Injuries around the shoulder

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Overview

- Fractures of the scapula + acromion + coracoid
- Fractures of the clavicle + distal end
- Acromioclavicular dislocation
- Fractures of the proximal humerus
Scapula
Epidemiology

- 1% of all orthopaedic fractures
- 3% of shoulder girdle injuries
- 5% of shoulder fractures
- more common in men (70%)
- mean age 35-45 years old

Hardegger FH et al, JBJS Br, 1984
Lantray J et al Injury, 2008
Anatomy

- The scapula serves as the attachment site for 18 muscles, linking it to the thorax, spine, and upper extremity.

Anatomy

- The Superior Shoulder Suspensory Complex (SSSC)
- Lesions to 2 of these structures allow for significant displacement

Goss TP. Double disruptions of the superior shoulder suspensory complex. JOT, 1993
Incidence (topography)

- 50% body and spine
- 25% scapular neck
- 10% glenoid rim - fossa
- 8% acromion
- 7% coracoid process

Mechanism of injury

- 60% high energy injury (RTA)
- 20% fall from height
- Indirect trauma (fall with the outstretched hand which drives the humeral head against the glenoid)
Associated injuries

- Rib fractures                  25-45%
- Pulmonary injury          15-55%
- Humeral fractures        12%
- Skull fractures               25%
- CNS deficits                  5%
- Major vascular injury    11%
- Splenic rupture              8%
Associated injuries


Multiple trauma and scapula fractures: so what?

Veysi VT, Mittal R, Agarwal S, Dosani A, Giannoudis PV

Department of Trauma and Orthopaedics, St James' University Hospital, Leeds, United Kingdom.

79/1.164 patients (6.8%)

The overall mortality rate was 11.4% in patients with scapula fractures and 20% in those without scapula fractures (p = 0.1).
Clinical examination

- swelling, tenderness, crepitus, and ecchymosis over the scapular region

- careful neurovascular examination to rule out arterial injury or brachial plexopathy (5-10%).
Radiological examination

- **AP** and **Y** view

- **CT** scan
  (glenoid #)
**Treatment**

Conservative treatment
- pain control
- ice
- sling immobilization
- early passive ROM

Body of the scapula (50%)
Treatment

Operative treatment
- spikes

Body of the scapula (50%)
Fractures of the neck (25%)

Operative treatment when...

- Translational displacement $\geq 1$ cm
- Angulatory displacement $\geq 40^\circ$ in either the transverse or coronal plane
Floating shoulder

Open reduction and internal fixation of ipsilateral fractures of the scapular neck and clavicle

KS Leung and TP Lam

The results in the current series appear superior to those that have been reported for patients in whom either the scapular or the clavicular fracture was fixed alone.

14/15 patients good/excellent result
Fractures of the glenoid rim - fossa

Iideberg Classification - study of 300 consecutive cases

Fractures of the glenoid rim - fossa

Type I
Fractures of the glenoid rim - fossa

Type II
Fractures of the glenoid rim - fossa

Type III
Fractures of the glenoid rim - fossa

Type IV-V
Fractures of the coracoid

FRACTURES OF THE CORACOID PROCESS
KIYOHISA OGAWA, ATSUSHI YOSHIDA, MASAAKI TAKAHASHI, MICHIMASA UI

Treatment was usually by open reduction and fixation for type-I fractures and conservative methods for type-II.
Fractures of the acromion

- Most fractures are treated conservatively
- Large fragments – weak deltoid?
- Occlusion of the subacromial space
CLAVICLE
Evidence based medicine

Early opinion (before and around 1980-1990)
Favor conservative treatment

Rowe stated: “Fortunately for man, nature has endowed the clavicle with excellent reparative powers”.

Current opinion
Favor surgical intervention
A METHOD OF FIXATION FOR FRACTURE OF THE CLAVICLE*
BY GORDON MURRAY, M.B., F.R.C.S. (ENG.), TORONTO, ONTARIO, CANADA
FROM THE TORONTO GENERAL HOSPITAL

* Received for publication on February 29, 1940.

THE JOURNAL OF BONE AND JOINT SURGERY

THE MECHANICS OF AMBULATORY TREATMENT OF FRACTURES OF THE CLAVICLE

BY CHARLES S. YOUNG, M.D., LOS ANGELES,
Questions?

