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Functional anatomy of the shoulder joint

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The function of the humeroscapular joint should be regarded as that of a link in the junction of the upper extremity to the trunk. Duchenne's view, based on clinical and experimental observations, that in the raising of the arm two planes are to be distinguished, a humeroscapular plane up to the horizontal position followed by a phase of movement of the scapula and the clavicle, has by now been practically abandoned.

It can be confirmed radiographically that during movements of the shoulder joint – raising of the arm in the frontal or sagittal plane – all the joints in the chain are involved from the start. This implies a coupling of the motional possibilities of the humerus and the scapula (and of the clavicle), which means further that movements in the shoulder joint will influence the shape of the shoulder region, the axillary fossa, and the positions of the local structures.

The close relationship between excursions in the humeroscapular joint and the excursion of the scapula can be demonstrated when the humerus in a frontal plane is abducted to approximately 90° without exorotation of the humerus. In this position, the humerus has reached the end of the excursion. Maximum elevation of the arm can be achieved by exorotation of the humerus. It appears that in this movement a further excursion is described not just by the arm, but also by the scapula.

Similar phenomena are found to occur when the arm is raised in the sagittal plane. In this mechanism, fibrous systems in the capsule of the humeroscapular joint play a part.

With reference to the steering of the articular contact in the shoulder joint, the special position of the muscles of the rotator cuff should be pointed out. The

relation of these muscles to the joint strongly suggest a function in the sense of a mutual determination of the positions of the articular surfaces in this joint. Reliable data on this dynamic function are lacking, however.

The myth of the subacromial bursa

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Doubt whether the terms "bursa" and, ipso facto, bursitis are actually justified here prompted us to perform a number of biopsies from the tissue between the acromion and the supraspinatus muscle, mostly from patients undergoing partial acromionectomy or cuff repair. Morbid-anatomically, the 13 biopsies could be graded as follows:

Grade 0 3

Grade I 5

Grade II 5

Grade III 0

Grade 0 was defined as normal loose-meshed connective tissue without bursal structures.

Grade I was defined as mucification and fibrin formation, sometimes cellular debris and inflammatory exudate, but no endothelial or epithelial elements.

Grade II was defined as thickening of the parietal layers and increase of the amount of liquid. Here, also, epithelial elements were found only sporadically.

Grade III was defined as coagulation of fibrin and fibrinous organization (chronic inflammation).

Accordingly, in only 5 cases was there a kind of wall; and an epithelial cover was only sporadically encountered.

Structures such as the subacromial bursa and, for instance, the scapulothoracic gliding mechanism should be regarded as belonging to the sliding mech-

anisms existing in the body between structures that are mobile in relation to each other. They frequently consist of loose-meshed connective tissue. These sliding layers may become so extensive that after injection of, e.g., a contrast medium, the x-ray film may appear to show a preformed bursa. However, a true bursa only develops after a substantial noxa or injury, as observed in prepatellar or olecranon bursitis. These bursae can be extirpated in toto and have a clearly recognizable fibrous wall. In the subacromial bursa, on the other hand, this is observed only in a minority of the cases. The structure in question, therefore, should be called the subacromial sliding mechanism rather than the subacromial bursa. The pathologic condition of subacromial bursitis does not exist; the condition should preferably be interpreted as a local cuff problem (calcification, fissure), which causes the symptoms presented.

Radiography in habitual anterior and posterior dislocation of the shoulder

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A habitual anterior dislocation of the shoulder may be difficult to diagnose because a few weeks after the dislocation the clinical findings are minimal. Radiographic demonstration of the osseous defect caused by the dislocation confirms the diagnosis. The defects in question are a posterolateral defect of the head of the humerus (Hill and Sachs lesion) and an osseous defect or ectopic bone formation at the anteroinferior edge of the glenoid fossa (Bankart lesion).

A prospective study was carried out to establish which radiographic projection is most suitable for demonstration of the Hill and Sachs lesion and the Bankart defect. The following projections were compared: AP, axial, Stryker, Hermodsson, Didiee, and the craniocaudal projection. The Hill and Sachs lesion is seen most frequently with the Stryker projection, but it is best visible with the craniocaudal projection. With this craniocaudal projection, the Bankart lesion is also visible most often.

