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MRI study of the subacromial space in retraction and protraction of the shoulder girdle

Eva Solem-Bertoft[1], Karl Åke Thuomas[2] and Carl-Einar Westerberg[3]

[1]Department of Physiotherapy and of Orthopedic Surgery, Central Hospital, Västerås, [2]Department of Diagnostic Radiology, University Hospital, Uppsala and [3]Department of Neurology, University Hospital, Uppsala, Sweden

Introduction: Patients with subacromial pain due to impingement of mild and moderate degree are often referred to a physiotherapist for conservative treatment. It has been pointed out by some authors that many of these patients have a slouched posture with protracted shoulders and that a change to a balanced and well coordinated posture including a slight retraction of the shoulders may give the patients amelioration of their symptoms.

The aim of this study was to clarify if, and to what extent, the shape of the subacromial space is altered on change from retraction to protraction.

Materials and methods: Four healthy students had their left shoulder examined in retraction and protraction in the sagittal and coronal planes by MRI technique.

Results: There was a significant decrease of the opening width and the opening angle of the subacromial space on change from retraction to protraction.

Conclusion: The result of this study might be regarded as an anatomical correlate to the clinical suggestion that a slouched posture may be one factor that predisposes to the development of an impingement syndrome, and that the kinesiologic dimension retraction/protraction is worthwhile to consider in these patients.

Prosthetic reconstruction of neglected large isolated tears of the subscapularis tendon

Jiro Ozaki, Yasuharu Tomita, Yoshiyuki Nakagawa and Susumu Tamai

Department of Orthopedic Surgery, Nara Medical University, Kashihara, Nara, 634, Japan

Introduction: Reports on isolated tears of the subscapularis tendon are rare. In some cases with this lesion, the subscapularis tendon has retracted and cannot be repaired with conventional procedures. This paper describes the reconstruction of neglected large isolated tears of the subscapularis tendon with 3-mm-thick Teflon felt.

Patients and methods: 15 shoulders with this lesion were operated on from 1981 to 1989. The average age of three women and 12 men was 53 years. Medial displacement of the bicipital long tendon was observed in 13 shoulders and coracoid impingement in six shoulders. Seven shoulders could be repaired with the conventional procedure, but eight shoulders received prosthetic reconstruction with Teflon felt.

Results: Six patients (eight cases) were followed-up 6 (2-9) years postoperatively. There were no complications. Five of the patients were completely free from pain, the remaining patient had some pain on shoulder motion. Active motion and muscle strength were improved in all.

Conclusion: 1) Medial displacement of the bicipital long tendon and subcoracoid impingement were often accompanied with this lesion. 2) Prosthetic reconstruction with Teflon felt has been confirmed to be a valuable procedure for the shoulders with neglected large isolated tears of the subscapularis tendon.

Acromial osteotomy for subacromial decompression

Ching-Chuan Jiang[1], James C. Otis[2], Russel F. Warren[2] and Thomas L. Wickiewicz[2]

[1]National Taiwan University Hospital, Taipei, Taiwan, Republic of China and [2]Hospital for Special Surgery, New York, USA

Introduction: The purpose of this study is to assess the method and the effect of the subacromial decompression by an acromionectomy and proximal advancement of the acromion in a cadaver shoulder model.

Material and methods: Five freshly thawed cadaver shoulder specimens were dissected to preserve the deltoid and rotator cuff muscles. Each shoulder was mounted in a frame with the scapula fixed. Wire cords attached to the insertion sites followed the paths of the muscles and were connected to dial gauges. Weights were attached to wire cords to simulate muscle tension and enable a balance to be achieved at each position. Eight different positions of the deltoid muscle were chosen for study. Excursion measurements which were read from dial gauges were obtained at 15° increments of abduction from 0° to 75° of glenohumeral angle in the plane of the scapula with humerus in neutral rotation. Excursion measurements were repeated after a proximal advancement of the acromion which was achieved by an oblique osteotomy through the base of the acromial process.

