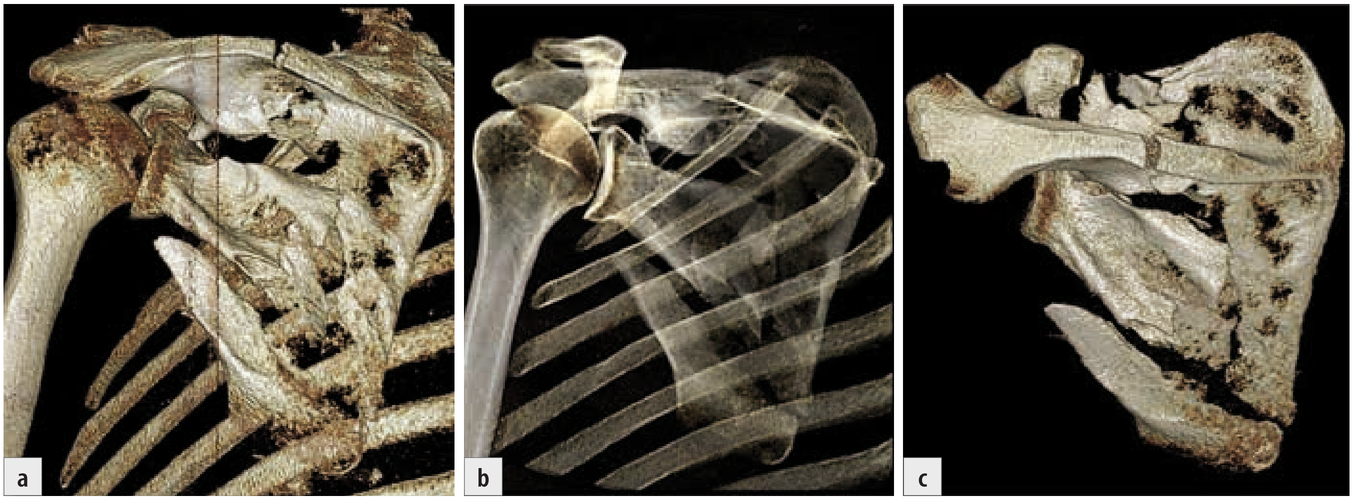

Fig. 16-7 Images of a complex extraarticular fracture of the scapula: **a)** 3D CT reconstruction without subtraction of the surrounding bones; **b)** semitransparent 3D CT reconstruction; **c)** subtraction of the surrounding bones.

TREATMENT

In polytrauma patients, the choice of the therapeutic procedure depends primarily on their general condition and, after that, on the fracture pattern, fragment displacement, concomitant injuries to the shoulder girdle, including injuries to the brachial plexus, and the condition of the soft tissues. In patients with a predominant injury to the scapula, the method of treatment is decided by the fracture pattern and the patient's functional demands, as well as their age. However, a higher age is not always a limiting factor, even in polytrauma patients, as was shown by Cole et al. [6, 7].

NON-OPERATIVE TREATMENT

Undisplaced, or minimally displaced, complex scapular fractures suitable for non-operative treatment are rare. In our series, we encountered only two such cases of an intraarticular fracture. We also use non-operative treatment in all displaced fractures where the patient's general condition and prognosis, or the condition of soft tissues, exclude operative treatment.

OPERATIVE TREATMENT

Operation is indicated in displaced fractures, especially the intraarticular ones, a prerequisite being a physically active patient in whom cooperation and an adequate functional result may be expected. In a polytrauma setting, all more severe injuries (pelvis, femur, chest, etc.) must be addressed as a first step. Scapular fractures are commonly treated on the second, or third, week following the injury. In any case it has to be taken into account that the operation may last 3 to 4 hours and the patient is all the time in a semiprone, or prone, position.

Surgical approach: Complex fractures require an extensive Judet approach with mobilization of the deltoid muscle and the infraspinatus. During the exposure, it is necessary also to have in mind injuries to the suprascapular nerve in the spinoglenoid notch. AC dislocation is preferably managed from the extended Judet approach [1].

Operative technique: The first step consists in a careful removal of the early callus, especially if the operation is performed several weeks after the injury, and identification of individual fragments. The fracture surfaces are cleaned and reduced. Reduction techniques have been described in Chapter 11. The technique of a lost K-wire has proven successful for the maintenance of temporary reduction, especially in fractures of both pillars [2] (Fig. 16-8). Internal fixation is usually performed using 2.7-mm implants.

In an intraarticular fracture, the first step is reconstruction of the glenoid fossa. This often also contributes to reconnection of the main articular fragments to the scapular body. If this is not the case, we have to reattach the reconstructed fossa gradually to both pillars. Subsequently, reconstruction is accomplished first of the lateral and then of the spinal pillar, including the lateral scapular spine.

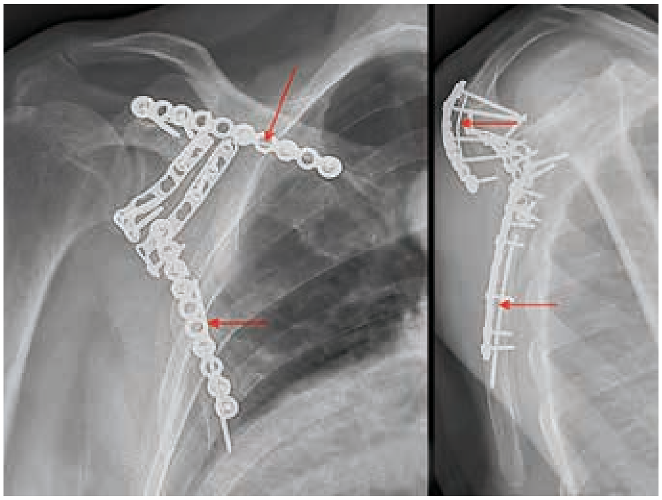

Fig. 16-8 The technique of a lost K-wire (red arrows) used to reconstruct both pillars of the scapula in a fracture shown in Fig. 16-7.

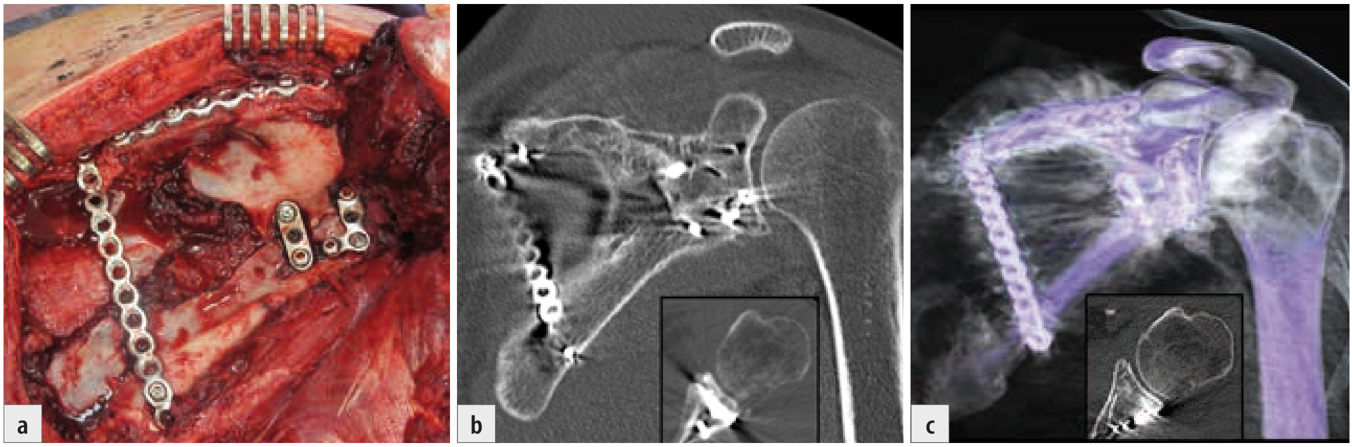

Fig. 16-9 A spanning plate connecting the two pillars in the fracture shown in Fig. 16-4b: **a)** intraoperative radiograph; **b+c)** postoperative CT reconstructions.

