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Surgical Treatment for the Shoulder Joint in Rheumatoid Patients

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Rheumatoid arthritis (RA) is a systemic disease with medication as the treatment of choice. However, surgical treatment is recommended when no improvement is noted despite aggressive conservative treatment. Synovectomy provides desirable outcomes for RA patients in the early stage with a glenohumeral joint of Larsen grade II or less; conversely, arthroplasty is recommended for patients with a glenohumeral joint of grade III or higher. RA patients often have attenuation and dysfunction of the rotator cuff, and reverse shoulder arthroplasty has been proven to provide favorable outcomes in some patients. RA is often complicated with osteoporosis and bony deformity; therefore, close attention is necessary to prevent fractures during shoulder arthroplasty.
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Key Words: Rheumatoid arthritis; Shoulder; Arthroplasty; Reverse shoulder arthroplasty

Introduction

Rheumatoid arthritis (RA) is a chronic, systemic inflammatory autoimmune disorder, characterized by erosive, symmetrical polyarthritis. The prevalence is about 1% worldwide, which has been shown to diminish with age, and the female-to-male ratio is 3:1.[1,2] The glenohumeral joint is a commonly affected joint in patients with RA. However, its incidence is variable.

The manifestation of RA varies from mild synovitis to severe joint destruction, eventually leading to uncontrolled pain and disability of the joint. Despite recent improvements in biological agents and scientific advancement, progressive joint destruction continues to occur in RA patients. Because RA patients have a greater possibility for developing complications compared with non-RA patients, many important considerations regarding preoperative evaluation and surgical technique must be taken addressed to improve the results of RA surgery. The purpose of this article is to summarize the clinical features and radiologic findings of RA in the shoulder joint and to review the surgical options and its outcomes.

Pathogenesis

RA is characterized by synovial inflammation and hyperplasia, autoantibody production, as well as cartilage and bone destruction. Auto-reactive T cells and inflammatory cytokines, such as tumor necrosis factor (TNF) and interleukins (IL), play a critical role in the pathologic process of RA. This process, via the accumulation of inflammatory cells, self-perpetuation of inflammation, production of matrix metalloproteinase, and induction and/or activation of osteoclasts, leads to the destruction of cartilages and bones.[3-5]

Hyperplastic synovium is a major contributor to cartilage damage in RA. The loss of joint protective effect of synovium promotes disassembly of the type II collagen network. Glycosaminoglycan content and water retention are also altered. Endogenous enzyme inhibitors (e.g., lubricin) fail to reverse this destructive cascade. Chondrocytes, which are influenced by the synovial cytokines (e.g., TNF and IL-1), undergo apoptosis.[6,7] Ultimately, these processes lead to the destruction of cartilages and narrowing of the joint space, according to radiologic findings.

Bone erosion could occur within 1 year after the diagnosis in 80% of patients.[8] Synovial cytokines—particularly macrophage

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colony-stimulating factors and receptor activator of nuclear factor kappa B ligand (RANKL)—promote osteoclast differentiation and invasion of the periosteal surface juxta-articular cartilage.[9] Other TNFs and ILs amplify the differentiation and activation of osteoclast.[10] Breakage of the cortical bone permits synovial access to the bone marrow, which causes inflammation of the bone marrow, and osteitis is visible on magnetic resonance imaging (MRI).[11]

Clinical Manifestation

The initial symptoms of RA are variable. Common symptoms include fatigue, musculoskeletal pain, weight loss, and variable fever.[1,2] In some cases, only mono-articular or poly-articular pain without systemic symptom may be present. The small joints of the hand and foot are affected early. The large joints, such as the knee, ankle, wrist, elbow, and shoulder, are usually affected later.[12] Subcutaneous rheumatoid nodules may be present over the elbow, forearm, Achilles tendon, or other joints.