Results: The effective moment arms of posterior half of the middle deltoid during 0° to 75° of glenohumeral abduction in the plane of the scapula were reduced 20-70% in a 1 cm lateral acromionectomy ($p < 0.05$) and reduced 32% to 138% in a 2 cm lateral acromionectomy ($p < 0.05$). Those of the anterior half of the middle deltoid and anterior deltoid were reduced less than 10% of the original moment arms and were not significantly affected by the acrionectomy. The effective moment arms of the posterior half of the middle deltoid increased 17% to 73% after 1 cm lateral advancement of the acromion ($p < 0.05$). The moment arms of the other portions of the deltoid remained essentially unchanged. By radiographic measurement, the acromion was advanced 5 mm proximally after a 1 cm lateral advancement.

Conclusion: Subacromial decompression can be achieved by an anterior acromionectomy and proximal advancement of the acromion. No adverse effect on the abduction moment arm of the deltoid muscle was demonstrated by these two procedures.

Treatment of calcific tendinitis in the shoulder

Yoshiyuki Nakagawa[1], Syuzo Umegaki[1], Jiro Ozaki[2], Yasuharu Tomita[2] and Goro Sakurai[2]

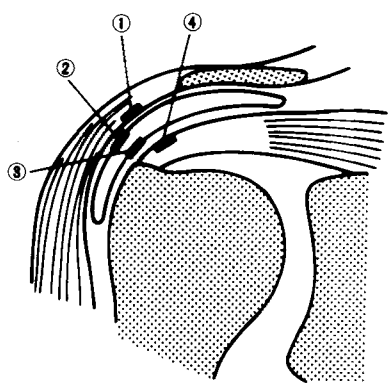
Departments of Orthopedic Surgery, [1]Haibara General Hospital, Haibara, and [2]Nara Medical University, Kashihara, Japan

The purpose of this report is to evaluate the histological changes of the calcific tendinitis in the shoulder and decide the most reasonable treatment on the individual basis, depending on symptoms and radiographic findings.

Materials and methods: This study was composed of 18 out of 200 patients treated surgically. Their average age was 52 (36-74) years. The histological changes were observed in four parts (Fig 1); the deltoid muscle, the roof of the subacromial bursa (SAB), the floor of the SAB, the rotator cuff.

Results: The histological study revealed mild inflammation in the deltoid muscle, mild inflammation in the roof of the SAB, severe inflammation in the floor of the SAB, and milder inflammation in the rotator cuff.

Conclusion: It is concluded that the main cause of symptoms of the calcific tendinitis in the shoulder is severe inflammation in the floor of the SAB. Therefore, the calcific tendinitis should be treated, first, by aspiration and infusion, and secondly, by surgical excision of the calcific deposits including the SAB, but excluding the rotator cuff, and, on occasion, anterior acromioplasty.



① Deltoid muscle
② Roof of subacromial bursa
③ Floor of subacromial bursa
④ Rotator cuff

Calcific tendinitis of the shoulder—indications for steroid injection

Kazuya Tamai, Muneyasu Hayashi, Jun-Ichiro Hamada, Hiroyuki Yoshida and Takashi Hoshino

Department of Orthopedic Surgery, Dokkyo University School of Medicine, Tochigi, Japan

Corticosteroid injection into the subacromial bursa is a common means to treat acute calcific tendinitis. However, it is not clear whether the therapeutic results can be determined by the acuteness of the disease alone. The aim of this study was to analyze the true effects of various factors on the outcome of steriod injections.

Patients and methods: We reviewed 62 patients (age range 30-85) treated with repeated intrabursal steroids (-median three injections). Those who received aspiration of the calcium deposit were excluded from the study. 25 patients rapidly (within three weeks from the start of treatment) regained their shoulder function. Whether the recovery was rapid or not was analyzed, using the quantification theory of Hayashi, in terms of the following items: age of the patient, preceding trauma, symptomatic period before treatment, active shoulder elevation before treatment, location of the calcium deposit, and bony changes.

