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Original article

Combined synovectomy and extensor carpi radialis longus transfer to realign and stabilise the rheumatoid wrist

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ABSTRACT

Background: In patients with rheumatoid arthritis, the surgical treatment of wrist lesions relies on synovectomy combined with stabilisation and realignment of the carpal bones. The objective of this study was to evaluate the outcomes and define the indications of extensor carpi radialis longus (ECRL) transfer to the extensor carpi ulnaris (ECU) as described by Clayton and Ferlic.

Hypothesis: ECRL-to-ECU transfer combined with synovectomy can prevent the development and/or progression of rheumatoid deformities at the wrist.

Material and methods: A retrospective observational study was performed in 16 wrists. The following data were collected before and after surgery: pain, synovitis, range of motion, carpal height, ulnar translocation and radial deviation of the carpal bones, and Larsen's grade of the radio-carpal and mid-carpal joints.

Results: After a mean follow-up of 42.5 months after surgery, pain relief was noted in 14 cases and synovitis resolution in 10 cases. Mean mobility gains were 19.7° in extension and 5.7° in flexion. The radiographs showed a decrease in carpal height, whereas radial deviation and ulnar translocation were unchanged. No change was seen in the radio-carpal and mid-carpal joint lines. In the 3 wrists that required mid-carpal arthrodesis due to advanced disease before surgery, the radio-carpal joint line was unchanged and outcomes were the same as in the overall population.

Discussion: ECRL-to-ECU transfer combined with synovectomy provides pain relief and prevents radio-carpal destabilisation. The main indication of ECRL transfer is reducible radial deviation and ulnar translocation. ECRL is also indicated in combination with mid-carpal arthrodesis in the small minority of patients who have predominant mid-carpal involvement with a Larsen grade greater than 2.

Level of evidence: IV, retrospective observational study.

1. Introduction

Synovial tissue is the main target of rheumatoid arthritis (RA). At the wrist, synovitis distends the joint capsule and impairs the ligaments and tendons, causing radio-carpal destabilisation and malalignment [1]. The deformities progress according to a documented and predictable sequence governed by the extension of the synovial pannus along the main blood vessels of the wrist [2]. Knowledge of the pattern of progression of dorsal rheumatoid wrist deformities can be used to design a treatment strategy [3]. In addition to synovectomy, this strategy must include a procedure to stabilise and realign the wrist [4].

When the radio-carpal joint cartilage is intact, conservative surgery involving stabilisation by tendon transfer can be used in combination with synovectomy. The frequency of advanced rheumatoid wrist deformities has diminished substantially since the introduction of biotherapies such as TNFα antagonists and, more recently, IL-17 antagonists. Nevertheless, surgery remains required in patients with no local synovitis response to pharmacotherapy and in those with isolated wrist malalignment who can be protected from further destruction by the administration of biotherapies.

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The objective of this study was to evaluate the outcomes and define the indications of extensor carpi radialis longus (ECRL) transfer to the extensor carpi ulnaris (ECU) as described by Clayton and Ferlic [5]. The working hypothesis was that ECRL-to-ECU transfer combined with synovectomy can prevent the development and/or progression of rheumatoid deformities at the wrist.

2. Patients and methods

Of 128 patients (144 wrists) who had surgery for rheumatoid wrist disease between 1995 and 2007, 15 (16 wrists) were managed using the same ECRL-to-ECU transfer technique, including 14 (93%) by the same surgeon. All surgical reports were reviewed to ensure that the surgical procedure included stabilisation and realignment as described by Clayton and Ferlic [5]. ECRL-to-ECU transfer was performed in patients with wrist pain warranting surgical synovectomy [6] and/or destruction of the distal radio-ulnar and/or mid-carpal joint, with an intact radio-carpal joint line and reduction of the ulnar translocation on the radiograph taken in ulnar inclination.

