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CHAPTER 18

Alternatives to Replacement Arthroplasty for Glenohumeral Arthritis

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INTRODUCTION

Although a century has passed since the French surgeon Pean performed the first prosthetic shoulder arthroplasty,[54] shoulder implants with predictable results have become available only in the past 20 years. Consequently, many other surgical procedures and nonsurgical interventions have been developed—and many still have a role today—for the treatment of patients with symptomatic glenohumeral arthritis. In most cases prosthetic arthroplasty is the optimal surgical option for patients with moderate to severe disease; however, in a small percentage of these cases, glenohumeral arthrodesis or resection arthroplasty are appropriate surgical alternatives. Arthroscopic debridement and capsular release are viable options in some patients with pain or stiffness associated with mild arthritis. On the horizon are techniques for transplanting autologous osteochondral tissue or genetically engineered cartilage. However, it is only after the failure of nonsurgical treatment that surgical interventions should be considered. Furthermore, there may be patients for whom surgery is contraindicated, even though they may have substantial shoulder pain (e.g., patients who have excessive risk of perioperative mortality or who are too young or active to consider replacement). For these patients, it is imperative that the practitioner fully explore alternatives to arthroplastic interventions. Specific alternatives to replacement arthroplasty discussed include physical therapy and other nonoperative interventions, arthroscopic debridement, capsule release, synovectomy, periarticular osteotomy, corrective osteotomy, resection arthroplasty, interpositional arthroplasty, and shoulder arthrodesis (see Treatment Algorithms I and II).

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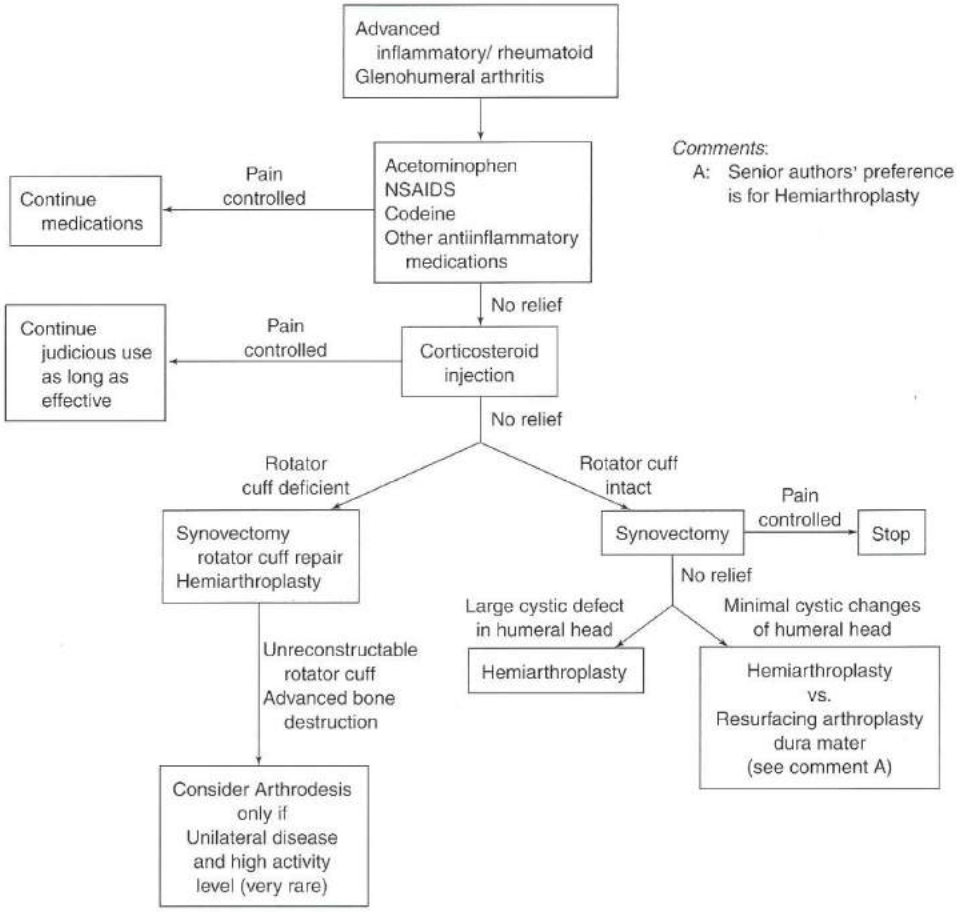


I. Algorithm for treatment of inflammatory arthritides.

Noninflammatory and Inflammatory Arthritides of the Shoulder

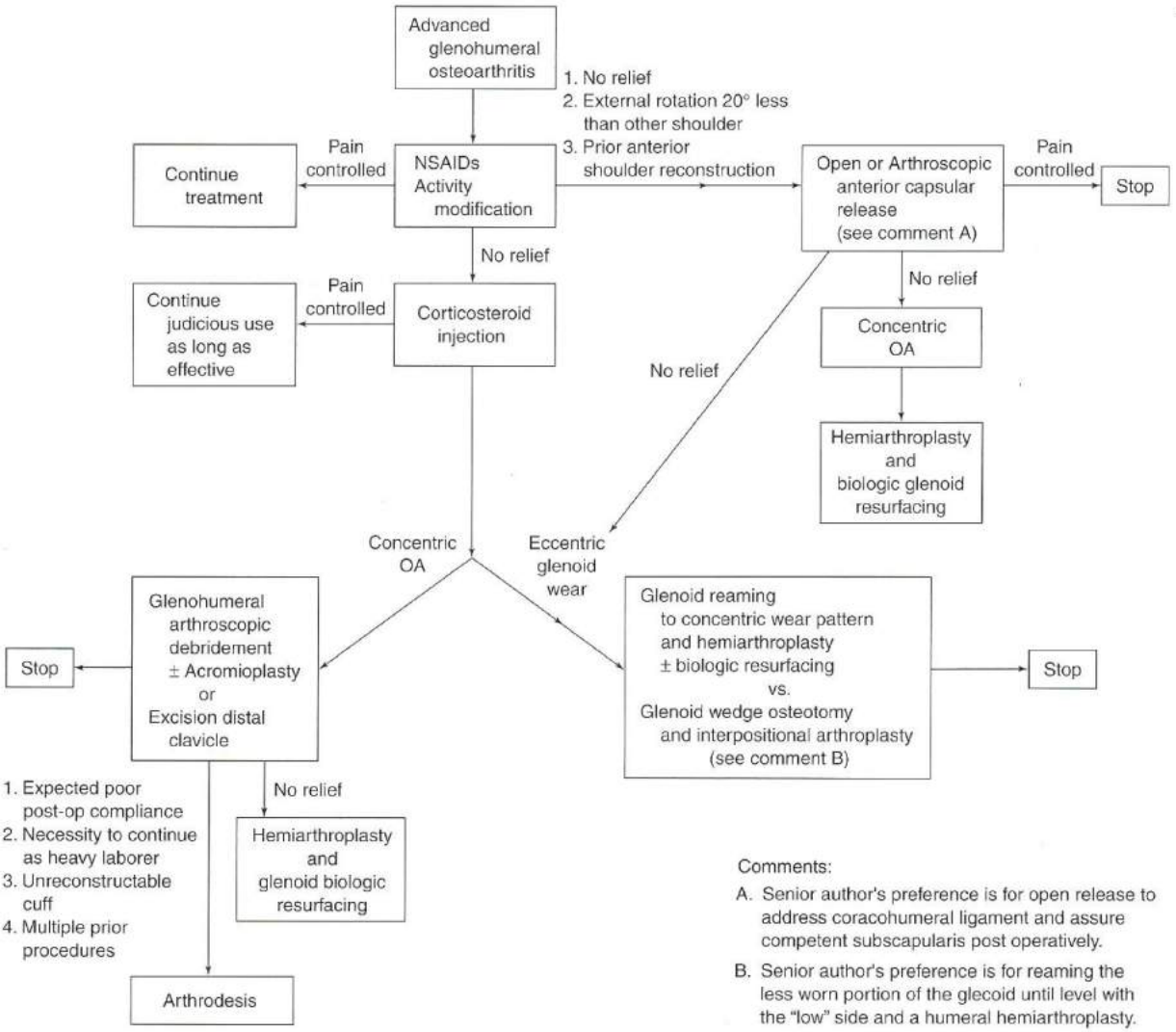
Distinguishing osteoarthritis from rheumatoid arthritis and other inflammatory arthritides is important because the following interventions that are discussed may not be similarly effective in treating shoulders with these disorders.