The posterior dislocation is rarely seen, but frequently missed. As a general rule, the first dislocation is caused by an indirect injury. This dislocation may also be brought about by an abnormal contraction pattern of the muscles, e.g., during a convulsion. In 30 per cent of the cases, this dislocation is associated with a fracture of, for instance, the posterior edge of the glenoid fossa, the greater or lesser tubercle, or the humeral head.

In habitual traumatic posterior dislocation of the

shoulder an anterolateral defect of the humeral head can be demonstrated. Habitual posterior dislocation of the shoulder is easily missed in the anteroposterior projection because overprojection of the humeral head and glenoid fossa, and an axial or transscapular radiograph is required to visualize this dislocation.

Arthrography of the shoulder

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Totally, 127 shoulder arthrograms performed between 1980 and 1985 are reviewed. Complications did not occur. The patient age was 40 (14–74) years; there were 72 males and 55 females. Of the 127 shoulder arthrograms, 45 were abnormal. A cuff lesion was encountered 12 times; 6 patients of this group were subjected to an operation (Neer acromioplasty) at which the cuff lesion was confirmed. In 1 patient, the operation revealed a cuff lesion that was not visible in the arthrogram. Of 12 patients with a frozen shoulder, 8 had an abnormal arthrogram compatible with adhesive capsulitis. In 22 patients with habitual (sub)luxations of the shoulder, a cuff lesion was encountered twice, a Hill-Sachs lesion seven times and a loose capsule only twice. Visibility or invisibility of the biceps tendon was not conclusive as regards the diagnosis of biceps tendinitis. In 26 patients with vague shoulder complaints, the arthrogram only twice provided supplementary diagnostic information. Few arthrograms were made after recent shoulder injuries; in our opinion, the examination is indicated only rarely in these cases.

In conclusion, arthrography of the shoulder supplies supplementary information to corroborate or confirm the diagnosis. It has no clear-cut influence on the therapeutic management, however.

MRI of the shoulder

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The development of a flexible surface spindle has made it possible with MRI to obtain a good image of the shoulder, with a better signal-scatter ratio. Of 10 volunteers, images were made in the axial, sagittal, coronal, and two oblique planes with a section thickness of 5 mm.

The two oblique planes: parallel to and perpendi-

cular (in the longitudinal direction) to the glenoid were evaluated further in the two shoulders of a cadaver.

Following the MRI examination, the shoulders were sawed into corresponding sections, enabling correlation of the relevant anatomic structures and the MR images.

Examination in pathologic processes, such as impingement syndrome, rheumatoid arthritis, and traumatic lesions, was simplified by choosing optimal imaging planes, selected on the basis of the anatomic studies. MRI can be very useful in the diagnosis of acute shoulder injuries, in particular, lesions of the soft tissues in dislocations and tendon ruptures.

Arthrography and CT scanning of the shoulder

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For double-contrast arthrography of the shoulder, 1–3 ml of iodinated water soluble contrast medium plus 10–15 ml air are injected. In this way, the following structures can be visualized: 1) undersurface of rotator cuff, 2) long biceps tendon, 3) articular cartilage, 4) articular capsule with synovial lining, 5) the glenoid labrum.

1. Rupture of the rotator cuff causes a communication with the subacromial and subdeltoid bursae, giving rise to a typical image with coating of the still intact part of the cuff on two sides.

2. An acute rupture of the long biceps tendon can be well diagnosed clinically. In the arthrogram, the shadow of the tendon at the joint is no longer visible.

3. Lesions of the cartilage and corpora libera can be visualized clearly.

4. Lesions of the articular capsule that can be demonstrated include synovial abnormalities, adhesive capsulitis, and ventral bulging in habitual anterior dislocations.

5. Lesions of the glenoid labrum after acute and habitual subluxations and in patients with chronic instability and habitual subluxations can usually be visualized in the axial projection (Mink 1979), but not always due to contrast overprojection. For the diagnosis of a lesion of the glenoid labrum, it is therefore preferable to have the arthrography followed by planigraphy or a CT scan.

The accuracy of CT arthrography is very high, slightly higher than that of arthroplanigraphy. Moreover, the CT arthrogram will also visualize a Hill-Sachs defect and the biceps tendon.

