Second Edition

Practical Procedures in **Orthopaedic Trauma Surgery**

Edited by
Peter V. Giannoudis and
Hans-Christoph Pape

CAMBRIDGE Medicine

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Preface

Over the years orthopaedic trauma has evolved to become an important subspecialty of orthopaedic surgery. An important component of the effective management of musculoskeletal injuries is the successful reconstruction of fractures. The art of surgery involves many steps, with ever-evolving techniques and implants.

Many textbooks are available for orthopaedic traumatologists. However, most of them are either handouts for scrub monkeys or advanced textbooks for experts. We have felt that the young orthopaedic surgeon on call is in need of an easy guide to help him or her set up a case until the attending surgeon is available. Moreover, standards for patient positioning are frequently absent and can be hard to understand unless they are well illustrated. Each chapter follows a comprehensive step-by-step approach which describes the hazards of surgery and gives technical tips in order to provide an overview of surgical procedures.

We do hope that this second edition has improved on the first, and that the book will continue to be a worthy companion for the young surgeon on call.

Acknowledgements

We thank the contributors of each chapter, and the theatre staff whose patience and support allowed us to obtain intraoperative pictures illustrating the different steps of the procedures. Finally we thank all the staff of Cambridge University Press who worked so hard to bring this project to production.

Contents

Part 4 – Lower extremity

Chapter 1

Fractures of the clavicle

1.1 Open reduction and internal fixation of midshaft and lateral clavicle fractures

Peter V. Giannoudis and George M. Kontakis

Indications

- Open fracture.
- Painful non-union.
- Associated injury to the brachial plexus and/or subclavian artery.
- Floating shoulder.
- Bilateral fractures.
- Multiple-injured patient.
- Soft tissue interposition between the fragments.
- Impending skin necrosis or penetration from a prominent fragment.
- Consideration for surgical fixation should be given to completely displaced, comminuted midshaft fractures that contain a transverse fragment (Z-shaped fractures). There is evidence in the current orthopaedic literature that these fractures have a high risk of non-union.
- Operative management is indicated in displaced type III, IV and V distal clavicle fractures according to the Neer classification.

Preoperative planning

Clinical assessment

- Mechanism of injury: motor vehicle collision, sports injury, fall on outstretched hand (FOOSH), direct trauma.
- Deformity, ecchymosis, swelling, tenderness, crepitation.
- Look for pneumothorax or haemothorax, especially in the presence of associated injuries.
- Assess and document the vascular status of the upper extremity and any difference in peripheral pulses between injured and contralateral extremity.
- Assess neurological status (usually brachial plexus injury presents as an upper roots traction injury).
- Pay special attention to the soft tissue envelope around the clavicle.

Radiological assessment

- Anteroposterior view of the clavicle including sternoclavicular and acromioclavicular joints (Fig. 1.1.1).
- Oblique views.
- Zanca view (10 degrees cephalalic tilt).
- Lordotic view (usually after surgery for ORIF evaluation).

Preoperative consent

- Obtain informed consent from the patient, including but not limited to risks, benefits, alternatives, complications and potential outcome.

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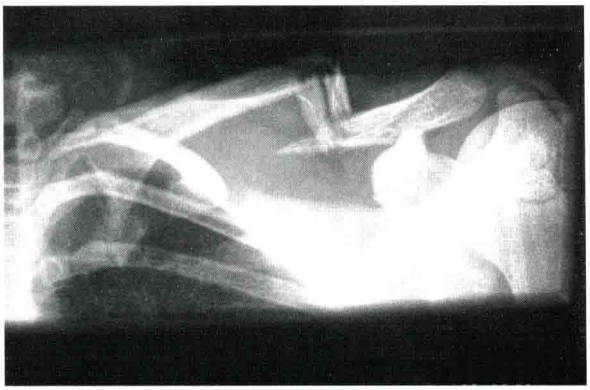


Fig. 1.1.1 AP view of the clavicle including sternoclavicular and acromioclavicular joints. This radiograph demonstrates a Z-type configuration of the fracture amenable to surgical treatment.

