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Review Article

Review of the Surgical Treatments Available for Rheumatoid Arthritis at the Wrist and Hand

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Introduction

Rheumatoid arthritis is a chronic, systemic autoimmune disease, which leads to joint swelling, degeneration and deformity. The hand, wrist and Distal Radioulnar Joint (DRUJ) are the most frequently involved joints in the upper limb, affecting 80% of cases [1]. There is an early predisposition for these joints in the disease process and after 12 years 95% of rheumatoid arthritis patients have signs of wrist arthritis [2]. However modern medication, particularly Disease Modifying Anti-Rheumatic Drugs (DMARDs) have revolutionised rheumatoid arthritis treatment and patients' lives; DMARD's have been shown to limit peripheral joint disease by 5 years when given in the first 2 years of early rheumatoid disease [3]. Slowing the disease progress and ultimately joint destruction consequently postpones future surgery. Yet the role of surgery in managing disease progression is still as important as ever. This article reviews the surgical treatment options available for the treatment of the rheumatoid hand and wrist, which have failed conservative management.

Keywords: Rheumatoid Arthritis Review; Ra Hand Surgery; Rheumatoid Surgical Treatments

Synovitis/Joint Synovectomy

The pathophysiology of rheumatoid arthritis commences with initial inflammation of the joint and evidence of soft tissue hypertrophy. The synovium becomes thickened which leads to the appearance of joint swelling particularly at the DRUJ and Metacarpal Phalangeal Joints (MCPJs) (Figure 1a).

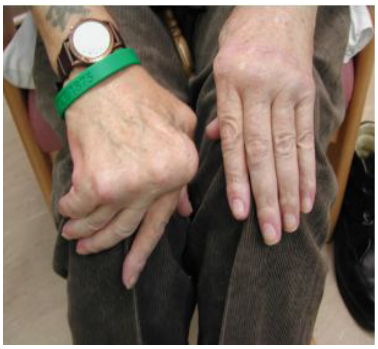
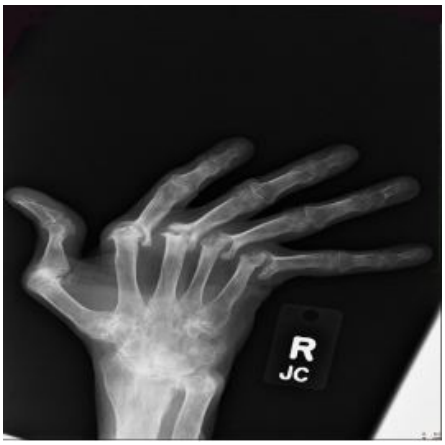


Figure 1a and 1b: Appearance of rheumatoid hands with volar subluxation at the MCP joints and ulnar deviation of the right-hand fingers. Left hand 1 year after Swanson MCPJ replacements (b) Radiological appearance of the end stage rheumatoid hand and wrist with ulnar deviation, joint subluxation and carpal bone destruction.

These swellings continue to enlarge, can become painful and may limit movements at the wrist and hand. Studies have shown that the thickened synovium produces proteolytic enzymes and cytokines such as Inter Leukin 1 (IL-1), Inter Leukin 6 (IL-6) and Tumour Necrosis Factor alpha (TNF-a) which cause joint destruction [4, 5] (Figure 1b).



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Surgery in the form of synovectomy aims to excise the inflamed synovium from the joint capsule. By reducing the amount of proteolytic enzymes and cytokines produced, the disease process and joint destruction would be diminished, whilst maintaining pain free hand and wrist function [6,7]. Studies suggest synovectomy is performed in patients with persistent synovitis for 3 months despite medical treatment [8] in cases with little radiographic destruction.The majority of synovectomies are performed as open procedures however arthroscopic synovectomy has been described. Park et al [6] described 18 patients that underwent arthroscopic synovectomy. All had pain and dysfunction of their wrists due to synovitis. They excluded those with tenosynovitis and advanced DRUJ that had undergone arthroplasty. Using visual analogue scores they observed an improvement in postoperative (3.6) compared to preoperative pain (8.6).