2.1. Operative tendon transfer technique

The procedure was performed under local and regional anaesthesia with a tourniquet. Through a longitudinal dorsal incision, the dorsal retinaculum was elevated from the ulnar to the radial side of the wrist. Extensor teno-synovectomy was performed, and the posterior inter-osseous nerve was severed. If the clinical findings, radiographs, and intra-operative findings in terms of appearance of the cartilage and stability of the ulnar head indicated involvement of the distal radio-ulnar joint (DRUJ), synovectomy was performed, combined, if appropriate, with ulnar head resection as described by Darrach [7]. Radio-carpal and mid-carpal arthrotomy was performed to allow articular synovectomy. If the mid-carpal joint line was involved, arthrodesis was performed, followed by fixation with two pins and a shape-memory staple. The ulnar stump was stabilised by overlapping suture of the distal radio-ulnar joint capsule and by the ECRL-to-ECU transfer. The extensor retinaculum was wrapped around the extensor tendons of the third, fourth, and fifth compartments then sutured to itself to retain the tendons behind the radius. Finally, the ECRL tendon was cut at the base of the second metacarpal, slipped under the extensor tendons, and sutured to the ECU tendon as described by Pulvertaft (Fig. 1). The ECRL transfer ensured dorsalisation of the ECU tendon behind the ulna.

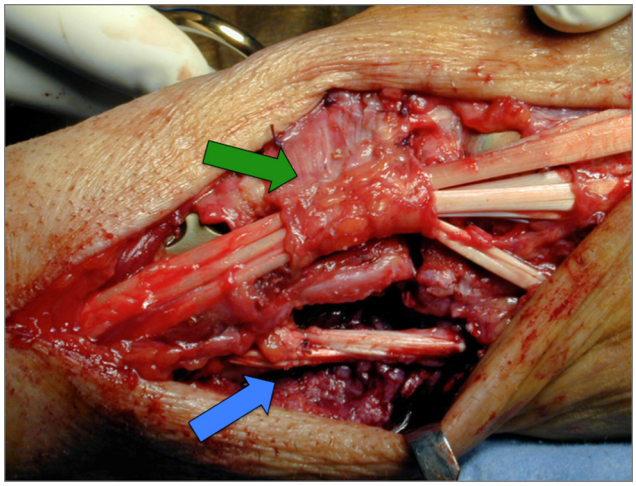

Fig. 1. Intra-operative view: extensor tendon stabilisation using the retinaculum (green arrow) after transfer of the extensor carpi radialis longus transfer to the extensor carpi ulnaris (blue arrow) combined with distal ulna resection (Darrach's procedure).

Table 1
Steinbroker functional classification.

Class	Functional ability
I	Complete ability to carry out all the usual duties without handicaps
II	Adequate for normal activities despite handicap of discomfort or limited motion of one of the joints
III	Limited to little or none of the duties of usual occupation or self-care
IV	Incapacitated, largely or wholly bed-ridden or confined to a wheelchair with little or no self-care

2.2. Patients

This study included 15 consecutive patients with polyarticular RA, 14 females and 1 male, with a mean age at surgery of 52.3 years (range, 15–81 years) and a mean disease duration of 12 years (range, 4–36 years), during which a mean of two disease-modifying anti-rheumatic drugs had been used. The dominant side was involved in 11 cases. Of the 15 patients, 11 were in work, including 4 in heavy manual jobs. A history of one or more surgical procedures for RA was noted in 11 patients, including 3 patients who had had surgery on the wrist under study consisting in flexor teno-synovectomy ($n = 1$) or extensor indicis proprius tendon transfer to the extensor pollicis longus tendon (wide-awake approach, $n = 2$). Non-surgical local treatments including orthoses, local injections, and radiation synovectomy had been used in 10 patients.