Results: The symptomatic period before treatment and the location of the calcium most significantly affected the recovery time. Categories speaking for rapid recovery were symptomatic period less than three weeks and calcium deposit in tendons other than supraspinatus. This analysis predicted rapid or delayed recovery with an overall accuracy of 81%.

Conclusion: The steroid injections should be limited to patients with a short history or without calcium in the supraspinatus tendon.

The deltoid contracture—a comparison of the long-untreated group and adult group

Masaaki Takahashi[1], Kiyohisa Ogawa[1] and Kenrou Matui[2]

[1]Keio University, Tokyo and [2]Saitama Medical School, Saitama, Japan

Introduction: We compared the patients who had developed a deltoid contracture in infancy and been left long-untreated, and those who contracted the disease in adulthood.

Patients and methods: The subjects included eight patients (nine joints) who had developed the disease in infancy but were left untreated up to the time when osseous growth stopped, and nine adult patients (13 joints) who developed the disease after they reached maturity. A comparison was made based on patient history and physical and radiographic findings.

Results: For all patients, the cause of the disease was intramuscular injection. The symptoms noted at physical examination consisted of winging of the scapula, dimples on the skin over the deltoid, and abduction contracture for all patients. In the long-untreated group, skeletal abnormalities such as distorted and drooped acromion and clavicle, flattened humeral head, high-positioned greater tuberosity, and reduced thoracic cage and lateral bending of the spine were noted. No bony deformation was noted in the group affected in adulthood.

Table. Skeletal deformities

	Long-untreated group	Adult group
Acromion	8	0
Clavicle	6	0
Humeral head	7	0
Greater tuberosity	3	0
Thoracic cage	5	0
Spine	6	0

Conclusion: The bony distorsion in the long-untreated group can be explained by the bending and/or compression force caused by muscular contracture exerted upon the immature bones.

Sarcoma localized in the shoulder region—an evaluation of 121 patients

Otto Sneppen, Niels Martin Søe Steinke and Svend Erik Østgaard

Centre for Bone and Soft Tissue Tumors, University Hospital of Aarhus, Denmark

Introduction: The purpose of this study is to evaluate the presenting symptoms, treatment and prognosis in sarcomas of the shoulder girdle.

Material and methods: A total of 121 patients with shoulder sarcomas (80 soft tissue sarcomas, 41 bone sarcomas) seen between 1956 and 1989 were investigated retrospectively. At referral 76 patients had had previous biopsy or non-radical surgery, only 45 were virginal. The great majority of the tumors (108 cases) had an extracompartmental localization. The principal treatment was radical surgery until 1980 and since then chemotherapy and/or preoperative radiation plus surgery were used in selected groups.

Results: The presenting symptoms in bone tumor cases were pain (70%), tender soft tissue mass (25%) and pathological fracture (5%). In soft tissue tumor the presenting symptoms were a firm mass and later in the course slight pain. 118 cases were treated with surgery (35 amputations, 83 excisions). The surgical margin was intralesional in 4%, marginal in 12%, wide without fascial containment in 20% and wide with fascial containment in 63%. The amputations included 17 intrascapular thoracic amputations, the excisions six Tikhoff Linberg procedures. Local recurrence was found in 31%, mean 17 months after surgery. The five year survival was in highly malignant (grade III) bone tumors 34%, and in highly malignant soft tissue tumors 56%.

Discussion: The initial symptoms of sarcomas of the shoulder girdle are often difficult to evaluate, and these tumors are frequently misdiagnosed initially and are often contaminated by intralesional or marginal surgery before referral. This can make limb salvage surgery impossible and may lead to a higher frequency of amputation and also a higher frequency of local recurrence. These tumors should be operated by a team including both a tumor surgeon and a shoulder surgeon.