Further isolated synovectomy studies appear limited. Other studies have described synovectomy as a combined procedure with partial wrist arthrodesis, distal ulna excision or tendon transfer [2,9-11]. This was because synovectomy was thought to lead to carpal instability and deformity [7]. Their results reflected similar outcomes of reduce pain and disease progression compared to Park et al [6]. However, the effect of combining a stabilisation procedure makes these results difficult to interpret. Current literature is limited with no comparative studies between synovectomy, and synovectomy combined procedures, to support these results.

Tenosynovitis/Tenosynovectomy

Tenosynovitis is where the inflamed, hypertrophied synovium begins to invade the tendons of the wrist and hand [2]. Both extensor and flexor tendons can be involved, which could lead to tendon rupture [12,13]. The little, ring and middle finger tendons are most commonly affected [14,15]. Tenosynovectomy involves the excision of inflamed synovial tissue around the extensor and flexor tendons. It is normally preformed early in the disease process to prevent both tendon rupture and recurrent tenosynovitis [16]. A study by Brown and Brown [17] reviewed the outcome of 125 RA patients who underwent tenosynovectomy of which 50 % of patients had tendon invasion at the time of surgery. At 5 years follow up tendon failure was evident in only 2% of patients with normal tendons or invaded tendons at the time of surgery. However, the failure rate was highest (7%) in those who had tendon rupture at the time of surgery. Recurrent tenosynovitis was also low (5.6% at 5 years), suggesting that early and prophylactic surgery is of benefit.

Extensor Tendon Ruptures-Thumb

Tendon ruptures frequently occur spontaneously in rheumatoid arthritis and present with loss of active extension at the affected MCPJ. This loss of active extension disturbs hand function by altering muscle balance, leading to further deformity and loss of function [18]. Vaughan Jackson was the first to identify the importance of this functional loss and to treat this surgically [19].

Isolated extensor tendon ruptures do occur and are frequently seen around Extensor Pollicis Longus (EPL) [20]. Functional loss varies in each patient and the rupture may go undetected for some time as the intrinsic muscles of the hand also allow Inter Phalangeal Joint (IPJ) extension [20]. Pathology has been attributed to direct synovial invasion or attrition from EPL's attachment to Lister's tubercle. Interestingly this tendon rupture has not been associated with radiological destruction of the wrist DRUJ [21]. A variety of surgical treatments have been described; end to end repair, tendon graft or tendon transfer [21-23]. Direct end to end repair is rarely possible as these ruptures are chronic, with the tendon normally in poor condition [24]. A gap also exists between its ends as the muscle attachment undergoes atrophy, fibrosis and contraction, causing the proximal tendon to retract to the wrist [20,25]. The advantage of a tendon graft is that it can overcome the tendon gap whilst avoiding any extensor lag or functional compromise to the index finger, which a tendon transfer may have. It involves the harvesting of a tendon, frequently palmaris longus and anastomosing this to the two ends of EPL. The disadvantage of this technique is that it relies on two suture anastomoses, either which may fail. A small study by Magnell et al [24] studied the outcome of 19 patients (3 rheumatoid patients) who underwent EPL repair using intercalated tendon graft from 1-12 weeks post rupture. They reported an overall subjected improvement in patient's satisfaction

with all patients able to raise the thumb to the level of their palm. Unfortunately, however they identified a reduction in pincher grip and metacarpalphlangeal- interphalangeal joint range of movement post-surgery. Interestingly no comment was made to this reduction in range of movement effecting thumb function. Failure of tendon graft was reported low at 5% (1 in 19 patients) due to rupture.

Tendon transfers are more commonly used to reconstruct EPL. Extensor Indicis Proprius (EIP) is the mostly frequently used tendon due to its location and length but extensor carpi radialis longus or extensor pollicis brevis have also been described [15,26]. The procedure involves the transfer of the distal portion of the EIP tendon, which is sectioned proximal to its insertion into the extensor hood. It is passed through a subcutaneous tunnel and then sutured to the origin of EPL. Many suturing techniques have been described to secure the graft; side to side and the most popular Pulvertaft weave [27,28].