Symptoms of rheumatoid shoulder are insidious onset of pain, swelling, warmth of joint with effusion, and progressive loss of motion. RA may affect all of the synovial joints such as the shoulder, as well as the glenohumeral, acromioclavicular, and sternoclavicular joints. Initially, active motion could be limited by pain, while passive motion is unaffected. As rheumatoid inflammation progresses, both active and passive motions become limited. Patients in the late stage of shoulder RA often have rotator cuff pathology, ranging from 38% to 70% (Fig. 1).[13,14] From continuous disuse, shoulder muscle atrophy occurs. Painful crepitus could be observed during motion by articular destruction and inflamed soft tissue.

Radiologic Findings

The conventional radiography is useful in detecting bony structural abnormalities, such as erosions, periarticular osteopenia, and joint space narrowing. The earliest radiologic findings on conventional radiography is osteopenia of the humeral head and glenoid. With RA progression, marginal erosions and cysts develop at the inferior margin of the humeral head and the glenoid. Humeral erosions initially occur at the articular margins and rotator cuff insertion sites. Glenoid erosions occur either centrally or peripherally.[1,15] Sclerosis is uncommon and usually reflects a late state. Because the conventional radiography could not explain the condition of the soft tissues, such as synovium, tendons, and cartilage, its effectiveness is limited in the diagnosis of early RA.[16]

MRI is useful for demonstrating the changes in the osseous, articular, and soft tissues (Fig. 1). Joint effusion, synovial inflammation, pannus formation, rotator cuff, and capsular distension can be identified. Synovial inflammation could be detected on an MRI as an increase in synovial thickening and/or enhancement of post intravenous contrast use (e.g., gadolinium).

Computed tomography is useful in the preoperative analysis of humeral head and glenoid defect (Fig. 2). Ultrasound (US) can provide a real-time examination in multiple joints. US is useful for demonstrating rotator cuff thinning or tear, synovial fluid, synovial hypertrophy, and synovial vascularity by Doppler.[17]

Classification

The Larsen classification system is one of the most widely used classification systems for the state of joints with RA.[18] This classification system can be used for not only shoulders, but

Fig. 1. Magnetic resonance imaging shows thinning of the rotator cuff in a 55-year-old woman with rheumatoid arthritis.

Fig. 2. Axial computed tomography shows glenoid bone loss due to medial erosion.

also hips, knees, elbows, wrists, hands, and feet in RA patients; therefore, many studies pertaining to RA have adopted this classification system. It does not consider the general severity of the disease, and it classifies the state of joints into 6 grades based on only a radiographic evaluation (Table 1).[18]

Another classification system is the Lévigne classification system. This classification system is only used for evaluating the glenohumeral joint in RA patients.[19] It classifies the shoulder into the following 3 types and 6 subtypes in accordance with the radiographic findings: concentric type without glenoid erosion (C1) and with glenoid erosion (C2), ascendant type without erosion (A1) and with erosion (A2), and destructive type without erosion (D1) and with erosion (D2). The concentric type resembles osteoarthritis in the radiographic image, with a normal acromiohumeral interval, and its main clinical issue is stiffness (Fig. 3A). The ascendant type is characterized by the proximal migration of the humeral head, and its main clinical issues are posterosuperior glenoid wear and thinning of the rotator cuff (Fig. 3B). Lastly, the destructive type is characterized by the loss of sphericity of the humeral head due to marginal erosion. This type is often accompanied with a rupture of the rotator cuff, and the wear of the articular surface is known to progress rapidly (Fig. 3C).[20] As such, the Lévigne classification system reflects the morphological changes of the glenohumeral joint, offering useful information for surgical decisions.[21,22]

Table 1. Larsen Classifications of Rheumatoid Arthritis[18]

Grade	Description
0	Normal radiograph
I	Slight abnormality. One or more of the following lesions are present: periarticular soft tissue swelling, periarticular osteoporosis and slight joint space narrowing
II	Early erosion and joint space narrowing
III	Medium erosion and joint space narrowing
IV	Sever erosion and joint space narrowing
V	Multilating abnormality. The original articular surface have disappeared.