2.3. Clinical findings before surgery

Before surgery, 15 of the 16 wrists had been painful for longer than 6 months, with a mean visual analogue scale (VAS) score of 5.5/10 (range, 4–9). The mean Steinbrocker functional score [8] (Table 1) was 2.2 (2–3). Location of the pain was available for 11 wrists and was over the DRUJ in 4 cases, over the mid-carpal joint in 1 case, and over both the DRUJ and the radio-carpal and/or mid-carpal joint in 6 cases. The extensor pollicis longus tendon was ruptured in 1 wrist and the extensor digiti quinti proprius tendon in another wrist. Information on synovitis was available for 14 wrists, of which 1 had no synovitis, 5 major synovitis, and 8 moderate synovitis. Of the 12 wrists with available information, 3 had no deformity, 1 severe deformity, and 8 moderate deformity. The ulnar head was dislocated in 3 wrists and unstable in 2 wrists. Mean range of motion was 30.8° in extension and 33.3° in flexion.

2.4. Radiographic assessment before and after surgery

The following radiographic parameters were evaluated before and after surgery:

- carpal height, to assess carpal collapse, using the Nattrass index [9,10]. The Nattrass index was deemed preferable over the Mc Murtry and Youm index [11] because it is less dependent on the quality of the radiographs and can be determined even in patients with damage to the third metacarpal head. The mean Nattrass index before surgery was 0.69 (range, 0.29–0.88; normal, 0.64 ± 0.02);
- ulnar carpal translocation, using the Di Benedetto index [12]. The Di Benedetto index was preferred over the Mc Murtry and Youm index (ulno-carpal translation index) [11], as the latter relies on the axis of the ulna, which is difficult to determine on radiographs after the Darrach procedure. The mean Di Benedetto index before surgery was 0.11 (range, 0.03–0.22; normal, 0.105 ± 0.024);

- radial carpal deviation, assessed as described by Shapiro [13]. Mean radial carpal deviation before surgery was 0.08 (range, 0.03–0.14; normal, 0.09 ± 0.02);
- wrist destruction-destabilisation according to the Simmen classification [2]. Before surgery, 1 wrist was type 1, 14 wrists were type 2, and 1 wrist was type 3;
- quality of the mid-carpal and radio-carpal joint lines, assessed based on the Larsen grade [14]. Before surgery, the radio-carpal joint line was grade 0 in 4 wrists, grade 1 in 5 wrists, grade 2 in 4 wrists, grade 3 in 2 wrists, and grade 1 in 1 wrist. At the mid-carpal joint, the grades before surgery were 0 in 4 wrists, 1 in 1 wrist, 2 in 6 wrists, 3 in 2 wrists, and 4 in 3 wrists.

2.5. Categorisation of patients

Based on the preoperative clinical and radiological evaluation, the wrists were categorised into three groups:

- 9 wrists had early synovitis refractory to non-operative treatment, with intact mid-carpal and radio-carpal joint lines but incipient destabilisation;
- 4 wrists had symptoms from the DRUJ and/or teno-synovitis refractory to non-operative treatment, as well as some radio-carpal joint impairment but with limited symptoms and no loss of mobility;
- 3 wrists had symptomatic mid-carpal joint destruction and at least partial preservation of the radio-carpal joint line.

2.6. Surgical procedures

DRUJ synovectomy was the only procedure performed for 4 wrists, as there was no cartilage damage indicating a need for ulnar head resection. For 1 wrist that had no DRUJ synovitis, DRUJ arthrotomy was not performed to avoid inducing joint stiffness. Thus, Darrach's procedure was not performed in 5 wrists.

Larsen grade 4 mid-carpal involvement and severe cartilage damage were noted in 3 wrists, including 1 wrist with ankylosis according to the Simmen classification. Mid-carpal arthrodesis was performed for these 3 wrists.

2.7. Postoperative assessment

At last follow-up, we assessed complications, subjective functional impairment, pain intensity on a VAS, source of pain, motion range, whether synovitis or teno-synovitis was present with its severity, whether a deformity of the wrist was present, stability of the ulna, whether any tendons were ruptured, and overall patient satisfaction.

3. Results

Mean follow-up was 42.5 months (range, 4–121 months). Of the 15 patients, 1 had died and 2 were lost to follow-up. However, information on the patient who died and 1 of the patients lost to follow-up was obtained from a previous visit to the surgeon who had performed the procedure. Three patients were interviewed by telephone. Thus, the functional data reported by the patients were available for 15 wrists and the clinical and radiographic findings were available for 12 wrists.