A small study by Magnussen et al [28] reviewed the outcome of 21 patients after EPL reconstructed with EIP tendon transfer. They showed that no patient had an extension deficit in the thumb, MCPJ or IP joint. Strength of the operated thumb averaged 51% compared to the non-operated side, whilst key pinch strength was good at 90%. In all patients a reduction in donor index finger strength was identified. Subjectively 19 out of the 21 patients described their results as 'Good' whilst 2 identified their result as 'Poor'. Further studies have echoed these findings with similar successful outcomes [29,30]. A small study by Schaller et al. [31] compared the results of 17 patients who had intercalated tendon graft versus 24 who had EIP tendon transfer. Although the study was limited in terms of patient size, lack of randomisation and a short follow up (mean of 4.3 years) they found no significant difference between the techniques. A further observational study by Manner felt et al [32] identified 23 rheumatoid patients that underwent tendon graft or transfer after EPL rupture. Unfortunately, they lost half of their patients to follow up, however interestingly their subjective results of wrist and thumb IPJ extension showed the tendon grafts to be superior to tendon transfers. The limitations of these studies illustrate that more randomised control trials are required to confirm these results.

Finger Extensor Tendon Ruptures

Rupture of the finger extensor tendons can similarly be repaired by direct tendon repair, tendon graft and tendon transfers usually EIP and flexor Carpi ulnaris [33,34]. However, in his 1948 paper Vaughan-Jackson [19] attributed rupture of the little and ring extensor tendons to attrition from bony spurs around the DRUJ. Further studies have also confirmed that these ruptures are associated with DRUJ destruction [15]. This has importance on surgical treatment as without addressing the degenerative DRUJ at the time of tendon reconstruction the rate of tendon re-rupture has been reported to be higher [15]. Consequently, studies have suggested combining tendon reconstruction with synovectomy and a Darrach procedure [15,33]. Popularised by Darrach in New York in 1911, it involved the excision of the distal 1-2 cm of ulna, just proximal to the sigmoid notch (Figure 2).

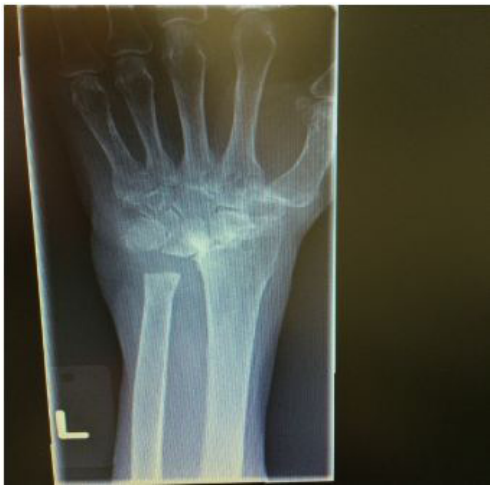

Figure 2: Darrach's procedure: Resection of the distal ulnar head just proximal to the sigmoid notch.

The ulna resection is made parallel to the slope of the distal radius in order to prevent impingement. The aim was to remove any bony spurs that could lead to tendon attrition and alleviate any associated ulnar sided wrist pain. Overall outcomes suggested that the Darrach's procedure significantly reduced wrist pain and improved wrist extension, pronation and supination but its effect on reducing the incidence of tendon ruptures remains unclear [35,36]. Unfortunately, however the procedure is not without complications, which can include; instability of the wrist and translocation of the carpus [37,38]. Some authors advocate tenodesis of extensor carpi ulnaris or insertion of an allograft to prevent this [39], however no study has demonstrated any additional advantage from stabilisation of the proximal ulna stump at the time of the initial Darrach procedure.

Multiple Finger Extensor Tendon Ruptures

Two or more extensor tendon ruptures are difficult cases to surgically treat and frequently become salvage procedures. Tendon transfers using EIP and flexor digit rumsuperficial is have been described for multiple extensor tendon ruptures [40]. Although the current studies in the published literature are small, the outcomes show an improvement in finger extension as flexor digit rumsuperficial is works by a tenodesis effect, straightening the fingers during wrist flexion [40]. Tendon grafts, particularly Palmaris long us or Plantaris have also been used for reconstruction [33,34,41]. Initial outcomes of multiple tendon grafts have appeared good with significant improvement in extensor lag and overall hand function [33,41]. However, one study by Nakamura et al [34] highlighted this benefit was not maintained at follow up at 48 months. They also showed the importance of time to reconstruction surgery [34].