Osteoarthritis

The relative importance of factors that control the development of symptoms in osteoarthritis (OA) is still disputed.[24,25] Although roentgenographic features seen in this disease primarily result from the loss of articular cartilage and changes in the adjacent bone,[96] this disease process affects all periarticular tissues.[12,53,86] To some extent this may explain the poor correlation between clinical symptoms and roentgenographic changes in various arthritic joints in some patients.[14,53] Many patients with this disease have mechanical, inflammatory, and psychologic components to their pain.[22] The shoulder joint is an uncommon site of primary OA, except in elderly women.[20] However, in relatively young individuals, OA of the shoulder may be seen as a consequence of trauma.[84] Specifics of the pathoanatomy of this diagnosis have been detailed by Neer.[64]

Rheumatoid Arthritis and Other Inflammatory Arthritides

Glenohumeral joint involvement is common in patients with rheumatoid arthritis (RA), and is usually part of a polyarthropathy. Laine and associates of Finland defined the spectrum of shoulder disease in 277 hospitalized patients with RA.[47] Glenohumeral arthritis was detected in 47% of patients and many of these also had symptoms arising from the coracoacromial arch. Of note, 16 (6%) patients, with a mean age of 31 years, had shoulder arthralgia without demonstrable roentgenographic changes. Petersson reported on a series of 105 patients with RA, 91% of whom reported shoulder problems.[73] Thirty-one percent of these patients had such severe shoulder disability that they considered it to be their main problem.



II. Algorithm for treatment of glenohumeral osteoarthritis.

Patients with symptomatic RA of the shoulder are typically women who are between 35 to 55 years of age and are rheumatoid factor positive. The destructive process may be quite advanced before significant symptoms are noted.[18] In addition to loss of motion, two common complaints in patients with RA are fatigue and muscle weakness. Rotator cuff defects occur in approximately 25% of these patients.[30,88] According to Pollock and associates[76] the treatment of choice in rotator cuff deficiency in moderately to severely painful rheumatoid shoulders is humeral hemiarthroplasty with cuff repair. We also recommend repair of symptomatic cuff defects when glenohumeral arthritis is minor; this facilitates future reconstructive procedures. In many respects, surgical management of rotator cuff tear arthropathy is similar to that of cuff-deficient rheumatoid shoulders.[76] Synovectomy of the rheumatoid shoulder joint, which can be effective in treating some patients with effusive disease, will be discussed later in this chapter.

Many symptomatic patients with early stages of arthritis, regardless of etiology, will benefit from noninvasive forms of therapy.

NONOPERATIVE TREATMENT

Education

An explanation of the arthritic process and its probable future implications is an important first step in treating all pa-

joints afflicted with RA, they are generally of comparatively limited value in OA, typically providing relatively short-term relief of symptoms.

Dacre et al.[21] studied the results of local steroid injections or physiotherapy in treating patients with painful or stiff rheumatoid shoulders. The study design was prospective, randomized, and observer-blinded. Sixty consecutive patients of similar age, sex, diagnosis, and disease severity were allocated into three groups to receive either local steroids, 6 weeks of physiotherapy, or both. Assessments of pain and shoulder movement were made initially, at 6 weeks and at 6 months. Results showed that physiotherapy alone was just as effective as local steroid injections or a combination of these 2 methods. In the uncomplicated case, a local steroid injection was the most cost-effective treatment.

Oral analgesics, such as salicylates, acetaminophen, and codeine, can be very effective in treating arthritic pain. The role of nonsteroidal antiinflammatory drugs (NSAIDs) in treating patients with symptomatic inflammatory arthropathies is well established.[44] However, for use in OA it is controversial whether NSAIDs are any better than simple analgesia.[24] NSAIDs may have deleterious effects on articular cartilage in addition to the risk of untoward effects on gastric, renal, and liver function, which are particular problems in elderly patients.[24,44] Nevertheless, in a randomized trial examining pain relief in patients with OA of the knee treated with NSAIDs versus simple analgesics, NSAIDs were clearly superior in providing better quality of life and pain relief at the time of true inflammation.[71]

Chronic Pain Management

Management of patients with intractable shoulder pain, without mechanical cause, can be difficult. They may be best treated initially with a trial of interventions managed by a team of specialists trained in treating chronic pain. These specialists can manage depression, manipulate medication intake, inject trigger points, perform nerve blocks, and administer other modalities. A neurologic workup is also often necessary to rule out cervical radiculopathy, brachial plexopathy, reflex sympathetic dystrophy, or other disorders.

OPERATIVE TREATMENT

Arthroscopic Debridement

Arthroscopic debridement or lavage for arthritis has been successfully used in the weight-bearing joints of the lower limb, particularly the knee.[38,70] In many cases, this may be the result of a strong placebo effect.[63] In contrast to the knee, the benefits of, and indications for, arthroscopic debridement in the shoulder are not as clear, although most orthopedic surgeons know of anecdotal evidence suggesting that this can benefit some patients. In some cases, arthroscopy will reveal previously unrecognized grade 2 to 4 osteochondral lesions.[37] Cofield reported[16] that in 8 patients with glenohumeral arthritis the use of arthroscopy confirmed or modified the diagnosis, or altered the course of treatment, in all cases. Ellman et al. reported[28] on 18 patients who underwent shoulder arthroscopy for impingement syndrome and, at surgery, were found to have coexisting glenohumeral degenerative joint disease, which was not apparent during preoperative, clinical, and roentgenographic evaluation.

