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Applying Evidence In The Care Of Patients With Rheumatoid Hand And Wrist Deformities

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Abstract

The traditional approach in managing rheumatoid hand deformities is based on the individual surgeon's experiences. In the current era of evidence-based medicine (EBM), formulating treatment for the rheumatoid hand fits perfectly within the framework of EBM by leveraging the best evidence from the literature, incorporating surgeons' experience, and considering patients' preferences. In this special article, we use a case example to illustrate how EBM can be practiced within the framework of treating rheumatoid hand deformities by distilling the best evidence from the literature to guide surgeons in a rational approach for treating this common condition.

Keywords

Rheumatoid arthritis; Hand; Wrist; Swan-neck; Boutonnière deformity

Introduction

RA is a chronic inflammatory autoimmune disease that causes articular and extra-articular manifestations.¹ The majority of patients with RA develop several structural deformities during the course of their disease, and the development of hand deformities is often disabling, affecting individuals' functional and psychological well-being. Over the past decades, advancements in the surgical and medical management of RA have substantially improved the care of patients with rheumatoid hand disease. However, the appropriate selection between various treatment options is both challenging and controversial for the physicians involved in the care of patients with RA for several reasons.² Studies have found disagreement and limited cooperation between rheumatologists and hand surgeons on the

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indications and efficacy of some of the surgical procedures that are commonly performed to treat rheumatoid hand deformities.^{3–6} This may result in a large variation in the treatment paradigm of rheumatoid hand disease. The lack of consensus among rheumatologists and hand surgeons on the indications of surgical management of the rheumatoid hand may originate from the paucity of comparative studies (surgical versus medical) and outcomes data in the literature.^{2,7–9} Nevertheless, factors such as surgeons' experiences, patients' preferences and cultural beliefs as well as the differences among healthcare systems may also contribute to this phenomenon.^{5,10–11} In this article we discuss hand deformities associated with RA and review the current evidence on the surgical management of the rheumatoid hand.

Management Principles of Rheumatoid Arthritis

The principal objectives for the treatment of rheumatoid hand deformities are pain relief and gain of function, but it has been reported that hand appearance ranks an important factor for patients seeking rheumatoid hand surgery.^{12–13} The current treatment protocols for RA consist of overlapping medical and surgical treatments. Pharmacological therapy has substantially decreased the incidence of rheumatoid hand deformities^{1,9}, yet surgery is still an essential treatment option that should be considered for symptomatic patients despite 3–6 months of optimal medical therapy, and can be classified as preventive/prophylactic or reconstructive procedures. Prophylactic procedures (e.g. synovectomy, tenosynovectomy, tendon rebalancing) aim to delay the development of deformities, whereas reconstructive procedures (e.g. arthroplasty, tendon transfer/graft) aim to correct established deformities. It is worth noting that the presence of a deformity is not an absolute indication for surgery, as many patients with hand deformities may still retain reasonable hand function.¹⁴

When considering surgery for RA patients, preoperative considerations should include a complete medical and surgical history as well as assessment of other joints. Multiple joint involvement is not uncommon in RA; if a patient has arthritis affecting both the lower and upper limb concomitantly, it is often recommended to treat the lower limb first before operating on the upper limb as the patient will be more dependant on his/her hands for support and mobility with crutches. Furthermore, the spine should be carefully evaluated for cervical spine instability and peripheral nerve compressions. Similarly the joints of the upper-limb (shoulder, elbow, wrist and small joints of the hand) should be examined sequentially to determine the full extent of arthritis. A proximal joint deformity may induce compensatory or secondary changes in a distal joint, hence it is advisable to correct proximal deformities first in order to minimize compensatory effects when reconstructing distal joints.¹⁵ In addition, several radiological grading systems (e.g. Larsen, Sharp, Van Heijde Sharp)^{16–17} can be used to assess the degree of joint destruction, yet radiographic images may not necessarily correlate with joint function.

Finally, it is important for surgeons to develop a good rapport with patients in order to assess patients' motivation and readiness for surgery. A motivated patient is more likely to be compliant with post-operative hand therapy. In the case presented, the patient had multiple joint involvement, including bilateral hand deformities, a right foot deformity and a tear of the right shoulder rotator cuff. This demonstrates the importance of exploring patients'

preferences regarding the site and timing of surgery, especially in cases of multiple deformities or if patients are using aids (e.g. crutches).