In an extraarticular fracture, the lateral pillar is reconstructed first, followed by the spinal pillar. Only exceptionally may it need to be done the other way round. Sometimes it is necessary, after reconstruction of the pillars, to increase the stability of internal fixation with a spanning plate (Fig. 16-9).

After internal fixation of the glenoid and both pillars, we check the situation in the region of the spinomedial angle, the medial border and the inferior angle. Minor fragment displacement, or instability, (less than 5 mm) caused by the motion in the glenohumeral joint does not require internal fixation. Greater instability, or angulation, is addressed by reduction and internal fixation with the use of 2.7-mm plates. Tolerable is also angulation of the inferior angle of the scapula up to 15 degrees.

An avulsed coracoid can be left without internal fixation, like surgical neck fractures with osseous instability. In complex fractures, the coracoid ligaments are preserved and prevent any great displacement of the process. Displacement is usually considerably reduced following the internal fixation of the scapular body and glenoid, and the separated coracoid is allowed to heal without direct fixation. A clavicular fracture, or AC dislocation, if present, is treated only after reconstruction of the scapula.

Postoperative care: The protocol is the same as in other fractures. Passive mobilization may be commenced immediately after operation, while special attention has to be paid to contusion of soft tissues, and healing of the wound, checked regularly for a potential development of hematoma.

AUTHORS' OWN SERIES

In our series of 519 scapular fractures, we identified 18 (3%) complex fractures, including 6 extraarticular and 12 intraarticular ones. The cohort comprised 15 men and 2 women, with a mean age of 43 years (range, 25-70). One of the polytrauma patients sustained complex intraarticular fractures of both scapulae. Another polytrauma patient also sustained bilateral scapular fractures, but only on the right side was it a complex intraarticular fracture. We recorded 2 open fractures and only 2 patients were older than 60 years.

Fx type	N	M/F	R/L	Cla-S	AC	PH	OP	BP
Extra-	6	6/0	4/2	1	0	1	2	1
Intra-	12	9/2	7/5	0	2	0	7	1
Total	18	15/2	11/7	1	2	1	9	2

Table 16-1 Basic characteristics of the series of complex scapular fractures. **AC** – AC dislocation, **BP** –brachial plexus injury, **Cla-S** – clavicular shaft fracture, **Extra** – extraarticular, **Fx** – fracture, **Intra** – intraarticular, **OP** – number of operatively treated patients, **M/F** – males/females, **PH** – proximal humerus fractures, **R/L** – right/left side.

At our institution, we provided primary treatment to 9 patients, 4 patients were referred from other institutions to our department for operative treatment after stabilization of their general condition, and 4 patients were merely advised by us. The basic characteristics are shown in Table 16-1. A detailed analysis of this cohort, not published to date, has revealed a number of interesting findings.

MECHANISM OF INJURY AND ASSOCIATED INJURIES

All cases were high-energy injuries; 8 patients with 9 fractures were classified as polytrauma. The cause in 5 cases (6 fractures) was a fall from a motorcycle, in 5 cases a fall from a height (from a tree, staircase, ladder), in 5 cases a traffic accident, in 1 case collision of a pedestrian with a truck and in 1 case a fall whilst skiing. Two of 8 polytrauma patients sustained open fractures, one during a traffic accident and another in a fall from a motorcycle.

Injuries to the ribs: The incidence of rib fractures was interesting from the viewpoint of the mechanism of injury. Such fractures were sustained by 9 of 17 patients. In 2 cases they were associated with injury to the lung. In the 8 polytrauma patients (9 fractures), a rib fracture occurred in only 5 cases. Absence of rib fractures in almost half of these patients is somewhat surprising in view of the high-energy injury mechanism. It may be explained by the fact that the blow impacted the scapula directly, rather than other parts of the chest.

17

ASSOCIATED INJURIES TO THE SHOULDER GIRDLE AND THE PROXIMAL HUMERUS

The shoulder girdle is formed, in addition to the scapula, by the sternoclavicular (SC) joint, the clavicle and the acromioclavicular (AC) joint. Any of these structures may be injured simultaneously with the scapula. Both the mechanism and frequency of these injuries vary [41, 46]. The highest incidence is of clavicular fractures, followed by AC dislocations; dislocations of the SC joint are rare [5, 41, 46].

These injuries are relatively often discussed in the context of scapular fractures, but only at a general level; no detailed analysis in this respect has hitherto been published in the literature. In our view, it is necessary to include also fractures of the proximal humerus in this chapter, as they may seriously complicate injuries to the scapula.

STERNOCLAVICULAR JOINT DISLOCATION

Sternoclavicular (SC) joint dislocation occurs quite rarely in connection with scapular fractures. Armstrong et al. [5] reported 2 (3.2%) cases in a series of 62 patients, but without further details. An exception is several cases of scapulothoracic dissociation (STD) in which a distraction injury of the SC joint was described [22, 25, 48, 52]. As we have found no other information about injuries to the SC joint associated with scapular fractures in the literature, we have based the following description primarily on our own experience.

PATHOANATOMY AND MECHANISM OF THE INJURY

There are two different mechanisms of injuries to the SC joint. The first of them is a compression mechanism caused by a blow to the posterolateral surface of the shoulder joint, when the force acting on the SC joint is transmitted along the long axis of the clavicle. This mechanism is similar to that in dislocation of the clavicle [42]. The resulting scapular fractures include a fracture of the acromion, or of the scapular spine, and are followed by subluxation, or dislocation, of the sternal end of the clavicle. Another possibility, typical of STD, is a traction mechanism which causes distension of the SC joint structures.

DIAGNOSIS

Visual inspection may reveal a swelling, or deformity, of the SC joint, sometimes also an abrasion in the region of the acromion and scapular spine. Palpation confirms marked tenderness around the jugular fossa and the SC joint, and also, in certain cases, instability of the medial end of the clavicle. The range

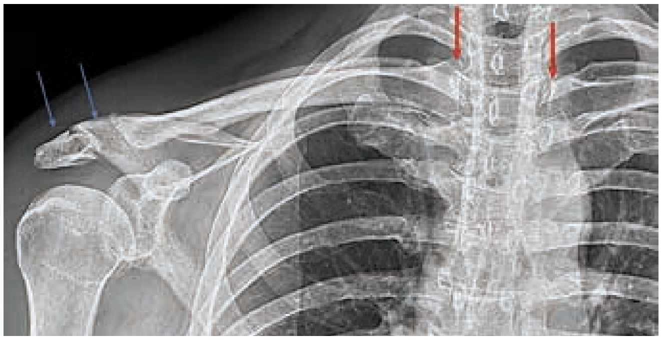

Fig. 17-1 Fracture of the right acromion associated with AC dislocation (blue arrows) and anterior SC dislocation on the same side (red arrows).

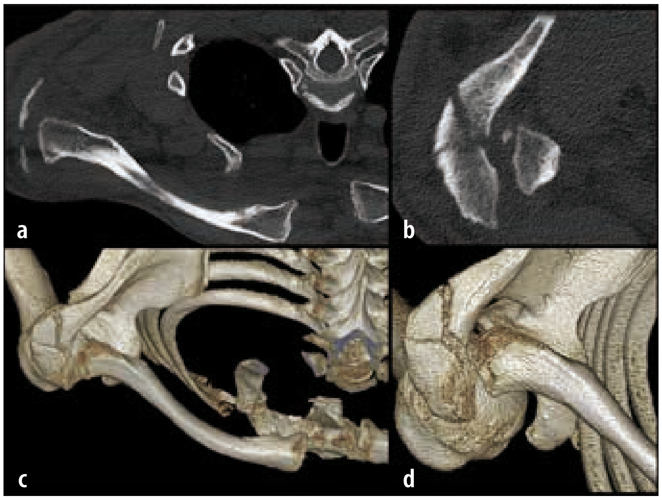

Fig. 17-2 CT scan from the case shown in Fig. 17-1: **a)** SC dislocation visible in CT horizontal section; **b)** fracture of the acromial angle and posterior AC dislocation (type IV) visible in CT horizontal section; **c)** 3D CT reconstruction of a fracture of the acromial angle, posterior AC dislocation and anterior SC dislocation; **d)** 3D CT reconstruction of a fracture of the acromial angle and posterior AC dislocation.