Surgery or Non-surgery?
Which conservative treatment is better?
Which surgical treatment is better?
What is the expected outcome?
Surgical anatomy

care should be observed with placement of screws in the medial half of the clavicle
Epidemiology

2.6% of all fractures and 44% of shoulder girdle
Men (68%) > women (32%).
Left side (61%) > right side (39%).
Middle 1/2 fractures are the most common (81%), are
displaced in 48% of cases and comminuted in 19%.

25-30% distal end
70-80% midshaft
3-4% proximal end
Epidemiology

males < 30y, midshaft, direct force is applied to the point of the shoulder during sports activity

elderly patients > 80, related to osteoporosis, low-energy falls
Moderate or high-energy traumatic impacts to the shoulder

- Fall from height
- Motor vehicle accident
- Sports injury
- Rarely a direct injury to the clavicle

Occur in cycling and equestrian sports (inertia after a sudden stop throws rider forward landing on unprotected shoulder)
Clinical examination

Inspection
   Evaluate deformity and/or displacement
   Beware of rare inferior or posterior displacement of distal or medial ends
   Skin penetration?

Palpation
   Evaluate pain
   Look for instability with stress
Clinical examination

Neurovascular examination
Upper extremity motion and sensation
Measure shoulder range-of-motion

A difference in blood pressure between the two upper extremities is suggestive of vascular injury, (arteriography for exclusion)
Radiological examination

Anteroposterior View

30-degree Cephalic Tilt View

Zanca View-better for distal clavicle
(AP with cephalic tilting of 15° and use of only 50% of the standard shoulder penetration strength)
Allman Classification

[JBJS 1967;49A:774]

Group III
- Medial 1/3
- 3%-6%

Group I
- Middle 1/3
- 69%-85%

Group II
- Distal 1/3
- 12%-28%
Classification

AO Classification

Type A

Type B

Type C
Treatment options

Nonoperative
- Sling
- Brace

Surgical
- Plate Fixation
- Intramedullary Fixation
- Hook plate
- KW-tension band
Conservative treatment

**Neer (1960)** = 3 nonunions / 2,235 clavicle midshaft fractures

**Rowe (1968)** = 4 nonunions / 566 clavicle midshaft fractures

These reports of < 1% incidence of nonunion dominated the clinical approach to displaced clavicular fractures for several years.
Conservative treatment - problems

- pain,
- loss of strength,
- rapid fatigability,
- paraesthesiae of the arm and hand,
- problems with sleeping on the back
- cosmetic complaints

Hill et al. 1997
Ledger et al. 2005
Nowak et al. 2005
McKee et al. 2006
Rosenberg et al. 2007
Conservative treatment

Overall prevalence of nonunion in 868 patients, at 24 weeks follow up was 8.3% of the medial end fractures, 4.5% of the diaphyseal fractures, and 11.5% of the lateral end fractures.
Reasons for Altered view of clavicular malunion

1. high-energy trauma – more displaced fractures

2. better-designed studies, without inclusion of children,

3. increased patient expectation regarding functional outcome after trauma,

4. outcome is now analyzed with patient-based outcome scores, instead of range of motion and radiographic fracture union only
Conservative treatment

Mean DASH score was 24.6 points, (10.1 normative value)
Mean Constant shoulder score was 71 points, (92 normative value)

Clavicular shortening was associated with a trend toward decreased abduction strength, and shortening of ≥2 cm was associated with a trend toward greater patient dissatisfaction
Conservative treatment

...we recommend treating fractures with a displacement of more than 21 mm, a shortening of more than 15 mm, primarily with open reduction and internal fixation with plates and screws.
Surgical indications

Malunion after midshaft clavicle fractures in adults
The current view on clavicular malunion in the literature

Robert J Hillen¹, Bart J Burger², Rudolf G Pöll³, Arthur de Gast⁴, and C Michael Robinson⁵

Acta Orthopaedica 2010; 81 (3): 273-279
Reconstruction on plates

LC-DCP 3.5 plates

Inferior plating associated with lower risk of hardware prominence
Intramedullary fixation

Large threaded cannulated screws
Flexible elastic nails
K-wires
Knowels nails
  Associated with risk of migration

Useful when plate fixation contra-indicated
  Bad skin
  Severe osteopenia

Fixation less secure
Both techniques are equally effective for displaced midclavicular fractures, and give better function than nonoperative treatment.