Generally, results of arthroscopic debridement for OA of the shoulder depend on the extent of degenerative changes.[40,66–68] Ogilvie-Harris and Wiley[66] reviewed 54 patients with OA of the shoulder who were followed for 3 years. When degenerative changes were mild, successful outcome occurred in two-thirds of cases; and when changes were severe, successful outcome occurred in only one-third of cases. An additional group of patients who did well were those who had debridements of degenerative labral tears. There are also several reported cases in whom synovial chondromatosis of the shoulder, associated with arthritic changes, has been adequately treated by arthroscopic debridement.[19,81,103]

Anecdotal experience suggests that if exposed bone is present, then abrasion arthroplasty may be of value.[40] However, this is unproved. It is unlikely that debridement without capsule release or manipulation will result in a significant increase in motion.[99] Debridement can also be used to treat some cases of aseptic necrosis of the humeral head, for which small early lesions can be debrided with removal of any coexisting loose bodies.[33,40,41]

In another study, a group of 27 patients, with a primary diagnosis of degenerative joint disease of the glenohumeral joint, underwent arthroscopic debridement.[98] Average follow-up was 30 months (range 9 to 63), and their average age was 42 years (range 27 to 72). These patients presented with moderate to severe pain and had failed conservative treatment. The average time from onset of symptoms to surgical treatment was 24 months (range 3 to 60). Arthroscopic treatment included simple joint lavage, loose body removal, debridement of degenerative cartilage, debridement of labral or soft tissue, and subacromial space bursectomy. Although there were no significant changes in range of motion, a significant improvement in pain relief and function was obtained. Overall, there were 78% satisfactory results (excellent and good) and 22% unsatisfactory (fair and poor). There were no surgical complications. Sixty-seven percent of the patients involved in recreational sports (unspecified) were able to return to their previous activities. Of the unsatisfactory results, some pain relief was obtained in all patients for a minimum of 8 months before deterioration. Additional surgical treatment had been recommended for 11% of the patients. These authors concluded that in patients with mild glenohumeral osteoarthritis, with concentricity maintained, arthroscopic debridement is a useful procedure.

In contrast, Norris and Green[65] were less enthusiastic about the usefulness of arthroscopic debridement in the

glenohumeral joint. In their series of patients only a small percentage obtained any long-lasting pain relief. They concluded that arthroscopic debridement did not alter the natural history of glenohumeral arthritis. It is possible that the addition of a subacromial bursectomy in the patients of Weinstein et al.[99] may have been responsible for some of the difference in these 2 studies.

The efficacy of subacromial decompression in providing pain relief in the face of established glenohumeral arthritis has been demonstrated in two recent studies. Simpson and Kelley[85] performed an acromioplasty and bursectomy in 24 patients with rheumatoid arthritis with radiographic evidence of advanced glenohumeral disease. They were able to achieve good pain relief and improved range of motion in 19 of these patients. Ellowitz et al.[29] also evaluated the results of subacromial decompression in a group of 21 patients who were noted to have Outerbride grade IV osteoarthritic changes in the glenohumeral joint on preliminary arthroscopic evaluation. They reported uniformly good results and concluded that subacromial decompression provided adequate pain relief in this group of patients. Given the foregoing information, the value of isolated glenohumeral arthroscopic debridement for the treatment of degenerative arthritis remains to be proved, but it may be an effective temporizing procedure in a select group of patients. In our current practice, we seldom recommend arthroscopic glenohumeral debridement as an isolated procedure.

Capsule Release

In 1990, Hawkins and Angelo[32] recognized OA in ten patients (11 shoulders) who had had Putti-Platt capsulorrhaphies for anterior shoulder instability. They hypothesized that this resulted from excessive stress imparted to the cartilage during the abnormal glenohumeral motion caused by the excessively tight anterior capsule imbrication. In seven shoulders the complication was treated successfully with periodic administration of NSAIDs, supplemented by gentle range of motion exercises and occasional mild analgesic medications. The remaining four shoulders were treated operatively; two of these received nonconstrained total shoulder replacements. All four of these shoulders received anterior capsule releases for improving motion and decreasing abnormal forces on the glenohumeral joint. Hawkins and Angelo expected that this procedure would improve pain and retard the degenerative process in the two cases where it was done without resurfacing arthroplasty. With this rationale, we suggest that in similar cases in whom mild to moderate OA is associated with limited motion, especially external rotation, capsular release should be considered.

Ogilvie-Harris and Wiley[66] reported that in 54 patients with OA of the shoulder who were treated with arthroscopic debridement, 14 had an associated frozen shoulder. In these cases severely restricted motion was restored either by cutting or removing adhesions, or by manipulation. In general, if there was more than 20 degrees loss of passive motion, compared with the opposite shoulder, then an arthroscopic capsular release was performed.

Surgical and Medical Synovectomy

Beneficial effects of synovectomy in the treatment of inflammatory arthropathies of some joints are well established.[18,46,100,101] The knee has historically been considered one of the most appropriate joints for this procedure, and open synovectomy was the means by which this was accomplished.[46,70,90] An early reported case of synovectomy in the shoulder was in 1965 when Wilkinson and Lowry reported on a series of 69 synovectomies, 1 of which was in a shoulder, and was done without the arthroscope.[100]

In proliferative synovitis of the shoulder, surgical synovectomy gives good pain relief and increased mobility and function.[69] Open synovectomy of the shoulder is no longer considered absolutely necessary unless carried out in conjunction with debridement of cystic bone lesions,[91] extensive disease,[73] rotator cuff repair,[66] or osteotomy (see later discussion); otherwise arthroscopic synovectomy is adequate.[13]

Synovectomy done early in the inflammatory disease process will slow its progression; however, the procedure may need to be repeated several times, but it is associated with low morbidity. Although abnormal synovium may regrow after synovectomy for rheumatoid arthritis,[72] patients typically enjoy a relatively pain-free period with improved function.

In an attempt to better evaluate the results of open surgical synovectomy in late stages of rheumatoid disease, Tressel et al.[95] reviewed 75 cases in 53 patients with average follow-up of 6 years. Only 4% of shoulders had early-stage disease. Swelling and motion improved in approximately 70% and pain was diminished in approximately 50%, irrespective of the site and degree of joint destruction (Fig. 1; Table 1). Overall, 75% of patients were satisfied with their results. The best outcomes were obtained when the shoulder joint alone was involved and the poorest outcome occurred with more extensive soft tissue involvement (e.g., adjacent bursa and rotator cuff).

TABLE 1. *Results of open synovectomy in late-stage rheumatoid disease*

Direction of motion	Stages I and II ($n=20$)	Stage III ($n=44$)	Stage IV ($n=11$)
Flexion beyond 90°	85%	66%	45%
Abduction beyond 90°	70%	52%	66%
Internal rotation beyond 20°	75%	66%	80%

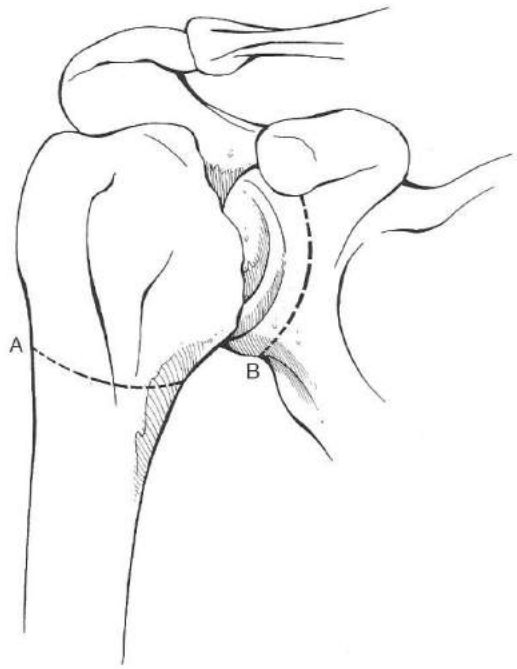


FIG. 1. Schematic representation of the Benjamin double osteotomy. **(A)** Humeral osteotomy. **(B)** Glenoid osteotomy. (Reproduced with permission from: Jaffe R, Learmonth ID. Benjamin double osteotomy for arthritis of the gleno-humeral joint. In: Lettin AFW, Petersson C, eds. *Rheumatoid Arthritis Surgery of the Shoulder.* Rheumatology. Basel: Karger. 1989;12:52–59.)