Operative treatment

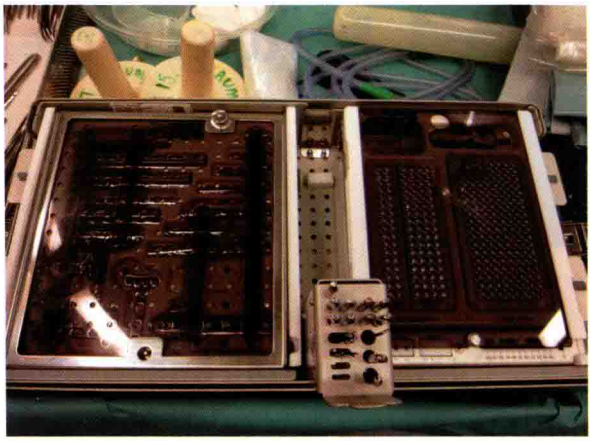
- The World Health Organization (WHO) Surgical Safety Checklist should be used in the operating room.

Anaesthesia

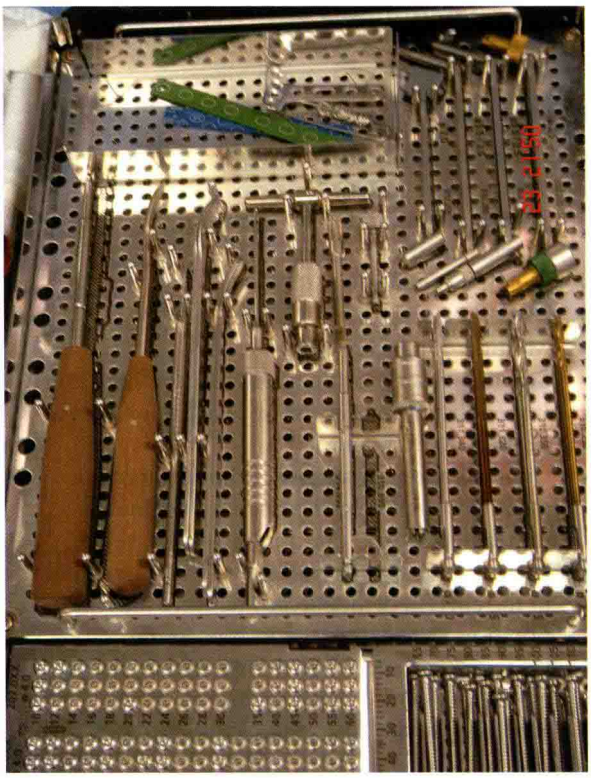
- General anaesthesia.
- Preoperative prophylactic antibiotics as per local hospital/unit protocol.

Table and equipment

- The type of fixation and instrumentation should be determined on a case-by-case basis.
- Absolute stability is desired whenever possible. In this situation, interfragmentary compression can be achieved with 3.5 or 2.7 mm screws. A neutralization plate that is subsequently used can either be a 3.5 mm reconstruction plate or a locking plate. A locking plate is preferable when distal fixation is limited (i.e. fewer than three screws) and/or the bone quality is poor (i.e. osteoporotic) (Fig. 1.1.2).
- When interfragmentary fixation is not possible because of comminution at the fracture site, a bridging plate is then used. Restoration of the length and rotation of the clavicle are the main objectives.
- When dealing with distal clavicle fractures, clavicle plates with lateral locking options are preferred. Heavy Ethibond or Fiberwire sutures are also necessary.
- Standard osteosynthesis set as per local hospital protocol.



(a)



(b)

Fig. 1.1.2 (a, b) A 3.5 mm dynamic compression plate (DCP) or a reconstruction plate can be used.

Operating room set-up

- The instrumentation is set up on the side of the operation.
- Image intensifier is from the ipsilateral side (head of the patient).
- Position the table diagonally across the operating room so that the operating area lies in the clean air field.
- The patient can be positioned either supine or in the beach-chair position, depending on surgeon's preference.
- A litre saline bag can be placed between the scapulas in order to facilitate extension of the shoulder.

(a)

Draping and surgical approach

- Skin preparation is carried out using usual antiseptic solutions (aqueous/alcoholic povidone–iodine).
- Prepare the skin of the chest to the medial border of the scapula. Clean up to the anterior and lateral surface of the neck and down to below the level of the nipple.
- Apply a stockinette that covers the area from the distal humerus to the hand. Make sure that you can freely move the upper extremity.
- Use single-use U-drapes. The C-arm is brought from the head of the patient in the beach-chair position (Fig. 1.1.3).
- Two surgical approaches and subsequent plate positions can be utilized.
- The anterosuperior approach, which necessitates the mobilization of platysma from the clavicle, allows for superior plate application, which is biomechanically stronger.
- The anteroinferior approach, which necessitates the mobilization of the deltoid muscle from the lateral clavicle, allows for longer screw placement and a less prominent plate.
- Make an incision over the clavicle (Fig. 1.1.4).
- Avoid the supraclavicular nerves.
- Using the cutting diathermy, bring down the incision to the periosteum.
- Identify the clavicle and the fracture fragments (Fig. 1.1.5).
- Perform a subperiosteal dissection on the clavicular edge and try to preserve the soft tissue attachments to the fracture fragments.