Medical Treatment of Rheumatoid Arthritis

The focus of medical therapy for RA is to prevent joint damage, loss of function, and to reduce pain. NSAIDs and corticosteroids are commonly used to control pain and swelling, but they do not stop disease progression. On the other hand, disease-modifying anti-rheumatic drugs (DMARDs) are used to slow disease progression and improve function.^{1,18} DMARDs are classified into two categories: non-biologic or conventional DMARDs and the 'newer-generation' biologic DMARDs. Biologics are considered for patients who have experienced an inadequate response to conventional therapy, and are most effective when administered early in the course of the disease.^{19–21}

Despite the recognized clinical benefits in the management of RA, the long-term use of biologic DMARDs may pose an economic burden on healthcare systems due to their higher cost compared to conventional therapy. In the United States, the average annual cost of biologic DMARD treatment per patient for RA is approximately \$19,016 compared to \$6,164 for non-biologic treatment.²² This trend holds true in the United Kingdom as well, where the average annual cost of biologic DMARD treatment per patient for RA is equivalent to \$16,600.¹⁹ In order to justify the use of these expensive medications, the National Institute for Health and Clinical Excellence (NICE) in the UK examined the available evidence and offered several recommendations for the use of biologic DMARDs in RA based on their cost-effectiveness.^{19,23} Other studies have evaluated cost-utility of DMARDs, but so far the lack of RCTs and head-to-head comparisons has limited the results.^{18,24}

Surgical Correction of Hand & Wrist Deformities

The Wrist Joint

Up to 50% of patients with RA have wrist involvement approximately 2 years following onset of the disease, and > 95% experience bilateral involvement after 10 years.²⁵ Damage to the complex ligamentous and musculotendinous support of the wrist is caused by progressive synovitis, typically affecting the radial and ulnar columns of the wrist joint. On the ulnar side, attenuation of the triangular fibrocartilage ligament (TFCC) and palmar and dorsal ulno-carpal ligaments as well as erosion of the distal radioulnar joint (DRUJ) results in dorsal dislocation of the distal ulna, supination of the proximal carpal row and volar subluxation of the Extensor Carpi Ulnaris (ECU). This type of disease progression is commonly referred to as Caput Ulnae Syndrome. Similarly, attenuation of the radiocarpal and intercarpal ligaments on the radial side results in volar subluxation as well as supination and ulnar translocation of the carpus. Eventually, the wrist joint collapses, leading to radial deviation of the metacarpals and a subsequent ulnar drift of the fingers, with the hand assuming a supinated and radially deviated position (Zig-Zag deformity, Fig. 3).²⁶

The physical and radiologic findings of the patient presented confirmed the diagnosis of right DRUJ arthritis, and dorsal dislocation of the ulna that was impinging on the carpus

(Fig. 4) and may have precipitated attrition rupture of the extensor tendons. Following clinical consultation, the patient later underwent excision of the distal ulnar head (Darrach procedure), extensor tenosynovectomy, and reconstruction of the ruptured extensor tendons.

Traditionally, the treatment of wrist arthritis includes prophylactic procedures such as synovectomy and tenosynovectomy or reconstructive procedures such as resection arthroplasty, wrist arthrodesis and wrist arthroplasty (Table 1).^{26–28} Wrist synovectomy improves pain and swelling, but it is not clear whether it decreases symptom recurrence or slows disease progression.²⁹ Tenosynovectomy, on the other hand, has been shown to relieve pain, decrease swelling, improve tendon gliding and decrease tendon attrition rupture if performed during the early stages of the disease.³⁰ Other procedures such as tendons reconstruction, stabilization of a subluxed ECU using a retinacular flap, or ECRL (Extensor Carpi Radialis Longus) to ECU transfer to correct radial deviation of the wrist can be preformed simultaneously with wrist synovectomy.