They noticed that a restriction in finger flexion post-surgery resulted in worse patient satisfaction outcome compared to an extension deficit. It was thought that a late presentation of tendon rupture resulted in muscle contraction and finger flexion, which could not be resolved by surgery. Earlier diagnosis and surgical intervention may have prevented this.

Flexor Tendon Ruptures

Rheumatoid patients who present with loss of active flexion at the MCPJ or IPJ may have flexor tenosynovitis or tendon ruptures. Flexor tendons ruptures are not uncommon. A classic paper by Mannerfelt and Norman [42] identified 23 (38%) of their 66 rheumatoid patients with a flexor tendon rupture. Flexor Pollicis Longus (FPL) was the most frequent ruptured flexor tendon identified, followed by the index finger Flexor Digitorum Profundus (FDP) - Mannerfelt lesion. They accounted for FPL rupture by the invading synovium and bony prominences. Frequently rupture of FPL and FDP are missed on clinical examination particularly when a FDP is functionin. Surgery is recommended even when symptoms are minimal so to prevent further functional loss.FPL tendon rupture can be treated by tendon graft or reconstruction, however direct repair achievable in a minority of patients. As the rupture occurs mainly in the carpal tunnel a short palmaris tendon graft is frequently used. Alternatively, flexor digitorumsuperficialis from the ring finger can also be used if the MCPJ joint mobility is required in younger patients [43]. Thumb interphalangeal fusion is an option if joint pain and arthropathy is present.

Metacarpal Synovitis and Arthropathy

As previously described synovectomy can be performed on swollen MCPJs early on in the disease process to restore some function. As the disease progresses the joints become destroyed. The extensor tendons become dislocated and the fingers drift ulna (Figure 1b and 1b). With dislocated extensor tendons simple tasks become very difficult, although commonly pain spontaneously improves with joint dislocation. MCPJ implants can relieve pain and restore functional impairment (in particular flexion and extension at the MCPJ), increase grip strength and decrease the ulna drift (Figure 3) [44].

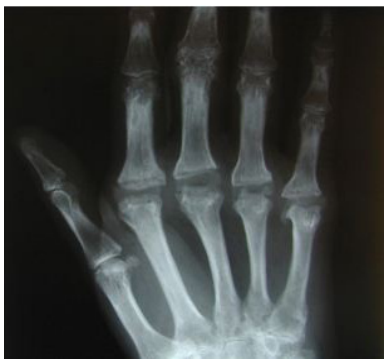

Figure 3: Swanson's MCP joint arthroplasties with silastic implants 5 years postoperatively.

Many type of implants have been described e.g. Swanson, Sutter. One Randomised Controlled Trial (RCT) compared the Swanson prosthesis with the Sutter prosthesis [45]. No significant difference was found between the prosthesis. Another RCT by Sollerman et al compared silicone and polyurethane prosthesis [46]. To date Swanson MCPJ replacements remain the most common procedure.

Interphalangeal Arthropathy

Frequently rheumatoid patients complain of pain and reduced range of movement at the Inter Phalangeal Joints (IPJs). Both arthroplasty and arthrodesis have been described. Studies describing arthroplasty have included those rheumatoid patients with pain, deformity and synovitis [47]. In this study by Ashworth et al, the results suggested that postoperatively patients had a reduction in pain and clinical deformity. However, their range of movement at the IPJs was slightly reduced (38o preoperatively and 29 o postoperatively). Searching the literature shows studies that have similar and opposing results, which makes predicting the range of movement postoperatively very difficult [48, 49,50,51].

Although the long-term outcome survivorship of IPJ arthroplasty appears good with only 19% of silicone implants requiring revision at 9 years [47] Complications are rare but include disease relapse, fracture, implant dislocation and infection [5,50].

