

Staged Surgical Management of Rheumatoid Arthritis of Wrist

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INTRODUCTION

Rheumatoid Arthritis (RA) is an autoimmune condition which stays life long and affects primarily the synovium of the joints. There is soft tissue laxity, joint erosion, and deformities as a result of inflamed synovial tissue. Wrist joint has an early involvement in the course of the disease and it is one of the main targets in R.A. Involvement of Rheumatoid Arthritis wrist affects the function of hand. Joint involvement is most significantly influenced by three main factors:

- 1.) Synovial Proliferation
- 2.) Ligamentous laxity
- 3.) Cartilage destruction

The synovial expansion (pannus) (fig 1) will lead on to cause bony erosions, particularly at the sites of vascular penetration of bone. When these erosions are there they cause sharp bony edges, which lead to tendon ruptures².

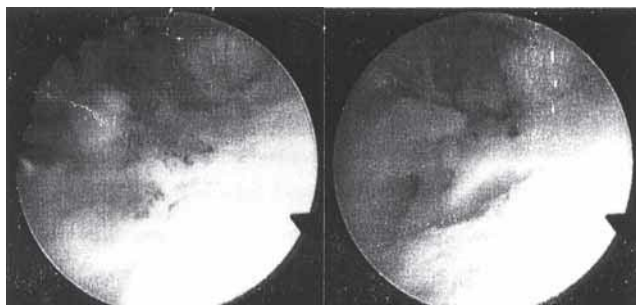


Fig.1: Pannus proliferating from margins and eroding bones

In addition tendon thinning and rupture is because of synovial proliferation in the tendon sheath. Scapholunate dissociation happens because of the stretching of scapholunate ligaments.

Force application across the wrist predominantly caused by muscles act in palmar and ulnar directions, and this ongoing destruction of the wrist, they lose their relation to the centre of rotation and become a deforming force³. Paralleling the processes at the radio carpal and mid carpal joints, the DRUJ undergoes pathological changes which Backdahl⁴ subsequently called it 'Caput ulnae syndrome. Extrinsic and intrinsic ligaments of the wrist cause carpal supination and ulnar translation³. Ulnar side of the wrist is the first place where significant synovitis in the wrist occurs and the long term prognosis is determined by the progression of the radio carpal disease. Ligamentous laxity and palmar subluxation occurs. Supination of the carpus leads to luxation of extensor carpi ulnaris which is a major stabilizer of the distal ulna. The destruction of the cartilage tissue is caused by cytochemical effects with degradation and inhibition of new cartilage synthesis¹. Wrist deformity has influence over the deformities of the hand distally³ and it affects the function of the hand. It is common to have tenosynovitis as an end stage which leads to tendon rupture and reconstruction which is very challenging in such circumstances; therefore it is advisable to do early surgeries like tenosynovectomy to avoid such complications.

If flexor tendon is involved it seems to correlate with higher disease activity⁵. The complications like tenosynovitis of the flexor tendon cause

restricted movements of the wrist joint and patients do complaint of locking sensation complaints of nerve compression and in worst cases tendon ruptures which are presented. Early signs are localized pain, morning stiffness, triggering of single digits, nocturnal paresthesia and or carpal tunnel syndrome (CTS). Rupture of flexor tendons is less in comparison to extensor tendon and the main mechanism is by invasion of tendons by the inflammatory synovial mass and attrition on the prominent bony spurs⁶. Flexor pollicis longus and profundus to the index commonly involved due to close relation with the scaphoid.

A Painless mass over the dorsum of the wrist near the retinaculum is the usual presentation. In these cases other wrist pathologies must be excluded. Role of MRI in identifying ruptured tendons can be difficult⁷. If expertise is available ultrasound can be useful. Rupture is an end process of Synovial infiltration with attrition on bony prominences and ischemia. Dorsal ulna dislocation and persistent tenosynovitis are additional risk factors⁸. Extensor digiti minimi rupture first but it is silent as extensor digitorum communis extends all four fingers. Clinically EDM can be assessed by examination for independent little finger extension⁹ to rule out rupture.