(b)

Fig. 1.1.3 (a) Beach-chair positioning and (b) draping of the patient. Note that the C-arm is brought from the head of the patient.

- Reduce the fracture fragments using reduction clamps (Fig. 1.1.6).
- When possible use 2.7 or 3.5 mm screws in a lag fashion to achieve interfragmentary compression.

Fig. 1.1.4 Make an incision over the clavicle.

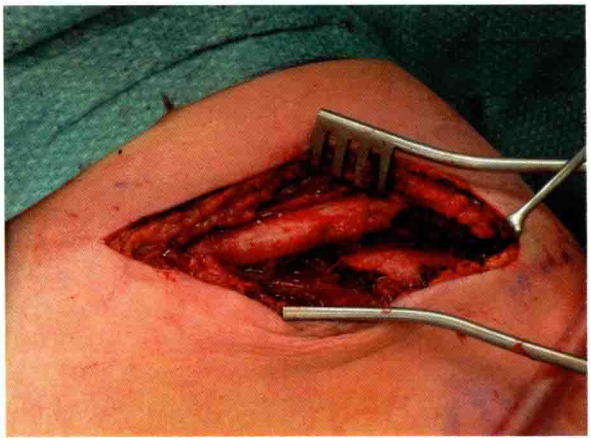


Fig. 1.1.5 The fracture as seen before the reduction.

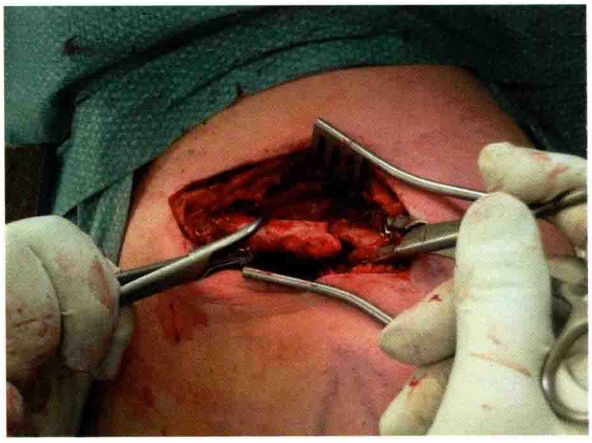
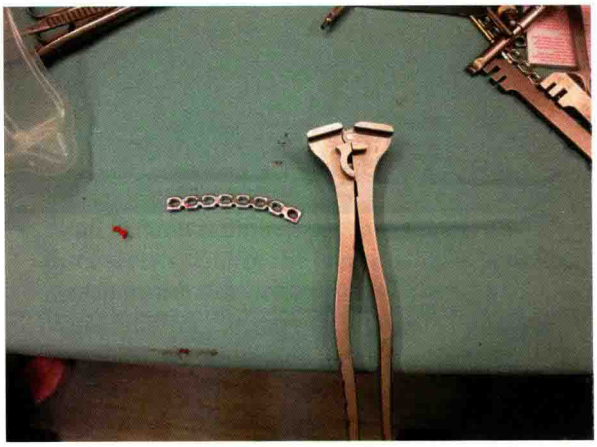
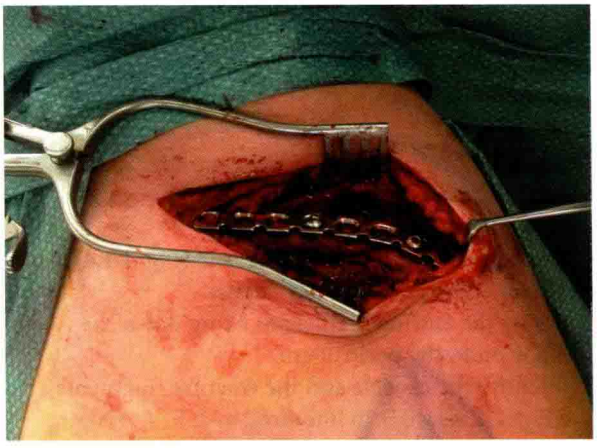


Fig. 1.1.6 Reduction of the fracture using clamps.