In the early effusive stages of inflammatory shoulder disease or in OA with synovitis, synovectomy can also be accomplished medically by the use of sclerosing agents or radiocolloids such as yttrium 90.[59,89] Yet these methods have an overall success rate of only about 50% and, similar to surgical synovectomy, often require multiple treatments. Radiocolloid synovectomy should be considered in patients who are not medically stable for arthroscopic shoulder synovectomy. In a study using yttrium 90 on various joints, Stucki et al.[89] reported poor results in the shoulder and suggested that this may be due to established pathologic involvement of the all-important rotator cuff, which would not be influenced by synovectomy.

Periarticular Osteotomy

Although uncommonly performed in the United States, periarticular osteotomy is a well-established treatment for symptomatic degenerative joint disease associated with biomechanically abnormal articulations. In addition to abnormal transarticular force transmission, subchondral venous hypertension may be one of the causal factors in the symptoms associated with OA in these patients.[10] This hypothesis resulted in the development of osteotomies for decreasing venous pressure in joints afflicted with OA. Other suggested benefits of such osteotomies may be the enhancement of local perfusion that, presumably, accompanies healing of the osteotomy.

On the basis of these principles and noted benefit in arthritic knees, Benjamin described a double osteotomy for the arthritic shoulder.[6] An anterior approach is used, and the subscapularis is incised medial to its insertion, exposing the neck of the glenoid. The glenoid is osteotomized 5 to 10 mm medial to the articular surface. The posterior cortex is not cut, but it is manually cracked so that the posterior periosteum maintains position and stability. Transverse osteotomy of the humeral neck is then performed just distal to the capsule, again the posterior cortex is cracked to preserve the posterior periosteal hinge (Fig. 1). The osteotomies are not fixed. Passive shoulder movements are started within a week. Although the suggested benefit of reducing venous pressure is supported by data showing venous hypertension near osteoarthritic joints, the double osteotomy is more commonly used in the treatment of RA, despite the lack of similar data.

In Benjamin's series of 16 patients, the procedure was performed for OA in 4 cases, adult RA in 10 cases, and adult or juvenile RA in 2 cases.[7] Average patient age was 51 years; average time to evaluation was 2 years and 11 months. All of these patients reported substantial pain relief and had an average of 50 degrees increase (range 10 to 150 degrees) in active abduction. The increased motion was from both scapulothoracic and glenohumeral joints. When using this double osteotomy for arthritic shoulders, Jaffe and Learmonth[39] reported similar improvement in pain and active motion in 32 shoulders of 28 patients followed up for 8 to 72 months (mean 35 months). Twenty-seven patients had rheumatoid arthritis, 4 had degenerative arthritis, and 1 had avascular necrosis. Tillmann and Braatz, however, achieved less improvement in their series of 24 surgeries carried out entirely for RA.[92,94] This discrepancy may be the consequence of the mixed diagnoses or the lower mean age (about 9 years) of patients in the study of Jaffe and Learmonth.[39] With this procedure, long-term maintenance of pain relief and motion has been less than ideal.[61,94] Most authors suggest that this procedure should be reserved for relatively young patients with severe RA, and for patients with limited functional goals, poor rehabilitative capacity, or poor compliance. In contrast, interpositional arthroplasty (see later discussion) is recommended for patients with good bone stock, an intact rotator cuff, and an ability to comply with the postoperative regimen.[94]

In general, periarticular osteotomy is not commonly performed and has not been reported by other surgeons in peer-reviewed publications. This is probably because endoprosthetic replacement provides more consistent pain relief and improvement in motion, and has a low reoperation rate.[18]

Corrective Osteotomies for Dysplasia and Acquired Deformities

Humeral osteotomy has been described for correcting rotational deficits and abnormal shoulder biomechanics associated with malunited fractures and glenohumeral instability. In theory, this procedure abates the early development of degenerative joint disease in the these conditions. External derotation osteotomy of the humerus is also effective in relieving pain in selective cases of shoulder rheumatoid arthritis associated with internal rotation contractures.[1]

It has been suggested that posterior glenohumeral instability may, occasionally, result from increased retroversion of the glenoid.[9,26,36] However, there is no documented evidence clearly showing that this leads to the development of degenerative disease of the glenohumeral joint. Radiographic projection-effect error may also errantly demonstrate significant (more than −7 degrees) glenoid retroversion. In some symptomatic individuals with significant retroversion or fixed subluxation, and early eccentric glenohumeral arthritis, osteotomy of the scapular neck may be an