Arthrodesis is another surgical option available to those patients with IPJ pain, deformity, dislocation or marked ligamentous instability who have failed conservative treatment [52]. Fusion techniques using Herbert screws, Kirschner wires, plating and tension band wiring have been described (Figure 4a and 4b) [53].

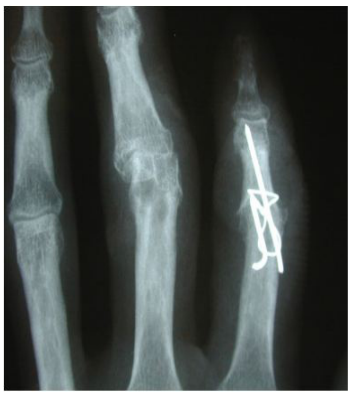

Figure 4a

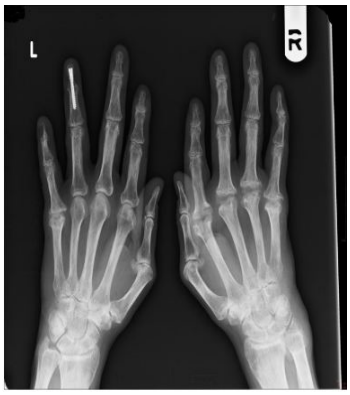

Figure 4b

Figure 4a and 4b: (a) PIPJ- and (b) DIPJ Arthrodesis using tension band wires and cannulated screw.

One retrospective study by Leibovic and Strickland [54] compared the different techniques available in 224 IPJ arthrodesis. They found the non-union rate was the lowest using the Herbert screw and the highest using the Kirschner wires. Overall studies suggest IPJ arthrodesis relieves pain and provides a stiff joint with

improvement in hand function [52,53].

Wrist Pain, Deformity and Arthropathy

Wrist pain from the destructive inflammatory arthropathy of rheumatoid arthritis is common. As previously described a Darrach procedure (see above) can be performed for ulna sided wrist pain especially those who have erosive changes in their distal ulna head and DRUJ pain. An alternative is hemiresection of the distal ulna (Bowers procedure), where the articular ulna head is excised leaving the shaft and styloid intact. The procedure mandates that the Triangular Fibro Cartilage Complex (TFCC) ligament must be intact or repairable [55]. For many rheumatoid patients this would mean early interventionas the TFCC is frequently damaged early on in the disease process. By preserving the distal ulna, the carpus is prevented from drifting more ulnas. Extensor Carpi ulnaris, the ulna carpal ligaments and TFCC stability are also maintained so preserving the normal loading between the carpus and forearm [1]. Bowers described a good patient outcome at an average of 2½ year of follow up [55] with 85%of his rheumatoid patients having a stable painless pronation and supination at the wrist joint [55].

Sauvé-Kapandji is another procedure which has been described for active rheumatoid patients with wrist pain, ulnar translocation, caput ulna syndrome or dorsal prominence of the ulna head [56,57]. It involves the arthrodesis of the DRUJ with a proximal osteotomy of the ulna to create a pseudarthrosis (Figure 5a and 5b).

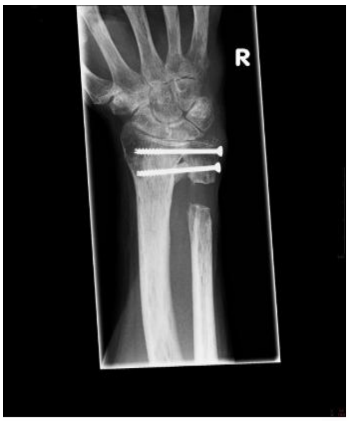

Figure 5a

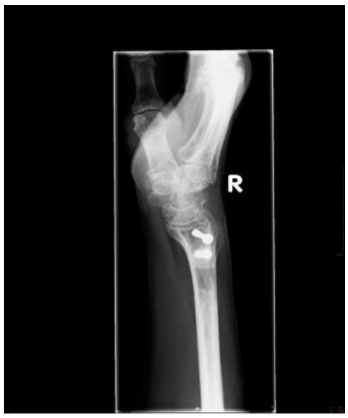

Figure 5b

Figure 5a and 5b: Sauvé-Kapandji procedure involves removing approximately 10mm of ulna proximal to the DRUJ, which is used by transfixing the distal fragment to the radius by virtue of screws and using the resected ulna segment as autograft.