As demonstrated by the clinical scenario, DRUJ arthritis and instability may result in attrition rupture of the extensor tendons due to tendons abrading against the dislocated, eroded ulna head as well as restriction of forearm rotation. Thus, the aims of treatment for DRUJ arthritis are pain relief, prevention of tendon attrition rupture if the patient presents prior to tendon rupture, and improvement of forearm rotation. These aims are commonly achieved using a Darrach procedure (resection, Fig. 5) or Sauvé-Kapandji procedure³¹ (arthrodesis/pseudoarthrosis, Fig. 6) and less commonly by ulnar head replacement arthroplasty. The description and indications of each procedure are summarized in Table 1.^{26–28} The Sauvé-Kapandji was introduced amid concerns over ulnar translocation of the carpus following resection of the distal ulnar head as in the Darrach procedure, yet both procedures have shown good outcomes in the treatment of DRUJ arthritis.^{29,32} In fact, a recent systematic review found no significant difference in outcomes between the two procedures in RA patients.³³

Regarding the radiocarpal joint, treatment options are usually limited to wrist fusion, or wrist arthroplasty. Total wrist fusion (TWF) provides reliable outcomes but the limitation of wrist motion may avert patients from this procedure. The decision to perform TWF or total wrist arthroplasty (TWA) is often a difficult decision to make. This in part may be due to the lack of outcome studies for both procedures as highlighted by a systematic review conducted by Cavaliere and Chung. In this review the authors concluded that pain relief, patient satisfaction and range of motion (ROM) were comparable between the two groups (TWF and TWA), and only few studies in literature reported wrist motion to be within the functional arc of motion (5 degrees of flexion, 30 degrees extension, 10 degrees of radial deviation and 15 degrees of ulnar deviation) following TWA.³⁴

The Metacarpophalangeal Joint

The classic deformity of the MCP joints in RA involves volar subluxation at the base of the proximal phalanx and ulnar deviation of the digits. Ulnar deviation of the digits is caused by asymmetry of the metacarpal heads, accumulation of fluid within joint spaces and the natural tendency of the flexor and extensor tendons to pull in an ulnar direction. Further imbalance between the long flexors and extensors, as well as the intrinsic muscles, may

exacerbate the deformity. The deformity is usually more profound in the ring and little fingers owing to the mobility of the Carpometacarpal (CMC) joints, which in contrast with the index and long finger CMC joints that are not mobile. On the extensor side, weakening of the transverse fibers of the extensor hood results in ulnar subluxation of the extensor tendons and further ulnar deviation of the digits. Over time, constant stress on the radial side of the fingers may lead to rupture of the radial collateral ligaments causing additional ulnar deviation. On the volar side, joint subluxation and/or dislocation occur due to unopposed flexion by flexor tendons and intrinsic muscle tightness (commonly associated with RA) as well as weakening of extension due to volar displacement of the extensor tendons.^{26,35}

Going back to the case presented, the patient had worsening symptoms despite her optimal medical treatment. This was notable for severe erosion of the MCP joints and marked ulnar deviation of the digits, requiring silicone MCP joint arthroplasty. In early and well-controlled RA, re-alignment of the MCP joints can be achieved by various soft tissue procedures. For example, crossed intrinsic muscle transfer can be preformed to correct the ulnar deviation of fingers by releasing the ulnar lateral bands of the index, long and ring fingers and transfer to the radial side of adjacent fingers. Oster and colleagues have shown that this procedure provides effective long-term correction of fingers ulnar deviation in RA patients.³⁶ Crossed intrinsic muscle transfer has also shown to decrease the amount of ulnar drift when performed with MCP joint silicone arthroplasty.³⁷ In an advanced joint disease, the options are usually limited to arthroplasty or arthrodesis (Table 2).^{26,35–38} For the finger MCP joints, arthroplasty is favored over arthrodesis to maintain motion, whereas the opposite is true in the thumb as stability at the MCP joint is more important for good hand function.

Several implant options have been used for MCP joint arthroplasty³⁸, yet silicone implants are considered the standard type of implant for this procedure (Fig. 7). Recently, a multicenter prospective controlled study by the senior author reported long-term outcomes of silicone implants in RA. Results showed significant improvement of ulnar deviation, extensor lag, and arc of motion of the MCP joint when compared to a group of patients who were treated medically.⁸ Other newer generation implants such as pyrolytic carbon 2-piece nonconstraint implants have also been used, but their efficacy and long-term outcomes are still not well established in RA patients.³⁹

The Interphalangeal Joints (PIPJ & DIPJ)