The RTEN technique has more advantages and lower complications than plating.
Distal Third Clavicle Fractures
Neer classification of distal third

Type III (intra-articular)
Treatment of Type II distal clavicle Fractures

Nonoperative treatment
  22 to 33% failed to unite
  45 to 67% took more than three months to heal

Operative treatment
  100% of fractures healed within 6 to 10 weeks after surgery
Surgical techniques

KW's into the distal fragment
Tension-band wire or suture
Clavicular Hook Plate
Dorsal plate fixation
CC screw fixation
Transfer of coracoid process
Complications of Clavicular Fractures

- Nonunion
- Malunion
- Neurovascular Sequelae
- Post-Traumatic Arthritis
Epidemiology

- 9% of shoulder girdle injuries
- 43.5% occur in adults in their 20s
- more common in men than in women (ratio 5:1)
- more often incomplete than complete (2:1)

Anatomy

- **static stabilizers**: AC ligaments (4), CC ligaments (trapezoid and conoid)

- **dynamic stabilizers**: deltoid and trapezius muscles

For **small** displacements the capsule and AC ligaments are the primary restraints to posterior (89%) and superior (68%) translation.

For **larger** displacements, the **conoid** ligament is the primary restraint (62%) to superior translation, while the AC ligaments are still the primary restraint to posterior translation.

**Trapezoid** ligament is the primary restraint to **compression** at both small and large displacements.

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Classification

Mechanism of injury

- Direct trauma (fall or blow with the arm in the adducted position)
- Indirect injury (fall on adducted outstretched hand or elbow, causing the humerus to translocate superiorly, driving the humeral head into the acromion)
Clinical examination

- Step-off, point tenderness, pain at the AC joint with cross-arm adduction, and relief of symptoms by injection of local anesthetic.

- Positive Paxinos test (thumb pressure at the posterior AC joint) and O’Briens test.
Radiological examination

- **Zanca view** (cephalic tilting of 10° to 15° and use of only 50% of the standard shoulder anteroposterior penetration strength)

- **Axillary view** is useful for evaluating dislocation in the horizontal plane

- **Stress views**
The optimum treatment for AC joint separations is controversial and a source of continuing debate in the literature.

Of the more than 500 articles written for this injury, approximately half of them contributed a new technique or a new approach to an old technique or management...
Evidence based medicine

• 27% of conservatively treated types I and II AC joint separations required further surgery at 26 months after injury [1]

• Successful treatment of failed types I and II AC joint separations with arthroscopic management [2]

• 20% rate of suboptimal outcome with conservative treatment for type III injuries [3]

Types of operative procedures:

1. Fixation across the acromioclavicular joint
   a. Kirschner wires
   b. Hook plate
2. Dynamic muscle transfer
3. Fixation between the clavicle and the coracoid
   a. Bosworth screw
   b. Coracoclavicular loop
4. Reconstruction of ligaments (Weaver-Dunn)
5. Anatomical reconstruction
6. Combinations, including arthroscopic techniques
1. Fixation across the acromioclavicular joint
   a. with wires, threaded pins, screws

- pin migration or breakage
- pin-site infection
- redislocation after pin removal
- damage to the articular cartilage or meniscus
1. Fixation across the acromioclavicular joint
   b. with hook plates

   - violation of the AC joint
   - need for implant removal
   - bending or redislocation
   - increased risk of infection

2. Dynamic muscle transfer (chronic injuries)

- bypasses the site of disruption
- injury to the musculocutaneous nerve
- nonunion of the transferred coracoid
- loss of fixation or screw breakage

- Skjeldal et al reported 10 complications in 17 patients, including coracoid fragmentation, infection, and pain

Treatment

3. Fixation between the clavicle and the coracoid
   a. Bosworth screw
   ± repair of the ligaments
   removal of the screw (8-10 weeks postop)
   - ossification between coracoid-clavicle
   - osteolysis
   - loosening
   - screw breakage
4. Reconstruction of ligaments (Weaver-Dunn)
- residual subluxation or dislocation
- CA lig. is important restraining mechanism to ↑ migration of the shoulder
- less strength of the intact CC ligament (additional augmentation needed, such as sutures, tapes, screws, or tendons)