Reflex sympathetic dystrophy of the shoulder

Toru Ishibashi[1], Motohiko Mikasa[1] and Hiroaki Fukuda[2]

[1]Tokyo Metropolitan Otsuka Hospital 2-8-1 Minamiotsuka Toshima-ku, Tokyo 170 and [2]Tokai University Oiso Hospital 21-1 Gakkyo Oiso-cho Naka-gun 259-01 Kanagawa Prefecture, Japan

Introduction: Reflex sympathetic dystrophy (RSD) is a therapeutic dilemma.

Materials and methods: 21 RSDs developed from ordinary diagnostic categories of shoulder lesions. 12 of these started postoperatively. Surgery was carried out in six cases to remove triggers of pain. Steroids and Prazocin were administered orally.

Results: 13 out of 21 patients returned to the previous social activities while three lost shoulder function and three died in distress. Two are still under treatment.

Mechanoreceptors in the coracoacromial ligament—a study of its morphology and distribution

Y. Morisawa, T. Sadahiro and H. Yamamoto

Department of Orthopaedic Surgery, Kochi Medical School, Nankoku, Japan

The pathology of rotator cuff lesion and impingement syndrome of the shoulder is still controversial. The authors investigated mechanoreceptors in the coracoacromial ligament histologically for the purpose of clarifying the mechanism of shoulder impingement syndrome.

Materials and methods: Ten coracoacromial ligaments were obtained at the time of surgery of four rotator cuff tears, two cases of impingement syndrome, three brachial plexus injuries and one scapular fracture. The ligaments were stained in bulk using a modification of the gold chloride stain used by Gairns. After staining, the ligaments were frozen and sectioned in a sliding microtome at 100 micrometers. The sections were examined under a microscope to clarify morphology and distribution of mechanoreceptors.

Results: The coracoacromial ligament was found to have an extensive neural network. Four types of mechanoreceptors were identified in the ligament. They were Ruffini receptors (Figure 1), Golgi tendon organ-like receptors, Pacinian corpuscles and free nerve endings. Ruffini receptors, Golgi tendon organ-like receptors and Pacinian corpuscles were mostly found in the subacromial undersurface of the attachment to the acromion and at the insertion to the coracoid process. Free nerve endings and neuron fibers were disseminated at the bursal side of the whole ligament.

Discussion: To our knowledge, there have been no reports on mechanoreceptors in the coracoacromial ligament. Mechanoreceptors in the coracoacromial ligament are possibly related to the protection against injurious and/or painful movements and subacromial impingement syndrome.

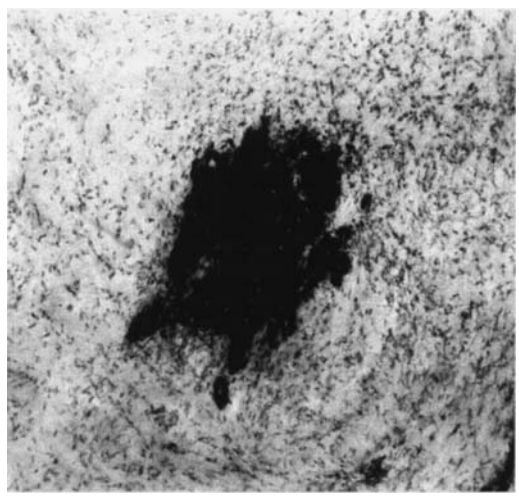


Fig 1. A Ruffini receptor in the coracoacromial ligament (x100)

Sensory nerve endings in the subacromial bursa

Yasuharu Tomita, Jiro Ozaki and Susumu Tamai

Department of Orthopedic Surgery, Nara Medical University, Kashihara, Nara, Japan

Introduction: The subacromial bursa is a common source of shoulder pain and discomfort in prolonged work with the arm lifted. This study was designed to investigate the innervation of the subacromial bursa.