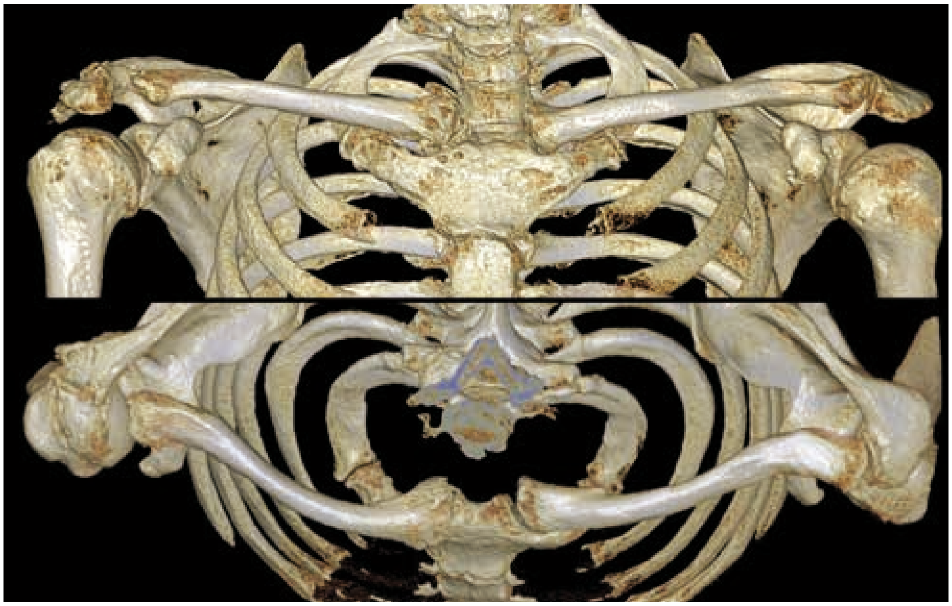

Fig. 17-3 The case shown in Fig. 17-1, postoperative 3D CT reconstruction, with a clearly visible reduction of the SC joint.

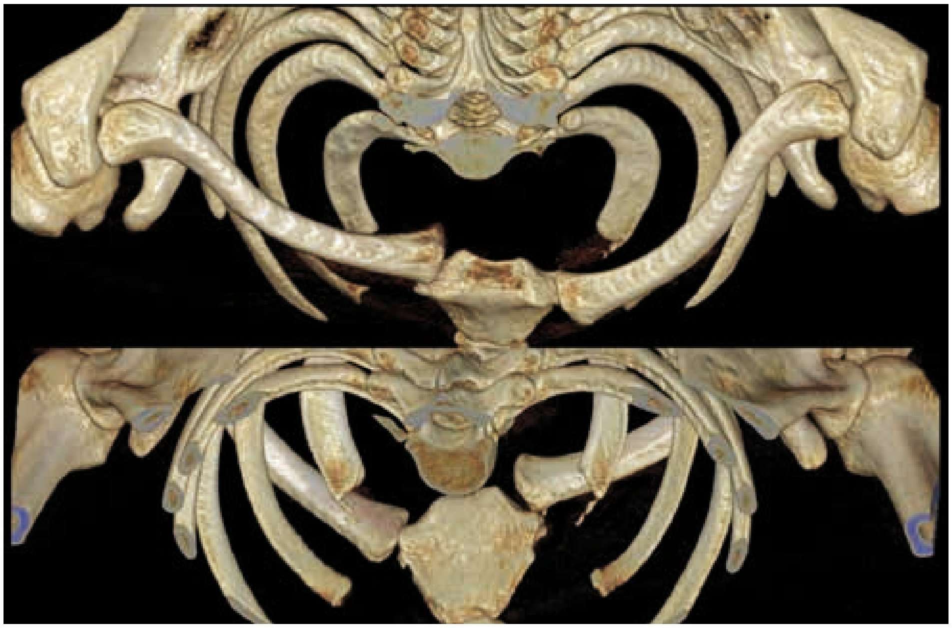

Fig. 17-4 Incomplete fracture of the spinal pillar associated with anterior SC dislocation on the left side anteriorly and distally.

of motion of the shoulder is limited by pain. Radiograph of the shoulder girdle capturing also the contralateral SC joint may show asymmetry of the position of the sternal ends of both clavicles (**Fig. 17-1**). As the radiograph is not always conclusive, CT examination, including 3D reconstructions showing both SC joints, is preferable in any case of a suspected SC joint injury (**Fig. 17-2**).

TREATMENT

The method of treatment depends on the patient's general condition and the type of scapular injury. In most cases the procedure is similar to that used in isolated injuries of the SC joint.

As the first step, we perform closed reduction, which, if successful and stable, is followed by non-operative treatment, i.e., immobilization of the extremity for 6 weeks, with subsequent careful rehabilitation.

If the closed reduction fails, or is unstable, operative treatment must be considered. A short longitudinal incision is made to revise the SC joint structures, reduce the medial end of the clavicle and to secure the position by fixation of the capsule with transosseous sutures, or bone anchors (**Fig. 17-3**). Postoperatively, the extremity is immobilized for 6 weeks.

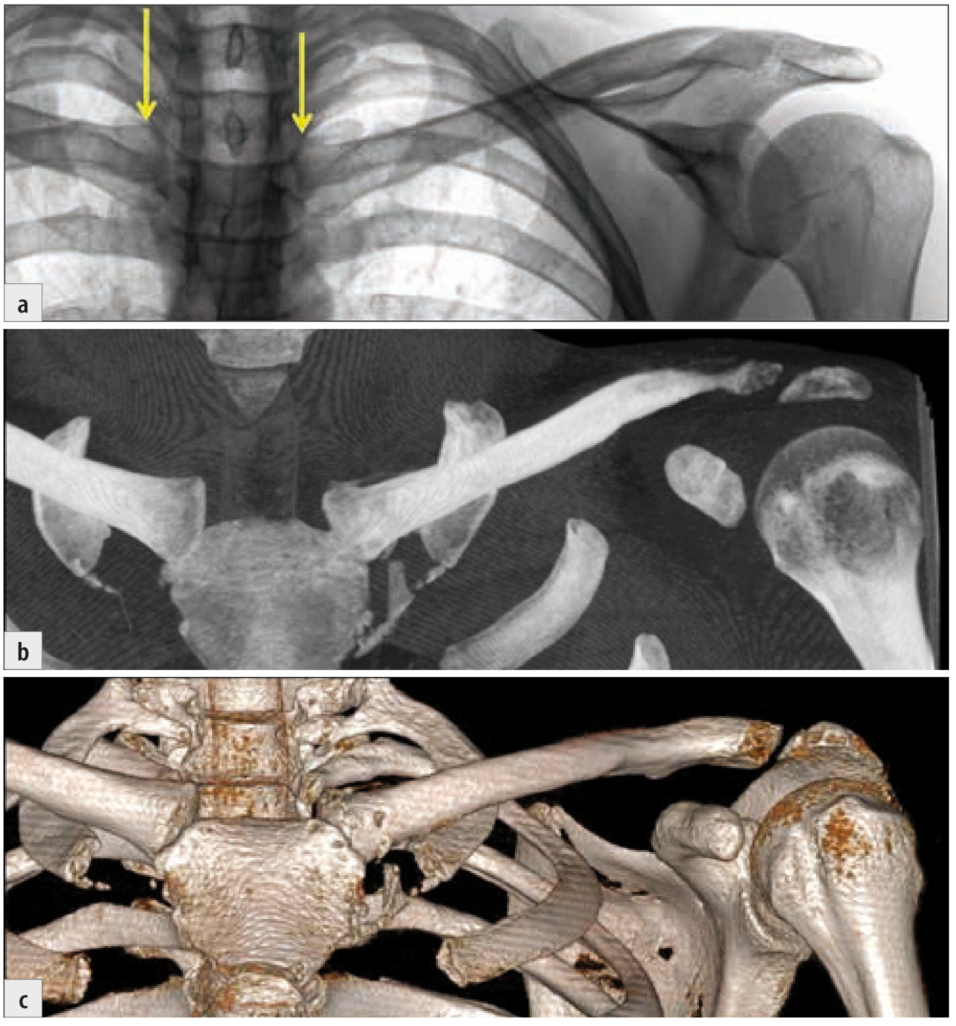

Fig. 17-5 The case shown in Fig. 17-4 on CT: **a)** preoperative radiograph (arrows show the position of the sternal end of the clavicle; **b)** postoperative CT; **c)** postoperative 3D CT reconstruction.