5. Anatomical reconstruction techniques

- FCR tendon, gracillis, semitendinosus, allografts....
- complex & expensive operations
- a normal tendon is sacrificed
- risk from the allografts

Treatment

6. Arthroscopic techniques

Technical Note

Arthroscopic Reconstruction for Acromioclavicular Joint Dislocation

Eugene M. Wolf, M.D., and William T. Pennington, M.D.
3. Fixation between the clavicle and the coracoid
   b. Coracoclavicular loop

- wires, sutures, PDS, Dacron-Mersilene tapes, other synthetic (LARS) loops, or bone anchors
- loss of reduction
- erosion through the distal clavicle
- anterior displacement
- infection, nerve damage
Double-Loop Suture Repair for Acute Acromioclavicular Joint Disruption

Panayotis Dimakopoulos, MD, Andreas Panagopoulos,* MD, PhD, Spyros A. Syggelos, MD, Elias Panagiotopoulos, MD, and Elias Lambiris, MD

From the Orthopaedic Clinic, Shoulder and Elbow Surgery Unit, University Hospital of Patras, Patras, Greece

Functional Coracoclavicular Stabilization for Acute Acromioclavicular Joint Disruption

Panayotis Dimakopoulos, MD, PhD; Andreas Panagopoulos, MD
Surgical technique
Surgical technique
Surgical technique
Surgical technique
Surgical technique

A

B

C

D
Take home message

- Types I and II AC joint separations are treated non-surgically.
- Type III injuries are usually evaluated on a case-by-case basis, taking into account hand dominance, occupation, heavy labor, position or sport requirements (pitchers), scapulothoracic dysfunction, and the risk for re-injury.
- Types IV, V, and VI injuries are generally treated operatively.

- Need for prospective-randomized multicenter studies.

FRACTURES OF THE HUMERAL HEAD
Epidemiology

Fractures of the proximal humerus:

- Increased overall incidence (17.1% to 47.9% last 15 years)
- Increase annual incidence 13%
- Increased age of presentation (78 ♀ 73 ♂)
Classification

The fracture lines are follow the old epiphyseal plate

Codman E. A: The soulder, Boston, T. Todd, 1934
Classification

If any of the part has > 1cm of displacement or > 45° of angulation the fracture will be considered as displaced

Neer C. S.  
JBJS A, 1970

JSES, 2001
Pathophysiology

One-part (type I)

displacement < 1 cm
angulation < 45°
Pathophysiology

2-part

Anatomical neck

LTB

GTB

> 5\(^1\) or 3\(^2\) mm

Surgical neck

1 McLaughlin HL. Surg Clin North Am 1963
Anterior Traumatic Shoulder Dislocation Associated With Displaced Greater Tuberosity Fracture: The Necessity of Operative Treatment

Panayiotis Dimakopoulos, MD, Andreas Panagopoulos, MD, PhD, George Kastimatis, MD, Spiros A. Syggelos, MD, and Elias Lambiris, MD

Despite these limitations, we recommend operative fixation of the GT fracture associated with a traumatic anterior dislocation of the shoulder. Anatomic reconstruction of the GT and subsequent rotator cuff repair allow for early passive motion of the joint; the subsequent avoidance of tendon retraction, malunion, and secondary GT displacement yields a predictable and satisfactory medium- to long-term outcome.
Pathophysiology

Posterior displacement

Anterior displacement
Pathophysiology
Pathophysiology

2-, 3- and part fractures-dislocations

**Anterior dislocation**

2-part

3-part

4-part

**Posterior dislocation**

2-part

3-part

4-part
Pathophysiology

Intra-articular fractures

Impaction fractures

Splitting fractures
4-part valgus impacted fracture
Humeral head blood supply

Arcuate a.

Vessels from GTB

Posterior circumflex a (x3 > anterior)

Important anastomoses postero-medial hinge

Gerber C, et al. JBJS Am 1990
Brooks CH, et al. JBJS Br 1993
Valgus impacted proximal humeral fractures and their blood supply after transosseous suturing

preop 6 to 12 hours
Postop 8-10 weeks
Axillary artery
Three images (0°, -45° κατ' +45°)
1 image per second
30 images / patient
Results

15/16 last fup
1 partial AVN (7 mm)
Constant score 87/100
What is the fracture pattern?

