Indian Journal of Plastic Surgery 1996;29:23-36

INDIAN JOURNAL OF PLASTIC SURGERY

Invited Article

THE RHEUMATOID WRIST - ITS ASSESSMENT AND SURGICAL TREATMENT

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INTRODUCTION

Rheumatoid arthritis is a systemic, incurable, destructive, disabling, deforming and lifelong condition mediated through an inflammatory process involving predominantly the synovial linings of the joints and tendons. Although anti-inflammatory and specific anti-rheumatoid drugs can, to some extent, control this process and alleviate some symptoms, long term therapy does not significantly alter the natural history of the disease[1]. It has been estimated that the wrist is involved in up to 95% of patients with disease in other areas of their hands.[2,3]

Rheumatoid involvement of the wrist presents either as a single joint involvement or as part of a more extensive upper limb problem that can involve both the young and old, the active and inactive. The choice of treatment depends on the involvement of other joints, the pattern of disease in the wrist, the age of the patient and the level of their activity. A full understanding of the normal and pathological mechanics of the wrist is essential in planning an appropriate surgical procedure that will alleviate the patient's symptoms producing a durable result.

Normal synovial lining is composed of three types of synovial cells without an underlying basement membrane. Type A cells have macrophage like activity, Type B cells are fibroblast like and Type C cells are of intermediate activity [4]. Initiation of the rheumatoid process results in proliferation of synovial lining cells, angiogenesis and perivascular lymphoid proliferation that includes both T and B cells with CD-4 cells in the perivascular areas. This arrangement of cells in the lymphoid aggregates is consistent with T-cell dependent B-cell activation[5]. This process results in synovial proliferation and an outpouring of destructive lysosomal enzymes and free oxygen radicals from cytokine activated neutrophils that destroy normal tissues, in particular, ligaments, cartilage, bone and tendon[6,7]. This destruction leads to the typical deformities and problems associated with rheumatoid arthritis.

PRESENTATION OF THE RHEUMATOID WRIST

Rheumatoid involvement of a joint produces symptoms as a result of synovial proliferation and effusion, cartilage and bone erosion, destruction of the supporting ligaments and defunctioning of stabilising tendons. These processes are then manifested by intra-articular or extra-articular symptoms. The intra-articular symptoms being pain, weakness, deformity and stiffness whereas the extra-articular symptoms are due to secondary nerve entrapment, tendon destruction and distal compensatory deformity.

In the acute phase of synovial inflammation and hypertrophy the wrist joint is often swollen, stiff and painful, this pain usually being at the extremes of movement when synovial recesses are compressed. As the cartilage destruction progresses, the pain occurs more often throughout the arc of movement. Swelling and effusion in the wrist is usually felt diffusely around the wrist joint on both the radial and ulnar aspects as opposed to the synovial swelling from extensor tenosynovialitis which is localised to the extensor tendon sheaths.

Synovial hypertrophy and the inflammatory process leads to weakness of grip strength from pain inhibition and from a reluctance to force the joint into its stable power position of extension as this compresses the already swollen joint. The patient may feel the wrist to be more comfortable resting in some degrees of flexion.

With further progression of the disease the joint may become stiff due to capsular and intra-articular fibrosis following cartilage destruction or spontaneous bony fusions or the joint may become loose and unstable as a result of destruction of the ligamentous support for the wrist. Clayton has

classified patients into "stiff" and "loose" types based on the reaction of the joint to destructive synovialitis[8].

Erosions of the Distal Radio Ulnar Joint (DRUJ) and dorsal subluxation of the ulna may lead to attrition rupture of the finger extensor tendons[9,10] and destruction of the scaphotrapezial joint with spur formation may lead to rupture of the flexors to the thumb and index finger[11] Collapse of the wrist into radial deviation has been linked to the development of ulnar drift at the metacarpo-phalangeal joints [12,13,14] and loss of carpal height has been implicated as a cause for intrinsic/ extrinsic imbalance in the fingers and swan neck deformity[15]. Synovial swelling and a flexion posture of the wrist plus subluxation may also contribute to the development of median and ulnar nerve compression at the wrist. Although these extra-articular manifestations of the rheumatoid wrist may be the primary reason for presentation for treatment, correction of the underlying pathology to prevent a troublesome recurrence must also be considered.

Patients with single joint involvement tend to be more active and younger without the built in restraints of disease at other levels and are often looking for a stronger and more durable result from their treatment whereas those with multiple level involvement often have much lower demands on their wrists and may cope well with procedures that would fail in a younger more active person.

Patients with unstable wrists, either in isolation or part of multilevel disease tend to complain of weakness and deformity and usually request procedures that restore stability to the wrist allowing the rest of the hand to function more effectively. Those however with stiff wrists in reasonable positions rarely have complaints of pain or weakness.

Pain is the most frequent presenting symptom from the rheumatoid wrist. In the early stages it is due to synovial hypertrophy and effusion in the joint and the effect of destructive enzymes and vaso-active substances and later follows cartilage destruction, then bone on bone contact and joint subluxation. Pain may also occur with tenosyno-vialitis and attrition of the various flexor and extensor tendons around the wrist and also with some nerve compression syndromes.

Weakness of grip is also common although most often it is generalised due to the systemic nature of the disease process. Specific causes of weakness secondary to wrist involvement are pain inhibition, inefficient musculo-tendinous function due to tendon rupture, dislocation and tenosynovialitis and joint instability. Loss of carpal height through cartilage thinning, bony erosion and carpal collapse will reduce carpal height reducing the effectiveness of the forearm muscles, combined with loss of motion leads to reduced grip strength[16]. Proximal nerve compressions around the elbow may also lead to weakness in the hand.

Stiffness although a very common finding even in the subluxated wrist is an uncommon cause for complaint by the patient who may have as little as 30 degree total wrist movement and yet be quite unconcerned by this loss. It is caused by synovialitis leading to capsular and intra-articular fibrosis and in later stages, spontaneous fusions.