AUTHORS' OWN SERIES

We recorded a total of 3 cases of SC dislocation. In 2 patients it was caused by a blow to the posterolateral surface of the shoulder joint, in 1 female patient it was a traction injury associated with STD.

The first patient sustained a concomitant displaced fracture of the acromion and AC dislocation of Rockwood type IV. CT examination revealed anterior dislocation of the SC joint (**Fig. 17-2**). The procedure included internal fixation of the acromion, transfixation of the AC joint by K-wires and revision of the SC joint from a separate approach with soft tissue repair using transosseous sutures. Subsequently, the extremity was immobilized for 6 weeks. CT examination at 3-month follow-up showed an anatomical position in the SC joint (**Fig. 17-3**). Currently, the patient has no residual problems.

In the second patient the impact resulted in a fissure of the central part of the scapular spine. The medial end of the clavicle was subluxated distally and slightly anteriorly (**Fig. 17-4**). This was a somewhat atypical finding, as anterior dislocation is usually associated with a proximal displacement. The patient was treated with open reduction and reconstruction of the articular capsule with transosseous suturing (**Fig. 17-5**). Immobilization was maintained for 6 weeks, then followed by rehabilitation. One year after the operation, the patient was satisfied with the outcome.

The third, a female patient, was involved in a car accident and sustained STD, including distraction of the SC joint and an injury to the brachial plexus. CT examination revealed a visible widening of the SC joint space, but no subluxation, or dislocation. Due to the patient's general condition, STD was treated non-operatively. The functional outcome 1 year postoperatively was poor (see Chapter 22).

ACROMIOCLAVICULAR DISLOCATION

The incidence of AC dislocation associated with scapular fractures is reported to be between 3% and 6% [1, 5, 39]. Gurtl [26] discussed a case of AC dislocation associated with a coracoid fracture as early as in 1864. The first sizeable study of the same injury was published by Ehalt [23] in 1934. Since

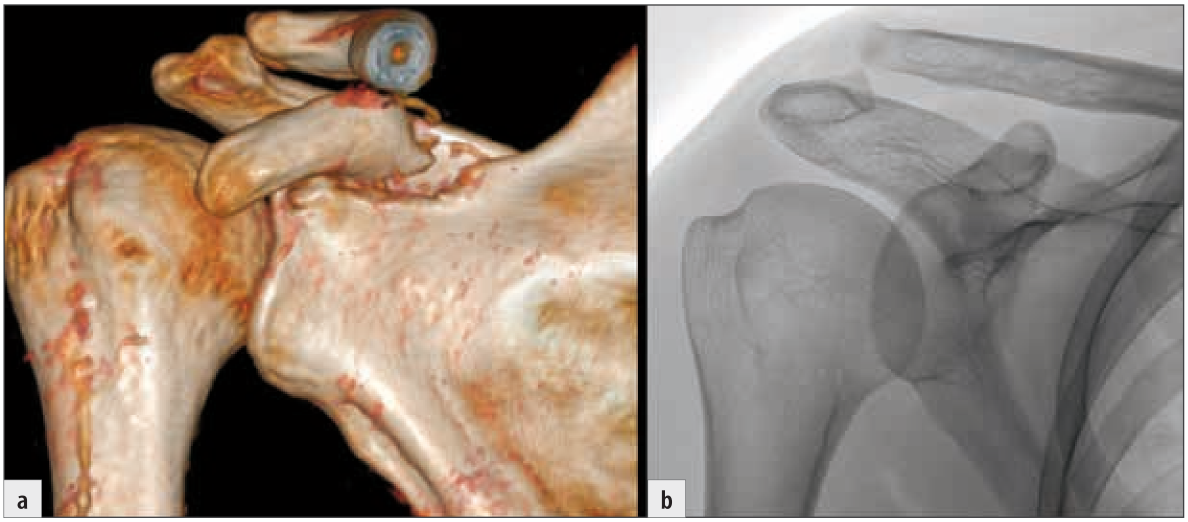

Fig. 17-6 Osseous extraarticular AC instability associated with a coracoid base fracture: **a)** 3D CT reconstruction; **b)** radiograph.

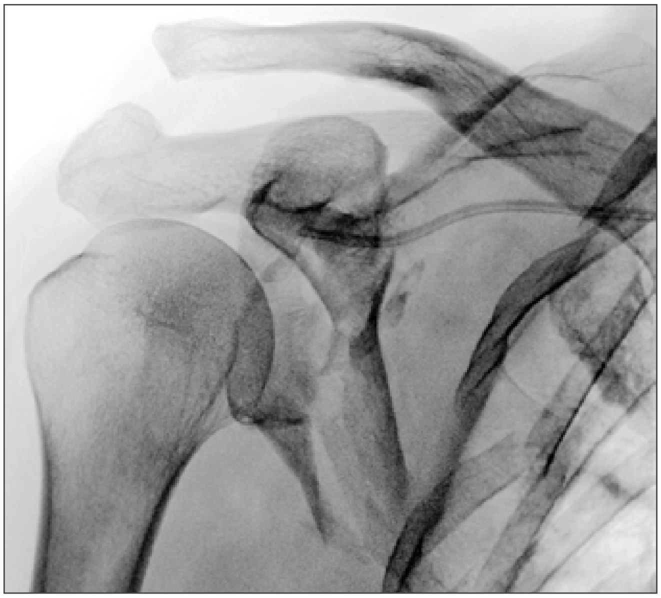

Fig. 17-7 Osseous intraarticular AC instability in a complex intraarticular scapular fracture.

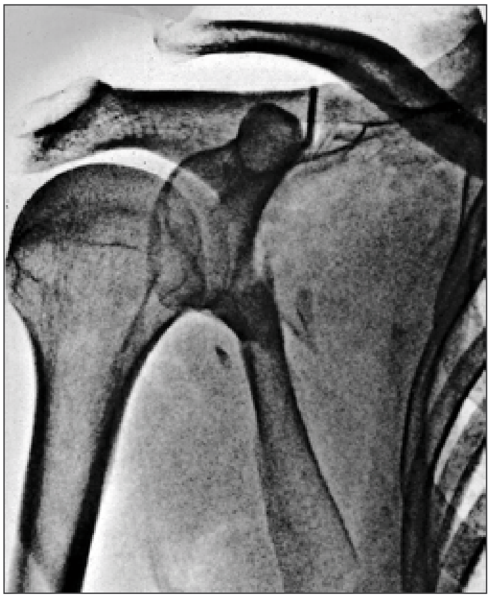

Fig. 17-8 Ligamentous instability of AC joint in a three-part infraspinous fracture of the scapular body.

Fig. 17-9 Combined AC instability in a fracture of the superior glenoid associated with rupture of the coracoclavicular ligament on 3D CT reconstructions. From the archives of J. Letocha, MD.