EVALUATION OF RHEUMATOID WRIST

Clinical Examination

It should always include the whole limb, as bad elbow and shoulder joint might affect intervention of the hand. When assessing function of the upper extremity following parameters should be recorded:

- Swelling and tenderness with its extent and exact anatomical localization.
- Degree and location of any deformity and to find out whether the deformity is correctable actively or passively.
- Range of motion needs to be checked with a goniometer by a neutral zero method, at the level of hand all joints should be measured.
- Compression neuropathy like the carpal and cubital tunnel syndrome.
- Strength measurement should be performed (grip and pinch) using **jamar dynamometer/vigorimeter**.

Radiological Examination

Type and extent of destruction of the wrist are best seen in the conventional radiograph that is AnteroPosterior and Lateral views. Radiographs at fixed intervals shows evolution of the disease and over the time it helps optimize the surgical treatment plan. When planning for surgical treatment one should know about the types of rheumatoid wrist and this is mandatory. **Simmen classification** is based upon long term radiological analysis¹⁰. The classification is given below:

Ranking	Observation
Type 1	Spontaneous tendency for ankylosis
Type 2	OA destruction pattern relatively stable over time
Type 3	Disintegration with progressive destruction and loss of alignment.
3A	Ligamentous destabilization
3B	Bony destabilization

CT & MRI Role

The role of CT & MRI is minimal and is utilized in the following situations. These tests are rarely indicated.

A list of situations in which CT and MRI has defined roles is as follows:

- Staging of Synovitis – MRI
- Identifying ruptured tendons with the help of an MRI is technically

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- difficult and sometimes inconclusive.
- Monitoring disease activity – MRI
- Evaluation of DRUJ – CT

Sonography

High resolution sonography is a popular diagnostic tool which requires expertise for the detection of erosions and synovitis (fig 2)¹¹. Tendon continuation can assessed with help of an expert.

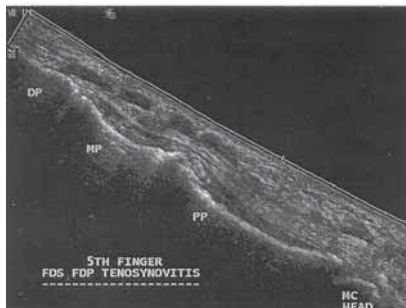


Fig 2: Shows tenosynovitis flexor tendons 5th finger

ASSESSMENT OF FUNCTION IN RHEUMATOID ARTHRITIS WRIST AND HAND

There are specific assessment tools for the wrist and hand function which are helpful in assessing the pre-therapeutic state of the hand, the disease progression and the outcome of the treatment.

There are three different approaches by which you can assess the patient functionally. They are as follows:

- Description of anatomic deviation and disorders with the help of goniometer and photographic documentation / Video based image.
- Measurement of functional deterioration with several tests for the evaluation of hand functions in complex deformity patterns^{12,13}.
- Assessment of disability with self administered questionnaires for e.g.
 - Patient-rated wrist evaluation questionnaires¹⁴
 - Michigan hand outcome for hand¹⁵.
 - Disabilities of arm, shoulder and hand (DASH) for whole upper extremity¹⁶.

SURGICAL MANAGEMENT OF RHEUMATOID WRIST

For a successful surgical reconstruction, it requires a strategy in the choosing the time of the procedure. There has to be priorities in choosing surgical in RA patients¹⁷. The priorities are as follows:

- Treat proximal to distal joints
- Treat most painful joints first.
- Prophylaxis versus reconstruction versus salvage.
- Consider combinations - hand and foot, elbow and wrist, wrist and MCP.
- Initiated treatment with a procedure with best prognosis.

Ranking system has been established by Souter; it was based upon elimination of pain; improvement of function, preventive value, and cosmetic improvement and hazards of complications.