- 'Bounce but not plunge' when you are drilling. This principle is especially useful in this area of the body by reason of the local anatomy.
- Contour the 3.5 mm reconstruction plate appropriately and apply it to the bone (Fig. 1.1.7).
- Drill a hole to the bone through a plate hole above the distal fragment and affix the plate to the distal fragment.
- Place one screw at the proximal fragment and ensure reduction maintenance with fluoroscopic control.
- Place the rest of the screws in the same manner (Fig. 1.1.8).
- Cancellous bone grafting is performed for bone defects or devitalized bone.

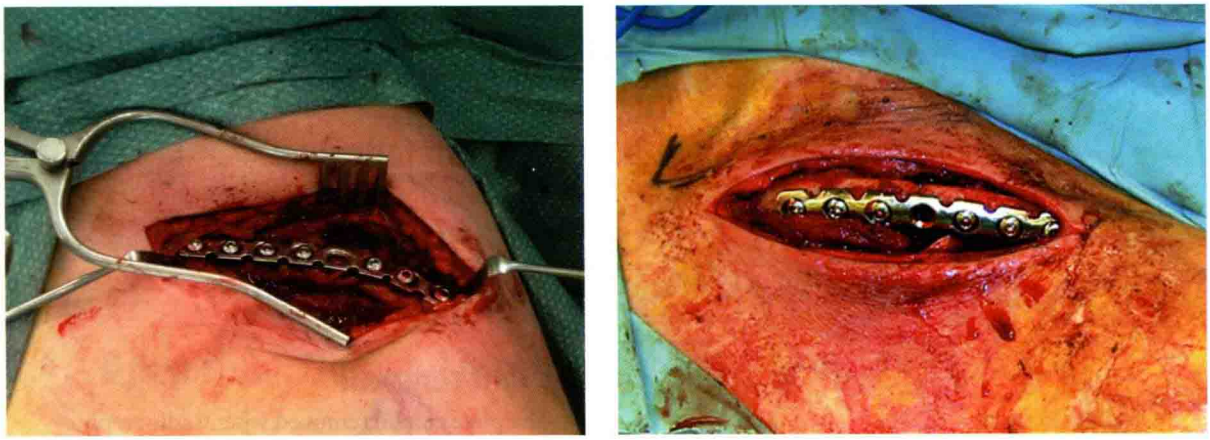


(a)



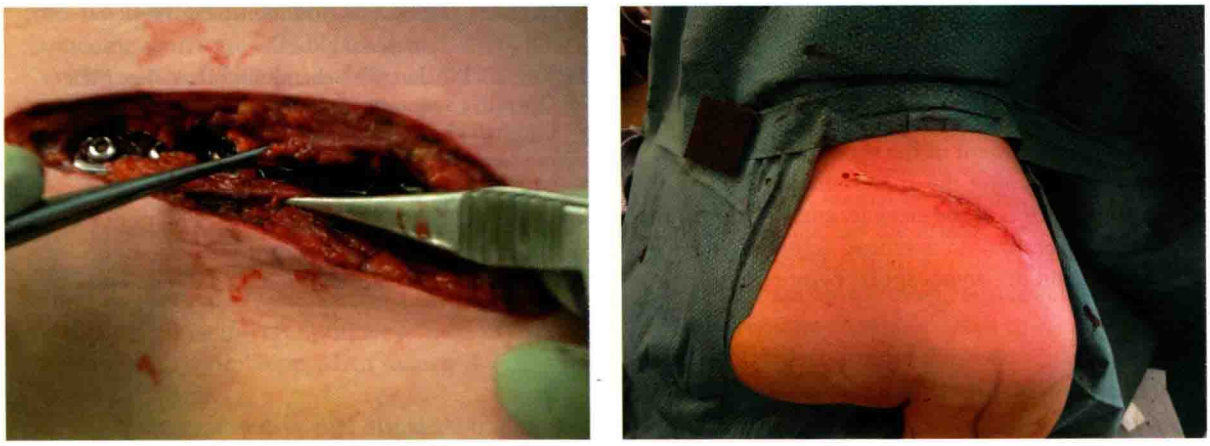
(b)

Fig. 1.1.7 (a, b) Contouring of the plate and application to the bone.