Deformity and Instability is on its own not a common primary reason for presentation but is often seen in association with other presenting symptoms of pain, weakness and stiffness. Deformity is caused by the action of normal forces of daily living acting on an abnormal joint weakened by ligament destruction or by abnormal forces from tendon dysfunction or instability acting on a weakened joint. Deformity not only directly affects the wrist and its function but also affects the distal joints producing the typical "Z" collapse of the hand so often seen as part of the rheumatoid disease elsewhere in the thumb and fingers[17]. Unfortunately most patients referred for surgical treatment of their disease present at a late stage when surgery can only be directed at correction of the various deformities caused by bone, ligament and tendon dysfunction. The patient's presenting symptoms define the aim of treatment. The radiological and anatomical changes determine which procedure would be best able to achieve those aims. The surgical procedure chosen then determines the post-operative rehabilitation program.

NORMAL WRIST MECHANICS

The wrist provides a mobile and yet stable link between the forearm and the hand allowing the hand to explore and manipulate the local environment. It allows the sensate finger tips to be applied to objects and allows the long flexor and extensor tendons to efficiently transmit power to the fingers for grip and manipulation. In order to achieve this function the wrist should ideally be pain free and mobile and most importantly, stable. This stability is provided by the bony integrity, the ligamentous competence and the effective function of local musculotendinous units. Restoration of this stability is the primary aim of the reconstructive surgeon and this requires some knowledge of the normal mechanics[18,19]

The Radiocarpal Joint is formed between the scaphoid, lunate and radius. The scaphoid and lunate are held together by tight interosseous ligaments with this unit held against the slope of the distal radius by a ligament sling. The main palmar ligaments are the radioscaphocapitate and the long and short radiolunate ligaments. The radioscapholunate ligament is a neurovascular structure probably involved only in proprioception. The dorsal radiocarpal component passes from the dorsal aspect of the radius to the dorsum of the triquetrum completing a palmar and dorsal sling holding the carpus to the radial styloid.

The Ulnocarpal Joint lies between the triangular fibrocartilage complex, the lunate and triquetrum and although continuous with the radiocarpal joint is functionally distinct. The ligament complexes here suspend the ulnar aspect of the carpus from the distal radius and the ulna preventing palmar subluxation and supination of the carpus. The major ligaments are again palmar comprising the palmar ulnolunate and ulnotriquetral ligaments arising from the palmar radioulnar ligaments, combining with the palmar radiocarpal ligaments to produce the palmar "V" ligament. The dorsal ligament complex is formed by the dorsal ulnolunate, ulnotriquetral, ulnar collateral ligaments and reinforced by the floor of the ECU sheath. Within this joint is an extension from the dorso-ulnar surface of the radius adjacent to the origin of the dorsal radioulnar ligament passing to the palmar aspect of the triquetrum, the so called meniscus homologue, because of its free intra-articular edge. These ligaments suspend the ulnar carpus from the distal ulna and radius whilst still allowing free forearm rotation. This requires that all ligaments attached to the ulna be closely inserted into the fovea at the base of the ulna styloid along the axis of forearm rotation.

The Distal Radio-Ulnar Joint is a complex weight bearing joint in which tension in the supporting ligaments is converted into compression across the articular surface. The strong flexors and extensors of the elbow are attached to the ulna and it is this bone that is flexed and extended. It is then through the interosseous membrane, the radio-ulnar and ulno-carpal ligaments that the radius and carpus are moved. The primary support of the distal radioulnar joint is through the dorsal and palmar radioulnar ligaments arising from the dorsal and palmar edge of the sigmoid notch passing to the base of the ulna styloid. The palmar ligament is the stronger with the dorsal ligament being reinforced by an extension curving proximally along the dorso-ulnar aspect of the radius. Further support comes from the floor of the 6th dorsal compartment and the fused deep and superficial components of the extensor retinaculum between the 5th & 6th compartments. This intercompartmental tissue overlies the head of the ulna and is firmly attached to the dorsal radioulnar ligament.

The Midcarpal Joint is a stable joint supported primarily by its bony architecture with the capitate and hamate forming a "ball" within the "socket" of the proximal carpal row. This joint is supported by the palmar "V" ligament on the palmar side between the scaphoid, capitate and the triquetrum and on the dorsal sides by extensions from the radiocarpal and ulno-carpal ligaments. There is also a dorsal transverse ligament from the trapezium and trapezoid to the dorsal aspect of the hamate protecting the dorsum of the capitate.

Carpo-Metacarpal Joints excluding the thumb are divided into stable radial half between the 2nd and 3rd metacarpals and the carpus and a mobile ulnar half between the 4th & 5th metacarpals and the hamate. Stability in the radial joints is from strong intercarpal and carpometacarpal ligaments reinforced by extensions from the radial wrist extensors supporting a bony mortice. Stability in the more mobile ulnar joints is purely ligamentous with some support from the ECU tendon insertion.

Musculo-Tendinous Stability is provided predominantly by the radial wrist extensors that extend and radially deviate the wrist in power grip. It is in this position that the joint is close packed and most stable. In the common position of function with the hand in pronation the ECU is lying on the ulnar axis of the wrist with only a small extension component. It does not effectively extend the wrist but acts to balance the radial deviation forces of the radial wrist extensors acting as a dynamic ulnar collateral ligament[20]. ECU can only effectively extend the wrist when the forearm is in supination. Loss of ECU function through synovialitis, rupture or joint subluxation allows the radial wrist extensors to act unopposed resulting in radial deviation of the carpus.