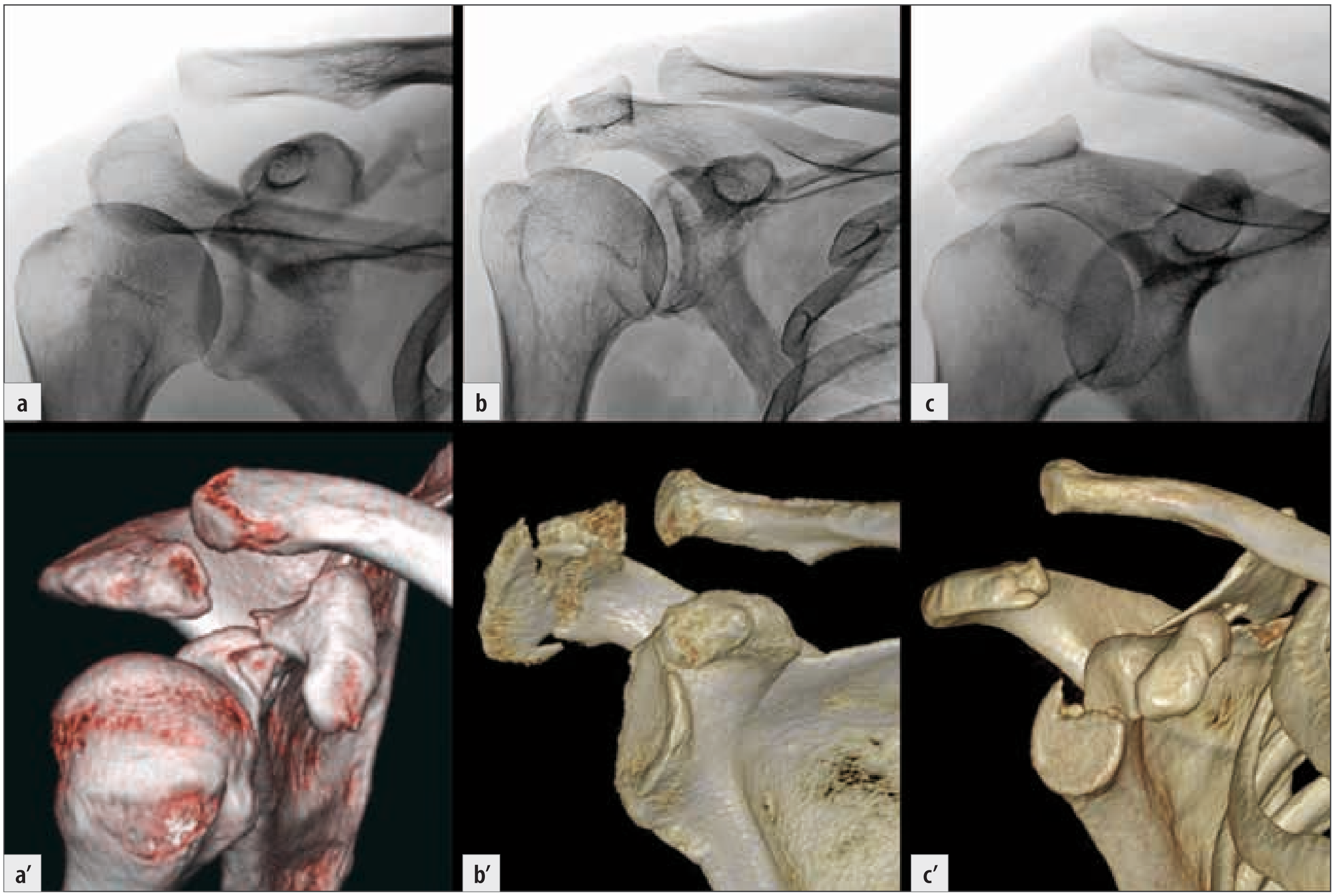

Fig. 17-10 AC dislocation types on radiographs and 3D CT reconstructions: **a)** type III; **b)** type IV; **c)** type V.

then, numerous cases of AC dislocation combined with scapular fractures have been described in the form of case reports [2, 6, 15, 16, 19, 21, 31, 34, 54, 59, 61].

PATHOANATOMY AND MECHANISM OF THE INJURY

AC dislocation in scapular fractures occurs in two basic variants, depending on the type of injury to the coracoclavicular articulation.

The first *"osseous"* variant is characterized by an intact coracoclavicular ligament and extraarticular (**Fig. 17-6**), or intraarticular (**Fig. 17-7**) separation of the coracoid base (primarily fractures of the superior glenoid).

In the other, *"ligamentous"*, variant, the coracoclavicular ligament is ruptured and the coracoid remains intact (**Fig. 17-8**). Rarely, the two variants may combine (**Fig. 17-9**) [59, 61].

AC dislocation often occurs in fractures of the processes, mainly in fractures of the coracoid base, less often in fractures of the acromion/lateral spine. In scapular body fractures and in glenoid fractures (with the exception of the superior glenoid) it is infrequent [10, 12, 13]. We have never noted AC dislocation associated with a scapular neck fracture [10].

AC dislocation is mostly of Rockwood type III and IV [44], type V being less frequent, and type VI has never been reported in association with a scapular fracture (**Fig. 17-10**). We encountered a specific injury to the AC joint in a case of STD, i.e., distraction alone, without proximal displacement of the clavicle.

AC dislocation usually results from medium-energy violence following a fall from a bicycle, or a motorbike, less often from high-energy impact during a serious traffic accident, or a fall from a height. Rupture of the coracoclavicular ligament, or separation of the coracoid, may be caused also by a direct blow to the superior surface of the shoulder joint, or impact of a proximally displaced humeral head.

DIAGNOSIS

AC joint injuries of types III and V are relatively easy to diagnose. They are typically associated with abrasion of the shoulder, prominence of the lateral clavicle and tenderness on palpation of the AC joint. Radiograph usually shows a clearly visible displacement. Type IV injuries are sometimes more difficult to diagnose as the prominence of the lateral clavicle is absent during clinical examination, which, however, may reveal its anteroposterior instability. An AC joint injury may be suggested on a radiograph by widening of the joint space. All three types, i.e., II, IV and V, are readily identifiable on 3D CT reconstructions (**Fig. 17-10**).

AC dislocation was most frequently combined with fractures of the processes (14 cases); no case of AC dislocation was recorded in fractures of the scapular neck.

The relative incidence of AC dislocation in individual types and subtypes of scapular fractures is shown in Table 17-2.

Type of injury to the coracoclavicular junction: Rupture of the coracoclavicular ligament was identified in 7 cases, causing ligamentous instability, combined with a fracture of the acromion, or the lateral spine, in 4 cases, a fracture of the scapular body in 2 cases and a fracture of the inferior glenoid in 1 case.

In 11 cases, the coracoclavicular ligament remained intact; however, separation of the coracoid, or the superior glenoid, resulted in osseous instability: there were 7 cases of an isolated extraarticular fracture of the coracoid base, 1 case of a comminuted fracture of the coracoid associated with a fracture of the lateral spine, and 1 case of a combination of a fracture of the superior glenoid and the acromion. In 2 complex intraarticular fractures AC instability was caused by separation of the superior glenoid.

In 2 cases there occurred combined osseous-ligamentous instability, including 1 case of rupture of the coracoclavicular ligament and fracture of the superior glenoid, and 1 case of rupture of the coracoclavicular ligament and fracture of the coracoid base, as part of STD.

Overall, rupture of the coracoclavicular ligament occurred in 9 cases, separation of the coracoid in 9 cases and fracture of the superior glenoid in 4 cases.

Types of AC dislocation: Rockwood type III was recorded in 12 cases, type IV in 5 cases (including 1 case combined also with dislocation of the SC joint), type V in 2 cases; and in 1 case of STD there occurred only distraction of the AC joint.

Type III was associated with a fracture of the coracoid base in 5 cases, with a scapular body fracture in 2 cases, with a complex intraarticular fracture in 2 cases, with a comminuted fracture of the coracoid and the lateral spine in 1 case, with a fracture of the inferior glenoid in 1 case and with a fracture of the superior glenoid and acromion in 1 case.

Type IV was recorded in 4 cases in combination with a fracture of the acromion, or the lateral spine, and in 1 case in association with a fracture of the coracoid base.

Type V was identified in 1 case of a fracture of the coracoid base and in 1 case of a fracture of the superior glenoid, with a concomitant rupture of the coracoclavicular ligament.

Treatment

We treated operatively 11 cases of AC dislocation. In 4 cases combined with a fracture of the coracoid, only the AC joint was treated. In 7 cases also other injuries to the scapula, in addition to those of the AC joint, were addressed, including one case each of a complex intraarticular fracture, a superior glenoid fracture, an inferior glenoid fracture, an infraspinous fracture of the scapular body, a fracture of the coracoid base, a fracture of the acromion and a fracture of the lateral spine. All injuries healed without complications, with a very good functional result.