(a) (b)

Fig. 1.1.8 Completion of the fixation in an (a) anterosuperior and (b) anteroinferior plate application.



(a) (b)

Fig. 1.1.9 (a, b) Closure of the wound.

- Ensure fracture reduction and adequate screw length with fluoroscopic lordotic views.
- For lateral clavicle fractures supplement the osseous fixation with coracoclavicular stabilization with a heavy Ethibond or Fiberwire suture that is placed around or through the coracoid. When the lateral fracture size does not allow the application of the plate, excision of the lateral fragment is an option, followed by exposure of the coracoid process. Coracoclavicular stabilization and augmentation is then required.

Closure

- Closure is performed as a full-thickness layer over the plate using 2-0 Vicryl and 3-0 subcuticular sutures for the skin (Fig. 1.1.9).

Postoperative care and rehabilitation

- Assess and document the neurovascular status of the extremity.
- Administration of antibiotics postoperatively should follow local hospital protocols/guidelines.

Fig. 1.1.10 Use a poly-sling for 10 days.

- Obtain postoperative radiographs.
- Use a sling for the initial 10 postoperative days (Fig. 1.1.10).
- Initiate active flexion and abduction 6–8 weeks after injury.
- Return to prior activities is possible 3 months after operative treatment.
- Pain-free movement of the shoulder girdle is achieved soon after the open reduction and internal fixation of the clavicle, and this drives the patients to embark in overhead activities and participation in contact sports before fracture healing, which might lead to osteosynthesis failure. These activities should be avoided until sound fracture healing is evident.

Outpatient follow-up

- Review at clinic in 2 and 6 weeks and at 3 and 6 months, with x-rays on arrival.
- Beware of late vascular complications (thrombosis, pseudoaneurysm).

Implant removal

- The plate can be removed when radiographic union occurs at 12–24 months.

Further reading

Kim W, McKee MD. Management of acute clavicle fractures. *Orthop Clin North Am* 2008; **39**(4): 491–505, vii.

McKee RC, Whelan DB, Schemitsch EH, McKee MD. Operative versus nonoperative care of displaced midshaft clavicular fractures: a meta-analysis of randomized clinical trials. *J Bone Joint Surg Am* 2012; **94**(8): 675–84.

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Chapter 2

Fractures of the scapula

2.1 Open reduction and internal fixation of scapula fractures

David Limb

Indications

- The indications for fixation of scapular fractures are not clearly defined. The literature is scant, outcome scores are variably used, and evidence-based choices are difficult. This is in large part due to the rarity of the injuries, as the scapula is well protected and supported by the rotator cuff muscles and other muscular attachments. Furthermore, these fractures most commonly occur in high-energy accidents and are therefore frequently associated with multiple injuries, particularly chest trauma, which may mitigate against intervention for a fracture that often gives few problems when managed non-operatively.
- There is some consensus that displaced fractures involving the glenoid fossa should be considered for fixation if they are associated with shoulder instability or if there is an articular step of 5 mm or more.
- The majority of fractures associated with instability are marginal fractures of the anteroinferior glenoid – bony Bankart lesions – which can be approached in the same way as soft tissue Bankart lesions, though usually fixation involves lag screws rather than soft tissue anchors. These injuries will not be considered further here.
- There is also consensus that combinations of injuries affecting the suspensory mechanism of the shoulder should be managed operatively, and one common pattern of these is a displaced fracture of the glenoid neck associated with a clavicle fracture (Fig. 2.1.1). However some argue that this 'floating shoulder' can be managed simply by plating the clavicle without addressing the glenoid neck. This remains one of the commoner indications for scapular surgery.
- Theoretically, medial displacement of the glenoid should defunction the rotator cuff, and it could be argued that these injuries should be treated to restore scapular width and cuff function. However, care should be taken to ensure that lateral displacement of the lateral column of the scapula, which is common, is not mistaken for medial displacement of the glenoid, which is rare.

Preoperative planning

Clinical assessment

- In the acute setting check the distal neurovascular status, as plexus injuries and arterial avulsion can occur. This is almost inevitable in scapulothoracic dissociation, in which the supporting thoracoscapular muscles are torn and the distance between the medial border of the scapula and the spine is increased. This is often apparent on chest radiography.

