Rheumatoid Arthritis of the Wrist
Doron I. Ilan, M.D., and Michael E. Rettig, M.D.

Abstract
The wrist is the most commonly involved joint in the upper extremity of patients with rheumatoid arthritis. Up to 75% of patients will develop wrist problems during the course of the disease. Cartilage degeneration and synovitis cause the typical skeletal erosions, ligamentous laxity, deformity, and tendon problems seen in the disease. Treatment involves a multidisciplinary approach with careful coordination of the primary care physician, rheumatologist, orthopaedic surgeon, and other members of the care team. As rheumatoid arthritis is a systemic, polyarticular disease, it is critical to consider the entire patient in any management decision. Initial management is usually non-operative and involves pharmacological treatment, activity modification, and possibly bracing. Operative treatments are geared to limit the negative effects of the disease, namely pain, loss of function, and deformity. Numerous procedures have been described. Common procedures from tenosynovectomy/synovectomy, distal radio-ulnar joint arthroplasty, arthrodesis, and total wrist arthroplasty are reviewed.

Rheumatoid arthritis (RA) has a worldwide prevalence of approximately 1%. The disorder occurs three times as often in women and has a peak onset of between 40 to 60 years of age. The cause is unknown, but it is possible that genetic as well as environmental factors play a role. Synovial hyperplasia with extensive infiltration by inflammatory cells is the basic manifestation of the disease. Growth factors and cytokines such as tumor necrosis factor alpha and interleukin-1 are central to the initiation and progression of RA. A symmetric, systemic polyarthritis with significant ligament and tendon involvement is seen.

The wrist is the most common joint involved in the upper extremity in RA. Approximately 75% of RA patients develop wrist symptoms. During the course of the disease, up to 95% of these patients will have bilateral involvement. The disability associated with progressive RA of the wrists is significant. Unfortunately, orthopaedic surgeons do not see many patients until the joint manifestations are advanced.

Wrist Involvement in Rheumatoid Arthritis
The wrist is a complex anatomic structure. It involves three joints [radiocarpal, midcarpal, and the distal radioulnar joint (DRUJ)] which have relatively low inherent bony stability. Much of the stability and balance of the wrist is due to the soft tissues including the radiocarpal ligaments, intercarpal ligaments, triangular fibrocartilage complex (TFCC), and crossing tendons. Since RA is a disease of the synovium, many of these stabilizing structures are affected. The ligaments are attenuated and become lax, the TFCC is progressively destroyed and the tendons are surrounded and infiltrated with hyperplastic synovium. In addition, inflammatory cytokines and proteolytic enzymes degenerate the cartilage and erode bone. Imbalance of the wrist then occurs causing deformity.

The anatomic effects of RA on the wrist are generally predictable. Typical deformity includes shortening of the wrist, scapho-lunate dissociation, carpal supination, translocation of the carpus in a ulnar and volar direction, radial deviation of the carpus and dorsal subluxation of the ulna. The extensor carpi ulnaris (ECU) tendon often subluxes volarily, further contributing to the deforming forces. Tendons, which are already weakened by the disease process, now course over a deformed wrist with bony spicules and may rupture. The clinical result of these problems are pain, loss of function,
and cosmetic changes.\textsuperscript{6}

**Patient Evaluation**

The history and physical examination of the wrist begins with a survey of the entire body. The extent of cervical spine, shoulder, elbow, hand, and lower extremity involvement are important in formulating a treatment plan. Progression of disease, functional ability, and occupational needs also affect decision-making. Only after a thorough understanding of the patients overall condition and needs should the wrist be isolated.

Inspection may reveal bulging of the dorsal wrist indicating tenosynovitis. Prominence of the ulna head (dorsal subluxation of ulna) and widening of the antero-posterior dimensions of the wrist (volar subluxation of carpus) are seen in more advanced cases. Radial deviation of the hand and a flattening of the ulnar border of the wrist also occur with progressive deformity.

Palpation of the wrist will reveal areas of tenderness (radiocarpal synovitis usually painful, dorsal tenosynovitis usually not painful) and reducibility of deformity (piano key sign for DRUJ). Range of motion, strength, and function must be evaluated. Pronation and supination are often painful or limited due to DRUJ involvement. Tendons are examined for rupture and subluxation. A neurovascular exam is performed, as compressive neuropathies are common in RA.

Standard radiographs of the wrist are all that are needed in most cases. Arthrography, magnetic resonance imaging (MRI), and ultrasound have limited usefulness. Some recent studies have attempted to use MRI or ultrasound to predict tendon rupture.