CLAVICULAR FRACTURES

Clavicular fractures are often associated with scapular fractures, ranging between 12% and 39% of cases [1, 5, 8, 20, 30, 33, 49, 53, 50, 55, 60].

The first case of a scapular fracture combined with a clavicular fracture was described by Vogt [57] in 1799. Currently, clavicular fractures are discussed primarily in connection with so-called floating shoulder [14]. However, no detailed study dealing with a combination of clavicular and scapular fractures has been published to date. Therefore, we have based this chapter primarily on analysis of our own cases.

PATHOANATOMY AND MECHANISM OF THE INJURY

Clavicular fractures are caused by different mechanisms, mostly by medium- or high-energy trauma. In diaphyseal fractures, the most frequent causal agent is an axial force transmitted after a direct lateral impact on the shoulder, less often a direct blow to the clavicle. Fractures of the lateral clavicle may also result from proximal displacement of the humeral head.

A more detailed specification of a clavicular fracture requires an accurate definition of its individual anatomical parts. For the purpose of classification of clavicular fractures, some authors divide the clavicle into the medial, middle and lateral thirds [3]. However, this division does not respect anatomical architecture of the clavicle, because the shaft is not formed only by the middle third, but by the middle two quarters of the clavicle bounded medially by the insertion of the costoclavicular ligament and laterally by the insertion of the coracoclavicular ligament. Therefore, other authors distinguish between diaphyseal fractures, fractures of the sternal end and of the acromial end of the clavicle [40, 46].

In our series of 97 associated clavicular fractures, the shaft was involved in 75 (77 %) cases. A fracture of the lateral third of the clavicle, i.e., the region between the insertion of the coracoclavicular ligament and AC joint, was recorded in 20 (21%) cases. In 2 (2%) cases, the fracture was segmental.

Diaphyseal fractures affected primarily the middle third of the clavicle, sometimes extending laterally to the insertion of the coracoclavicular ligament, but never across this region (Fig. 17-14). The medial third of the clavicle was involved only in 1 case and was associated with a fracture of the first rib. A total of 37 cases were simple two-part fractures. The fracture line was transverse, or short, exceptionally long, oblique (Fig. 17-15). In 38 cases one or more intermediate fragments were separated (Fig. 17-16).

Fractures of the lateral third of the clavicle are injuries affecting, in anatomical terms, the dia-meta-epihyseal region of the bone. We identified three types in our series (Fig. 17-17). The first type was classified as an *epiphyseal fracture* close to the AC joint, with a vertical fracture line and minimal displacement. The second, *epi-metaphyseal* type, involved the whole lateral quarter of the clavicle, i.e., lateral to the insertion of the coracoclavicular ligament. In both these types the coracoclavicular ligament was intact in all our cases. In the third, *epi-meta-diaphyseal* type, the fracture line started medial to

Fig. 17-14 Basic categorization of diaphyseal fractures of the clavicle according to localization: **a)** fractures of the medial third; **b)** fractures of the middle third; **c)** fractures of the lateral third. Yellow arrow – fracture of the 1st rib, red arrow – fracture of the clavicle.

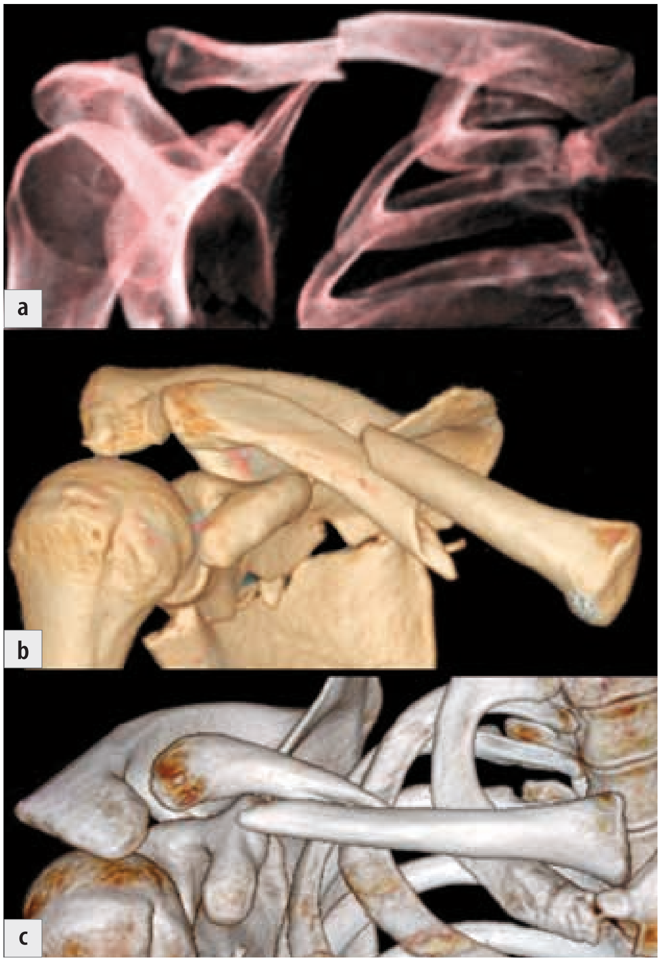

Fig. 17-15 Basic categorization of diaphyseal fractures of the clavicle according to the course of the fracture line: **a)** transverse; **b)** short oblique; **c)** long oblique.

the insertion of the coracoclavicular ligament, i.e., still within the shaft. The lateral third of the clavicle was as a rule split into multiple fragments and fracture lines extended laterally from the insertion of the coracoclavicular ligament as far as the AC joint (**Fig. 17-18**).

Segmental fractures were observed only in 2 cases in our series (**Fig. 17-19**). In the first case, fracture lines passed through the medial and lateral quarters of the clavicle, with a separated large fragment representing more than three quarters of the whole clavicle. In the second case, the medial fracture line ran through the center of the clavicle, with the lateral one again close to the AC joint, resulting in separation of almost the whole lateral half of the clavicle.

DIAGNOSIS

Diaphyseal fractures are relatively easy to diagnose, with a typical clinical finding detected both visually and by palpation. Only in certain cases, fractures of the lateral third of the clavicle may be confused during clinical examination with an injury to the AC joint. Except for fractures of the medial clavicle, all fractures can be well seen on radiographs. Almost all scapular fractures currently undergo CT examination, which may be easily completed with 3D reconstruction of the clavicle. Thereby, we can get a clear picture of the condition of the whole clavicle and its joints.

TREATMENT

There are four options to treat ipsilateral fractures of the scapula and the clavicle: non-operative or operative treatment of both fractures, operative treatment of the clavicular fracture alone, or operative treatment of the scapular fracture alone.

Indications

The treatment procedure depends on the type and displacement of a clavicular fracture, as well as on the pattern of a scapular fracture. Internal fixation of a diaphyseal fracture of the clavicle allows the start of rehabilitation in operatively-treated scapular fractures, e.g., glenoid fractures, immediately after the operation. In non-operatively-treated scapular fractures, particularly in quickly healing infraspinous fractures of the scapular body, internal fixation of an ipsilateral diaphyseal fracture of the clavicle reduces the period of immobilization of the shoulder joint to 2-4 weeks.