Materials and methods: Biopsy specimens of subacromial bursa were obtained from patients who underwent surgery for various disorders of the shoulder (e.g. rotator cuff tear and recurrent dislocation) and three cadavers without any lesion of the shoulder. The neurohistology of the subacromial bursa was studied by using a modified gold chloride method.

Results: The subacromial bursa was found to have an extensive neural network. In addition to free nerve endings, four morphologically distinct mechanoreceptors were identified. These neural elements were observed mainly in the normal subacromial bursae, while it was difficult to identify the nerve endings in the degenerative subacromial bursae.

Conclusion: The role of the subacromial bursa, preventing the subacromial friction, as a passive synovial structure has now become obsolete. We should reconsider the subacromial bursa as a storehouse of the proprioceptive information for coordination movement and regulating muscle tone.

Sympathetic and sensory innervation of the shoulder joint in the rat and human materials

Niro Yoshida, Shin-ichi Kikuchi and Yasuo Sugiura

Fukushima Medical College, Fukushima, Japan

Abstract: The purpose of this paper is to analyze morphologically the innervation of the shoulder joint, and to identify the origin of the nerves.

First, the origin of the innervations was assessed by injection of the neuronal tracer, wheat germ agglutinin conjugated horseradish peroxidase (WGA-HRP), into the joint cavity of the rat. Second, calcitonin gene-related peptide (CGRP) was studied immunohistochemically using an anti-CGRP antibody in rats and human tissues.

In the sympathetic ganglia, 83% of the labelled cells were found in the stellate ganglion and 17% were found in the superior cervical ganglion. None of them were found in thoracic sympathetic ganglia.

In dorsal root ganglia, 75% of the labelled cells existed in C3 to C5 DRG. In addition, some labelled cells were separately found in the third thoracic DRG.

CGRP immunoreactive fibers were found in the synovial capsule of the rat shoulder and in human subacromial bursa. These fibers were fine and morphologically belonged to the type 4 axons classified by Brodal which are interpreted as sensory nerves concerning pain.

These findings revealed that sensory nerves in the middle cervical cord and sympathetic nerves from the cervical ganglia were distributed in the shoulder joint, and that they were related to symptoms such as pain associated with "frozen shoulder" or other shoulder diseases.

Local pressures in subacromial space at different positions of the humerus

Pekka Jalovaara and Vilho Lantto

Department of Surgery and Laboratory of Microelectronics, University of Oulu, Oulu, Finland

Introduction: The impingement syndrome has been defined as a painful, localized compression of the supraspinatus tendon in the subacromial compartment. The good effect of acromioplasty stresses the importance of the pathology of the anterior part of the acromion in its pathogenesis. Assuming that the impingement is concentrated under the anterior acromion, a zone of elevated pressure should exist between it and the rotator cuff. We have measured the pressures in various subacromial locations at different positions of the humerus in patients with chronic impingement syndrome and compared these with those of patients with acromioclavicular dislocation.

Methods and materials: The measurements were performed under general anaesthesia during 14 acromioplasty operations for impingement syndrome in tendinitis stage (impingement group) and eight open repairs of acute acromioclavicular dislocation (control group). A pressure transducer based on the piezoresistive type sensor operating in a fully active Wheatstone Bridge was used. The sensor was fused to a flexible plastic rod with a thickness of 2 mm.

The pressures were recorded at four different locations of the subacromial space: 1) anterolateral; tip of the acromion as near to the borders as possible, practically 5-7 mm from the lateral and anterior border, 2) anteromedial; 5 mm distal from the acromioclavicular joint and 5-7 mm posterior to the anterior border of the acromion, 3) posterolateral; 25 mm posterior from point 1, and 4) posteromedial; 25 mm posterior to point 2. At every measurement point the recordings were made with the arm abducted 0, 30, 60 and 90 degrees in maximal internal rotation, neutral position and maximal external rotation, resulting in altogether 12 recordings.

