures, respiratory insufficiency. *AO* Arbeitsgemeinschaft für Osteosynthesefragen

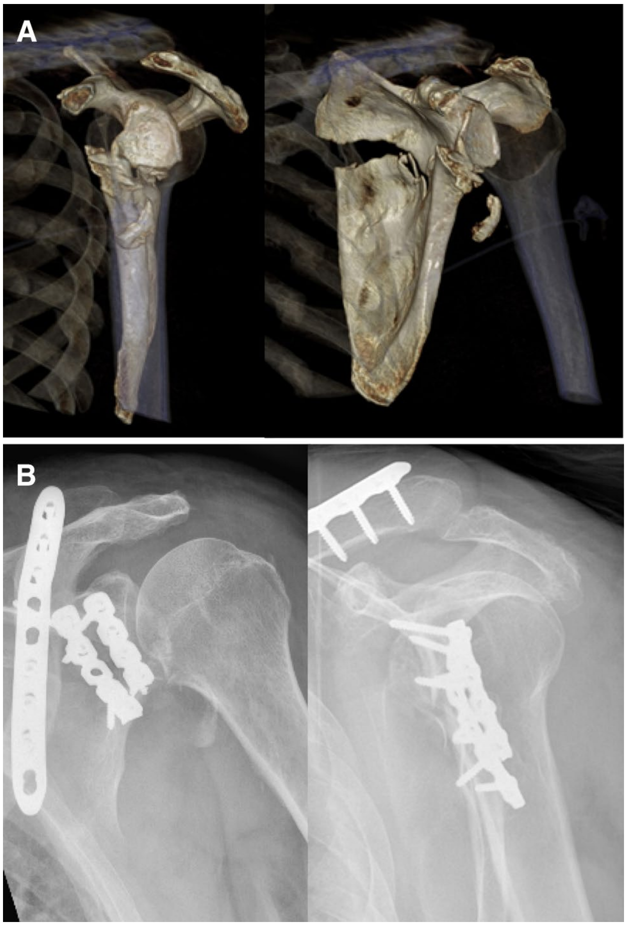

Fig. 2 **a** 3D scan of the left shoulder. The fracture type is best described as an Ideberg Type IV. **b** Postoperative X-ray 6 weeks after reconstruction. The glenoid surface is successfully reconstructed, but the bony fragment of the inferior osteoligamenteous rupture of the inferior glenohumeral ligament (IHGL) could not be sufficiently reattached

the five treatment options. For example, one key finding was that displaced scapula neck fractures are associated with poorer clinical outcomes. Several studies describe weakness of abduction and pain in the subacromial region due to a shortened lever arm of the rotator cuff [17–19, 31]. Bozkurt et al. [38] and Lin et al. [14] found a high correlation between GPA and functional outcome—the Constant Score decreased as GPA decreased. Furthermore, they concluded that a decreased GPA is more reliable in detecting instability than the fracture type itself.

Perhaps the most critical issue in the management of these cases is to assess if a malpositioned glenoid leads to shoulder dysfunction. Since most complex shoulder fractures are the result of a high energy trauma and associated with concomitant thoracic trauma, the injury is initially handled in accordance with the ATLS® guidelines for 'primary treatment'. If secondary dislocation is detected in follow-up radiographs, instability is assumed. It is likely that the patient's pulmonary function will improve only after stabilization of the clavicle fracture, as it did in the case that we present below (see Figs. 2, 3). Conservative treatment of non-displaced fractures of the scapular neck or body, with or without involving the glenoid, is widely recommended throughout the literature [18, 39]. Less agreement exists, however, on scapular fractures with displaced glenoid fractures [8, 40, 41]. For cases in which involvement is limited to the glenoid rim, large displacement would be tolerated (> 5 mm) if a centered glenohumeral joint is shown in post-reduction radiographs [42]. Decentered glenohumeral joints are more often seen in displaced central glenoid fractures and less displacement is tolerated (< 2 mm, gap of < 5 mm) [39] in such fractures. Surgical neck fractures exit the superior scapular border medial to the coracoid process, near or through the scapular notch. However, anatomical neck fractures stay completely lateral to the coracoid process.

Fig. 3 Abduction, internal and external rotation 6 months postoperatively. Constant-Murley-Score 73, relative (age- and gender-adapted) Constant Score 76. The patient was 'very satisfied', pain free and demonstrated good function without restriction in daily living

Due to a lack of concomitant ligamentous stability, anatomic neck fractures are considered unstable and reconstruction is widely recommended [5, 10, 19]. While fractures to the anatomic neck are relatively rare, surgical neck fractures are much more common [10].