Epidemiological study of acute shoulder injuries in the casualty department

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An epidemiologic study was made of acute shoulder injuries seen in a casualty department in 1984. Of the total number of accident victims seen, 3 per cent (360 cases) had sustained a shoulder injury. The male-female ratio was 2:1. The age distribution showed 32 per cent of the shoulder injuries in the group aged 16–24 years. Of the women, 17 per cent belonged to the group aged 65 years and older. An increased incidence was seen during the spring and summer months and during the weekends. The largest number of injuries occurred during athletic activities, followed by home accidents and traffic accidents, with only a few injuries occurring in the work environment (3 per cent). For shoulder lesions sustained during sports, the male-female ratio was 4:1. In two thirds of the cases, the cause was an indirect injury. Clavicular fractures constituted the largest group, 167 (46%), followed by dislocations, with 81 (23 per cent).

Subcapital fractures of the humerus (42) were seen mostly in the groups aged 1–14 years (45 per cent) and over 65 years (26 per cent). Subsequent treatment was on an outpatient basis in 71 per cent of the cases. Ten per cent (36) were hospitalized. Of these, 29 were admitted because of a road accident. In most cases the indication for hospitalization was associated injuries.

Arthroscopy of the shoulder, indications and personal experiences

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Arthroscopy of the shoulder was carried out in 15 patients between June 1984 and February 1986. Most of the patients were young and active in various sports in which abduction-external rotation strain with, anamnesticly, minor or more severe injuries in maximal abduction-external rotation readily occur.

The purpose was to determine whether osteotomy of the collum scapulae and collum humeri was indicated.

The following arthroscopic findings were obtained: Limbus pathology (avulsion and/or dislocation, ar-

throlith, osteochondral fracture caput humeri, cuff rupture, omarthrosis) in 10 cases. Ten of these patients have been operated on, with confirmation of the arthroscopic findings.

To conclude, arthroscopy of the shoulder is indicated in patients with posttraumatic disorders of the shoulder manifested as instability and locking phenomena that lead to the presumptive diagnosis of limbus avulsion – a lesion that cannot be visualized radiographically.

Arthroscopic surgery of the shoulder

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Arthroscopy of the shoulder joint is a method for the diagnosis of pathology of the glenohumeral joint. Improved technique and equipment make arthroscopic surgery of the shoulder joint possible. Accurate technique and knowledge of the normal anatomy of the shoulder joint are conditions. Because the instruments have to pass through a thicker layer of fat, muscle, and capsule than in the knee, finding the adequate approach requires good orientation. The duration of the operation should be restricted in view of the risk of extravasation via the subscapular bursa and the bicipital sulcus. The possibilities of arthroscopic surgery include resection of limbus lesions, removal of arthroliths, the excision of a remnant of the biceps tendon after a rupture, adhesiolysis, and synovectomy.

Arthroscopy of the shoulder joint was carried out in 34 patients: in 18 patients because of a subluxation and a possible limbus lesion, in 2 patients because of a habitual dislocation of the shoulder, and in 14 for other reasons. Arthroscopic surgery was performed in 16 patients; resection of a limbus lesion in 14; and adhesiolysis in 2 patients. In 1 patient, an arthrolith was removed, and in another the stump of the biceps was resected. Complications did not occur.

Results and comparison of a Neer acromioplasty versus manipulation under anesthetics of the painful shoulder

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In this study, 36 patients with frozen shoulder (group A) were compared with 38 patients with a

painful arc syndrome (group B). Group A included twice as many females as males, whereas in group B there was a 1:1 sex ratio. The two groups matched for age. In both groups, 95 per cent of the patients were over aged 40 years.

In group A, manipulation under anesthetics was carried out 39 times, followed immediately by intensive physiotherapy. In group B, a Neer acromioplasty was carried out, followed by a brief period of rest and then intensive physiotherapy. Complete subjective recovery was achieved in 70 per cent of group A and in 55 per cent of group B, but only after very long periods: 2 years in group A and 1 year in group B. Objective normalization i.e., absence of functional restrictions, was obtained in 70 per cent of group A and in 60 per cent of group B. Resumption of occupational activities was achieved in 70 per cent of both groups. Athletic activities, finally, were resumed by 45 per cent in group A, as well as in group B. All the patients were subjected to an extensive radiographic examination. This, however, yielded no additional information. The minor calcium deposits observed sporadically were not significant.

Conclusions 1. Due reserve is required in interpreting the indication for a Neer acromioplasty in the painful arc syndrome.