Ranking of operation by Souter¹⁷ is as follows in the table given below:

RANKING	OPERATION
First order	Caput ulnae resection Dorsal tenosynovectomy Arthrodesis of the first MCP joint Synovectomy of the flexor tendons
Second order	Arthroplasty of the MCP joints Arthrodesis of PIP joints Correction of the swan neck deformity Carpal Synovectomy Carpal Arthrodesis
Third order	Synovectomy of MCP JOINTS Correction of Boutonniere deformity PIP Arthroplasty (Carpal Arthroplasty)

Indications for the surgery can be influenced by multiple factors like concomitant musculoskeletal involvement, general health condition, disease activity, patient needs and desires, compliance, social and medical environment.

CLASSIFICATION AND TREATMENT ALOGRITHM OF THE RHEUMATOID WRIST

Disease such as RA has many stages and each stage has its own surgical consequences. Classification mentioned below is made by involvement with various RA surgeons like Stanley, Lucht, and Simmen with their ideas and expertise. Universal classification for typing and staging of inflammatory wrist arthropathy¹⁸ has five types which are as follows:

- Slow progressive type without significant OA- Destructive type
- Slow progressive type with significant OA changes – Reactive type
- Progressive soft tissue disruption – Ligamentous type
- Progressive bony destruction- Lutilans type
- Spontaneous intercarpal ankylosis- Juvenile type

And the staging of the inflammatory wrist arthropathy is as mentioned below which was proposed by Larsen, Dahle and Eek (LDE) classification:

- Stage I :** Early erosions with reducible translation.
- Stage II :** Early erosions with an irreducible translation.
- Stage III:** Translation, translocation, volar subluxation, non-reducible with OA changes in the radio carpal joint.
- Stage IV:** Translation, translocation, volar subluxation, non-reducible without OA changes in the radio carpal joint.
- Stage V:** With previous characteristics with midcarpal joint loss, Disorganized wrist with or without significant bone loss, Intercarpal ankylosis.

Treatment Options according to the type and stage of the disease in the wrist¹⁸

Disease type	Stage I	Stage II	Stage III	Stage IV	Stage V
Destructive	Synovectomy+ Soft tissue Balancing ± Ulnar head surgery	R (S) L; Ulnar Head Surgery	Capitate head Replacement + R(S)L± Ulnar head surgery TWR	TWR or Panarthrodesis	TWR or Panarthrodesis
Reactive	Synovectomy+ Soft tissue Balancing ± Ulnar head surgery	R (S) L; Ulnar Head Surgery	Capitate head Replacement + R(S)L± TWR	TWR or Panarthrodesis	TWR or Panarthrodesis
Ligamentous		R (S) L; Ulnar Head Surgery	Panarthrodesis	Panarthrodesis	
Mutilans	R (S) L; Ulnar Head Surgery	Panarthrodesis	Panarthrodesis	Panarthrodesis	
Juvenile	Synovectomy+ Soft tissue Balancing ± Ulnar head surgery	Panarthrodesis	Panarthrodesis	Panarthrodesis	Panarthrodesis

R(S) L: Radioscapholunate fusion. TWR: Total wrist arthroplasty

SYNOVECTOMY

There are two main goals of undertaking prophylactic surgery:

- 1.) To stop or at least retard the disease process
 - 2.) To prevent complications that could have occurred otherwise.
- Only type I ankylosing of Type II arthritic type of RA qualify for undergoing **synovectomy**.

When synovitis is surgically removed, it releases of the pressure in the joint and may have an effect prophylactically on the retaining structures. There is some denervation effect.

The main effect of synovectomy is pain relief but often with restricted flexion movement¹⁹.

To diminish this problem arthroscopic *synovectomy* might be considered. The indications for carpal synovectomy are:

1. Persistent synovitis not responding to drugs for duration of six months.
2. Persistent pain and local tenderness without major bone deformities.
3. Treatment in combination with dorsal tenosynovectomy or treatment of distal ulnar or both.