**Classification**

Several classification systems have been proposed for RA of the wrist. Larsen’s classification was introduced in 1977 as a radiographic descriptive method to describe RA\textsuperscript{7} (Table 1). In 1989 the Wrightington classification was introduced also as a radiographic means of evaluating RA of the wrist\textsuperscript{8} (Table 2). The Simmen classification was introduced in 1994 to represent a prognostic typing of RA wrists\textsuperscript{9} (Table 3).

**Treatment**

The goals of treatment in RA of the wrist are: pain relief, restoration of function, prevention of further damage, and cosmesis.\textsuperscript{10} There are several key points to consider when treating any RA patient. Rheumatoid arthritis is generally a progressive disease and the physician must consider the future effects on the treated and other joints. Deterioration of the patient’s condition frequently continues despite what may be considered a successful surgical procedure. Additionally, a team approach (primary care physician, rheumatologist, orthopaedic surgeon, and patient) must be used in all decision making.

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**Table 1** Larsen’s Classification for Rheumatoid Arthritis of the Wrist

<table>
<thead>
<tr>
<th>Grade</th>
<th>Description</th>
</tr>
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<tbody>
<tr>
<td>0</td>
<td>No changes</td>
</tr>
<tr>
<td>1</td>
<td>Soft tissue swelling, demineralization</td>
</tr>
<tr>
<td>2</td>
<td>Marginal erosions, initial deviation</td>
</tr>
<tr>
<td>3</td>
<td>Articular erosions, joint line narrowing, mild instability</td>
</tr>
<tr>
<td>4a</td>
<td>Midcarpal ankylosis, major radiocarpal instability</td>
</tr>
<tr>
<td>4b</td>
<td>Radiocarpal ankylosis, stable</td>
</tr>
<tr>
<td>5a</td>
<td>Destruction of carpus, radiocarpal dislocation</td>
</tr>
<tr>
<td>5b</td>
<td>Destruction of carpus, complete ankylosis</td>
</tr>
</tbody>
</table>

**Table 2** Wrightington’s Classification for Rheumatoid Arthritis of the Wrist

<table>
<thead>
<tr>
<th>Grade</th>
<th>Description</th>
</tr>
</thead>
<tbody>
<tr>
<td>Grade I</td>
<td>Wrist architecture preserved, mild RSS, periarticular osteoporosis, early cyst formation.</td>
</tr>
<tr>
<td>Grade II</td>
<td>Ulnar translocation, lunate volar flexed, flexed radiolunate destruction (RS and midcarpal preserved)</td>
</tr>
<tr>
<td>Grade III</td>
<td>Intercarpal joints arthritic, radiocarpal eroded, volar subluxation of carpus (gross bony architecture preserved)</td>
</tr>
<tr>
<td>Grade IV</td>
<td>Loss of large amount of bone stock from distal radius, gross erosion of ulnar side of radius</td>
</tr>
</tbody>
</table>

**Table 3** Simmen’s Classification for Rheumatoid Arthritis of the Wrist

<table>
<thead>
<tr>
<th>Type</th>
<th>Description</th>
</tr>
</thead>
<tbody>
<tr>
<td>Type I (ankylosis)</td>
<td>Spontaneous tendency to fuse, stable pattern</td>
</tr>
<tr>
<td>Type II (arthrosis)</td>
<td>Articular loss progresses at equilibrium with arthrosis, stable</td>
</tr>
<tr>
<td>Type III (disintegration)</td>
<td>Progressive destruction, loss of alignment, unstable</td>
</tr>
</tbody>
</table>

**Non-Operative Treatment**

The non-operative treatment of RA has progressed substantially in recent years. Rheumatologists are now attacking the disease with drugs earlier in the course of the disease rather than waiting for advanced changes. In addition some new drugs such as TNF inhibitors have made an impact on current care.\textsuperscript{3} Unfortunately, many physicians and patients are weary of surgery and delay surgical consultation despite potential benefits. Although surgical care may not be indicated early in the course of the disease, early evaluation can greatly benefit the patient. Steroid injections may have a limited role in the treatment of RA of the wrist, however their use must be balanced by the chronic nature of the disease and the potential risks of repeated injection.\textsuperscript{11} Bracing and splints are used with some success to maintain a stable position of the wrist, reduce motion, limit inflammation, and to assist function\textsuperscript{10,12,13} Activity modifications and occupational training are of benefit to patients with difficulty with their activities of daily living and vocations.\textsuperscript{10}
Surgical Treatment
The indications for operative treatment are generally considered to be:

- Pain/symptoms not controlled with non-operative modalities for at least 6 months,
- Persistent synovitis with threat of or actual tendon rupture, and
- Progressive carpal deformity.