Surgical Indication

The treatment of choice for RA patients is medication, which includes nonsteroidal anti-inflammatory drugs, disease-modifying anti-rheumatic drugs, and recent biological agents, which are continuously being developed. When general symptoms are present, or when the disease activity is high, medical treatment should be considered. Surgical treatment in such cases is not appropriate because the general symptoms can be aggravated and result in the discontinuation or reduction of medication for surgery. Additionally, if symptoms are limited to 1 or 2 joints, steroid injections can be administered to improve pain and function; however, if symptoms relapse after injections within a short period, surgical treatment should be considered (Fig. 4). RA patients with incapacitating shoulder pain that is not responding to conservative treatment should also be considered as candidates for surgery.

Surgical Options and Outcomes

Synovectomy

Synovectomy is a useful procedure in alleviating pain and swelling for RA patients who are unresponsive to conservative treatment.[23] The reduction of inflammatory tissue and cytokines, as well as sensory denervation after surgical synovectomy are considered to be responsible for pain relief.[24] Several studies have reported good pain relief after shoulder synovectomy; however, limited functional improvement has been reported using this procedure.[25-27] Pahle and Kvarnes[25] reported the results of open synovectomy from 54 shoulder joints in RA with a mean

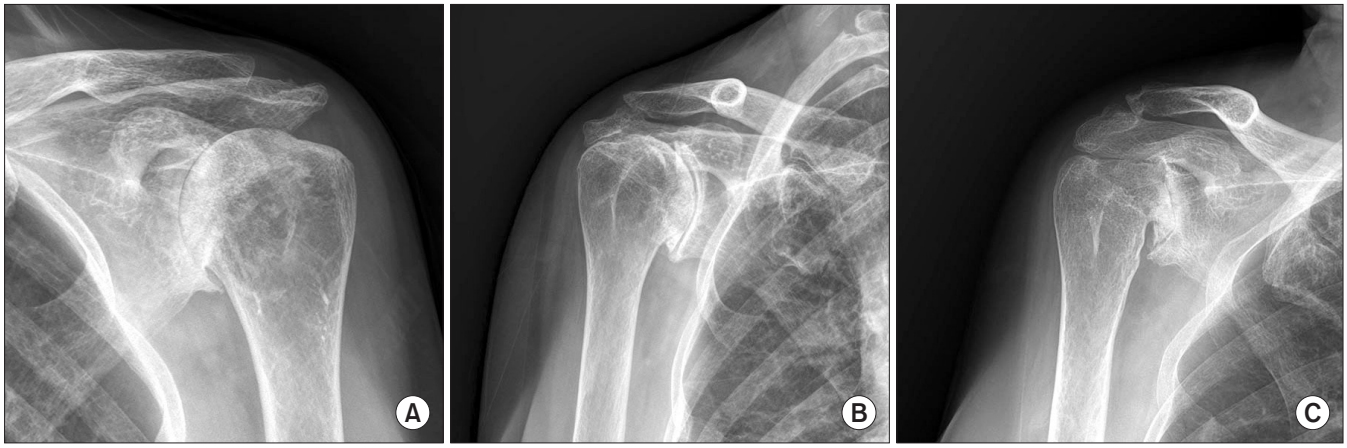

Fig. 3. Lévigne classification. (A) Concentric type. (B) Ascendant type. (C) Destructive type.