Indications for extensor tendon synovectomy are for the patients having persistent even painless swelling in extensor compartment after adequate medical treatment is indication for surgical intervention.

Two main indications for isolated flexor tendon synovectomy are as follows:

1. CTS combined with excision of bony spurs and synovectomy.
2. In case of tendon rupture – excision of bony spurs.

Dorsal wrist surgery decompression of carpal tunnel is possible. At present at our center arthroscopic synovectomy is the procedure of choice.

WRIST ARTHROSCOPY

The procedure is used in RA when conservative measures have failed. There are various advantages of this procedure over the open method as:

- It reduces pain.
- It gives high patient satisfaction
- It has a short period of rehabilitation.
- It decreases of post operative stiffness.
- It provides superior views and excellent access to all the compartments of the wrist.

Wrist arthroscopy (fig. 3a & b) is a procedure performed under general anesthesia for which the forearm is suspended in a traction device using a 5.5 to 7 kg load and a finger traps. Tourniquet is used. 2.4mm diameter 30° arthroscope, motorized shaver system with 2 mm diameter synovial resector blade is used for synovectomy. 3-4/4-5 portals are used as standard entry points for radio carpal joints. Radio and ulnar portal for mid-carpal joint. All the areas are examined through additional portals like midcarpal portals. Post operatively a compression dressing was applied. Active movements of the wrist are starts in a day following arthroscopy.

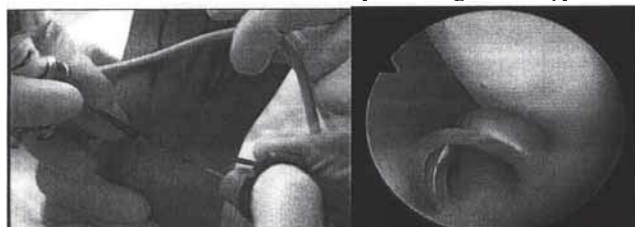


Fig.3a: shows arthroscopic synovectomy of wrist **Fig.3b:** shows resection of synovium with shaver

DRUJ is a frequent target of RA destruction. According to Resnik²⁰, there are three areas of DRUJ where synovial proliferation is observed:

1. Distal to ulnar head
2. In the prestyloid recess
3. Recess of ECU tendon

Damage of synovitis is related to the duration and degree of inflammation. Synovitis invades TFCC and the palmar and dorsal radioulnar ligaments resulting in destabilization of DRUJ.

Caput ulnae syndrome is an end stage destructive process with characteristics dorsal prominence of the distal ulna in combination with local bulge of synovial and signs of tendon ruptures⁴. Forearm rotation is markedly reduced and painful. Instability of DRUJ produces painful clicking in supination and pronation with or without fingerdrop.

If a patient is having pain and functional difficulty may sometime present together with the need to prevent further damage can be an indication for a surgical procedure.

- Joint and tendon synovectomy
- Partial or total resection of ulnar head.
- Stabilization of ulnar stump.
- Stabilization of radio carpal joint is needed.

So in early cases younger patients with limited destruction is indicated for Tendon synovectomy. The distal ulna is addressed to compete or partial resection or by fusion of DRUJ. However significant rates of failure of unsatisfactory results such as distal ulna stump instability variations ulna wrist translocation are shown in analysis²¹. To overcome this there are variations of ulna head resection, such as – Bower's Hemi resection arthroplasty. Amongst European surgeons there is greater popularity for Sauve – Kapandji procedure in which distal ulnar stump is fused more proximally to the radius with and ulnar pseudoarthrosis. There are procedures which correct this ulnar stump instability and the most popular

ones are: the stabilization slings from extensor carpi ulnaris or extensor carpal ulnaris or pronator quadrates interposition transfer. Most distal ulnar stumps tend to dislocate dorsally and this makes more sense to use flexor carpi ulnaris tenodesis.

In ulnar translation, you need stabilization on the level of radio carpal joint. Another method of treating a destructed DRUJ is ulnar head replacement, described by Swanson with silicone cap. This has a long term unsatisfactory results, but, articulation with metal on plastic components or with ceramic head responds better.