A myriad of surgical procedures have been used to treat RA of the wrist with varying success. Often multiple procedures are performed concurrently. Unfortunately, well-designed placebo, controlled studies have not been performed to evaluate the effectiveness of these procedures. Current recommendations are largely based on case series reviews and personal preferences and not on evidence-based medicine. The following will review the currently described and commonly used procedures.

Flexor Compartment
The flexor compartment of the wrist is commonly involved in RA. Several problems exist due to the synovial nature of this compartment. Unfortunately, diagnosis is often delayed as this compartment is deep and a careful physical exam is necessary to detect problems. Twenty-three percent of RA patients have clinical symptoms of carpal tunnel syndrome (CTS) and 49% have electrodiagnostic evidence of CTS. Ulnar nerve entrapment in Guyon’s canal is also common. Cervical spine and other proximal causes of nerve compression must be ruled out. Flexor tendon rupture is also common due to the synovial infiltration and bony spicules occurring on the scaphoid. Rupture of the flexor pollicis longus (FPL) tendon generally occurs first and is known as the Mannerfelt lesion.14,15 Operative treatment involves a wide synovectomy, release of entrapments, examination of tendons, and debridement of bony spicules. Prior to closure, bare bony areas are covered by flaps of the capsule. Ruptured flexor tendons are addressed on an individual basis. An isolated FPL rupture may be treated with interphalangeal (IP) joint fusion or a flexor digitorum superficialis (FDS) transfer. Flexor digitorum profundus (FDP) ruptures are treated with IP fusion or transfer and isolated FDS ruptures may be left untreated.15

Extensor Compartment
Dorsal tenosynovectomy is performed in patients with refractory tenosynovitis. Tenosynovectomy is a common procedure but is rarely done in isolation. It is usually done in conjunction with a distal ulna resection and radio-carpal synovectomy. The goal of the surgery is to prevent tendon rupture and avoid recurrence of the synovitis. Several series have shown minimal ruptures and recurrence in patients undergoing this procedure.16-20 Early treatment is recommended because results are poorer in patients with previous tendon rupture.20 When performing a tenosynovectomy, it is important to also eliminate any bony cause of potential tendon rupture. Therefore distal ulna resection is often performed and bony spicules must be removed. The extensor retinaculum may be placed beneath the tendons. Bow stringing is generally not a problem in RA due to the limited range of motion and low demands of these patients. Some investigators have had success with simple decompression of the extensor compartments without tenosynovectomy.21,22

Extensor tendon rupture is one of the end results of the deformity and synovitis in the RA wrist. Most commonly the ulnar digital extensor tendons rupture first and progress radially. This is known as the Vaughn-Jackson syndrome and is caused by tendon weakness, distal ulna prominence, and bony spicules. It is manifest by the sudden inability to extend the metacarpophalangeal (MP) joints. This may be insidious in onset if only the extensor digiti minimi (EDM) is ruptured. Six months of tenosynovitis, dorsal ulna dislocation, and a “scallop” sign (erosion of the radial side of the DRUJ) on radiographs are all predictive of impending rupture.19 Although tendon rupture is the most common cause of inability to extend the MPs the differential diagnosis includes: MP dislocation, posterior interosseous nerve entrapment, extensor tendon subluxation, and volar tendon triggering.

If tendon ruptures have occurred, urgent surgery is recommended to prevent further ipsilateral and contralateral ruptures. Tenosynovectomy is performed along with transfers to ruptured tendons.23

The ECU tendon is often displaced volarly in RA wrists. This causes the ECU to lose its ability to stabilize the wrist against the radial wrist extensors. Stabilization of a volarly subluxed ECU tendon is also performed routinely if necessary. This may be done by a variety of methods including a slip of dorsal retinaculum or a transfer of the pronator quadratus to the ECU sheath dorsally.23 An alternative is to transfer the extensor carpi radialis longus (ECRL) tendon to the ECU in order to stabilize the ECU and help balance the wrist. Clayton showed that this procedure not only reduced radial deviation at the wrist but also reduced the ulnar deviation deformity that commonly occurs in the MP joints.25

Carpal Synovectomy
Synovitis of the radiocarpal and mid-carpal joints can be very painful. The simple mass effect of the synovium within the wrist capsule causes pain. Power grip further increases the pressure within the wrist and exacerbates pain. Synovectomy of the radiocarpal and midcarpal joints is very successful at relieving pain, however this is usually at the cost of loss of motion of the wrist and it does not prevent further deterioration of the cartilage and bony architecture of the wrist.23,26 As with dorsal tenosynovectomy, this procedure is generally performed in conjunction with other procedures. Adolphson reported on the use of arthroscopic synovectomy of the radiocarpal and midcarpal joints in RA. He found good pain relief, increase grip, improved range of motion, and a short rehabilitation period. The use of this procedure, however,
is limited to early RA and separate incisions are necessary if other procedures are to be performed.27