The two most common digital deformities in RA are swan-neck (SND) and boutonnière (BND) deformities (Fig. 8–9), however they are not exclusive to RA. The prevalence of finger deformities in patients with established rheumatoid arthritis is approximately 14% for SND and 36% for BND.⁴⁰ SND is characterized by hyperextension of the proximal interphalangeal (PIP) joint and flexion of the distal interphalangeal (DIP) joint. The opposite is true for BND, which is characterized by flexion of the PIP joint and hyperextension of the DIP joint. Although progressive synovitis is the primary pathology of both deformities, the pathomechanics are quite different. SND primarily develops due to an attenuation of the PIP joint volar plate, collateral ligaments and/or rupture of the FDS insertion. This results in hyperextension of the PIP joint due to an unopposed extension force. Nevertheless, SND

may also arise secondary to deformities of the MCP or DIP joints. MCP joint volar subluxation or flexion secondary to intrinsic muscle tightness may result in compensatory hyperextension of the PIP joint. Additionally, intrinsic tightness of the lateral bands may cause further extension of the PIP joint. At the DIP joint, disruption of the extensor terminal extensor tendon causes a proximal shift of extension forces onto the PIP joint, resulting in joint hyperextension while the DIP joint remains in flexion. Contrary to multiple etiologies of SND, BND always develops secondary to a central slip disruption. Attenuation of the extensor mechanism and triangular ligament causes volar subluxation of the lateral bands, and migration of the lateral bands volar to the axis of rotation of the PIP joint leads to joint flexion instead of extension.^{9,14–15} Additionally, this results in increased tension on the distal aspect of the lateral bands, thus causing hyperextension of the DIP joint^{40–41}. Destruction of the articular cartilage together with altered joint mechanics may eventually result in joint contractures and a fixed deformity. Nalebuff has devised classifications for both deformities to help guide proper treatment.^{41–42} In general, if the underlying joint is severely damaged and fixed, then an arthroplasty or arthrodesis are the most appropriate treatment option. However, if there is a degree of flexibility, soft tissue reconstructive options should be considered.⁹ Deformities at the wrist, MCP joint or DIP joint that may contribute to finger deformities should be addressed as previously described to achieve final good outcomes. Common reconstructive procedures for SND and BND are summarized in Table 3.^{9,14,43–44}

Tendon Rupture

As shown in the case presented, tendon rupture can be the initial presentation of RA patients. Tendon rupture is caused by infiltration of the tendons by inflammatory synovium (tenosynovitis) or attrition of attenuated tendons over bony edges. Early tenosynovectomy is therefore recommended in symptomatic patients following 3–6 months of optimal medical therapy to prevent tendon rupture. Once tendons rupture, primary repair is no longer possible because attrition leads to fraying of tendons. Depending on the functional deficit, site and number of tendons ruptured, reconstructive procedures may include end-to-side repair, tendon transfer or tendon grafting. Extensor tendon attrition ruptures predominantly occur in the region of a dorsally dislocated ulna head, as in caput ulnae syndrome, or around Lister tubercle. Tendons most commonly affected are the extensor digiti minimi (EDM), extensor pollicis longus (EPL) and extensor digitorum communis (EDC), which cause extension lag. Differential diagnosis for inability to extend the MCP joints also includes ulnar subluxation of the extensor tendons, volar subluxation or dislocation of the MCP joints, or posterior interosseous nerve (PIN) palsy. On the volar side, the flexor pollicis longus (FPL) is the most commonly ruptured tendon due to abrasion against a displaced scaphoid (Mannerfelt syndrome).¹⁴

When performing a tendon reconstruction procedure, one must consider the causes of tendon rupture to prevent future rupture of the reconstructed tendon. For example, the Darrach or Sauvé-Kapandji procedures are usually performed to prevent further attrition by the displaced ulna head. Similarly, a protruded scaphoid can be debrided to prevent flexor tendon rupture. Tendon reconstructive procedures are summarized in Table 4.^{45–47} With the exception of FPL reconstruction, tendon transfers are usually favored over tendon grafts due

to increased susceptibility of developing adhesions following tendon grafting and also the decreased excursion from myostatic contracture of the proximal muscle in the ruptured tendon. Examples of donor tendons for extensor tendon grafting include the palmaris longus (PL) and half of the segment of the extensor carpi radialis longus (ECRL). For the FPL, a segment of the flexor carpi radialis (FCR) or PL are suitable donor tendons. In both tendon transfers and grafts, tendons are secured together by a weaving (Pulvertaft) technique (Fig. 10–13).

The Thumb

The patient presented in the clinical scenario had a clinically unstable and radiologically subluxed MCP joint of left thumb that led to the development of BND and interfered with patient's hand function. In order to correct this deformity, the patient underwent fusion of the left thumb MCP joint (Fig. 14), performed simultaneously with MCP joint arthroplasty of the fingers.