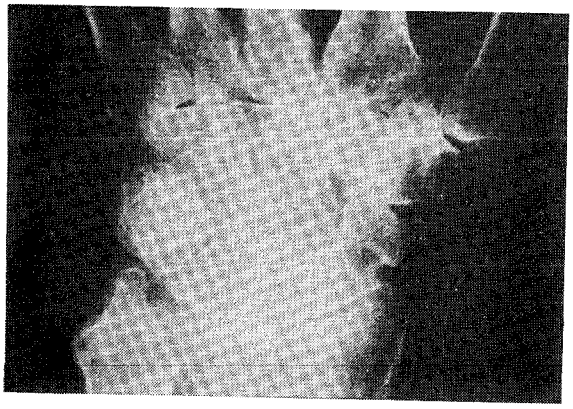
PATHOMECHANICS OF WRIST DEFORMITY

Synovial proliferation, expansion and invasion is the hallmark of rheumatoid disease. It has its greatest destructive effects in areas where normal synovial reflections and concentrations occur as well as the sites of vascular penetration in bone such as around the radioscaphocapitate ligament, at the attachment of the radioscapholunate ligament and around the prestyloid recess and distal radioulnar joint. The sheer bulk of synovial tissue in the radiocarpal joint can force the wrist into adopting a flexion posture seen in upto 80% of

wrists[2,21]. It is helpful to assess the relative contributions from the various parts of the wrist joint in producting the classical rheumatoid wrist deformity.

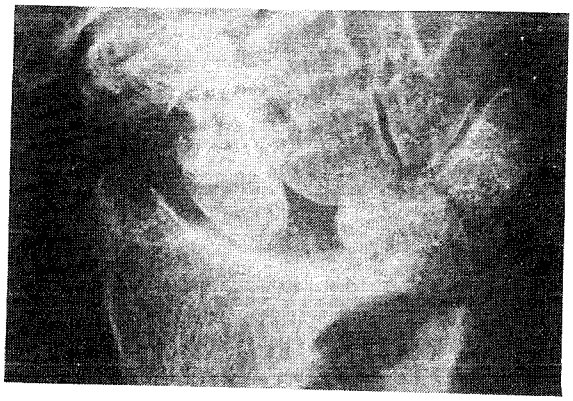
Radiocarpal Disease

Synovial proliferation and erosion in the radio-carpal joint initially occurs at sites of synovial reflection and ligament attachment, typically around the radioscaphocapitate ligament and the attachment of the radioscapholunate ligament of Testut to the radius. This results in notching of the waist of the scaphoid seen in oblique radiographs and intraosseous erosions at the attachment of the ligament of Testut[22](Fig.1). Damage to these structures and the adjacent long and short radiolunate ligaments contributes to ulnar translocation of the carpus with or without disruption of the scapholunate interosseous ligament[23,24](Fig 2) Synovialitis and the effects of



(Fig-1) Early synovialitis has caused characteristic notching at the waist of the scaphoid around the radioscaphocapitate ligament and erosion in the radius at the attachment of the radioscapholunate ligament. Other small erosions can be seen at the lunotriquetral joint and around the head of the ulna.

destructive enzymes soften the articular cartilage and combined with the stress loading on the radiolunate joint brought on by the ulnar translocation results in narrowing and destruction of this joint. Ulnar translocation also decompresses the radioscaphoid joint helping preserve the articular cartilage necessary for subsequent reconstruction. Progresion of the radioulnar disease may lead to spontaneous radiolunate fusions seen in 13-15% of rheumatoid wrists[2]. This pattern of degeneration differs from the findings of arthritic degeneration seen following post-traumatic carpal instability or scaphoid non-unions where the radioscaphoid joint is more severely involved and the radiolunate joint is preserved.

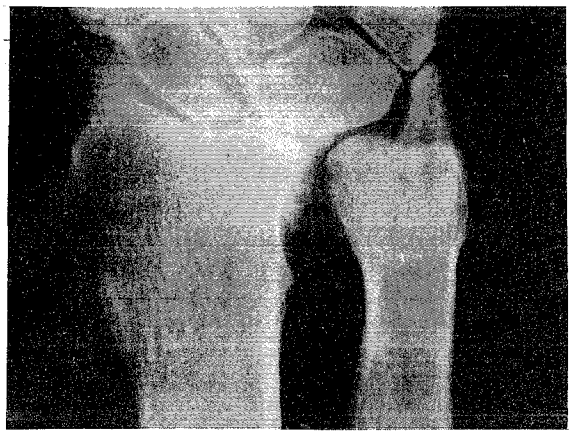


(Fig-2) Severe ulnar translocation along with scapholunate ligament rupture can only be corrected by reducing the lunate subluxation. Note the erosion on the radial styloid, the notching of the scaphoid waist and scaphoid flexion indicating incompetence of the radioscaphocapitate ligament. Note also the scalloping of the sigmoid notch and the spur formation that may lead to tendon rupture.

Ulno-carpal joint disease is seen either in isolation or in combination with DRUJ or radiocarpal disease. Damage to the lunotriquetral ligament results in palmar flexion of the lunate further encouraging a flexion posture of the scaphoid and radial deviation of the carpus. The major consequence however of ulno-carpal synovialitis is the loss of ligamentous support for the ulnar aspect of the wrist. This results in palmar subluxation of the carpus relative to the ulna and carpal supination. Combined with ulnar translocation, the lunate also subluxates from the palmar aspect of the radius. This combination of palmar flexion of the proximal row, ulnar translocation of the carpus, palmar subluxation of the lunate and carpal supination makes up a very common radiological picture at the time of presentation of the patient[20,23].

Distal Radio-Ulnar Joint involvement is a frequent initial presentation rheumatoid disease in the upper limb either with symptoms directly attributable to the joint or more often secondary to the joint subluxation with involvement of the extensor tendons[9,10]. Early synovialitis in this joint may produce pain and some restriction of movement with later erosions occurring at the ulnar styloid and at the sigmoid notch of the distal radius. Large expansion or scalloping of the sigmoid notch is an early radiological sign of possible extensor tendon rupture[25,26](Fig.3).

Synovitis in this joint results in attenuation of dorsal and palmar radioulnar ligaments, capsule and TFCC, the floor of the 6th compartment and the intercompartmental tissue allowing the head of the ulna to buttonhole dorsally between the 5th and



(Fig-3) The "Scalloping" of the sigmoid notch is evident here implying the possibility of extenson tendon rupture. This erosion of the distal radius results in a sharp spur formation at the dorso-ulnar edge of the radius that may lead to tendon attrition.