One hypothesis frequently noted in the literature is that a malpositioned glenoid may lead to shoulder dysfunction [17–19, 31]. However, little evidence is available to clearly define an adequately positioned glenoid. Surgical indications include a variety of parameters, such as medialization of 10–25 mm or angular deformity 25–45° [18, 43, 44], shortening > 25 mm [44], intraarticular fractures with gap of 2–10 mm or glenohumeral instability [19, 45–47] and a GPA < 20–25° [33, 39, 48]. A significant negative correlation was reported between the change in GPA and the Constant Score [22], which is consistent with findings of Lin et al. [14]. Other studies found no correlation between GPA and outcome (Herscovici score) [12]. This may be since dislocation of the glenoid can occur in three dimensions, while the GPA only includes the frontal plane. Nevertheless, there is evidence for diminished shoulder function when GPA < 20° [14, 15, 22, 38]. Consequently, we used this as a cut-off point for surgical intervention in the proposed diagram. As stated above, medialization of > 20 mm may lead to shortened lever arm of the rotator cuff. These cases, as well as those with axial angulation and rotational errors, should be considered candidates for surgical reconstruction. To our knowledge, there is no clear evidence of an acceptable degree of dislocation in rotation and angulation in the axial plane.

Regarding clavicle fractures, many publications recommend only reconstruction of the clavicle, especially earlier studies (Table 2, section B). More recently published studies are more apt to recommend surgical reconstruction [12, 14] of both the clavicle and scapula, which leads to more favorable results for improved functional outcomes. Both the dislocation degree and fracture type are often secondary, and neither are well described in the literature. Based on our experience, several factors should be indications for surgical treatment: respiratory insufficiency indicating instability, near skin perforation or open fractures, no fragment contact, and possible neurovascular affection due to fragment displacement.

Sample case using decision-tree

To illustrate use of the decision-tree when determining treatment for patients with this complex injury pattern, we present a case of a 70-year-old man who was admitted to the emergency room following a motorcycle accident (Figs. 2, 3). A full body CT scan revealed a concomitant lacerated spleen, a small subarachnoid hemorrhage, multiple rib fractures on the left side, a dislocated clavicular shaft fracture, and a dislocated scapula fracture involving the glenoid. Splenectomy was necessary 48 h after trauma due to secondary hemorrhage. To minimize pulmonary restriction and improve ventilation, a plate fixation of the clavicular fracture, performed 4 days after the trauma, was done as the first part of a two-step procedure. The patient was extubated after 5 days and ventilation could be stopped immediately. Fourteen days after trauma, an ORIF of the scapula was performed through a dorsal approach.

In this case, the decision for further treatment was made without knowing the existence of concomitant ligamentous injuries. The two-step procedure was performed because of the concomitant lung and spleen injury. Given that the patient underwent a high energy trauma and he could be easily extubated after open reduction and internal fixation of the clavicle, the likelihood of concomitant ligamentous injuries was high. However, this could not be determined preoperatively. The patient experienced such notable improvements in respiration after plating of the clavicular fracture only that he could be extubated just 1 day after reconstruction of the clavicle. Regarding the scapula injury, there was no scapular neck fracture as first described by Herscovici et al., but rather a dislocated horizontal fracture involving the inferior glenoid, best described by Ideberg et al. as Type IV. According to the classification by Friedrichs et al. [10], it was a displaced but stable fracture (B2 with involvement of the glenoid). We also assume that this fracture pattern does not lead to the primary instability of the shoulder girdle as would be the case with a neck fracture. However, by involving the inferior glenoidal part, it might result in glenohumeral instability that causes persistent pain, poor functioning, and arthritis. If posttraumatic osteoarthritis develops and shoulder arthroplasty would be needed in the future, the previous reconstruction ensures a substantial bone stock.

Conclusions

“Floating shoulder” is a challenge to treat and often requires collaboration among various medical disciplines. Ligamentous injuries cannot be adequately measured at the preoperative stage, and it is still unclear if a concomitant ligamentous disruption leads to a true and relevant instability of the shoulder girdle. The question of stability is preoperatively less relevant than the question of whether the dislocated fragments lead to insufficient shoulder function. Severe dislocation of the glenoid, respiratory insufficiency or secondary fracture dislocation suggest the presence of a relevant instability, which indicates the need for surgery. Patient characteristics such as age, activity level and functional demand should also be factored into the treatment strategy. The decision-tree for the management of these complex cases is offered as a tool to be tested, refined and eventually used in the clinical setting.

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Compliance with ethical standards

Conflict of interest Florian Hess, Ralph Zettl, Daniel Smolen and Christoph Knoth declare that they have no conflict of interest.

Ethical approval This article does not contain any studies with human participants or animals performed by any of the authors.

Informed consent Informed consent was obtained from all individual participants included in the study.

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