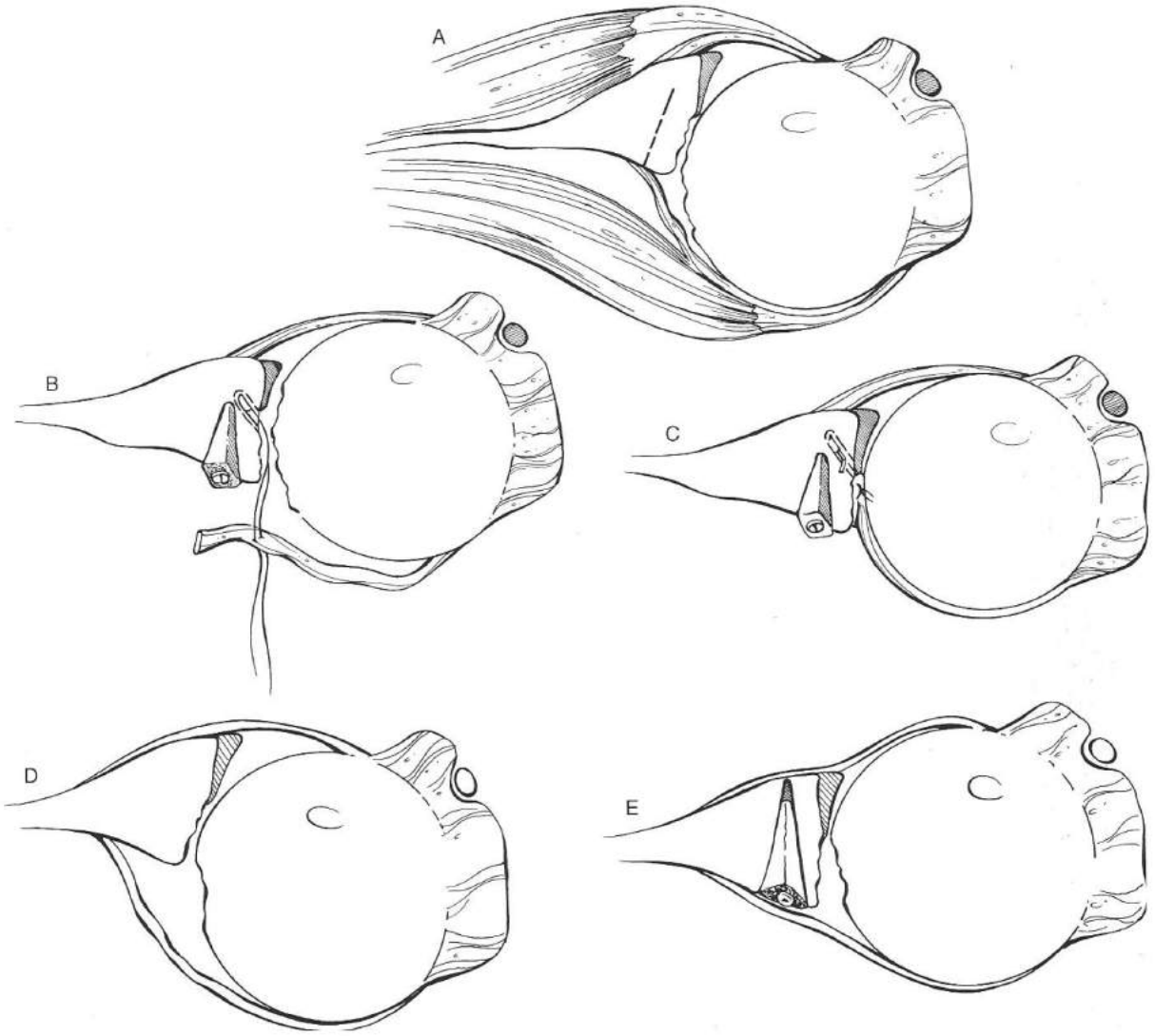


FIG. 2. Interposition arthroplasty with wedge osteotomy for eccentric glenohumeral wear. **(A)** Posterior subluxation: The *dotted line* demonstrates depth and direction of osteotomy; **(B)** proper position of iliac crest wedge graft and placement of suture anchor in glenoid; **(C)** final construct with interposed posterior capsule in area of eccentric wear; **(D)** symmetrical posterior eccentric wear with posterior subluxation of the humeral head and "relative" redundancy of the posterior capsule. **(E)** The osteotomy is carried out to the anterior cortex, and the anterior periostomy capsule sleeve is kept intact to improve stability of the glenoid fossa. The wedge is opened and bone is grafted with an opening posterior wedge. The capsule is tightened and the head is recentered. (From ref. 37, with permission.)

effective treatment by correcting the abnormal biomechanics of the joint (Fig. 2).[37] Complications of these osteotomies include infection, nonunion, and arthritis secondary to glenoid penetration by metal hardware.

Destructive osteoarthritic changes in the glenohumeral joint have rarely been described in patients who have glenoid hypoplasia.[75,77] Although glenoid hypoplasia is very uncommon, progressive degenerative joint disease, which can be quite symptomatic, develops in a small percentage of patients.[102] Nearly all patients can be managed with a specific rehabilitation program for the shoulder.[102]

Resection Arthroplasty

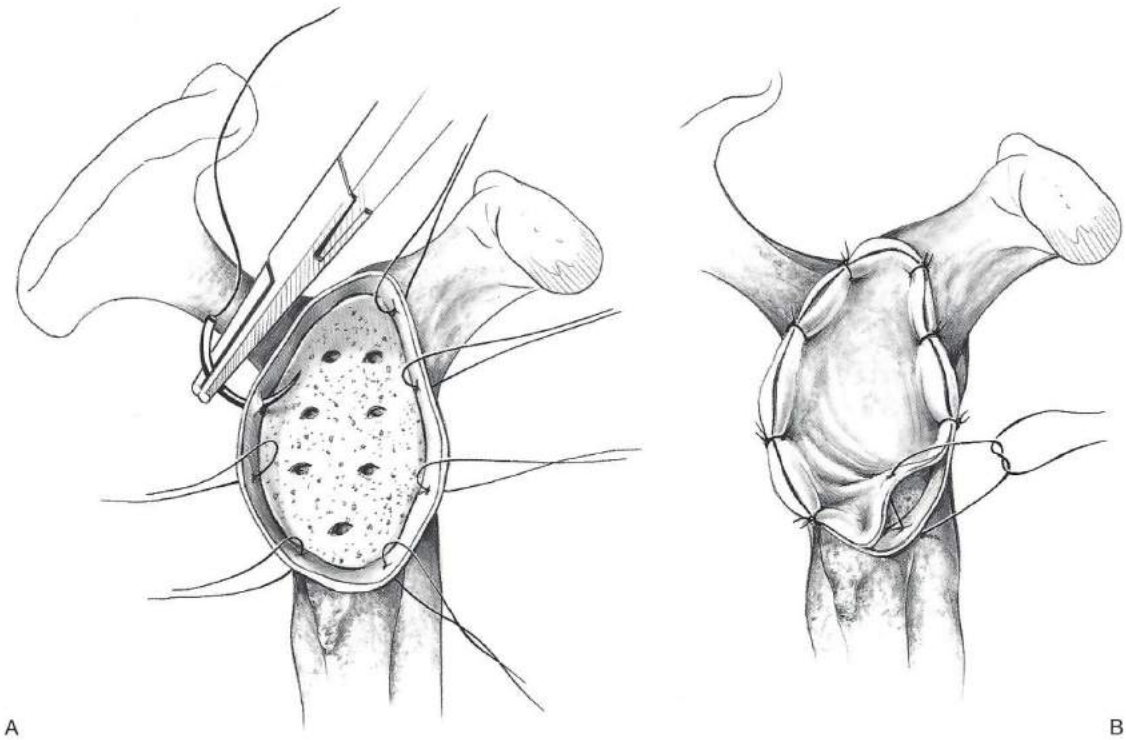
The reluctance of most surgeons to undertake shoulder arthroplasty for glenohumeral arthritis in younger high-demand patients resulted in the development of techniques for resecting, debriding, or reshaping the articular surfaces of the glenohumeral joint. Resection of the humeral head has been advocated in the past as a treatment for severe fracture or sepsis; but only occasionally for degenerative or inflammatory arthropathies.[18] After humeral head resection, chondroid tissue forms between the remaining humeral head and the glenoid. The pseudarthrosis formed is important in achieving a good functional result.

Rather than resecting the humeral head, some authors have reduced its diameter.[92] If stability is a concern, then adjustments in the version of the newly fashioned head can also be made. For example, in situations of rotator cuff deficiency, increasing retroversion by some 10 degrees can reduce the chance of dislocation. However, the results of this procedure have not been reported in peer-reviewed publications by these or other surgeons.