6th compartments. The radius then falls palmarwards on the radial side of the ulna and the ECU tendon subluxates palmarwards on the ulnar side[23]. Further attenuation and later erosion of the floor of the 5th and later the 4th dorsal compartments results in exposure of the tendons to the denuded ulnar head. Synovial expansion of the sigmoid notch also leads to the formation of a bony spur lying in the ulnar aspect of the floor of the 4th compartment at the dorsal lip of the sigmoid notch. This spur combined with the denuded head of the ulna causes attrition rupture of the extensor tendons. Tenosynovialitis of the ECU tendon sheath results in expansion of the sheath, weakness of the compartment floor and palmar subluxation of the tendon resulting in further instability of the distal ulna and loss of a vital ulnar deviator of the wrist[20,27].

Midcarpal Joint involvement rarely presents in an isolated form and does not contribute significantly to any carpal instability due to its inherent bony stability. Cartilage destruction here may result in pain and stiffness and later may lead to spontaneous bony fusion.

Carpometacarpal Joint disease predominantly involves the 4th & 5th CMC joints as they are more mobile and do not have the benefit of separate stabilizing extensor tendons. The unopposed action of the finger flexors and the hypothenar muscles therefore results in descent of the metacarpals contributing to the supination deformity in the hand[19,28]. Ulnar metacarpal descent also contributes to the ulnar deviation forces on the metacarpophalangeal joints by pulling the long extensors in an ulnar direction via the juncture tendinae.

ASSESSMENT OF THE PATIENT

Surgery for the rheumatoid wrist cannot cure the disease but only help alleviate the symptoms and so we should aim only for limited goals. Treatment decisions therefore must take into account the patient's symptoms, the pathology producing those symptoms and their individual needs. We must be aware of the effect the chosen surgery will have on the patient's remaining joints and the procedure chosen must be durable. These patients are often subjected to multiple hospital admissions and surgical procedures in their lives and both the patient and the surgeons are disappointed if the same procedure needs repeating many times.

Matching the available surgical procedures to a given patient will often require more than one visit and is frequently assisted by assessment from an Occupational Therapist, who will look at the various aspects of daily activity that trouble the patient and frequently be able to assist with preoperative and postoperative therapy and aids, as well as contributing to the final surgical decision. The importance of splinting and joint protection programs must be emphasised to the patient at an early stage. The younger patient with disease limited to the wrist joint is more likely to be active and require more stability than mobility whereas the older patient or the one with multiple joints involved would have fewer demands on their wrists and may be prepared to sacrifice stability than mobility to compensate for deficiencies in other joints. It would not be advisable to consider a joint replacement in someone who relies on walking sticks or their upper limbs for transfer due to lower limb problems. For these reasons I believe that combinations of limited wrist fusions and some soft tissue procedures or total wrist fusion gives the best compromise with respect to pain relief, strength, durability and function. Joint replacement surgery, and totally soft tissue reconstructions are useful only in a very small selected group of patients.

The indication for a surgical procedure is most often the presence of a patient's symptoms. However, there are some situations where it may be advisable to consider a particular procedure in the absence of any symptoms directly referrable to that joint. This would most often be considered in an attempt to prolong the results of metacarpophalangeal joint replacement by attempting to realign the wrist preventing or reducing radial deviation of the carpus. Tendon transfers[29] and arthrodesis of the 4th and 5th carpometacarpal joints[19] to correct carpal supination are two such procedures considered. The decision

to recommend a surgical procedure on an asymptomatic joint to correct only one of the many deforming forces acting on the metacarpo-phalangeal joints must be made carefully given that no surgery is complication free.

SURGICAL PROCEDURES ON THE WRIST

Many surgical procedures are available for the treatment of the rheumatoid wrist with each having specific indications, advantages and disadvantages. The list of procedures to be discussed can be seen in Table 1. These can be broadly grouped into disease modifying procedures, reconstructive procedures and salvage procedures all with the aim of relieving pain, restoring stability and function.

Most surgical procedures on the rheumatoid wrist are performed through a dorsal approach and because of the potential need for further surgery, due to the progressive nature of the disease, a universal incision is needed. This incision should respect the vascular supply to the dorsal skin which at times is quite tenuous. A straight midline dorsal incision centred on Lister's tubercle is ideal for procedures with the deeper approach through the floor of the 3rd dorsal compartment unless the extensor retinaculum is to be preserved when an approach through the ulnar aspect is preferable lifting a radially based retinacular flap. In most dorsal procedures a posterior interosseous nerve neurectomy should be included to prevent the nerve being caught up in the postoperative scar producing a painful neuroma, rather than for any theoretical pain relieving benefit.

Synovectomy of the wrist as an isolated procedure does provide good results with respect to pain but at the expense of some motion[20,30,31,32,33,34]. Although the best time for a synovectomy is before there has been any significant cartilage erosion or joint instability (Fig.1), this damage occurs insidiously with very little in the way of symptoms. So, many patients present at a stage already too advanced to consider synovectomy. It is becoming clearer that medication may help with symptoms but often does not alter the natural history of the disease and so early synovectomy is recommended if there is still evidence of synovial proliferation after 4-6 months treatment, even if relatively asymptomatic. Synovectomy helps decompress the joint and removes the source of the destructive enzymes. It is impossible to remove all synovial tissue from a joint. However the synovium that does grow back seems to be less vascular and more amenable to anti-rheumatoid drug control[35]. Open total wrist synovectomy is a major procedure causing marked scarring and subsequent wrist stiffness but with further experience in arthroscopic techniques and the selection of younger patients with poorly controlled disease, arthroscopic total synovectomy will become a more acceptable, low morbidity procedure that may delay the inevitable joint destruction[36].

Wrist synovectomy at present is most often partial, being performed in conjunction with other procedures and is an essential part of any limited wrist fusion or procedure on the distal radio-ulnar joint. If good articular cartilage remains, then synovectomy will help to alleviate some pain and delay the inevitable joint destruction. It is performed through a dorsal capsulotomy with small rongeurs and synovectomy forceps, paying particular attention to palmar and ulnar recesses. Early postoperative mobilization should be encouraged once the wound has healed.