Results: In both groups the highest subacromial compression values were found under anterolateral part of the acromion (Fig 1) and they were significantly higher than those of

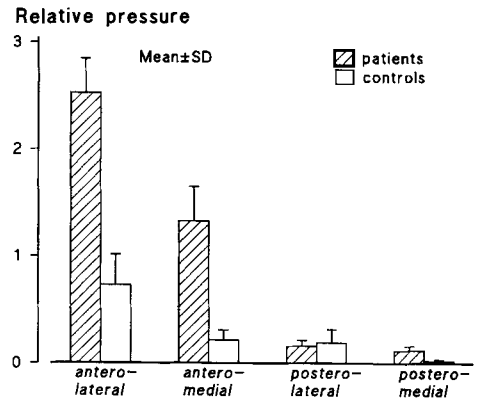


Figure 1. Subacromial pressures at different locations in neutral rotation and 90° abduction of the humerus

anteromedial, posterolateral and posteromedial part in all rotation positions. In the control group the differences were however generally less.

The comparison between the groups showed that the compressions were significantly higher in the impingement group than in the control group (Fig 1) at the anterolateral and anteromedial, but not at the posterolateral and posteromedial measurement points.

In the impingement group the pressures increased during abduction, but no such significant increases were observed in the control group.

The rotational position of the humerus proved to have only minor effect. In both groups the compression during external rotation was slightly higher than those of neutral position and internal rotation.

Conclusions: The concentration of the subacromial pressure under the anterolateral tip of the acromion may play a role in the pathogenesis of impingement syndrome and explain the good effect of acromioplasty in this disease.

The zone of elevated pressure of the subacromial space in the tendinitis stage of impingement syndrome

Pekka Jalovaara and Vilho Lantto

Department of Surgery and Laboratory of Microelectronics, University of Oulu, Oulu, Finland

Introduction: The importance of the pathology of the anterior part of the acromion in impingement syndrome of the shoulder is stressed by the fact that excision of the anterior undersurface of the acromion in acromioplasty leads to pain relief in the majority of patients. Consequently it can be assumed that there is a zone of increased pressure under the anterior part of the subacromial space. Therefore the pressures between the acromion and rotator cuff in different locations of the subacromial space were measured.

Material and methods: The measurements were performed during acromioplasty operations for impingement syndrome in tendinitis stage in 15 patients, mean age 43 (26–53) years; 9 male and 6 female. The recordings were made with a pressure transducer based on the piezoresistive type sensor operating in a fully active Wheatstone bridge. The sensor was fused to a flexible plastic rod with a thickness of 2 mm. During the measurements the arm was in a neutral position and the shoulder abducted 30 degrees. To begin with, the transducer was introduced into the posterior part of the subacromial space to a depth of 30 mm from the anterior border of the lateral tip of the acromion. Then the sensor was pulled out initially at 5 and then at 2 mm increments and pressure recordings registered. The procedure was repeated at the middle and proximal part of the subacromial space.

Results: The increased pressure zone started at 18–14 mm distance from the anterior acromial margin. The relative pressures were highest at 10 to 8 mm distance from the anterior margin of the acromion in every measurement area and there they were 15-30-fold higher than those 30 to 25 mm from the anterior acromial margin. The recordings of the middle part of the subacromial space were slightly higher than those of the lateral and proximal part.

Conclusion: It is concluded that there is an increased pressure zone in the anterior part of the subacromial space, which may interfere with the pathogenesis of the impingement syndrome. We recommend that at least a 18-mm-long piece of bone from the anterior undersurface of the acromion should be removed during the acromioplasty.

The stability of an experimental modular shoulder prosthesis

J. O. Søjbjerg, L. H. Frich, P. Suder, P. Helmig, S. Østgaard and P. Kjærsgaard-Andersen

Biomechanics Laboratory, University Hospital of Aarhus, Denmark

The aim of the present study was to compare the different mobility patterns in normal shoulder specimens and specimens fitted with a total shoulder arthroplasty, designed as a modular system, thereby comparing the effect of different head sizes.