Similar to the fingers, the two most common thumb deformities in RA are BND and SND, respectively⁴⁸. BND of the thumb is characterized by flexion of the MCP joint and hyperextension of the IP joint. Progressive synovitis causes capsular laxity and joint instability as well as volar and ulnar subluxation of the EPL tendon, which results in volar subluxation of the MCP joint. The subluxed EPL causes further hyperextension of the distal phalanx. On the other hand, SND develops mainly due to synovitis of the CMC joint, which is characterized by hyperextension of the MCP joint and flexion of the IP joint as well as metacarpal adduction.^{48–49}

The thumb represents approximately 50% of hand function^{9,48}, and treatment of thumb deformities follows the same principles as other joints. In early disease progression with preserved articular cartilage, synovectomy is performed to alleviate pain and decrease swelling, whereas in advanced RA with established deformities, reconstruction should be considered. When considering thumb reconstruction, one must assess mobility of the CMC, MCP and IP joints. In general, CMC joint arthroplasty is favored over arthrodesis to maintain thumb mobility, whereas the opposite is true for the IP joint if the mobility of the MCP and CMC joints is spared.⁵⁰ Regarding the MCP joint, arthrodesis is still considered the standard type of treatment, however, arthroplasty can be performed in cases of damaged articular surfaces with preserved ligamentous stability.⁴⁹ In BND, if the CMC and IP joints are preserved, then MCP joint arthrodesis has been shown to have good outcomes.⁵¹ However, in low-demand patients who have stable MCP joints and severely damaged IP joints, MCP joint arthroplasty can be combined with IP joint arthrodesis. For SND, attention should be directed towards the CMC joint, and trapezial resection suspension arthroplasty procedures are considered the treatment of choice. Other procedures include partial or complete prosthetic CMC joint replacement, however the outcomes of these techniques are still less favorable.^{50–52}

Summary

RA is a multifaceted disease that often requires complex medical and surgical management. Despite the vast progress of pharmacological therapy, surgery is considered the mainstay of

treatment in patients who are unresponsive to medical treatment. A multidisciplinary team approach that tailors treatment based on individuals' needs is more likely to improve hand function, increase level of patients' satisfaction and enhance their quality of life.

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Clinical Scenario

A 58-year-old right hand dominant housewife who is known to have a long-term history of rheumatoid arthritis (RA) presented with bilateral wrist pain, weakness of handgrip and difficulty extending her right long, ring and little fingers. Physical exam demonstrated weakness of active extension of the right long, ring and little fingers, which was consistent with the patient's presenting complaint. Additionally, there was ulnar deviation of the digits at the metacarpophalangeal (MCP) joints that was worse on the left hand as well as marked instability of the left thumb MCP joint. Radiologic investigation confirmed findings of the physical exam and revealed other structural deformities, including collapse of the right wrist joint (Fig. 1 & 2). How would you treat this patient's deformities?

Figure 1. Showing severe rheumatoid arthritis of the patients' hands with ulnar deviation of the digits that is more prominent on the left hand (top picture). Note the weakness of active extension of the right long finger and lack of extension of the right ring and little fingers (bottom picture).

Figure 2.

X-ray of the patients' hands demonstrating 1) Collapse of the proximal carpal row of the right wrist joint (lower arrow) 2) Ulnar deviation of the digits (top arrow) 3) Subluxation of the left thumb MCP joint (middle arrow) 4) Erosion of several small joints resulting in multiple deformities.

Figure 3.
Demonstrating wrist deformity in RA and subsequent effects on the distal joints e.g. carpometacarpal and metacarpophalangeal joints, resulting in hand Zig-Zag deformity.

Figure 4.
X-ray showing DRUJ arthritis. Note the carpal collapse and impingement of the ulna head on the carpus.

Figure 5. Excision of the distal ulnar head (Darrach procedure) performed in a patient with DRUJ arthritis. Note the arrow pointing towards surface marking of the dorsal sensory branch of the ulnar nerve.

Figure 6.

Showing post-operative X-ray of a modified Sauvé-Kapandji procedure that involves resection of ulna head, 90 degrees rotation of the resected ulna head and fixation to the distal radius using a cancellous bone screw. The traditional Sauvé-Kapandji procedure does not involve rotation of the resected ulna.

Figure 7.
Insertion of a silicone implant into the MCP joint.

Figure 8.