Tendon Rebalancing Procedures

Radial deviation of the wrist is a frequent occurrence in rheumatoid disease contributed to by radio-carpal synovialitis, palmar flexion of the scaphoid, ulnar translocation of the carpus, loss of ECU function and possibly ulnar drift of the metacarpophalangeal joints. If the radial deviation is mobile, then synovectomy and tenolysis of the ECU tendon combined with transfer of ECRL to ECU can rebalance wrist extension[23,29]. Rebalancing at an early stage may help delay the destruction of the radio-lunate joint by keeping the lunate well centred over the radius and may also reduce the tendency for ulnar drift of the MCP joints.

The ECRL tendon is detached distally and passed in a straight line subcutaneously over the finger extensors to be woven into an intact ECU tendon relocated over the dorsum of the distal ulna. This removes a deforming force from the radial side of the wrist, provides reinforcement to the extensor pulley, if this has been relocated after tenosynovectomy, and helps elevate the ulnar carpus from its supinated position[23].

Ligament Reconstruction

Soft tissue reconstruction for instability in the wrist is limited to early scapholunate dissociation[23,37] usually in the form of dorsal capsulodesis. These procedures are, I believe, unpredictable as the severely weakened soft tissues that are used i.e local capsule and ligament are too unstable for a satisfactory and durable reconstruction. Early recurrence of the instability would be expected unless further supported by some bony procedures. There is some advantage if the procedure is performed as part of a very early

synovectomy where relatively normal tissue may be available for reconstruction. These procedures however are generally not recommended for the rheumatoid patient. It is also very important to differentiate a scapholunate dissociation from ulnar translocation of the carpus with associated scapholunate disruption (Fig.2) as reconstruction of the scapholunate ligament will simple ensure that the scaphoid subluxates with the lunate[37].

Limited Carpal Fusions

Limited carpul fusions are, I believe, the most reliable surgical procedures to correct the problems of instability in the rheumatoid wrist. They provide permanent stability of the involved joints, good pain relief and help prevent further degeneration in the other parts of the wrist and are generally very reliable[37]. The most frequently fused joint is the radiolunate joint followed by the radioscapholunate with scaphocapitate, STT and midcarpal joints only rarely being fused. These limited fusions result in pain relief and a satisfactory range of motion quite acceptable for activities of daily living[38].

Radiolunate Arthrodesis

Isolated radiolunate degeneration with ulnar translocation and palmar subluxation of the lunate is one of the commonest radiological finding in the symptomatic wrist with approximately 13-15% of these wrists undergoing spontaneous fusion with resolution of symptoms[2] (Fig.4). Chamay[39] and later Lindscheid[40] noted this and proposed a surgical radiolunate arthrodesis as a means of correcting the subluxation of the carpus and removing a painful joint. The procedure, although successful, is difficult to perform and has a high non-union rate.

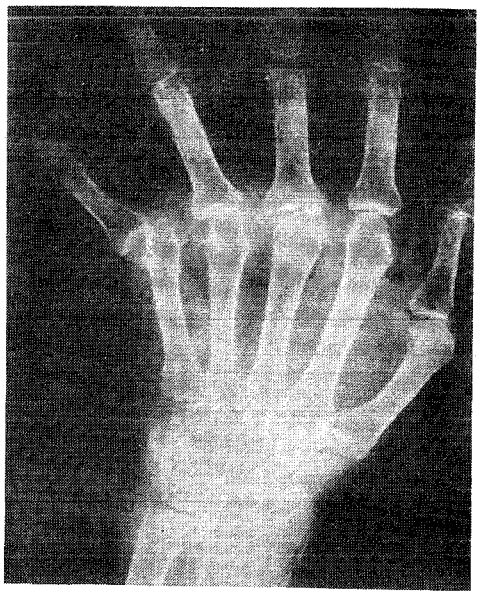
(Fig-4) Spontaneous fusion of the radiolunate joint can result in pain relief and will prevent further ulnar translocation of the carpus.

For the past 7 years I have included the triquetrum in the radiolunate fusion as I believe this makes the procedure easier and increases the union rate by allowing compression of the arthrodesis by a screw passed from the ulnar surface of the triquetrum through the lunate to the radius. Including the triquetrum in the fusion does not alter the expected range of motion but does help to stabilise the ulnocarpal joint and help correct any carpal supination. Bone graft is added from the radius or ulnar head which is often also removed. Following this procedure most patients could expect a total range of wrist flexion and extension of 50 degree to 60 degree and radial and ulnar deviation of 20 deg. to 30 deg, this movement occurring at the midcarpal joint and the attenuated scapholunate ligament. A pre-requisite for this procedure is preservation of a satisfactory midcarpal joint with good motion and this may need to be assessed by fluoroscopy. If the scaphoid fossa and the proximal pole of the scaphoid seem in good condition as seen at the time of the surgery, then the wrist can be fully relocated. However if the cartilage is unsatisfactory than a less that full correction is advisable allowing decompression of the joint. Synovectomy of the radiocarpal and midcarpal joint is also performed. If the radial bone stock is poor due to large radial erosions then including the ulnar head in the fusion mass as with the Sauve-Kapandji procedure will increase the potential for bony union and stability (Fig.5).

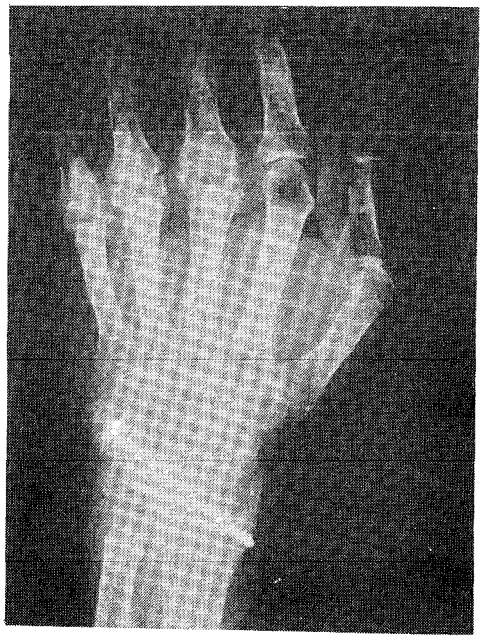
Radioscapholunate Arthrodesis

Radioscapholunate arthrodesis[23,41] is required in situations of ulnar translocation where the radioscaphoid articulation is so damaged that it is likely to be painful if the translocation is reduced. (Fig. 6) or with isolated symptomatic radiocarpal degeneration. The radiolunotriquetral fusion is performed as above with the radioscaphoid joint being added by passing a screw from the dorsal aspect of the radius along the shaft of the scaphoid. The range of motion following this is less but still functional in patients with a well preserved midcarpal joint.