**Distal Radioulnar Joint**

The DRUJ is one of the most significant causes of pain and disability in the RA patient. This is an inherently unstable joint and is supported primarily by the soft tissues (TFCC, ECU subsheath, pronator quadratus, and interosseous membrane). Damage to these restraints causes instability and a relative dorsal subluxation of the distal ulna. Direct damage to the joint causes pain with forearm rotation. In 1963, Backdahl28 labeled these changes along with decreased range of motion and possible extensor tendon ruptures the “caput ulnae.”

Non-operative treatment is generally attempted for at least 6 months. Surgical management is indicated for persistent symptoms and for ruptured or impending ruptured tendons. Although many procedures have been described, the mainstay of DRUJ treatment is distal ulna resection. This is usually combined with stabilization of the distal ulna, ECU, and radiocarpal alignment (correct carpal supination). In addition, synovectomy/tenosynovectomy is also often performed.

Distal ulna resection has several benefits: it eliminates ulna prominence (tendon rupture), allows DRUJ synovectomy, reduces pain, increases forearm rotation, and improves function. Unfortunately, radiocarpal changes are not delayed and the progression of the degeneration follows a course that is consistent with the pattern of RA in the individual. Common complications of distal ulna resection are impingement of the stump on the radius and proximal stump instability. These problems can be reduced by limiting the amount of bone resected, beveling the ulna stump, and stabilizing the distal ulna. Stabilization of the ulna may be done by an ECU tenodesis, suture of the retinaculum to the distal radius, or pronator quadratus transfer. A further criticism of distal ulna resection is that it may contribute to ulnar translocation of the carpus by removing the bony support ulnarly.26-29,32

Bowers33 and Watson and associates34 have devised variations of the distal ulna resection where only the radial aspect of the distal ulna is removed leaving the ulna styloid and TFCC attachment. Both have had good results with this procedure although the usefulness of preserving the TFCC attachment may be minimal in RA patients since it is often destroyed by the disease.

The Suave-Kapandji procedure (DRUJ arthrodesis with ulna osteotomy and pseudarthrosis) is advocated by some because it may lessen the chance of ulna translocation, retains normal ulnocarpal relationship, preserves bone stock, and provides a more normal appearance of the wrist. Several studies have shown good pain relief, range of motion, and patient satisfaction. Although the reports have shown no significant ulnar translocation, the follow-up periods were short and 30% of patients had some proximal stump instability.35,37

**Limited Arthrodesis**

Approximately 15% of patients with RA have spontaneously fused radioulnar joints. This fusion appears to protect the wrist from translocation. In an attempt to duplicate this natural stabilization, many have promoted the use of radioulnar and radioscapulohumeral arthrodesis in moderate wrist RA. Several studies have shown that carpal translocation is actually reduced or prevented, however the carpus continued to deteriorate at a rate consistent with the individuals disease progression.38-41 Chamay and Della Santa38 recommended this procedure only for patients with the arthritis form of the disease and total arthrodesis for the disintegration type. These investigators also found that it was possible to correct prior carpal translocation with this procedure and patients retained approximately 60° degrees of flexion/extension of the wrist.

**Wrist Arthrodesis**

Wrist fusion is the most often performed bony procedure for the RA wrist. It is a time-honored procedure with predictable results. Wrist fusion is indicated for advanced RA with severe radiocarpal instability, midcarpal involvement, absence of wrist motors, PIN palsy, disintegration type RA, or as a salvage procedure. Fusion may be accomplished with a pin/rod technique, plate technique, or without implants. The fusion rate for patients with RA is excellent regardless of the technique used.16-42 Even patients in whom bone grafts were not used experienced excellent fusion rates.56 The use pins or rods seem to be preferred since it is difficult to secure plate fixation on poor RA bone. In general, patients had good pain relief, improved hand function, and good correction of deformity. Grip, digital range of motion, and forearm rotation do not significantly change, although patients may feel a subjective increase in these functions. Patient satisfaction varies with this procedure and patients do require task modifications. Kobus and Turner46 and Weiss and coworkers53 each found that patients had difficulty with many activities of daily living, including perineal care and reaching into tight spaces. The position of fusion is recommended to be slight extension and ulnar deviation. If bilateral fusions are to be performed, then the positions must be individualized to the patients needs.54,55 Complications of fusion can be high (5% to 80%), but most complications are related to prominent hardware or skin breakdown. Pseudarthrosis (usually painless) and CTS have also been reported.44-46,51,56