Demonstrating the patho-anatomy of Swan-neck deformity. 1) Laxity of PIP joint volar plate & FDS rupture. 2) MCPJ volar dislocation & intrinsic muscle tightness. 3) Terminal tendon rupture (e.g. Mallet deformity).

Figure 9.

Demonstrating the patho-anatomy of Boutonnière deformity. Note the disruption of central slip and the migration of lateral band volar to the axis of rotation of the PIP joint.

Figure 10.

Showing EIP transfer to repair a ruptured EPL tendon of the thumb. Tensioning of the tendons with the thumb in full extension and the wrist in neutral gives good thumb flexion and extension range.

Figure 11.
End-to-side repair of EDC 4 (ring) to EDC 3 (long) and EIP (index) transfer to EDM (little) to restore extension of the ring and little fingers.

Figure 12.
End-to-side repair of EDC 3 (long) to EDC 2 (index) and EIP transfer to EDC 4 (ring) and EDM (little) to restore extension of the long, ring and little fingers.

Figure 13.

FDS 3 (long) and FDS 4 (ring) transfer to restore extension of the index, long, ring and little fingers.

Figure 14. Showing arthrodesis of the left thumb MCP joint to correct boutonnière deformity. Also note the presence of swan-neck deformity of the right thumb.

Table 1

Summary description of wrist joint procedures performed in rheumatoid arthritis

Procedure	Indications	Description
Preventive procedures		
Synovectomy and/or tenosynovectomy	Persistent wrist synovitis and pain with a fairly preserved wrist ROM and mild to moderate radiographic evidence of RA despite 3–6 months of optimal medical treatment.	Excision of inflamed synovial tissue between joints (synovectomy) and tendons (tenosynovectomy). Dorsal synovectomy Dorsal longitudinal skin incision, the extensor retinaculum is reflected over 4 th /5 th compartment +/- PIN neurectomy to decrease wrist pain. The wrist capsule and DRUJ are then exposed. Synovectomy, tenosynovectomy, debridement of bony spurs and osteophytes are performed. Volar synovectomy skin incision through an extended carpal tunnel approach. Tenosynovectomy is performed, the joint capsule is then exposed and incised to perform joint synovectomy.
Reconstructive procedures		
Radioulnar Joint		
Darrach procedure (1912)	DRUJ arthritis and distal ulnar instability such as in Caput Ulnae Syndrome.	Resection of distal ulnar head. A dorsal approach is used to gain access to the DRUJ via dorsal 5 th extensor compartment. The TFCC and ECU sheath are preserved. Excision of the distal ulnar head proximal to the radial sigmoid notch.
Sauvé-Kapandji (S-K) Procedure (1936)	As above, however S-K preserves distal ulnar head and surrounding soft tissue that may prevent ulnar translocation of the carpus.	Arthrodesis of the DRUJ and excision (osteotomy) of a segment of ulna proximal to the site of arthrodesis to allow for forearm rotation. A modified technique of the S-K involves, 90 degrees rotation of the resected ulna head and insertion into the radius using an AO cancellous bone screw (shelf arthroplasty) to enhance fusion in patients with poor bony stock.
Ulnar-head arthroplasty	Chronic instability of DRUJ or following a failed hemi or complete distal ulnar head resection or failed S-K procedure.	Excision of the distal ulnar head and placement of a prosthesis according to manufacture's guide. The prosthesis is stabilized by the surrounding soft tissue e.g. joint capsule, TFCC and ECU.
Radiocarpal Joint		
Wrist arthrodesis	Partial arthrodesis (Radiolunate and radioscapolunate arthrodesis). Is performed in less severe wrist disease with volar subluxation of the carpus and preserved midcarpal joint, and radiocarpal instability. Total arthrodesis Pan-carpal disease with severe wrist destruction.	Standard dorsal incision to gain access to the radiocarpal joint. The cartilage is denuded and bone ends are approximated. Displaced lunate and scaphoid are reduced. Arthrodesis is stabilized using plates, screws or K-wires. Interposition bone graft is recommended to preserve carpal height. In total wrist arthrodesis, the same steps are performed as above, however debridement extends to involve most of wrist joint cartilages, which are fused and stabilized by K-wires or plates.
Wrist arthroplasty	Pan-carpal disease.	Similar approach to wrist arthrodesis. The implant is then placed, carefully aligned with the wrist joint and stabilized by screws.