Movements of pronation and supination then occur through this pseudarthrosis. The advantage of this partial fusion is that it provides wrist stability with maintenance of the ulna support structures whilst allowing movement. Studies suggest it has good patient outcome with a reduction in pain and improved or maintained, pronation and supination [58,59]. Complications include distal stump instability, impingement and extensor tendon rupture, however these remain low [60]. These complications appear to be less frequent compared to a Darrach procedure [57].

DRUJ arthroplasty is another option for surgical intervention. With examples such as the Swanson silicone ulna head, Uhead prosthesis and the Herbert ceramic head amongst others [57,61]. These arthroplasties replace the ulna head alone but depend on an intact sigmoid notch. Concerns have been raised with an early failure rate and the long term stability of the prosthesis [62, 63]. A small cohort study by McMurtry et al [64] demonstrated that bone re-absorption around the prosthesis was greatest in the rheumatoid arthritis group, predisposing them to early implant failure. They also described a revision rate of 10% for silicone synovitis. Consequently, they recommended the implant to be restricted to use in elderly patients with rheumatoid arthritis [64]. Recently semi constrained devices have been designed to tackle the instability and early failure rate [57], however good long term outcomes have so far only been demonstrated in post-traumatic arthritic cases [65].

Fusion of the wrist has been one of the standard surgical techniques for wrist pain, instability and fixed flexion in rheumatoid patients with advanced arthropathy [66]. The aim is to provide stability at the DRUJ and in so doing relieve pain. Standard techniques describe fusion of the radius with the 3rd Metacarpal utilising rods, pins or plates [66-68]. To aid fusion a trough is developed between the radius and 3rd Metacarpal where autogenous bone graft is placed [69]. Historically surgeons have described insertion of a Rush or Steinmann pin down the 3rd Metacarpal shaft into the radius [69,70] (Figure 6a and 6b).

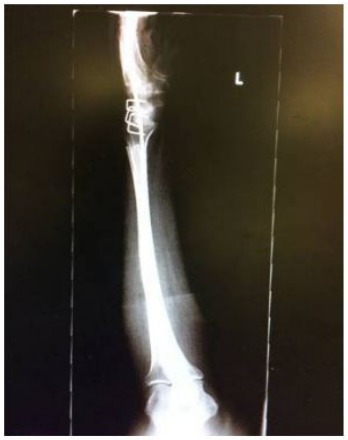

Figure 6a

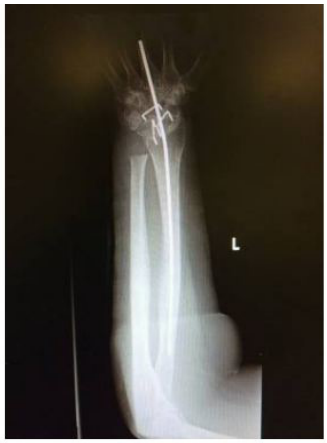

Figure 6b

Figure 6a and 6b: The postoperative AP (6a) and lateral (6b) radiographic view of the wrist following the tunnel Mannerfelt procedure

Millender and Nalebuff modified this technique by suggesting the insertion to be in the 2nd or 3rd web space [71]. Advocates of intramedullary rod or pin techniques have described its advan-

tages, which included the simplicity of the technique, low implant costs, quicker operative time, the ability to perform multiple operations on the hand at the same time and to choose the position of the wrist for arthrodesis [72,73]. Complications appear to be low and arise mainly due to the implant, such as pin migration, pin breakage, infection, skin and tendon irritation [70]. The use of plates for wrist arthrodesis has been driven by their reported high union rates [68]. The AO Synthes dorsal plate ultilises a low profile contour design, which allows the wrist to be fused in 10 degrees of extension. However even with its low profile; Meads et al [68] reported tendon irritation and a plate removal rate of 15%. Further complications have also been associated with the use of plates for arthrodesis such as tendon rupture, poor wound healing, non-union and acute carpal tunnel syndrome [68].