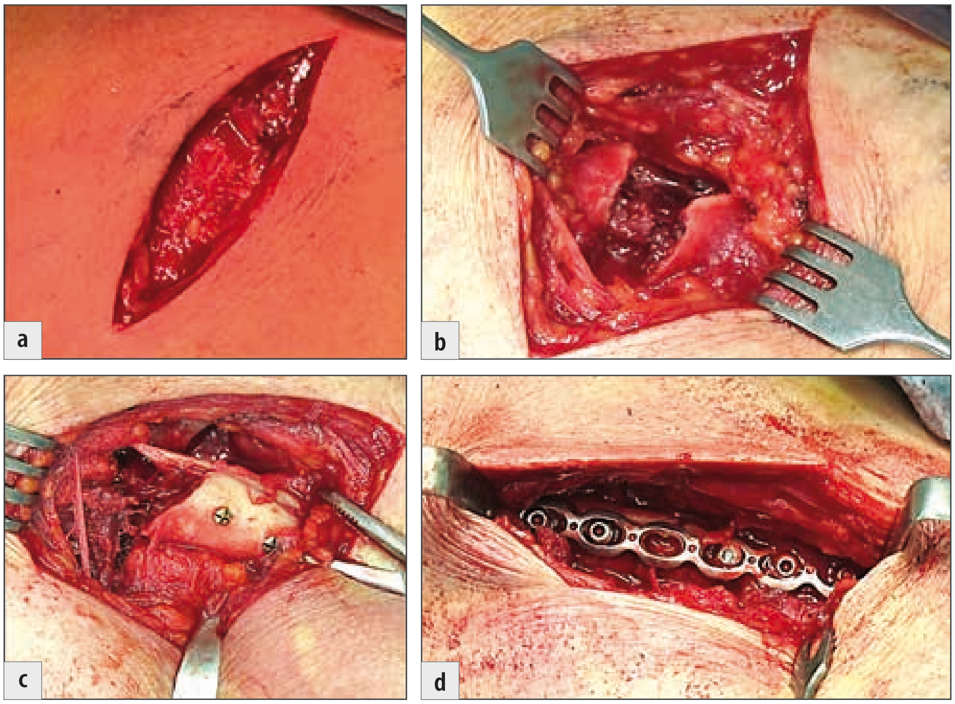

Fig. 17-23 Oblique approach to the clavicle – technique of dissection, the patient from Fig. 17-22: **a)** oblique incision; **b)** visualization of the fracture line; **c)** simplification of the fracture line by fixation of the intermediate fragment with lag screws to the main lateral fragment, the suprascapular nerve can be seen close to the hook; **d)** completion of internal fixation with a 3.5-mm reconstruction plate.

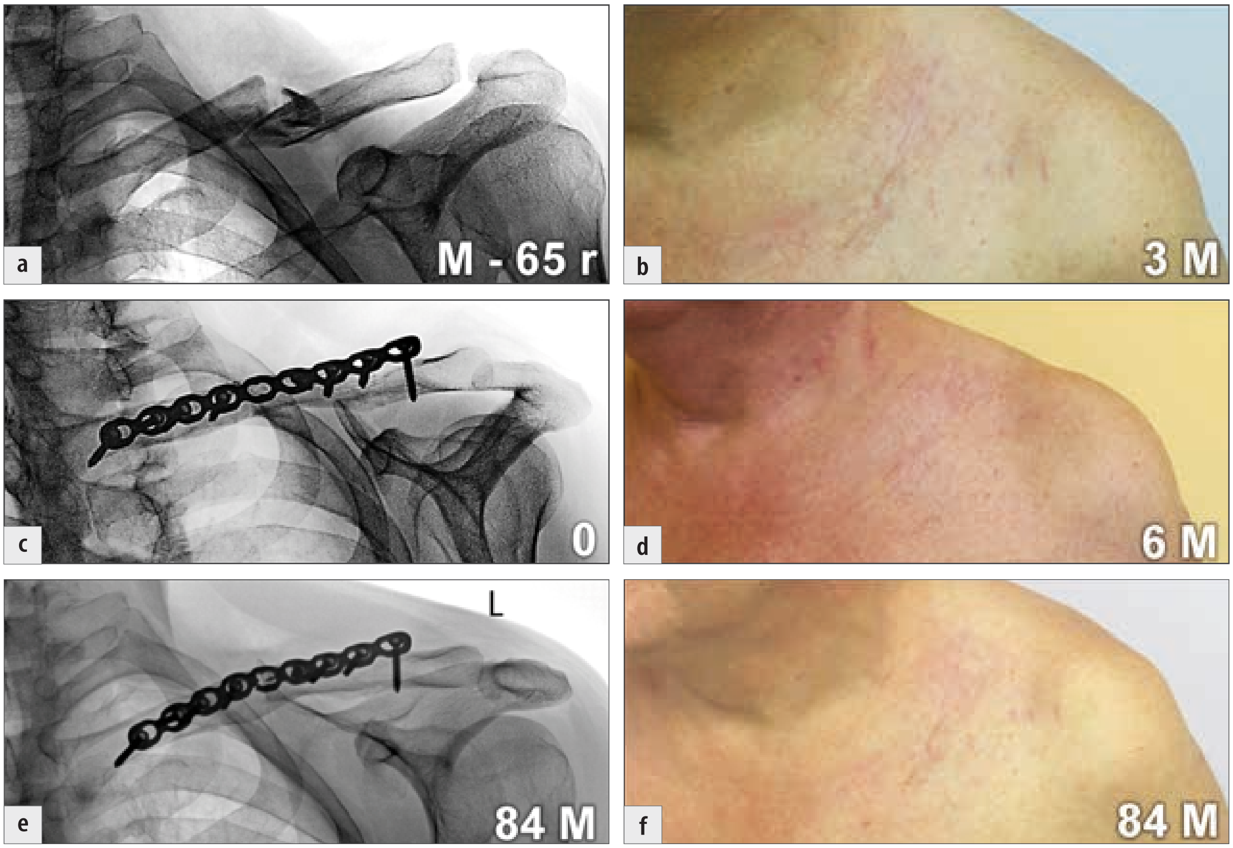

Fig. 17-24 The course of bone union and the cosmetic effect of oblique incision, the patient from Fig. 17-22: **a)** preoperative radiograph; **b)** a scar 3 months after the operation; **c)** postoperative radiograph; **d)** a scar 6 months after the operation; **e)** radiograph 7 years after the operation, with the healed fracture; **f)** a scar 7 years after the operation.

Fracture type	N	Cla S	Cla Lat	Cla Seg	Cla Total	Cla (%)
body	243	53	9	2	64	26
neck	26	5	1	0	6	23
glenoid	128	11	4	0	15	12
processes	102	3	6	0	9	9
complex	18	2	0	0	2	11
STD	2	1	0	0	1	50
Total	**519**	**75**	**20**	**2**	**97**	**19**

Table 17-5 Incidence of clavicular fractures in individual patterns of scapular fractures. **Cla** – clavicular fractures, **ClaS** –fractures of the clavicular shaft, **ClaLat** – fractures of the lateral clavicle, **ClaSeg** – segmental fractures of the clavicle, **STD** – scapulothoracic dissociation.

Fracture type	Scapular neck (N)	Cla (N)	Cla (%)
anatomical	6	0	0
surgical	13	1	8
transspinous	7	5	71
Total	**26**	**6**	**23**

Table 17-6 Incidence of clavicular fractures in individual patterns of scapular neck fractures. **Cla** – clavicle.

Fracture type	Scapular body (N)	Cla (N)	Cla (%)
Lateral pillar	189	55	29
two-part	117	44	38
three-part	41	9	22
comminuted	31	2	6
Spinal pillar	14	3	21
Both pillars	40	6	15
Total	**243**	**64**	**26**

Table 17-7 Incidence of clavicular fractures in individual patterns of scapular body fractures. **Cla** – clavicle.

Treatment

We have not analyzed the outcomes of treatment of clavicular fractures alone, but always within individual patterns of scapular fractures [10-13]. A total of 39 clavicular fractures were treated operatively, including 33 diaphyseal, 5 lateral clavicular and a segmental one. In 2 cases we performed internal fixation of the scapula after initial internal fixation of the clavicle performed at another institution. In 2 cases we performed internal fixation of the clavicle alone.

From the viewpoint of the pattern of scapular fractures, the highest number of operations was performed in clavicular fractures associated in 5 cases with a transspinous fracture of the scapular neck, in 7 cases with a fracture of the inferior glenoid and in 21 cases with a fracture of the infraspinous part of the scapular body.

The total number of operatively-treated clavicles will probably be higher, as we have no follow-on information about the injuries that were only referred to us for an opinion.

We encountered only 1 complication related to a clavicular fracture in our series. A robust patient with a fracture of the anatomical body (both pillars) of the scapula failed to follow the postoperative regime (wood chopping 6 weeks after operation), which resulted in loosening of a 2.7-mm plate applied on the anterior surface of the clavicle. The subsequent hypertrophic non-union, the treatment of which was refused by the patient, had no impact on the function of the extremity.