2. Manipulation under anesthetics is a good method of treating frozen shoulder.

Surgical treatment of rotator cuff lesions

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Lesions of the rotator cuff for which surgical treatment is or may be indicated are tendinitis with calcium deposits and ruptures.

Avulsions of the rotator cuff insertion are due to tendon degeneration, which is common at that level and may be regarded as a normal phenomenon of ageing. They are never purely traumatic injuries.

The clinical picture varies greatly, depending on the extent of the rupture. Minor ruptures are usually asymptomatic; sometimes they give rise to the clinical picture of tendinitis with a typical impingement syndrome, alterations of the humeroscapular rhythm, and pain during resisted abduction and exorotation. A massive interruption in the rotator cuff, on the other hand, brings about the picture of a pseudoparalytic shoulder.

In minor ruptures, good results may be obtained by conservative therapy, like in degenerative tendinitis, but in the pseudoparalytic shoulder, a satisfactory functional recovery can only be achieved by sur-

gical restoration of the continuity of the rotator cuff. One technique is that described by Debeyre et al., with mobilization of the supraspinatus muscle. We prefer the technique of Codman et al., which involves reinsertion of the edge of the tendon in a groove that is made in the bone at the level of the anatomic neck. In extensive avulsions with tendon retraction, a suture without tension is only made possible by abducting the arm. With this technique, we obtained good functional recovery in 80 per cent of the pseudo-paralytic shoulders operated on.

Proximal humerus fractures in children and adults

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The indication for surgical treatment of proximal humerus fractures in the growing individual in view of the very good remodelling capacity remains limited to lateral dislocation by more than one shaft's width and/or over 45°; angulation after an attempt at closed reduction. Between 1975 and 1984, we operated on 10 patients with a Salter I or II lesion. Types III, IV, and V did not occur. The anatomic and functional results were good in all cases. In retrospect, the indication for operation has been interpreted too liberally.

Of all proximal humerus fractures in adults, 85 per cent showed what Neer calls "minimal displacement." The majority of displaced fractures were 2-part fractures. In subcapital fractures, an operation was rarely considered indicated. Nonreducible fractures, dislocation of the humeral head, several fractures in the same extremity, multiple injuries, and associated nerve injuries were indications to operate. Twelve adult patients were operated on (screws, T-plate, or cerclage). The 10 patients younger than aged 70 years all had painless, complete shoulder function 2 years postoperatively. The same is true for three of four displaced avulsions of the greater tubercle. The fourth patient could not be followed up. Of 10 patients with a 3-part fracture whom we operated on, 5 had a dislocated head. Four of these 5 patients developed necrosis of the head. Of the 5 others, 2 also developed capital necrosis. Patients under aged 60 years, however, tolerated this complication remarkably well. In patients over aged 60 years with displaced fractures, a primary prosthesis should be considered, such as in 4-part fractures.

Classification and results of the treatment of comminuted and dislocated fractures of the proximal humerus

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Proximal humeral fractures in 80 per cent of the cases have a favorable prognosis because they are often undisplaced and stable. In 20 per cent of the cases, there is a comminuted fracture with a loose greater or lesser tubercle fragment. Neer's classification may be of guidance in the choice of the treatment and evaluation of the prognosis. With larger numbers of fragments, the risk of necrosis of the head, detracting from the end result, increases.

A follow-up study was made of 24 patients operated on during 1975–1984. All the patients had a 3–4 part fracture, displaced in 11 cases. In 5 of these 11 fractures, a Neer prosthesis was implanted. One of these patients was dissatisfied because of instability, the other 4 patients had no pain, but did have loss of function. Osteosynthesis was carried out in 19 patients, cerclage (14) and plate (4); necrosis of the head occurred in 9 and 2 patients, respectively. In spite of this and loss of function, 15 patients had no pain and were satisfied.

Conclusion: In displaced comminuted fractures of the proximal humerus, necrosis of the head is found to occur frequently in spite of anatomic reconstruction. For older patients, an endoprosthesis may be considered.

Follow-up of Neer prostheses in four-part fractures of the proximal humerus

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During the period 1979–1984, a follow-up study was made of 14 patients in whom a Neer I prosthesis was implanted because of a four-part fracture of the proximal humerus. The mean age was 66 years, and the mean follow-up time was 3 years.