In each shoulder specimen, the normal mobility pattern, concerning internal- and external rotation, antero-posterior translation and supero-inferior translation was measured in an unloaded set-up. The specimens were fitted with a cemented glenoid and a humeral head, and the test sequence was repeated. All humeral head sizes were tested in exactly the same degree of retroversion.

The results of the experiments showed that inferior and anterior translations were significantly increased after application of the smaller head sizes. The inferior translation was significantly reduced with increased humeral head sizes, and in some cases testing with an extra large prosthesis showed an increased superior migration.

The present experimental study shows the importance of a proper selection of humeral head size to stabilize the shoulder after arthroplasty. Furthermore, the movement patterns after TSR are significantly different from the movement patterns in the normal shoulder joint.

Eden-Hybinette procedure—long-term results

M. Vastamäki, I. Antti-Poika, T. Viljakka and M. Landtman

Orthopedic Hospital of the Invalid Foundation, SF-00280, Helsinki, Finland

A number of operative procedures have been tried in the treatment of recurrent anterior dislocation of the shoulder. In Finland the Eden-Hybinette method with or without modifications has been the one most often used. Since 1943 this method has been employed in the treatment of recurrent anterior dislocation of the shoulder at the Orthopaedic Hospital of the Invalid Foundation in Helsinki. The material presented here concerns patients treated during the period from 1943 to 1979 (196 patients).

We evaluated 100 patients (70 men and 30 women). The mean age of the patients at surgery was 31 (15-60) years. The mean follow-up time was 22 (11-46) years. The interval from the first dislocation to surgery averaged 7 (0.5-28) years.

Recurrence of the dislocation after the Eden-Hybinette procedure occurred in 11 shoulders. Four of them were reoperated. 13 patients had marked pain in the operated shoulder and in 15 patients' opinion the operated shoulder was considerably inferior to that of the contralateral one. However, the functional capacity was normal or almost normal in 93 cases. There was a restriction of the external rotation of 16° (57° vs 73°), but range of motion in flexion and abduction was unaffected, as well as the strength of the shoulder. Subjectively, 70 patients considered the result as excellent or good, 23 as fair and seven patients as poor.

Before surgery, slight glenohumeral arthrosis existed in only four shoulders. At follow-up, arthrotic changes were observed in 56 shoulders. However, the arthrotic changes were slight in the majority and there were only four severe arthrotic changes. On the other hand, in the contralateral glenohumeral joints, only seven showed arthrotic changes. This difference was highly significant.

We were not able to find any correlation between postoperative glenohumeral arthrosis and any variables except arthrotic changes in the acromiclavicular joint. Thus, neither of the number of dislocations, the time relapse after the first dislocation to the operation, and the size or position of the bone graft correlated with the existence of arthrotic changes.

The Eden-Hybinette procedure gives acceptable long-term results in recurrent anterior dislocations of the shoulder. However, arthrotic changes often develop in the glenohumeral joint. Today we prefer the Bankart procedure.

The role of bone graft in Oudard-Sowinski's operation—CT and sonography investigations

Jaroslaw Fabis and Henryk Zwierzchowski

Orthopedic Clinic of Medical Academy of Lódz, Poland

This paper attempts to explain the role of the bone graft in anterior recurrent shoulder dislocation on the basis of postoperative CT and sonographic examination performed on seven patients on whom Oudard-Sowinski's procedure was applied (3, 5). The average follow-up time was 5.5 years. As it was shown, the bone graft, despite its partial resorption, deepens the natural glenoid at the front and creates a mechanical bar for the humeral head. Moreover, it enhances both tone of subscapularis muscle which was emphasized by Yamamoto (6) and tension of joint capsule, the detachment of which is a common finding in anterior recurrent shoulder dislocation (2, 4) thanks to the compression to the anterior glenoid rim. Sonographic examination performed according to Hedtmann and Fett's technique (1) disclosed small adhesions between the bone graft and the subscapularis tendon which were not of importance for anterior shoulder stability.

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