**Total Wrist Arthroplasty**

Total wrist arthroplasty (TWA) has not enjoyed the same overwhelming success and acceptance as total joint arthroplasty in the hip and knee. The earliest TWA was performed in 1890 by Themistocles Gluck who used an ivory implant for tuberculosis.37 Since that time several generations of implants have evolved. The lack of some patient’s satisfaction with fusion has led surgeons to continue to develop implants despite problems with early designs.
Investigations have found that fusions are very limiting to patients, especially those with bilateral fusions. The average range of motion needed in the wrist to perform activities of daily living is 30° of flexion and extension and 5° to 10° of radial and ulnar deviation. In several studies patients with TWA on one side and fusions on the other side almost all preferred the TWA. The goal of TWA is to provide pain relief and preserve motion and function while limiting complications.

The indications for a TWA are painful, pancarpal advanced RA in a patient willing to accept a low-demand lifestyle and who desires the ability to perform activities that require wrist motion. However patients must be informed of and accept the high risk of failure and complications. Contraindications are previous sepsis, non-functional radial wrist extensors, resorption of the distal carpal row, and the need to use walking aids.

Swanson developed the first widely used implant made from silicone, which is not a true TWA but is in fact a spacer. This implant had good early results, however the results declined progressively with time. A high rate of implant fracture, silicone synovitis, and carpal collapse combined with a pain relief rate at 5 years of only 50% to 68% has prompted most surgeons to discontinue use of the Swanson implant.

In 1972, Meuli introduced the first true TWA. It was an articulated, ball-and-trunion-type implant with fixation into the metacarpals and radius. The advantages of this implant were restoration of wrist height and good range of motion. Unfortunately there was a high rate of imbalance due to an offset center of rotation as well as a high distal component loosening rate. One third of the patients with first generation implants needed reoperation and future generations have not significantly improved the results.

Volz started implanting his prosthesis soon after Meuli in 1973. This prosthesis was a semi-constrained dorso-palmar tracking device with limited radioulnar motion and no rotation. It also was fixed to the metacarpals and radius. This prosthesis had good pain relief, motion, and patient satisfaction, but it also had a 29% to 50% complication rate. Dislocations, infection, tendon rupture, wound complications, imbalance, and loosening were all problems. Some later studies with a newer prosthesis have had improved results, but the implants still have a 27% complication rate.

The Trispherical prosthesis was introduced by Figgie and Ranawat in 1977. This prosthesis differs from previous implants in that it is semi-constrained with a loose axle. It better restores the center of rotation but still has metacarpal fixation. Limited studies have shown high implant survival (95% at 10 years), good range of motion, and good pain relief. Radiographic loosening at the metacarpals was still a problem and investigators found poorer results in patients who had tendon ruptures prior to TWA.

In 1982, Beckenbaugh developed a more anatomic prosthesis with an ellipsoidal articulation. This prosthesis has had a high patient satisfaction with good functional results and an 83% survival rate at 5 years. Distal loosening continues to be a problem with 8 of 57 implants loosening in 5 years. Eighty percent of patients with failed implants chose revision over fusion.

The Universal Total Wrist, designed by Mennon, is similar to an anatomic prosthesis with an ellipsoidal articulation. In addition, it adds radial inclination and, most importantly, addresses distal fixation by performing an intercarpal arthrodesis and broadly securing the distal component to the carpal bones. No carpal loosening has occurred to date in 1 to 6.7 year follow-up. Polyethylene modularity has also aided in soft tissue balancing. Patient satisfaction has been high, but this prosthesis has a 25% complication rate (dislocation is the most common complication).

Failed TWA has been a challenge. Revision TWA has shown good results in retained components, however there is a high loosening rate. Fusion after failed TWA has had high fusion or painless pseudarthrosis rates.

Patient selection is critical in TWA. Patients must be informed of the unpredictability of the current prostheses and high complication rates.

**Summary**

The treatment of RA of the wrist is complicated. Multidisciplinary decision-making should be employed. For those patients needing surgical intervention, general treatment options can be recommended. Early stage patients can benefit from tenosynovectomy and possibly synovectomy and tendon balancing. Those who progress and have DRUJ instability should have a distal ulna resection and stabilization procedure as well as tenosynovectomy and synovectomy. Advanced RA with preserved radius bone stock may have a TWA or fusion and those with poor bone stock or soft tissues should have a fusion.

**References**