Glenoidectomy has also been advocated for treatment of the painful arthritic shoulder.[31,97] Gariepy described resecting 7 to 8 mm of the glenoid surface, leaving a new flat surface. More recently, this has been carried out, albeit with more limited bone resection, in conjunction with a humeral hemiarthroplasty and biologic interpositional arthroplasty over the glenoid fossa (Fig. 3).[11] Glenoidectomy is probably performed relatively infrequently because of both the limited indications for its use and the greater predictability of prosthetic replacement.

Interpositional Arthroplasty

The use of biologic tissue to form an interpositional arthroplasty has been successful in treating some patients with arthritic joints. In the shoulder this technique was first



A B

FIG. 3. (A) Preparation of the glenoid, showing marginal suture placement and central drill holes to enhance incorporation of the graft. **(B)** Final glenoid construct demonstrating graft material sutured to the glenoid surface. A suture anchor placed in the central glenoid helps to firmly appose the graft. (From ref. 11, with permission.)

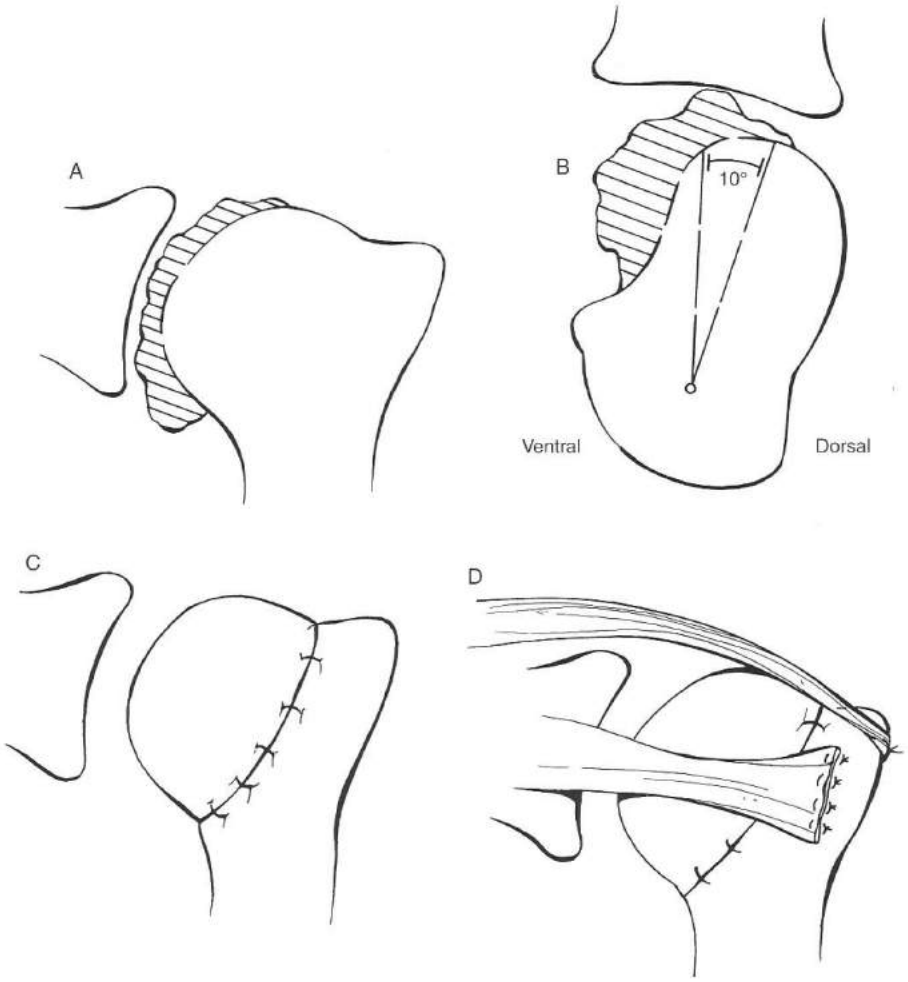


FIG. 4. Interpositional arthroplasty of the shoulder: **(A)** bony deformity of the humeral head seen in anteroposterior view; **(B)** axillary lateral view; **(C)** newly shaped humeral head covered by lyophylized dura mater; **(D)** refixation of the rotator cuff tendons. (From ref. 93, with permission.)

described in 1918 by Baer who used a pig's bladder.[4] Tillmann and associates[93,94] described an interpositional arthroplasty using lyophilized dura mater to cover the surfaces of the glenohumeral articulation (Fig. 4). A transacromial approach is used to expose the glenohumeral joint. The anterior two-thirds of the rotator cuff, including the cranial half of the infraspinatus insertion, is dissected off the bone. After a complete synovectomy, the humeral head is reshaped to a smaller radius of curvature that facilitates reconstruction of the usually deficient rotator cuff; retroversion is also increased by 10 degrees to reduce the chance of dislocation. Lyophylized dura mater is then sutured around the circumference of the reshaped head. The rotator cuff is then reattached under appropriate tension. A 4- to 10-year follow-up in 29 patients showed good pain relief and approximately an average of 80-degree–increased range of movement in combined flexion and abduction. During the course of follow-up there was no deterioration in either pain relief or range of motion.

Miehlke and Thabe[60] evaluated the results of interpositional arthroplasty performed on 32 shoulders and evaluated at an average of 20-months follow-up. The diagnosis was rheumatoid arthritis in 29 of the 32 cases. Twenty-seven shoulders had mild or no pain, 3 had moderate pain, and 2 had severe pain. Range of motion improved in all cases. In 23 of the 32 cases, a rotator cuff tear was present and subsequently repaired. Complications included 3 cases of dislocation of the lateral part of the acromion. (The acromion was osteotomized in the surgical approach.) One case was revised, and the other remained asymptomatic and was not treated. The third case had an associated rotator cuff tear in addition to acromial dislocation; ultimately arthrodesis was performed for biomechanical instability resulting from severe muscular deficit.

Milbrink and Wigren[61] have described a modification of the procedure of Tillman and Braatz[92] in which the glenoid and humeral head of rheumatoid shoulders are covered with a biologic membrane. If necessary, the surface of the glenoid may be smoothed. A sheet of lyophylized dura mater is folded and sutured at the fold to the posterior wall of the glenohumeral joint capsule. The remaining portions of the graft are then sutured, one to the rim of the glenoid and the other over the humeral head. Results reported in ten patients with late-stage shoulder RA at 6 months to 1 year follow-up showed very good pain relief and improvement in range of motion. There was also significant improvement in strength by the end of the first postoperative year. But it is important to emphasize that the follow-up in this study averaged only approximately 6 months.

The main indication for modern techniques of shoulder interpositional arthroplasty is in the rheumatoid patient who has late-stage disease and a well-preserved rotator cuff, and who is capable of complying with postoperative rehabilitation. Contraindications include the presence of large cysts in the humeral head or major defects in the rotator cuff.