FRACTURES OF THE PROXIMAL HUMERUS

A picture of a fracture of the proximal humerus, in combination with a comminuted intraarticular fracture of the scapula, was presented in the Malgaigne's atlas as early as in 1855 [38] (see **Fig. 1-7**). Studies in the literature usually report the incidence of all fractures of the humerus, namely between 11% and 15%, without singling out the category of fractures of the proximal humerus [5, 20, 39, 49, 56, 57]. As no study has yet dealt in detail with fractures of the proximal humerus in connection with scapular fractures, we base the following section primarily on our experience.

PATHOANATOMY AND MECHANISM OF THE INJURY

The pattern of fractures of the proximal humerus and of the scapula is determined by the trauma energy, mechanism of the injury and bone quality. According to these criteria, fractures of the proximal humerus may be divided into two main groups.

The first group comprises predominantly younger men with a good bone quality, who have sustained a fracture due to a high-energy trauma (**Fig. 17-28**). The injury to the scapula, whether intraarticular or extraarticular, is usually severe, and the severity of the fracture of the proximal humerus varies.

The other group includes older patients, primarily women, with osteoporosis, in whom the fracture is commonly caused by a simple fall associated with dislocation of the glenohumeral joint. A fracture of the humerus is in these cases the predominant injury.

In both groups, particularly the second, it is the humeral head which is responsible for the injury to the scapula. Injuries to the surrounding structures depend on the direction of displacement of the humeral head (**Fig. 17-29**).

Anterior displacement is associated with separation of the anterior rim of the glenoid and/ or of the coracoid tip. In younger patients, the injury to the proximal humerus may simply be a mere avulsion of the greater tubercle [18, 43, 51], while older patients always sustain a fracture of the whole proximal humerus. In this respect, it is necessary to take into account a potential risk of entrapment of a separated part of the coracoid into the glenohumeral joint cavity.

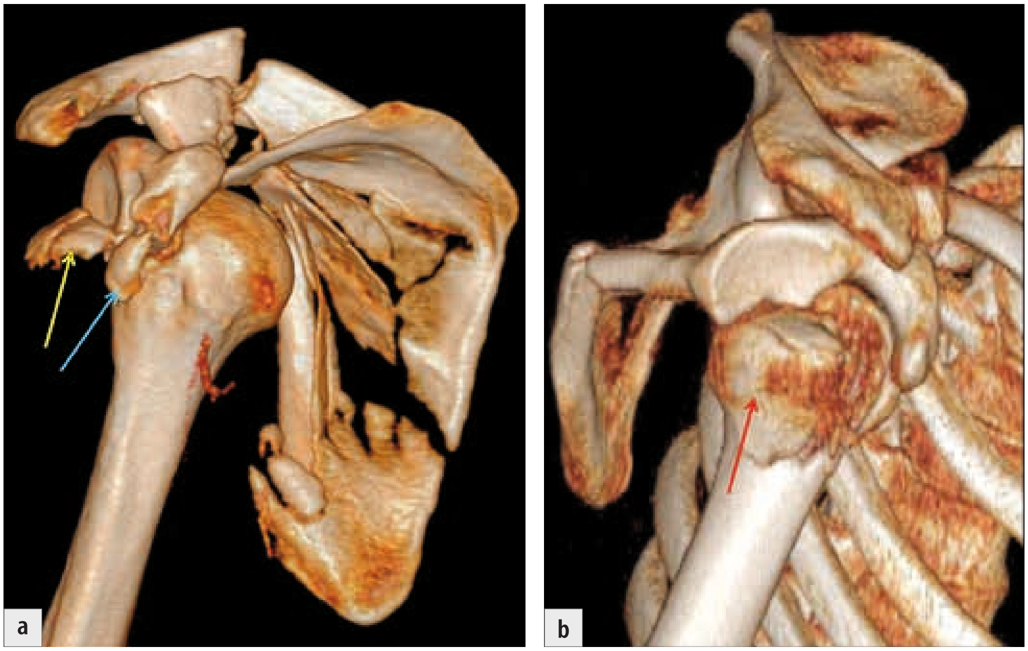

Fig. 17-28 Injuries to the proximal humerus in scapular fractures caused by high-energy mechanisms: **a)** a complex extraarticular fracture of the scapula associated with anterior glenohumeral dislocation and a fracture of the greater tubercle (yellow arrow), the blue arrow indicates the separated coracoid tip; **b)** a fracture of the infraspinous part of the scapular body, the anterior rim of the glenoid associated with anterior dislocation of the shoulder joint and separation of the greater tubercle.

Proximal displacement of the humeral head causes injury to the lateral clavicle, separation of the coracoid base, or a fracture of the superior glenoid, and sometimes combined fractures of the coracoid and the acromion. Posterolateral displacement results in separation of the scapular spine.

In younger patients this is often associated with avulsion of the lesser tubercle [28] (**Fig. 17-28**), while in older patients the whole humeral head is affected (**Fig. 17-30**). Posterior dislocation involves injury to the humeral head as well as to the posterior rim of the glenoid (**Fig. 17-31**).

The severity of a fracture of the proximal humerus depends on the bone quality, trauma energy and force vector. Minimally, there occurs avulsion of one of the tubercles; another extreme is comminution of the proximal humerus involving the shaft (**Fig. 17-32**).

In certain high-energy fractures, the trauma force acts directly on the scapula, and simultaneously also on the proximal humerus, resulting in a combined injury to the scapular body, the glenoid fossa and the proximal humerus.

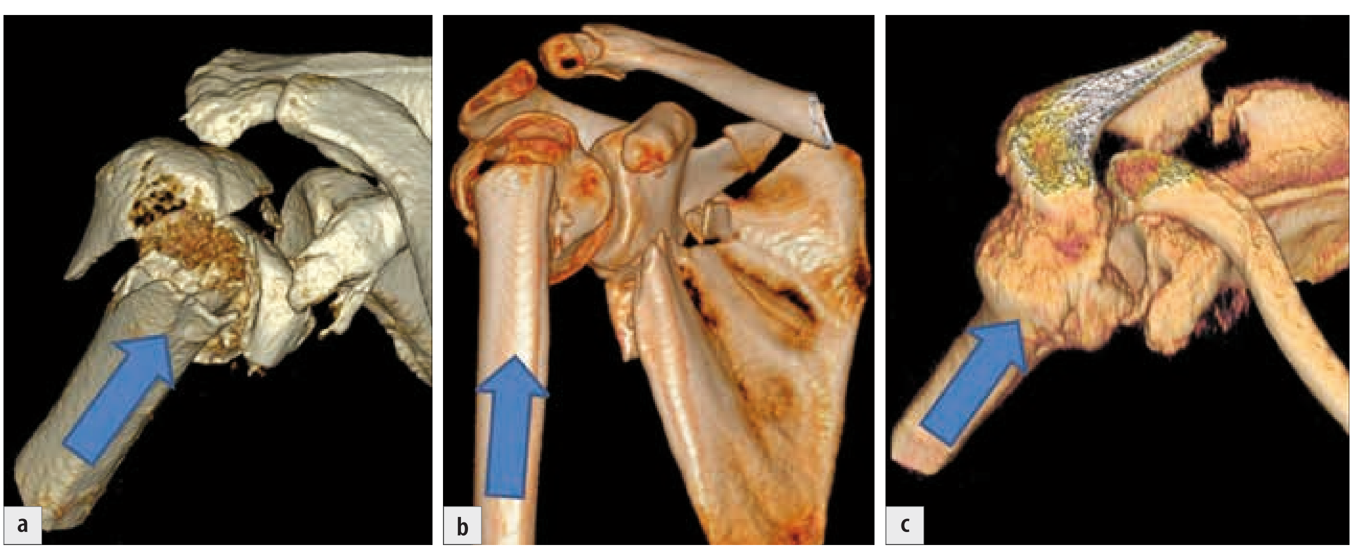

Fig. 17-29 The effect of direction of displacement of the humeral head on injury to the surrounding structures of the scapula: **a)** anterior and proximal displacement results in injury to the anterior rim of the glenoid and the coracoid; **b)** proximal displacement causes injury to the AC joint or the lateral clavicle; **c)** proximal and posterior displacement results in injury to the acromion, or the lateral part of the scapular spine.