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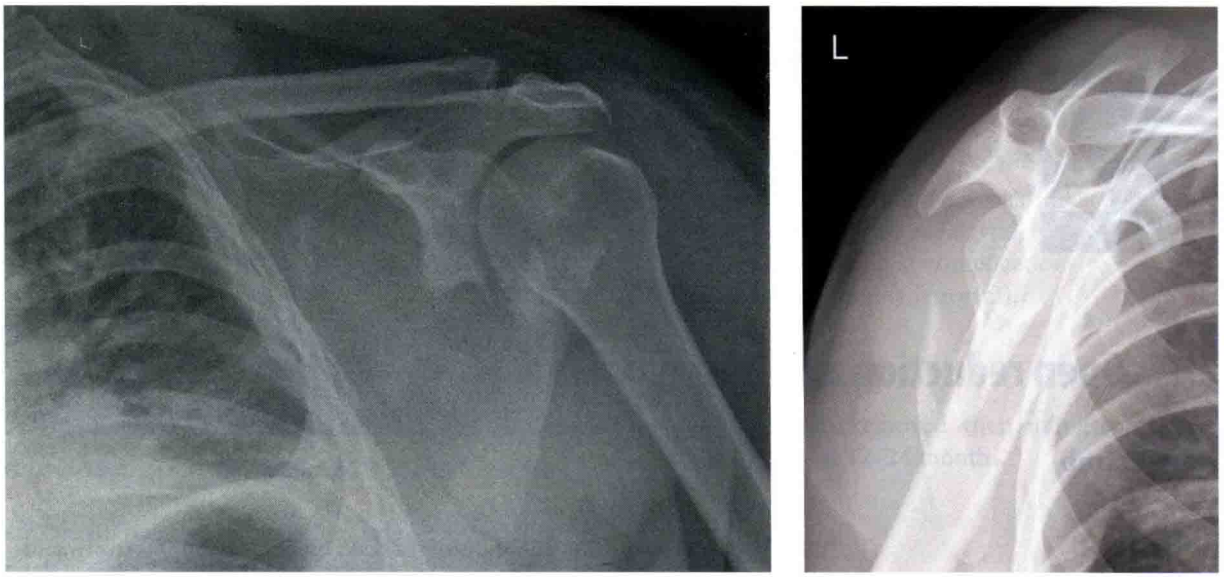

(a) (b)

Fig. 2.1.1 (a) AP and (b) scapular lateral preoperative radiographs. This case will be used to illustrate operative technique as the chapter progresses.

- Assess the chest – these injuries are commonly associated with rib fractures and pneumothorax, which may influence the risks/rewards calculation when deciding on management.
- Observe the contour of the shoulder – medial displacement, particularly in association with a clavicle fracture, may be apparent by loss of the shoulder prominence. Likewise inferior displacement of the whole shoulder girdle may occur in injuries that defunction the suspensory mechanism of the shoulder.
- Observe the skin – scapular fractures often result from a direct mechanism of injury, so the skin overlying the intended surgical approach may be bruised and fragile.

Radiological assessment

- A chest radiograph may show clavicle fractures, acromioclavicular injuries and lateral displacement of the scapula suggestive of scapulothoracic dissociation.
- Although a scapula fracture may be visible on a chest radiograph, the body of the scapula lies tilted at approximately 30 degrees to the coronal plane. Proper anteroposterior and scapular lateral views are therefore indicated (Fig. 2.1.1).
- An understanding of fracture anatomy, particularly in the complex region around the glenoid, base of coracoid and acromion, is facilitated by CT scanning, further enhanced by multiplanar reconstruction or, ideally, 3D reconstruction (Fig. 2.1.2). Subtraction of the humeral head further improves visualization of fractures involving the glenoid fossa, facilitating surgical planning.
- It is important to establish where plates and screws can be situated to stabilize the fracture – in many areas the scapula is so thin that it is almost transparent and screws have no purchase (Fig. 2.1.3).
- Areas of stout bone suitable for screw fixation are peripheral, particularly the lateral column and posterior surface of glenoid.

Surgical plan

- After considering the clinical state of the patient and the radiological investigations a surgical tactic can be formulated, if the decision is taken to treat the fracture by open reduction and internal fixation.
- Most anterior glenoid fractures, and some fractures involving the superior glenoid, can be