Shoulder Arthrodesis

Although advances in the development of shoulder prosthetic arthroplasty have greatly reduced the indications and frequency of shoulder arthrodesis as a primary procedure, arthrodesis remains an excellent salvage procedure in a small percentage of patients with glenohumeral arthritis.[5,78,80,82] Indications for glenohumeral arthrodesis include recurrent or indolent infection, severe soft-tissue deficiency including massive rotator cuff tear and coracoacromial deficiencies, poor function of the deltoid, brachial plexus palsy, or persistent symptomatic instability. It is also a viable option in multiply operated on patients. Patients with both neurogenic pain (e.g., owing to brachial plexus injury) and glenohumeral pain (caused by arthritis) will not have relief of neurogenic pain with a shoulder arthrodesis. However, if function is improved, then the neurogenic pain is generally better tolerated by the patient.[79,80]

In times past, shoulder arthrodesis, coupled with spica immobilization, did not predictably produce solid fusion and was not tolerated well by individuals at risk for surgical complications.[2,15,17,18] However, with the use of internal fixation, autogenic and allogenic bone graft material, and aggressive medical management, glenohumeral fusion is more predictable in these patients.[2] The procedure is contraindicated for a patient who cannot cooperate with the program of rehabilitation.[80] Sufficient motion of the scapulothoracic muscles and strength of the trapezius and serratus anterior muscles are important for good function of the arthrodesed shoulder.[58,79]

In a review of a series of 71 shoulder arthrodeses performed for a variety of conditions, Cofield and Briggs[15] reported a pseudarthrosis rate of 4%. Other potential complications include reflex sympathetic dystrophy, acromioclavicular joint arthritis, infection, and failure of the internal fixation. In a review of a series of 41 arthrodeses carried out solely for rheumatoid arthritis, Rybka et al.[82] reported that 90% of shoulders had solid bony fusion at 6-years–average follow-up (range 6 months to 20 years). The remaining shoulders had not yet achieved fusion or had fibrous ankylosis. The range of scapulothoracic movement improved by an average of 60% (includes active abduction plus sagittal flexion). Results were rated as excellent or good in 68%, and fair in the remaining 32%.

Current techniques for shoulder arthrodesis are described by Richards in Chapter 19. We also use these techniques.

AUTHORS' PREFERENCE

Illustrative Cases

For the younger patient who is significantly debilitated as a result of glenohumeral arthritis, we prefer to avoid prosthetic arthroplasty whenever possible. This is not always possible, as will be illustrated by one of the cases described in the following.

Case 1

A 43-year-old male prison officer presented with pain in his dominant right shoulder. Although he had played college football as a linebacker, he denied any history of shoulder trauma. He had progressive right shoulder pain for several years. His past medical history was not significant.

On examination he had a slightly reduced range of motion in his symptomatic right shoulder: 170-degrees flexion, 40-degrees external rotation, and internal rotation to the T-12 vertebra; as compared with the left shoulder showing 180-degrees flexion, 60-degrees external rotation, and internal rotation to T-8. There was significant crepitation with glenohumeral motion. Manual muscle testing showed good strength of the rotator cuff muscles. Roentgenograms demonstrated severe glenohumeral osteoarthritis, with multiple loose bodies (Fig. 5A).

The patient was very active and desired to continue working in his occupation, maintaining his current level of duties. Initial treatment included intraarticular steroid injections and a gentle exercise program. Symptomatic relief was temporary. Therefore, surgical treatment options were discussed and included arthroscopic lavage–debridement with removal of loose bodies, versus open debridement and cheilectomy with coronal Z-lengthening of the subscapularis, versus biologic resurfacing procedure. He opted for the biologic resurfacing, for it was felt that this would offer the best possibility of continuing his current occupation.

Surgery

A long deltopectoral incision was used. The subscapularis was incised in a single layer from its humeral attachment to expose the joint. Multiple loose bodies were removed and

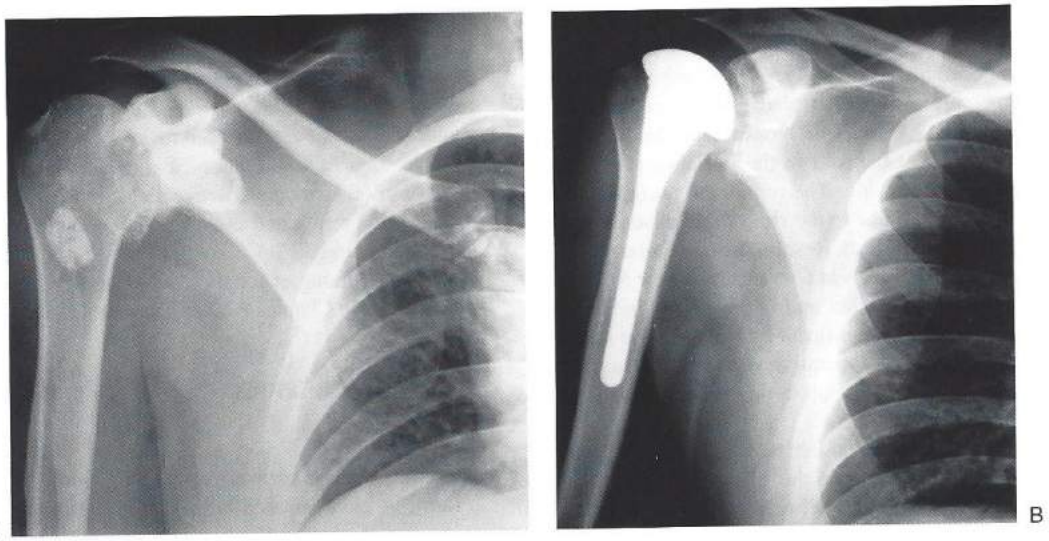


FIG. 5. (A) Preoperative anteroposterior roentgenogram showing complete loss of joint space and osteophyte formation. **(B)** One-year postoperative roentgenogram showing hemiarthroplasty and reconstitution of apparent joint space, demonstrating maintenance of interpositional graft.

osteophytes were debrided. With the use of reamers, the diameter of the humeral head was then reduced to 48 mm. This exposed a 2 × 3-cm cyst in the head. An attempt was made to fill the cyst with morcellized bone graft, but the resulting surface was not deemed strong enough to support forces that would be applied to this region. Therefore, the humerus was prepared for a standard hemiarthroplasty.

Using a burr, the glenoid was reamed to bleeding subchondral bone and multiple drill holes were made on the reamed surface. A 5 × 15-cm fascia lata autograft was harvested from the thigh. The graft was folded and the edges sutured together. The two-layer graft was then secured to the margins of the glenoid using simple transosseus sutures. A suture anchor was used to appose the center of the graft to the central glenoid.

An uncemented humeral hemiarthroplasty (Select Shoulder; Sulzer Orthopedics, Austin, TX) was then performed. The subscapularis was repaired using a combination of suture anchors and transosseus sutures (see Fig. 5A,B). Postoperative recovery was uneventful. The limb was placed in an upper limb immobilizer for approximately 1 week. The patient was then started on pendulum, pulley, and stick exercises. At 6 weeks, external rotation and range of motion exercises were started. At 8 weeks a gentle strengthening program was commenced with the addition of internal rotation exercises at 10 weeks.

Postoperative Results

By 4½ months after surgery, the patient had resumed work, during the course of which he was required to subdue a prisoner. This was achieved by rendering the prisoner unconscious with a punch, using his arm that had been operated on. Radiographs of the shoulder 1 year postoperatively demonstrated a preserved joint space and satisfactory component position (see Fig. 6B).