Clinical examination: Evaluation scheme (Neer 1970)

Excellent: 2, satisfactory: 8, unsatisfactory: 0, failure: 4.

In all patients, restriction of glenohumeral abduction was conspicuous. Rotation was less restricted, and pain usually was mild.

Radiography: Abduction in the scapular plane was mostly scapulohoracic. Glenohumeral mobility was greatly restricted and proved to depend, above all, on the distance between the prosthesis and the greater tubercle.

Electromyography: In 12 shoulders, the EMG was recorded during abduction in the scapular plane. All the muscles measured showed good EMG activity on both sides, but the activity pattern in the operated on shoulder differed from that in the normal shoulder.

Conclusions: The Neer I prosthesis has a good effect on the pain, but in spite of distinct EMG activity, mobility is often disappointing. Reconstruction of the cuff and the tubercular complex appears essential. A different model of prosthesis may have to be considered.

Primary or secondary implantation of prostheses after comminuted fractures of the shoulder

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In 2 patients whose injuries had involved removal of the humeral head, prostheses of the Isoelastic type were implanted after 6 and 13 months, respectively. After such long intervals, severe shrinkage and fibrosis of the rotator cuff will be present, leaving less space for the prosthetic head. Consequently, a smaller size has to be used; and this endangers stability, as this depends largely on the soft tissues in shoulder prostheses, as well as in the normal humeral head. Twice, a secondary implantation of a prosthesis was carried out – once for pseudarthrosis and once for necrosis of the head. Also in such cases, there is frequently extensive fibrosis and damage to the rotator cuff, with destruction of its insertions in the greater and lesser tubercles. In a few cases, reconstruction of the rotator cuff proved possible with the aid of a double-length biceps tendon, resulting in better stability of the prosthesis.

Compared with 3 patients treated by primary surgery, functional recovery was slower and less complete. This suggests the advisability of a broader interpretation of the indication for surgery in cases of severe comminuted fractures of the humeral head.

Epidemiology of clavicular fractures

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During three 4-year periods from 1970 to 1981, GAK accident insurance medical officers followed up and encoded 4,091 fractures of the shoulder girdle, including 2,409 (59 per cent) clavicular fractures. The proportion of sports fractures was increasing, a trend that can be observed in regard to other fractures as well. The frequency with which surgical treatment was decided upon showed an annual variation for the 1969–1981 period, with a minimum of 13 per cent in 1969 and a maximum of 33 per cent in 1976. In approximately 10 per cent of the cases, the results of surgical or conservative treatment were unsatisfactory.

The surgical methods were mainly intramedullary fixation with Kirschner wires or the Rush nail. The durations of absenteeism in the various periods differed little.

Closed treatment of clavicular fractures: a prospective randomized trial

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Treatment of simple clavicular fractures is still controversial. An inquiry among 162 departments showed that 32 per cent of the Dutch surgeons prefer a figure-of-8 splint, 38 per cent a simple sling, and 28 per cent a combination of these two methods. Three surgeons favor internal fixation. In a prospective randomized clinical trial, we are evaluating the results of conservative treatment of closed diaphyseal clavicular fractures comparing a figure-of-8 splint and a simple sling.

In the period from December 1983 to January 1986, we saw 275 patients with a clavicular fracture, 91 of whom were submitted to the trial. These 91 patients gave their permission to participate in the study; they were all over 14 years of age, and their fracture was diaphyseal and closed. There was no accompanying vascular or nerve injury and no other fracture in the same extremity. Forty patients were treated with a figure-of-8 splint and 51 with a sling.

The time for bone healing was equal in both groups. Nonunion occurred in 3 cases after treatment with a figure-of-8 splint. At the final radio-

graphic examination there were no differences in the length of the healed clavicle in either group.

The early results of this study show that common fractures of the clavicle are easily overtreated, and that a figure-of-8 splint neither reduces the fracture nor maintains length of the clavicle.

Infraclavicular plexus lesions

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Plexus or nerve lesions encountered in injuries to the glenohumeral joint are most often infraclavicular. They occur in 25–30 per cent of dislocations and subcapital humeral fractures. The paralysis/paresis is usually partial and due to neurapraxia.