Does it need to be treated surgically?

Does the medical status of the patient permit operative treatment?

Could the anatomy can be restored by means of stable and durable fixation?

Is the humeral head viable?

Well informed patient about outcome & expectations
Radiological evaluation

**AP in the scapular plane**

**Y-view**

**Axillary**

**Velpau axillary**
CT scan

- Tuberosities displacement
- Better visualization of the head
- Glenoid pathology


Ischemia predisposing factors

• a) length of medial metaphyseal head extension (< 8 mm in ischemic heads)

• b) integrity of the medial hinge (43 / 55 ischemic heads > 2 mm)

• c) splitting head component

Hertel R, et al. JESS 2004
More than one method of treatment for a given fracture may result in a satisfactory outcome, even if surgeons do not have uniformity of opinion.

This question would be an important subsequent consideration in future studies.
Treatment options

- Conservative
- Internal fixation
- Arthroplasty
- Reverse arthroplasty
Conservative

125 fractures\(^1\) AO type B1.1 (valgus impacted)
Constant score 71.8/100 (1 year follow up)
80.6% excellent-very good
1- part $\rightarrow$ 3-part (CS: 74.5 $\rightarrow$ 65.6)

507 fractures\(^2\) AO type A
376 patients (1 year follow up)
88% excellent or very good

131 patients lost???

---

\(^1\) Court-Brown CM, et al. Impacted valgus fractures (B1.1) of the proximal humerus the results of non-operative treatment. JBJS Br 2002

Conservative
Natural history of complex fractures of the proximal humerus using a three-dimensional classification system

Gordon Edelson, MD, Husam Safuri, MD, Joseph Salami, MD, Fino Vigder, MD, and Daniela Militianu, MD. Tiberias and Haifa, Israel
Review article

THE OPERATIVE MANAGEMENT OF DISPLACED FRACTURES OF THE PROXIMAL HUMERUS

P. Hoffmeyer

From the University Hospital, Geneva, Switzerland

(Printed with permission of EFORT. The original version of this article appears in European Instructional Course Lectures Vol 5, 2001.)
What kind of osteosynthesis?
How much minimal ...?
Options for internal fixation

- **Plate-screws**
  (T, L, 90° blade, cloverleaf, 1/3 tubular, Plantan, Philos)

- **Percutaneous KW or cannulated screws**

- **Intramedullary KW or rods**
  (Kapandji, Rush, Ender, Prevot, Zifko, Evans, Jig etc)

- **Antegradde or retrograde intramedullary nailing**
  (Polarous, Halder, PHN-T, PHN-S, Targon etc)

- **Osteosuture**
  (wiring, cross screw osteosynthesis, isolated sutures, dacron tapes etc.

- **Combined techniques ± grafting, cement, Norian**
Philos plate

osteosuture

im nailing?

Not for 4-part fractures
A systematic review of locking plate fixation of proximal humerus fractures

Robert C. Sproul, Jaicharan J. Iyengar, Zlatko Devcic, Brian T. Feeley
University of California, San Francisco, Department of Orthopaedic Surgery, Sports Medicine and Shoulder Surgery Service, 1500 Owens Street, San Francisco, CA 94158, United States

12 studies/ 514 patients
Constant score 74
DASH score 27

Complications

varus malunion 16%,
AVN 10%,
screw perforation 8%,
subacromial impingement 6%,
infection 4%
Internal fixation with Philos

C-arm control

Be prepared...