Partial Fusion is mostly for Type II Ra going for type III as per Simmen classification. This procedure provides realignment and stability. Partial fusion of the rheumatoid wrist in the early stages is prophylactic. The concept of partial fusion in rheumatoid wrist was first described by Chanay et al²² and later by Linscheid and Dobyns²³. This includes realignment of the subluxed carpus by reduction of the proximal carpal row combined with long term stability. In case of excessive damage to the radio carpal present then limited wrist fusion is expanded to radio scaphounate fusion. This method shows good clinical results and higher patient satisfaction for limited wrist fusion in RA patients^{22,24}. Range of movements varies postoperatively. Radiolunate fusion provides stability on the inner side of the wrist, usually combined with ulnar head resection.

TOTAL WRIST FUSION

There is a debate whether to fuse a destroyed RA wrist or perform radio carpal arthroplasty. Despite good clinical results complication rates are high. Wrist arthroplasty requires good bone stock and a reasonable, reconstructible, tendon balance. Bilateral wrist fusion is still a subject of controversy and most patients prefer at least one mobile wrist. The two main concerns which surrounds wrist fusion is – position and surgical technique of fixation. For most activities of daily living a functional range of motion requires 10° of motion and 35° of extension. In flexed wrist grip strength reduces whereas there is no difference in strength between neutral and an extended fusion position. 5° to 10° coronal deviation is needed to counterbalance an ulnar drift of the fingers. In most of the cases a neutral or slightly flexed position of the dominant hand is there to facilitate personal care and a slightly flexed position for the non dominant hand combined with 5° to 10° of ulnar deviation are chosen.

Different fixation methods for wrist fusion have been described of which Steinman pin technique radio carpal fusion using bone drafts with or without absorbable internal fixation. Plate fixation for wrist fusion is popular especially for past traumatic conditions. Pin fixation has advantages over plate fixation in RA.

1. RA is common in females who generally have small wrists which always cannot accommodate plate which is often too bulky to be applied.
2. Soft tissue and skin condition may not be ideal to cover a plate adequately. Secondary removal of implant is needed.
3. In severe RA bone quality might be poor that no screw fixation is possible.
4. RA has high fusion rates so it requires less rigid fixation than OA patients.
5. Lastly pin fixation is less costly.

ARTHROPLASTY OF THE WRIST JOINT

The procedure is performed either by resection or implant arthroplasty²⁵. Resection arthroplasty or otherwise the Palmar Shelf Arthroplasty which is performed with or without soft tissue interposition. Total wrist arthroplasty has several advantages over the resection and Silicone Wrist Arthroplasty in which silicone works as a "Soft tissue spacer". Total wrist arthroplasty provides fulcrum and stability by virtue of its solid components. Most of the deformities can be corrected and the prerequisites for doing arthroplasty are:

- Intact wrist extensor tendons.
- Independent ambulation without aids.

The only significant contraindications for performing the total wrist

arthroplasty are previous sepsis and absence of appropriate motors to control the wrist. There are prosthesis which is constrained, semi-constrained, and unconstrained with various types' metal on plastic and ceramic on ceramic (fig 4).



Fig 4a shows Ceramic on Ceramic unconstrained total wrist arthroplasty

Fig 4b&c shows radiograph of same patient

Constrained prosthesis are the one in which the forces are transmitted directly to the prosthesis therefore long term surface is present less because of aseptic loosening, but this indicative only in cases of soft tissue loosening. Surgical exposure for total wrist arthroplasty is basically the same regardless of the device used. Success of the procedure lies with good soft tissue rebalancing, post operative alignment and splinting for strenuous activities with 40-50 degrees of motion. Post operative care with regular dressings and along arm plaster splint which is applied to maintain the position. After two weeks the splint and the sutures need to be removed. The goals of the procedure are to relieve pain and provide wrist movements through a 60-degree flexion and extension arc. Dynamic splinting is used only if increased tightness or deformity is present²⁶. Rate of complication and failure is at 25% in wrist arthroplasty which if occurs, and then option of wrist fusion is left which is reliable.