Among 99 patients operated on, five groups were encountered: 1) an isolated axillary nerve injury ($n = 25$), 2) injury of the axillary and suprascapular nerves ($n = 15$), 3) damage of the axillary nerve and of several rami of the infraclavicular plexus ($n = 30$), 4) posterior plexus lesion predominantly affecting the dorsal fasciculus ($n = 19$), 5) an anterior plexus lesion, predominantly affecting the lateral and/or medial fasciculus ($n = 10$). In 75 patients there were one or several ruptures. In 84 patients, the follow-up exceeded 1 year. Fifty-two patients were operated on within 6 months, 25 within 1 year, and 7 more than 1 year after the injury.

A force 95 ± 10 M4 was achieved in the deltoid muscle in 60 per cent of the cases, in the biceps in 60 per cent, in the spinati in 55 per cent, and in the triceps in 60 per cent; a force 95 ± 10 M3 in the extensors of the wrist and fingers in 40 per cent. Neurolysis of the lateral and/or medial fasciculus or their rami gave a good result in 60 per cent. Repair resulted in a force of M3 in 40 per cent of the cases, but only when wrist flexion was concerned. It improved, however, the trophic condition and the sensibility of the hand.

Pseudarthrosis of the clavicle. Surgical technique and therapeutic results

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In the period 1974–1984, osteosynthesis of the clavicle for pseudarthrosis was carried out in 23 patients. The primary treatment had mostly been conservative. All patients had a painful, abnormally mobile bayonet displacement of the clavicle, with muscular

atrophy and loss of function. In most cases there was hypertrophic pseudarthrosis, in one third of the cases lateral to the thoracoclavicular ligamentous complex. The treatment consisted in Zuggurtung osteosynthesis (lateral) or plate osteosynthesis, sometimes with decortication, cancellous bone plasty, or even chip interpositioning. The aftertreatment was functional.

In most cases bony union was achieved after one operation. In one case, pseudarthrosis after infection had to be accepted.

After a mean follow-up of 5 years, three fourth of the patients were asymptomatic while the remainder had residual symptoms of brachialgia, compatible with a thoracic outlet syndrome that in most cases had already been present before operation.

Intramedullary osteosynthesis of clavicular fractures

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In 598 clavicular fractures treated between 1975 and 1985, primary osteosynthesis by intramedullary nailing was carried out in 6 cases. This technique involves drilling the nail outward, from the fracture through the marrow cavity of the lateral fragment, perforating the skin at the acromion. After reduction, the guiding wire is drilled back from the outside into the marrow cavity of the medial fracture fragment and then cut off flush with the skin. After bony union 4–6 weeks later, the nail can be removed transcutaneously.

An operation was considered indicated in complicated fractures and in lateral clavicular fractures with pronounced displacement. Uncomplicated fracture healing was obtained.

Pseudarthrosis occurred twice among the 592 fractures treated conservatively and was treated by means of a corticocancellous bone graft and the same technique of intramedullary nailing. Bony union ensued in both cases.

Plate osteosynthesis of clavicular fractures. Indications and results

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There may be an absolute or relative indication for surgical treatment of certain clavicular fractures.

Plate osteosynthesis appears to offer the advantage that the rigid fixation allows fast(er) resumption of work and sports. This hypothesis was tested in a follow-up study of the patients treated in the Merwede Hospital, Dordrecht, in 1983. Of the 48 patients, 14 were treated surgically, with use of a DC plate in 12 cases. Indications for operation were endangered skin (4), unacceptable dislocation (5), unacceptable shortening (2), pseudoluxation (1), comminution (4), lateral fracture (1), and unacceptable angulation (1). The fixation was judged exercise-stable in 11 instances. Severe complications did not occur. In the group operated on work was resumed after 7 (1–16) weeks and sports after 16 (6–32) weeks. In the group treated conservatively, the intervals were 5 (1–12) weeks and 8 (1–16) weeks, respectively.

Plate osteosynthesis is a safe method that may be used if there is an absolute indication for operation, in the treatment of pseudarthrosis, and in patients with multiple injuries. Earlier resumption of work and sports could not be demonstrated.

In case of a relative indication for operation, consideration should be given to whether the desired result might not be achieved with a simpler fixation method, such as Kirschner wires or a Steinman pin.

Organization and mode of operation of a brachial plexus team

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Since 1976, 156 patients with a brachial plexus lesion (BPL) have been treated in the De Wever Hospital. In 127 cases the lesion had been caused by a trauma, including 13 obstetrical and seven iatrogenic injuries. In 16 patients, the BPL was regarded as an accompanying symptom of a tumor, whereas in the remaining 13 patients there were miscellaneous causes.