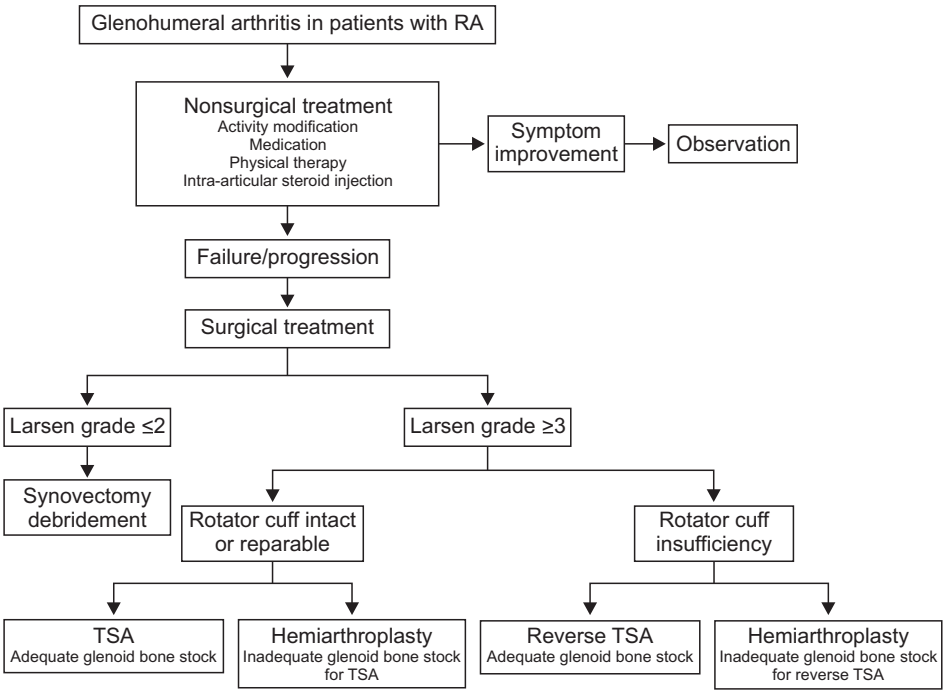

Fig. 4. Treatment algorithm for rheumatoid shoulder.
RA: rheumatoid arthritis, TSA: total shoulder arthroplasty.

follow-up time of 5.3 years (range, 1–16 years); they showed that the procedure was associated with good pain relief. This previous study also showed that even in advanced cases, it was possible to obtain good pain relief, but with insufficient improvement in motion. Petersson[26] reported similar results of pain relief and functional gain.

With the development of arthroscopic shoulder surgery, recent studies are reporting more on the outcomes of arthroscopic shoulder synovectomy, rather than open synovectomy, and the outcomes of arthroscopic synovectomy appear to be similar to that of open synovectomy.[27,28] Most studies report that in RA patients, synovectomy has been shown to be associated with excellent pain relief but not with the prevention of disease progression. Moreover, the outcome is less favorable with synovectomy than with arthroplasty in patients with advanced destruction of the articular cartilage.[29]

Hemiarthroplasty and Total Shoulder Arthroplasty

Shoulder arthroplasty is now widely performed in RA patients. In RA patients with a glenohumeral joint of Larsen grade III or higher, arthroplasty procedures—such as hemiarthroplasty and hemiarthroplasty and total shoulder arthroplasty (TSA)—have shown good outcome from the perspective of pain relief in the literature.[29] However, due to the thinning or the rotator cuff tear, the functional outcome after arthroplasty is usually more unfavorable in RA patients than in other patients.[30] Even if the function is not well improved, patients are often satisfied with just pain relief brought on by arthroplasty, because the main problem of RA patients seems to be pain, and to some extent, the function of shoulder joint is compensated.

RA patients with rotator cuff tear and poor glenoid bone stock should be careful while selecting TSA, owing to the possibility of glenoid loosening. Stewart and Kelly[31] reported the outcomes of 37 TSA in 32 RA patients with an average follow-up of 9.5 years (range, 7–13 years). They found that proximal migration of the humeral prosthesis, attributing to rotator cuff failure, was a common complication (21 shoulders, 56.8%), and it was highly associated with a high incidence of progressive lucencies around both the glenoid and humeral components (10 shoulder, 27.0%). Sneppen et al.[32] performed TSA in 51 RA patients (62 shoulders) and also reported that 40.3% of patients (25 shoulders) had glenoid loosening and that 54.8% of the patients (34 shoulders) had proximal migration of the humerus after a mean follow-up of 92 months (range, 52–139 months). Although glenoid loosening and proximal migration were noted, good pain relief was achieved in 88.7% of patients (55 shoulders). The authors recommended hemiarthroplasty for end-stage RA. Cuff repair is easy when hemiarthroplasty is performed because reduced lateralization of the humerus decreases the tension on the repaired cuff.[33]