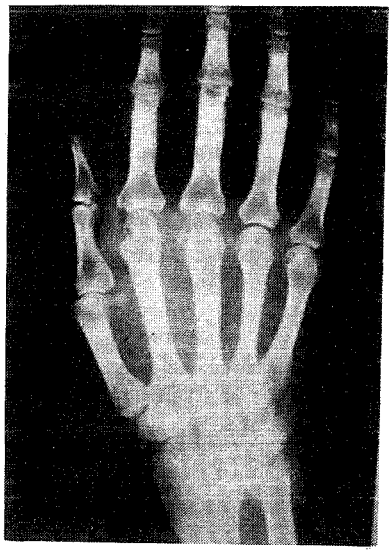
Ryu[42] has suggested a novel way of stabilising the radiocarpal joint while improving the motion obtained following a radioscapholunate arthrodesis by creating a stable fibrous union instead of a bony union. A synovectomy of the joint is performed and then the joint is reduced and pinned in place

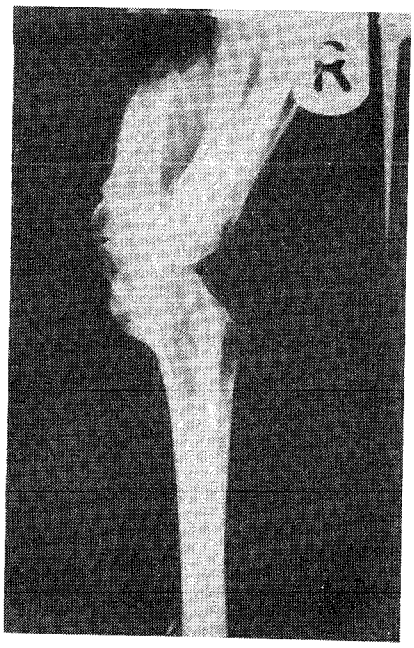


(Fig - 5a) The classical position of ulnar translocation of the carpus leads to increased stress on the already softened articular cartilage because of the reduced contact area. This leads to rapid degeneration and pain on all motion. There is also a mild scapholunate dissociation.



(Fig - 5b) Radiolunotriqeutral arthrodesis has removed the painful radiolunate joint, stabilizing the wrist against further ulnar and palmar subluxation. Note the reasonable preservation of the radioscaphoid joint space.





(Fig-6) Severe erosion of the whole radiocarpal joint with ulnar and palmar translocation of the carpus with good preservation of the midcarpal joint. Arthrodesis of the radiolunotriquetral joints and the radioscaphoid joint will correct the instability and reduce the pain while still allowing some midcarpal motion.

without any formal cartilage resection. The fixation pins are removed early to allow movement. Taleisnik has also described a variation of this procedure for situations where the midcarpal joint is in poor condition by replacing the head of the capitate with a silicone condylar replacement after radioscapholunate arthrodesis[43].

Scaphocapitate and Scaphotrapezial Arthrodesis

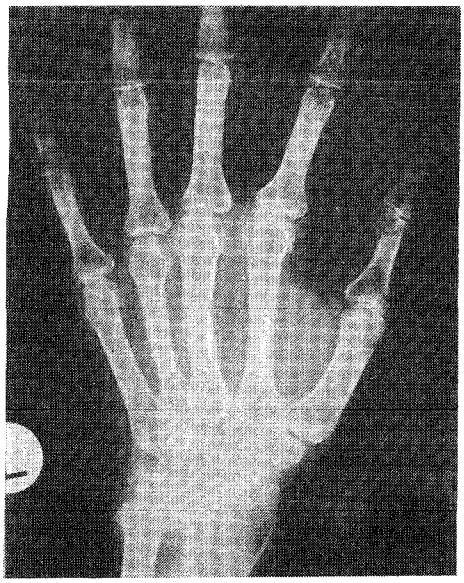
These fusions are only occasionally used in the rheumatoid patient for symptomatic rotary subluxation of the scaphoid following scapholunate ligament disruption. It is usually only considered in the younger active patient with early disease and symptomatic instability. Fusion is preferable

to ligament reconstruction for reasons mentioned earlier, that the ligaments and capsule used for soft tissue reconstructions are weakened and probably will attenuate rapidly.

Scaphocapitate fusion is preferable to STT fusion because the surface area for successful fusion is greater and the trapezium is not compromised making any subsequent procedure needed for thumb basal joint arthritis easier. The procedure is performed via a dorsal approach inserting a cortico-cancellous block into the joint and securing it with 2 Herbert screws. As with ligament reconstructions, it is important to differentiate between simple scapholunate instability and ulnar translocation of the carpus.

Midcarpal Arthrodesis

Spontaneous fusion of the midcarpal joint is also not uncommon and is often associated with remodelling of the radiocarpal joint to resemble a simple ball and socket joint that is frequently very stable and functional (Fig.7). There is rarely any radiocarpal instability or ulnar translocation in this situation. Fusion of this joint can be considered with severe locally destructive disease in the presence of a well preserved radiocarpal joint. In this situation fusion may progress without the need for surgery but if the patients symptoms demand, then fusion through a dorsal approach with cancellous grafting and K-wire fixation would be sufficient. Again a synovectomy of the radiocarpal joint would be included.



(Fig-7) Spontaneous fusion of the midcarpal joint is often seen with remodelling of the proximal radiocarpal joint to resemble a "ball and socket" joint. These wrists are frequently quite stable, functional and pain free.