Of the 107 patients in whom the lesion was the consequence of a typical external impact, 92 were males. Sixty-nine patients were between 15 and 25 years of age. Forty-two had multiple injuries and 7 exhibited a bilateral BPL. In 52 patients, the brachial plexus was explored surgically, which involved not only neurolysis and nerve transplantations, but neurotizations as well. In consultation with the brachial plexus team, the following functional priorities were defined: 1) elbow flexion, 2) finger flexion and sensibility, 3) shoulder stability and function, 4) extension of hand and fingers, 5) intrinsic musculature of the hand.

Pathomechanics, diagnosis, and surgical treatment of supraclavicular brachial plexus injuries

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Over 1,000 cases of BP lesions were referred to a clinic for reconstructive surgery of the upper limb. Seventy-five per cent were caused by traction or crush injuries, mostly due to traffic accidents, in particular motorcycle accidents. Seventy-five per cent of the patients had fractures of the cervical spine, thorax, shoulder, arm and/or hand; 20 per cent had a major vascular injury. Eighty per cent of these traumatic lesions were supraclavicular.

Clinically there was involvement of the whole plexus (C5-T1) in 5 per cent. Even after complete neurological examination and recording of findings on easily readable charts, the exact type of lesion and subsequent prognosis became only clear at surgical exploration, which was performed in about 350 supraclavicular lesions.

If ruptures are suspected, exploration should be performed as soon as possible, i.e., within weeks. Palsies may be caused by root avulsions (mostly C8, T1), lesions in continuity, or ruptures of spinal nerves (mostly C5, C6, C7) and/or primary trunks. Possibilities of nerve surgery and other reconstructive surgery, such as arthrodesis, muscle, and tendon transfer can be determined at exploration. Priorities in repair are elbow control, wrist and finger flexion with median nerve sensation, shoulder control, and wrist and finger extension. Secondary neurolysis of upper and lower levels leads to useful recovery in over 50 per cent of cases. In case of avulsion of the upper roots, successful neurotizization of the musculocutaneous nerve with intercostal nerves or the spinal accessory nerve can be performed. Grafting the ruptured upper or middle trunk gave useful results, in particular elbow flexion, in over 60 per cent of the cases, although good shoulder function cannot be obtained. In lower plexus (C8, T1) lesions, good hand function cannot be obtained except in babies. Patients with pain syndrome benefit from operation in 50 per cent of the cases.

Acromioclavicular dislocations, treatment in the acute phase

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Of several classifications of acromioclavicular dislocations described, that of Tossy (1963) appears to be the most practically useful. It is generally agreed that Grades I and II dislocations should be treated conservatively.

In our clinic, 162 Grade III dislocations have been treated since 1962 by means of a crossed 8-shaped cerclage technique that provides a firm, but dynamic, fixation of the AC joint. Follow-up was limited to 41 patients who had been operated on between 1976 and 1985 for a Grade III dislocation. Of 31 patients obtained for follow-up, 28 were satisfied or highly satisfied; 2 patients were reasonably satisfied; and 1 patient was dissatisfied. In 1 patient, the cerclage wire broke within a month, so that refixation became necessary. The ultimate result was good. At follow-up, 1 patient was found to have a recurrence of the dislocation, for which a coracoid transplantation was performed. No other complications were seen in this group.

Scapular fractures

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Scapular fractures are rare, constituting 1 per cent of all fractures and 5 per cent of fractures involving the shoulder. They are usually caused by high-energy vehicular trauma or by falling from a height. There are often associated injuries of the ipsilateral limb, shoulder girdle, and thorax. In patients with multiple injuries, scapular fractures are frequently overlooked or neglected.

Operative treatment may, however, be indicated, especially with displaced intraarticular fractures, fractures of the glenoid rim associated with humeral head subluxation, or unstable fractures of the scapular neck.

Between 1967 and 1981, we treated 37 such fractures by open reduction and stable osteosynthesis. We were able to follow-up 33 patients, 21 of whom had complete functional recovery. The other 12 had varying degrees of pain, loss of mobility, and weakness. Overall, however, 79 per cent of the patients had good to excellent results.