However, many previous studies have reported an inferior outcome with hemiarthroplasty than with TSA, with respect to pain relief and restoration of motion in RA patients.[34,35] Sperling et al.[35] performed a follow-up in 247 RA patients (303 shoulders, 195 TSA and 108 hemiarthroplasty) for a mean of 11.6 years. They reported that pain and abduction were better in the TSA group than in the hemiarthroplasty group among patients with intact cuffs. The authors also reported that revision

surgery was performed more frequently due to painful glenoid arthritis (7.4%, 8/108; hemiarthroplasty) than glenoid loosening (5.6%, 11/195; TSA). Moreover, Trail and Nuttall[36] performed a follow-up of 105 RA shoulders (hemiarthroplasty, 65 and TSA, 40) for a mean of 5.1 years. They reported that no patient who underwent TSA required a revision surgery, although radiological loosening was noted in 53% of patients who underwent TSA and that 4 patients who underwent hemiarthroplasty required a revision surgery with TSA, owing to the pain related to progressive glenoid wear. Previous studies did not note clinical loosening after TSA, although the frequency of a radiolucent line in the glenoid component was high; these studies recommended TSA over hemiarthroplasty for RA patients.[29,37] Considering these previous findings, TSA appears to be better than hemiarthroplasty for pain relief in RA shoulders with an intact rotator cuff; however, in patients with a thin or torn rotator cuff, surgical procedure should be carefully selected because both TSA and hemiarthroplasty are associated with its respective disadvantages (glenoid loosening associated with TSA and painful glenoid arthritis associated with hemiarthroplasty).

In TSA and hemiarthroplasty for RA shoulders, the occurrence of superior migration of the humeral head is high, owing to rotator cuff rupture or altered balance between the deltoid and cuff muscles (Fig. 5).[32,36] Superior subluxation shows predisposition to the impingement of greater tuberosity on the acromion during elevation, thus reducing the range of motion at the glenohumeral joint, whether the cuff is functional or not.[37] In RA patients, the coracoacromial arch should preferably be kept intact, because it is an important structure to counteract the tendency for anterosuperior subluxation of the humeral head during TSA or hemiarthroplasty.

Many studies have recommend the use of cemented humeral components rather than the use of uncemented humeral components due to the high rate of loosening with the latter as a result of poor bone quality in RA patients.[29,32,38] A previous randomized controlled trial with a follow-up of 2 years made a comparison between the cemented and uncemented humeral stem fixation during arthroplasty in RA patients and reported no significant differences between the two groups.[39] However, other studies with longer follow-up durations—7.7 years in one and 9.5 years in the other—have shown loosening in more than 40% of the press-fit humeral components.[31,32] From a long-term perspective, the use of cemented humeral components is considered to be safer than the use of uncemented humeral components in RA patients.

Reverse Shoulder Arthroplasty

It is difficult to achieve improvements in both pain relief and range of motion while maintaining joint stability in RA patients with rotator cuff dysfunction, using conventional arthroplasty procedures. Recently, satisfactory results have been reported with reverse shoulder arthroplasty (RSA), which can overcome the problems of conventional arthroplasty in RA patients.[21,22] This procedure might be an alternative treatment option. The biomechanical features of RSA is that this procedure confers high stability and improves the lever arm for the deltoid muscle, potentially resulting in the improvement of range and strength of abduction, even in the presence of rotator cuff dysfunction.[40] Gee et al.[41] systematically reviewed 7 case series of RSA performed in RA patients and reported that the minimum mean forward flexion was 115 degrees after a mean follow-up of 46.9 months for 121 shoulders. Studies have shown that TSA and hemiarthroplasty performed in RA patients resulted in a mean forward flexion of 90 degrees or less, and that RA patients with a compromised cuff had favorable outcomes regarding forward flexion when RSA was performed.[32,36,37]

One of the issues associated with RSA in RA patients is glenoid bone loss. Poor bone stock might increase the risk of glenoid failure or loosening. In addition, deformed morphology and osteophytes present around the glenoid could cause the