Arthroplasty

Replacement of the diseased wrist with a mobile, stable and durable prosthesis is an ideal that has not yet been met by the range of prostheses available at the present time. All prostheses to date do achieve the aims of pain relief, correction of deformity with preservation of some degree of motion and stability[44] but without the strength or durability required for general use. The complication rates are high and these procedures should only be performed in patients where an arthrodesis would be indicated but in whom other limitations demand some preservation of motion[37].

Carpal Bone Replacement

Carpal bone replacement with either silastic or titanium prostheses is no longer a recommended procedure for the rheumatoid wrist. Instability and the tendency to early collapse of the joint and fragmentation of the prosthesis leading to particulate synovialitis makes their use unpredictable. Taleisnik's hybrid procedure[43] however may be acceptable as the prosthesis is resting in a stable joint reducing the problems of instability. However prosthesis wear and synovialitis may be a late problem requiring revision.

Silastic Interposition Arthroplasty

The Swanson interposition arthroplasty[45] for the wrist has been in clinical use for many years but more recently has become less popular due to concerns with its durability, bone erosion, subsidence, fracture and synovialitis[46,47]. The use of titanium grommets has unfortunately not improved this. The problems are usually due to inappropriate patient selection, bone preparation, capsular reconstruction and tendon rebalancing. Relying solely on the perceived stability of the prosthesis will result in excessive stress on the prosthesis, fracture at the distal stem/hinge junction and fragmentation. Just as in replacement of the MCP joints it is the capsulo-ligamentous and tendon balance that is responsible for the stability and long term function of the prosthesis, it should only be used in patients with very low demands, with good radial and distal carpal bone stock, effective capsule and functioning tendons. The bone cuts must be perpendicular to the reamed medullary cavity allowing the transverse hinge to be evenly supported. Capsular flaps elevated from the radius must be securely reattached and the extensor tendons must be realigned including placing the 4th compartment tendons over the central line of the prosthesis. Post operatively the joint should be splinted for a prolonged period to allow good capsular healing and the limb cannot

be used for weight bearing.

Total Wrist Replacement

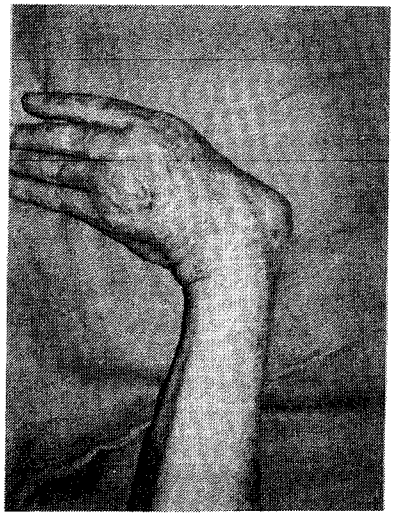
Total replacement with a constrained or non-constrained articulating prosthesis is an attractive option[48,49]. All designs to date suffer from the same problems as silastic joints of loosening, subsidence, prosthesis wear, capsular and tendon imbalance and infection with the added problems associated with the use of cement[50,51,52]. They are again suitable for non-dominant limbs in very low demand patients. Their complication rate and longevity preclude their general use. Care must again be taken with precise fitting of the prosthesis, balance of both the capsule and tendons and controlled splinting and protection for a prolonged period. In general it seems that the stiffer the wrist after replacement the longer the joint will last.

TOTAL WRIST ARTHRODESIS

Total arthrodesis of the wrist is the most common bony procedure performed on the rheumatoid wrist usually being performed for pain with severe total wrist destruction, following failed arthroplasty or if the extensor tendons are ruptured. It is the most reliable and durable procedure available to relieve the patients symptoms whilst maintaining reasonable function[53,54,55]. Although all movement is lost, the gain in comfort and strength more than compensates for this loss. It can be performed in any wrist at any stage of disease even after failed joint replacement with severe bone loss and is suitable for both young and old, active and sedentary. In a less active patient it may provide a stable limb for heavy activity allowing a motion preserving procedure to be used in the opposite wrist. Bilateral wrist fusions are also very satisfactory and should be performed in the neutral position to avoid committing that wrist to a particular function. Although a little extension helps grip strength there are so many other factors that reduce strength that a few degrees of wrist extension will not significantly change this. Similarly, fusing a wrist in flexion to help with toileting commits that hand to that function and may have a more deleterious effect on other functions. Rheumatoid arthritis is a progressive disease and changes in hand function may produce unforseen problems if the wrist is committed to one or other position.

If the bone stock is good then a standard wrist fusion with an internal fixation plate is suitable particularly in the young patient where the wrist may be the only joint involved. The standard 3.5mm AO plate is suitable but is very prominent on the dorsum of the hand and may cause skin and tendon problems. The newer AO wrist fusion plates with the slimmer 2.7mm metacarpal end reduce this risk. Their increased cost is compensated for by reducing the need for subsequent plate removal and hospitalisation. Intramedullary rod fixation is however the preferable procedure in the more common situation with severe osteoporosis and bone loss, a technique popularised by Mannerfelt[56], although with various recent modifications. These include using either one or two rods and passing them between the metacarpal bases or along the shafts of the metacarpals. I find the most reliable method is to pass a 4.0mm to 4.5mm Steinman pin along the shaft of the 3rd metacarpal into the radius (Fig.8).

The wrist is approached dorsally through the 3rd compartment. A local synovectomy is performed along with removal of any remaining soft tissue from within the joint. The joint is flexed and any palmar and ulnar shelf is removed to prevent subsequent median nerve compression after the joint is reduced. The dorsal half of the distal radius, carpus and base of 3rd metacarpal are then morcellated and left in situ as bone graft including the distal ulna if it is removed. The pin is inserted through the head of the 3rd metacarpal via a small stab incision and advanced along the shaft to the wrist. The hand is then aligned with the radius and the pin advanced and countersunk with a small punch. The defect remaining in the head of the 3rd metacarpal very rarely causes anything more than that of a little synovialitis. If a silastic metacarpophalangeal prosthesis is in situ, the joint



(Fig-8a) A severely unstable and painful wrist due to gross bone loss following removal of a failed prosthesis. The grip is very weak and the finger flexion poor due to the inefficient pull of the flexor tendons.