Long term outcome studies report arthrodesis to be safe and reliable with good patient satisfaction [72,74]. This appears to be reflected when comparing it to arthroplasty. A systematic review compared 18 arthroplasty studies to 20 arthrodesis studies in rheumatoid patients with wrist disease [75]. They found that although patient satisfaction was high in both groups, wrist arthrodesis gave more reliable relief of pain than arthroplasty. Unsurprisingly, the rate of complications and revision surgery were higher in the wrist arthroplasty group. Overall, they recommended that wrist arthrodesis should be the treatment of choice in these patients. However, the results of wrist arthrodesis are not always beneficial. Some studies have suggested that certain patients struggle with certain tasks such as opening jars, writing and personal hygiene [68]. For those rheumatoid patients with multiple joint involvement e.g. contra-lateral shoulder or elbow, these simple tasks would be very difficult to do with a wrist arthrodesis. It is therefore not a straight forward procedure to consider in every patient. Time must be taken for correct patient selection and then discussion for the possible functional benefit and impact on the patient's life. For those patients who have isolated or multiple joint rheumatoid arthritis, partial wrist denervation (Figure 7)

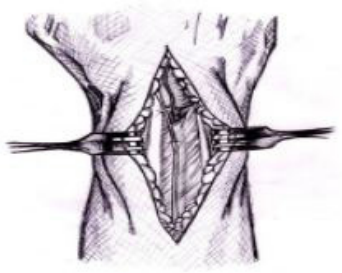

Figure 7: The posterior interosseous neurectomy is performed through a single dorsal longitudinal skin incision approximately 3cm proximal to the carpus. The posterior interosseous nerve lies on the floor of the 4th extensor compartment.

With resection of the distal Posterior Interosseous Nerve (PIN) is an alternative to arthrodesis [76]. It is used in those patients with advanced disease, who wish to be pain free but want to maintain some wrist movement. A preceding local anaesthetic PIN infiltration test is mandatory to ensure adequate pain relief. The procedure is technically simple and involves the resection of posterior interosseous nerve, whose terminal branches innervate the wrist joint capsule [77]. Studies have shown a significant reduction in wrist pain, normal or increase grip strength and patients returning to work [78,79]. Long term studies of wrist denervation in arthritis patients around 10 years' post-surgery continue to show good patient satisfaction but this is unclear in rheumatoid patients [80]. However recently published short to mid-term results in RA patients with residual wrist mobility have been extremely encouraging [77]. With few complications, this relatively safe procedure can be performed knowing that the option of arthrodesis is still available in the future.

Conclusions

The aim of this review was to describe the surgical options available when treating a rheumatoid arthritis patient with hand and wrist disease. Searching the literature has revealed the limitation of randomised control trials, unbiased patient selection and limited outcome measures, making some surgical decisions unclear. Besides this, the available evidence, in the form of cohort and case studies does suggest some trends.

It appears that early synovectomy and tenosynovectomy yield benefits for reducing the disease progress and preventing tendon rupture. When tendon rupture does occur, either flexors or extensors, treatment in the form of early tendon graft or transfer has the best functional outcome. Symptomatic metacarpal joint destruction (pain and loss of function) can be successfully treated with arthroplasty. Interphalangeal joint pain and deformity can be treated with arthroplasty or arthrodesis, although arthrodesis provides more predictable outcomes.

Isolated, DRUJ related wrist pain can be treated by distal ulna excision for ulna sided wrist pain but in the active, young patient a Bowers or Sauvé-Kapandji should be considered. In those with advanced rheumatoid disease wrist arthrodesis appears the gold standard, using pins or rods to reduce complications rather than plates, although recently PIN denervation should be considered first in patients with some preserved wrist mobility. With advancing technology arthroplasty designs will improve making wrist arthroplasty a true surgical alternative to wrist arthrodesis.

Disclosure

The authors have declared no conflict of interest. We confirm that all persons involved in this study gave their informed consent prior to their inclusion in the study and that this study has been performed in accordance with the ethical standards laid down in the 1964 Declaration of Helsinki and its later amendments.

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