Shorter screws
Lower position
## TABLE II Clinical and Radiographic Outcomes

<table>
<thead>
<tr>
<th>Fracture Type</th>
<th>Total No./No. Lost to Follow-up/No. with Complete Clinical and Radiographic Evaluation</th>
<th>Reoperation</th>
<th>Union</th>
</tr>
</thead>
<tbody>
<tr>
<td>Two-part greater tuberosity without dislocation</td>
<td>24/4/(20)</td>
<td>1</td>
<td>—</td>
</tr>
<tr>
<td>Two-part greater tuberosity with dislocation</td>
<td>41/5/(36)</td>
<td>—</td>
<td>1</td>
</tr>
<tr>
<td>Three-part</td>
<td>72/8/(64)</td>
<td>3</td>
<td>6</td>
</tr>
<tr>
<td>Four-part varus impacted</td>
<td>51/6/(45)</td>
<td>3</td>
<td>2</td>
</tr>
<tr>
<td>Total series</td>
<td>188/23/(165)</td>
<td>7 (4%)</td>
<td>9 (5%)</td>
</tr>
</tbody>
</table>

## TABLE II (Continued)

<table>
<thead>
<tr>
<th>Osteonecrosis</th>
<th>Nonunion</th>
<th>Partial</th>
<th>Total</th>
<th>Subacromial Impingement</th>
<th>Heterotopic Ossification</th>
<th>Symptomatic Osteoarthritis</th>
</tr>
</thead>
<tbody>
<tr>
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<td>1</td>
<td>4</td>
<td>1</td>
</tr>
<tr>
<td>2 (1%)</td>
<td>7 (4%)</td>
<td>4 (2%)</td>
<td>4 (2%)</td>
<td>15 (9%)</td>
<td>2 (1%)</td>
<td></td>
</tr>
</tbody>
</table>
INDICATIONS:

• 2-part GT fractures with or without dislocation
• 3-part fractures or 3-part fracture-dislocations
• 4-part valgus impacted fractures
  (no more than 45° of rotational deformity and <6 to 7 mm of lateral displacement)

CONTRAINDICATIONS:

• Complex 4-part or 4-part fracture-dislocations
• 2-part surgical neck fractures
• Head-splitting or anatomical neck fractures
Skin incision

Deltoid splitting and bursa removal
Recognition of fracture pattern

Transosseous suturing of the tuberosities
Sutures through the humeral head and diaphysis

Cross-manner fixation with tension band effect

Minimal intraoperative reduction of the head fragment
Final assessment of reduction and knotting -
Complications

Nonunion (3.9%)  Avascular necrosis (5.9%)
Indications for arthroplasty

1. Complex 4-part fractures
2. 3- or 4- part fractures-dislocations
3. Impression fractures > 40% of the articular surface
4. Splitting head fractures
5. Complications after conservative or operative treatment
6. Not feasible fixation after intraoperative recognition of fracture pattern
Neer’s good results had been achieved from only 6\(^1\) studies (13-49 patients), whereas there are at least 14 studies (10-70 patients) with moderate or disappointing results.

\(^1\) Boileau P, Bigliani LU, Moeckel BH, Neumann K, Dimakopoulos P, Compito CA
Early management of proximal humeral fractures with hemiarthroplasty
A SYSTEMATIC REVIEW

G. Kontakis, MD, Assistant Professor of Orthopaedics; C. Koutras, MD, Fellow; T. Tosounidis, MD, Resident in Orthopaedics; and P. Giannoudis, MD, Professor of Orthopaedics

- 16 studies = 810 hemiarthroplasties
- mean age of 67.7 years
- mean follow-up of 3.7 years met the inclusion criteria
- four-part fractures or fracture-dislocations

- mean active anterior elevation was to 105.7°
- mean abduction to 92.4°
- mean Constant score was 56.63

At the final follow-up, no pain or only mild pain was experienced by most patients, but marked limitation of function persisted.
Final tuberosity malposition occurred in 33 patients (50%) and correlated with an unsatisfactory result, superior migration of the prosthesis, stiffness or weakness, and persistent pain.
In these early results, the anticipated functional gains of RSA over hemiarthroplasty were not realized, suggesting the use of RSA for treatment of proximal humeral fractures should remain guarded.
Conclusions

Review article

THE OPERATIVE MANAGEMENT OF DISPLACED FRACTURES OF THE PROXIMAL HUMERUS

P. Hoffmeyer
From the University Hospital, Geneva, Switzerland

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Status of head of humerus

VASCULAR

AVASCULAR

Strong bone

Soft bone

Strong bone

Soft bone

Osteosynthesis

Osteosuture

Osteosynthesis (Arthroplasty)

Arthroplasty
Conclusions

Philos plate, screws, nails

osteosuture

Not amenable for fixation and/or dislocation, impaction or splitting