Posterior interosseous nerve (PIN)

Table 2

Summary description of metacarpophalangeal joint procedures performed in rheumatoid arthritis

Procedure	Indications	Description
Preventive procedures		
Synovectomy	Persistent MCP joint synovitis and pain with minimal deformity and minimal radiographic evidence of RA despite 3–6 months of optimal medical treatment.	Longitudinal or transverse skin incisions to gain access to MCP joints. The joint capsule is deflected and the inflamed synovial tissue is excised.
Reconstructive procedures		
Intrinsic release	Intrinsic muscle tightness causing ulnar deviation of the fingers and/or volar subluxation of the MCP joints.	The sagittal band, transverse and oblique fibres of the intrinsic mechanism on ulnar side of the fingers (as well as ADQ of little finger) are divided/released. Commonly performed in conjunction with MCP joints synovectomy or arthroplasty.
Cross intrinsic transfer	Ulnar deviation of fingers.	Release of intrinsic muscles from the ulnar sides of the index, middle, and ring fingers and transfer to the radial aspect of adjacent fingers to provide additional radial stability.
Extensor tendon centralization	Extensor tendon subluxation resulting in ulnar drift of the fingers and/or volar subluxation of the MCP joint.	Repositioning of subluxed extensor tendons over dorsum of metacarpal heads to restore joint extension and correct deformity.
Metacarpophalangeal joint arthroplasty	Damage of the articular cartilage and moderate to severe joint deformity that is not correctable by soft tissue procedures only.	Multiple longitudinal dorsal incisions or single transverse dorsal skin incision to gain access to MCP joints. The metacarpal heads are resected, the implant is then sized and inserted into pre-prepared medullary canals. An important step is to centralize extensor tendons at the end of the procedure.

Adductor digiti quinti (ADQ)

Table 3

Common reconstructive procedures performed for Swan-neck and Boutonnière deformities

Procedure	Description
Swan neck deformity	
FDS tenodesis	This procedure corrects PIP joint hyperextension. A proximal slip of FDS is divided proximally leaving the distal end attached. The FDS is then re-attached proximally to A1 pulley or anchored to the bone with PIP joint in 30 degrees of flexion.
Retinacular ligament (Littler) reconstruction	This procedure simultaneously corrects PIP joint hyperextension and restores extension of the DIP joint. The ulnar lateral band is divided proximally leaving the distal end attached. The lateral band is then mobilized under Cleland ligament volar to axis of rotation of PIP joint and sutured proximally to the flexor sheath. Tension is adjusted so that it allows for simultaneous PIP joint flexion and DIP joint extension.
Boutonnière deformity	
Central slip reconstruction	Correction of the PIP joint flexion in boutonniere deformity is achieved by central slip shortening and dorsal mobilization of the lateral bands. The DIP joint hyperextension is corrected by dividing the extensor tendon (tenotomy) to allow DIP joint flexion whilst preserving oblique retinacular ligament to maintain ability of DIP joint extension.

Table 4

Summary description of common tendon reconstruction procedures performed in rheumatoid arthritis

Ruptured tendon	Reconstruction
Extensor tendons	
EPL	Tendon transfer: EIP to EPL
EDM	End to side: EDM to EDC5, OR Tendon transfer: EIP to EDM
EDM+EDC 5	End to side: EDM/EDC5 to EDC 4, OR Tendon transfer: EIP to EDC5 +EDM
EDM+EDC5/4	End to side: EDC4 to EDC3, AND Tendon transfer: EIP to EDC5+EDM
EDM+EDC5/4/3	End to side: EDC3 to EDC2, AND Tendon transfer: EIP to EDC4/5+EDM
All four fingers	Tendon transfer: FDS3 (long) to power index and long fingers & FDS4 (ring) to power ring and little fingers. FDS tendon transfer through the interosseous membrane was first described to restore fingers extension in patients with radial nerve palsy. However the relative long outreach of the FDS tendons allows the muscle to be bridged subcutaneously around the radial side of the forearm in order to avoid the potential scarring from tunneling the through the interosseous membrane.
Flexor tendons	
FPL	Tendon graft: PL or FCR, OR Tendon transfer: FDS3 to FPL, OR IP arthrodesis if the MCP joint is relatively spared.

Extensor indicis proprius (EIP), extensor pollicis longus (EPL), extensor digitorum communis (EDC), extensor digiti minimi (EDM), flexor pollicis longus (FPL), flexor digitorum superficialis (FDS), flexor carpi radialis (FCR), palmaris longus (PL).