(Fig - 8b) The extent of bone loss is evident due to carpal excision needed to replace the joint and erosion secondary to particulate synovitis.

(Fig - 8c) Arthrodesis with an intramedullary Steinman pin and supplementary bone graft has resulted in total pain relief, excellent stability and improved finger flexion and grip strength.

is formally approached, the prosthesis removed, the pin inserted and then replaced after trimming the stem appropriately. The degree of joint incongruity following bone preparation usually provides sufficient rotary stability although this can be supplemented with an oblique K-wire if desired. Post operative immobilisation in a light splint is needed until union is evident at about 8 weeks.

Placement of the pin in the 2nd or 3rd inter-metacarpal space is not recommended as fixation here is very poor due to involvement of the CMC joints and this may result in excessive movement, loosening, non-union and pin migration.

CARPOMETACARPAL JOINT ARTHRODESIS

Disease at the carpometacarpal joints most often involves the ulnar column with descent of these metacarpals as part of the supinated hand[28] brought on by the unopposed action of the finger flexors and the hypothenar muscles. The more stable radial CMC joints tend to ascend with the carpus as part of the radial deviation posture. This carpal supination has an effect on the development or progression of ulnar deviation at the metacarpophalangeal joints[20]. Correction of this deformity through arthrodesis of the 4th and 5th CMC joints may improve the longevity of MCP replacement and realignment procedures and is performed via a dorsal approach using an inlay bone graft with K-wire fixation. Arthrodesis of the radial joints is rarely required as an isolated procedure. However the 3rd CMC joint is included in the routine total wrist fusion.

DISTAL RADIO-ULNAR JOINT PROCEDURES

The distal radioulnar joint may require surgical attention due to isolated disease producing pain and stiffness, as part of a more extensive wrist reconstruction or in the treatment of ruptured extensor tendons[57]. The most common procedure performed is a simple excisional arthroplasty of the ulnar head attributed to Darrach[58,59] but now being combined with soft tisue reconstruction to stabilise the ulnar stump. This procedure is far more successful in the rheumatoid patient with a lower activity level than in the younger patients with a higher level of activity who may require a stronger reconstruction such as a Sauve-Kapandji procedure[60].

Synovectomy of the distal radioulnar joint is, like with the wrist joint, an attractive proposition but unfortunately the benefits have not yet been proven although, if performed early for recalcitrant disease, may be of benefit along with soft tissue reconstruction[2,61].

The approach to the distal ulna must take into account the subsequent reconstruction requirements and the pathology present. If there are associated tendon ruptures, then an approach through the 4th compartment is needed to address the tendon ruptures and repair the defect where the ulnar head is exposed. The defect is enlarged and periosteal flaps are elevated from the distal radius, sometimes revealing a spur at the distal

edge of the sigmoid notch which is excised and the defect then repaired. The distal ulna is then exposed through the retinaculum just to the ulnar aspect of the 5th compartment followed by synovectomy and excision of the ulna head at the neck, preserving the periosteum. Many techniques for soft tissue reconstruction are described including free fascia lata strips,[62,63], FCU[64], ECU[65,66] Pronator quadratus[67] and palmar capsule[68]. I prefer to use palmar capsule leaving it attached distally and suturing it to the dorsal aspect of the ulna stump as it lifts the ulnar carpus onto the distal ulna reversing the supination deformity. The TFCC, if still intact, can also be sutured to the dorsoulnar corner of the radius helping to correct the carpal supination[28,69]. The inter-compartmental tissue is then advanced to the dorsal radius and plicated to close off the dorsal buttonhole. This closure, along with elevation of the ulnar carpus, pulls the ECU and its sheath dorsally to their normal position. A tenosynovectomy of the ECU is also performed. The patient is rested in a below elbow splint for 4 weeks.

There is some concern with the possibility for progression of pre-existing ulnar translocation following excision of the distal ulna as described by Goncalves[70]. In this situation either a Sauve-Kapandji procedure or direct stabilisation of the radiolunate joint would be preferred. Concerns for the development of further instability of the ulnar carpus following a Darrach procedure or symptomatic ulnar stump instability has led others to develop more conservative ulnar resections including the Bower's hemiresection arthroplasty,[71] the Watson matched resection arthroplasty[72] and the Sauve Kapandji procedure[60]. Swanson[74] also developed a silastic cap for the ulna head following resection. However this prosthesis did not help with stability, very frequently fragmented and dislocated and is now rarely used. The Sauve-Kapandji procedure in the young or active rheumatoid patient is very reliable for pain relief and the maintenance of carpal stability, although instability of the proximal ulna can still be a problem[74,75]. In performing the procedure the positioning of the radio-ulnar fusion must be done carefully to ensure a neutral ulna variance preventing impingement with the lunate which may be subluxated either ulnar or palmar to its normal position. The ulnar excision at the site of the pseudarthrosis should be about 1cm long, starting at the neck of the ulna, supported by soft tissue reconstruction as for simple ulna head excision. This may be supplemented by passing a section of distally based ECU through the ulna head to the proximal stump followed by firm closure of the intercompartmental tissue around the pseudoarthrosis.

CONCLUSIONS

The treatment of a patient with rheumatoid involvement of the wrist starts with a careful assessment of their symptoms and assessment of the pathomechanical processes leading to these complaints. Once the cause has been identified then the surgical options can be selected taking into account the state of the adjacent joints and the specific needs of the patient. The ideal procedure is one that achieves the aim of resolution of the patient symptoms with good durability and the least interference with function. In most cases I believe this is best achieved by combinations of limited wrist fusions and some soft tissue reconstruction or total wrist fusion. These procedures restore stability, relieve pain and improve strength in a reliable and durable fashion. Joint replacements have a small role to play in selected patients where maintenance of motion is essential.

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