TENDON RECONSTRUCTION

The best treatment for tendon rupture is prevention by early aggressive treatment of the DRUJ and accompanying tenosynovitis. End to end repairs of ruptured tendon in RA, patient is almost never feasible. Tendon transfers might be performed as end to site transfers or end to end reconstructions. EDC, extensor digitorum communis; EDM, extensor digiti minimi; EIP, extensor indicis proprius

Before surgery and possible tendon reconstruction, the following points should be clarified the ones mentioned below:

- How much of functional loss does the patient have with the ruptures?
- What is the general condition of the wrist and finger joints?
- Is the patient suitable for what might be a long rehabilitation process with an unpredictable result?

As an alternative to tendon reconstruction, interphalangeal joint fusion, especially in arthritic joints may be indicated as there are far fewer rehabilitation difficulties. If there is an indication for flexor tendon reconstruction, the following principles are important^{2,6,8}.

- Isolated FPL ruptures are reconstructed with a transfer of a Superficialis tendon preferably the ring finger.
- Rupture of profundus tendon and Superficialis tendon in one finger, a tendon transfer from an intact Superficialis is performed.
- Ruptures of profundus tendon are best treated by end-to-side anastomosis with an intact adjacent profundus tendon.
- Some investigators have recommended bridge grafts^{2,6}, others prefer tendon transfers⁸.

- Isolated Superficialis tendon ruptures, which are rare, need no reconstruction

Table below gives an overview of possible transfers²⁷

RUPTURED TENDON	TRANSFER	ALTERNATIVES
ED	EDM to EDCV	No treatment
EDM, EDC V	EDV V to EDC IV	EDC V to EDC IV EIP to EDM
EDM, EDC V, EDC IV	EIP to EDC IV V	Flexor digitorum
EDC III	EDC III to EDC II	Superficialis IV EDC IV & V EIP to EDC III

CONCLUSION

Wrist joint is one of the commonest joint which gets affected in upper extremity. Wrist arthropathy due to rheumatoid is staged and various deformities are examined functionally and in different stages are treated differently to provide a good outcome. Initial stages of rheumatoid wrist would do with synovectomy, soft tissue balancing, ulnar head surgery, radioscapholunate fusion and late end stages have success with procedures like capitates head replacement, panarthrodesis and total wrist replacement.

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NOBEL PRIZE IN MEDICINE

Two American and a German scientist share this year's Nobel prize for medicine for their groundbreaking research on the human body's complex transport system that makes cells deliver life-saving proteins and other molecules. The discoveries by American scientists **James Rothman** (62) and **Randy Schekman** (64) and German **Thomas Sudhof** (58) have given insight into diseases ranging from diabetes to the immune system, the Nobel Committee said on Monday while announcing the award worth \$1.2 million, to be shared equally by the three. The winners, all professors at American universities, have explained how molecules packaged in tiny bubbles called vesicles are taken around through an internal freight system. Any cellular malfunction can have deleterious effects and lead to several pathological conditions. The panel said the three have been honoured for their discoveries of machinery regulating vesicle traffic, a major transport system in our cells a discovery that will help explain the release of insulin into the blood, communication between nerve cells and the way viruses like tetanus infect cells and kill thousands of children every year. Each cell is a factory that produces and exports molecules. For instance, insulin is manufactured and released into the blood and chemical signals called neurotransmitters are sent from one nerve cell to another. These molecules are transported around the cell through vesicles. Through their discoveries, Rothman, Schekman and Sudhof have revealed the precise control system for the transport and delivery of cellular cargo, it said. Schekman found a set of genes that were required for vesicle traffic. Rothman unravelled protein machinery that allows vesicles to fuse with their targets to permit transfer of cargo. Sudhof explained how signals instruct vesicles to release their cargo with precision.