It is now more than 2 years after his surgery, and he has range of motion of 160-degrees flexion, 45-degrees external rotation, and internal rotation to T-12. Currently, he is pain-free and reports minimal functional limitations because of his shoulder.

Case 2

A 24-year-old right-hand dominant male office worker presented with pain in his right shoulder. Four years previously he had shoulder surgery for recurrent, symptomatic posterior subluxation. Surgery consisted of a glenoid osteotomy for glenoid hypoplasia and a posterior capsular reconstruction. A severe postoperative infection developed and proved difficult to eradicate, persisting for 9 months. Pain and limitations in activities of daily living progressively worsened. Even light office work was painful. He was regularly taking NSAIDS and simple analgesics with intermittent courses of narcotics, but pain relief was always incomplete and of short duration.

On examination there was atrophy of the supraspinatus, infraspinatus, trapezius, and deltoid muscles. A bony fullness was noted at the posterior aspect of the shoulder and the coracoid was prominent anteriorly. Range of motion was painful and restricted to 80-degrees flexion, 60-degrees abduction, 20-degrees external rotation, and internal rotation to the sacroiliac joint. Muscle weakness (3/5 to 3+/5) was noted in abduction, external rotation, and elevation in the plane of the scapula. Tinel's sign was mildly positive at both the thoracic outlet and inlet.

Electromyography demonstrated a suprascapular nerve palsy and brachial plexus traction neuritis. Roentgenograms revealed marked destruction of the humeral head and glenoid (Fig. 6A,B). An MRI scan showed no obvious foci of residual infection. Selective injections into the glenohumeral and acromioclavicular joints and subacromial space showed that most of the pain was relieved with the glenohumeral injection.

In view of the patient's age and shoulder muscle atrophy, a glenohumeral arthrodesis was recommended as the best surgical option for abating symptoms and improving function.

Surgery

The incision used extended from the spine of the scapula, across the anterior aspect of the acromion, and down to the anterior aspect of the humerus. The deltoid was detached from the scapular spine and acromion. The axillary nerve was preserved. The rotator cuff tendons were excised. A burr was used to expose bleeding subchondral bone of the humeral head, glenoid, and the undersurface of the acromion.

With interfragmentary screws, the humeral head was fixed to the glenoid in a position of 30-degrees flexion, 30-degrees abduction, and 30-degrees internal rotation. A 4.5-mm dynamic compression plate (Synthes; Wayne, PA) was then applied, spanning across the spine of the scapula to the anterior aspect of the humeral head (see Fig. 6C). The acromioclavicular joint was excised and the deltoid was reattached with suture through drill holes.

Postoperative Results

Postoperative recovery was uneventful, and intraoperative fluid and tissue cultures showed no evidence of infection. At 3-weeks postoperation, gradual passive mobilization was commenced. By 7 weeks the range of scapulothoracic movement was 75-degrees of flexion, 65-degrees of abduction, 30-degrees of external rotation, and internal rotation to the hip pocket. Unfortunately, during the rehabilitation phase, reflex sympathetic dystrophy developed. This has since resolved. At 1-year postoperation, the fusion is solid and the metal hardware has been removed. The patient reports good use of his arm.

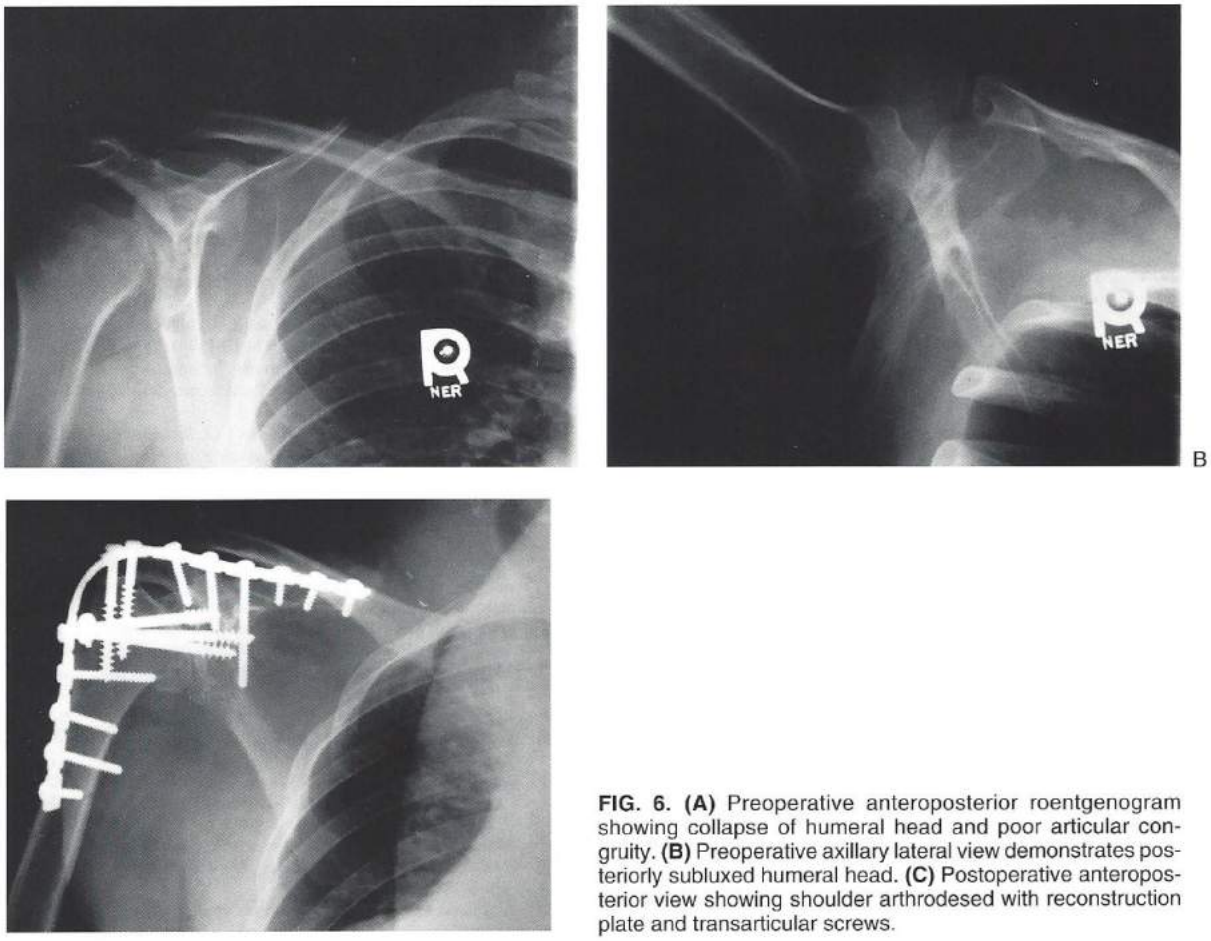


FIG. 6. (A) Preoperative anteroposterior roentgenogram showing collapse of humeral head and poor articular congruity. **(B)** Preoperative axillary lateral view demonstrates posteriorly subluxed humeral head. **(C)** Postoperative anteroposterior view showing shoulder arthrodesed with reconstruction plate and transarticular screws.

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