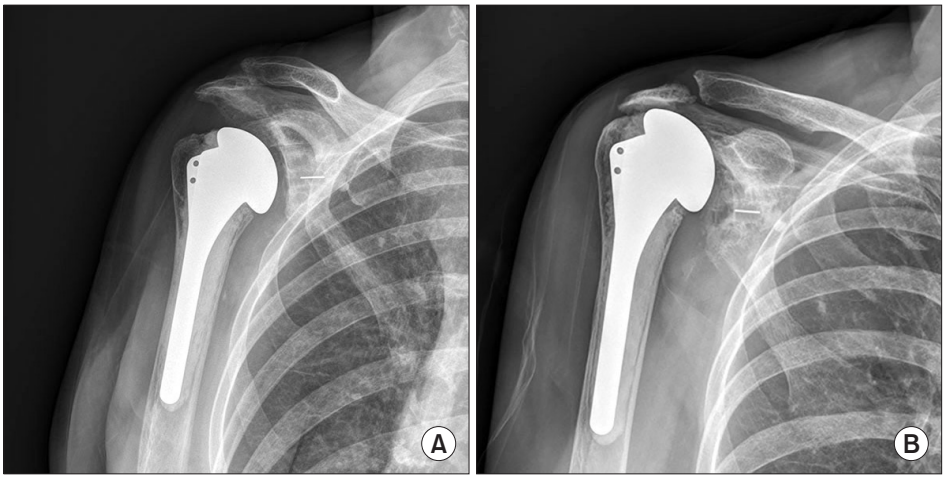

Fig. 5. Total shoulder arthroplasty performed in a 67-year-old woman with rheumatoid arthritis. (A) Early postoperative radiograph. (B) Two-year postoperative radiograph demonstrating superior migration of the humeral head.

surgeon to make a mistake in determining the glenoid center. Young et al.[21] claimed that careful glenoid preparation is necessary to prevent malposition (too high and/or with superior tilt) for Lévigne classification A2 type (ascendant with superior glenoid erosion). Bone grafting is not needed in most cases; however, it should be noted that a humeral head bone graft or other structural graft may be necessary in cases of bone defects with significant glenoid erosion.

Scapula notching is a relatively common finding after RSA.[42] According to a previous systematic review, the incidence of scapular notching after RSA is 34% in RA patients.[41] However, there is a lack of clinical evidence showing that notching is related to fracture, loosening, or revision surgery. The occurrences of symptomatic glenoid loosening (1.7%), deep infection (3.3%), and revision surgery (5%) in RA patients after RSA are not much different when compared with other non-RA patients after RSA; however, the occurrence of fracture (10.7%) was high in RA patients.[41] Because RA patients have a high incidence of osteopenia or osteoporosis, and the tension in the deltoid muscle and remnant cuff tissue increases during glenohumeral joint reduction, the risk of fracture during RSA is high for RA patients. Fractures have been reported at the greater tuberosity, glenoid, acromion and humerus around the tip of humeral stem (Fig. 6).[21,41] Therefore, careful attention is required during the RSA procedure in RA patients.

Conclusion

Arthroscopic synovectomy, when glenohumeral arthritis is unresponsive to conservative treatment, offers good pain relief for RA patients with Larsen grade II or lower joints. However, improvement in joint function is limited, and this approach does not prevent disease progression. For patients with Larsen grade III or higher joints, TSA and hemiarthroplasty can provide more favorable outcomes than arthroscopic synovectomy with respect to pain relief. In addition, in patients with intact cuffs, TSA is preferred over hemiarthroplasty. RSA is a good treatment option for patients with cuff deficiency, and the clinical results are better with RSA than with TSA or hemiarthroplasty; however, further studies are needed, as data on this approach are limited to date. RA patients have a high risk of complications during or after surgery; therefore, thorough preoperative planning and appropriate surgical technique are required.

Fig. 6. Intraoperative fracture of the greater tuberosity that occurred during reverse shoulder arthroplasty, and a postoperative radiograph shows fixation of the greater tuberosity using a cerclage wire.

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