Complex regional pain syndrome type I (CRPS I) developed in 2 wrists during the immediate postoperative period. There were 2 cases of tendon rupture, involving the extensor digiti quinti proprius tendon, in which damage was observed during surgery, in 1 case, and consisting in the other case in recurrent rupture of the extensor tendons that had been the focus of a wake-up procedure during the initial surgery. None of the wrists required further surgery to treat joint problems.

Pain relief was noted for 14 of the 15 re-evaluated wrists. The mean VAS pain score was 3.5/10. The only wrist that remained as painful as before surgery was in a patient with CRPS I. The Steinbrocker functional score remained unchanged, with a mean of 2.33 (range, 2–4). Two of the patients interviewed over the telephone had a worse Steinbrocker functional score of 4, due to lower limb involvement with RA. Of the 12 wrists re-evaluated during a visit after a mean follow-up of 2.8 years (range, 4 months–9.8 years), 2 had moderate synovitis; 8 had no deformity and 4 a moderate deformity. Mean range of motion had improved by 19.7° (to 50.5° postoperatively) for extension and by 5.7° (to 39° postoperatively) for flexion. No wrist had ulnar stump instability.

The radiographs showed no progression of the carpal deformity in the coronal plane (Fig. 2). The ulnar carpal translocation and radial carpal deviation indices were unchanged. Carpal height was diminished (Table 2). The Larsen grades for the radio-carpal and mid-carpal joint lines were unchanged (Table 3). The 3 wrists with a mid-carpal Larsen grade of 5 were treated by arthrodesis (Fig. 3). Overall radiographic progression was seen for 2 wrists but was minimal. Radiographic progression was doubtful for 2 other wrist sand absent for 8 wrists. Of the 12 patients who were interviewed during a visit or telephone call, 6 (50%) were very satisfied and 6 satisfied with the procedure. The examiner classified the outcome as very good for 5 (42%) wrists and good for 7 (58%) wrists. Finally, 1 (8%) patient, who had unchanged pain after experiencing CRPS I, stated being unwilling to undergo the procedure again.

4. Discussion

The objectives of surgery on the rheumatoid wrist are to relieve pain and improve function. Restoring normal anatomy, in contrast, is not a treatment goal.

In our study, pain relief and complete freedom for pain were achieved in 93% and 50% of wrists, respectively. These findings are consistent with earlier reports. In a study by Dumontier et al. [15], freedom from pain was noted for only 5% of wrists before surgery compared to 66% after surgery. The pain remained absent in 80% to 95% of cases and became more severe than before surgery in 4% of cases. In our study, all wrists that were pain-free after surgery were managed with mid-carpal and radio-carpal synovectomy. Removing the abnormal synovial membrane as completely as possible from all the compartments therefore seems helpful for relieving pain. Freedom from pain may result in motion range preservation or improvement. Of the 3 wrists managed by mid-carpal arthrodesis, 2 were pain-free and had normal ranges of extension and flexion. A single wrist remained as painful as before surgery. CRPS I occurred after surgery in this case. The most frequently listed causes of persistent pain [15] are distal radio-ulnar impingement and local recurrence of the synovitis. However, neither cause can explain the persistent pain in our case, since the Darrach's procedure was performed and there was no clinical evidence of synovitis.

Clinical synovitis was also improved by the surgical procedure. Clinical synovitis was a feature in 94% of the wrists before surgery but was no longer present in 84% of the re-evaluated wrists. In earlier studies, the rate of recurrence of clinical synovitis ranged from 4% to 20%. Factors associated with a higher risk of synovitis recurrence are aggressive RA and localised synovectomy [15].

In patients whose dynamic radiograph in ulnar inclination showed radial carpal deviation and reducible ulnar carpal translocation, Fourastier et al. [15] and Ito et al. [16] reported effective correction of radial carpal deviation with no adverse effect on motion range in the coronal plane and with no worsening of the ulnar carpal translocation. In our study, ulnar carpal translocation

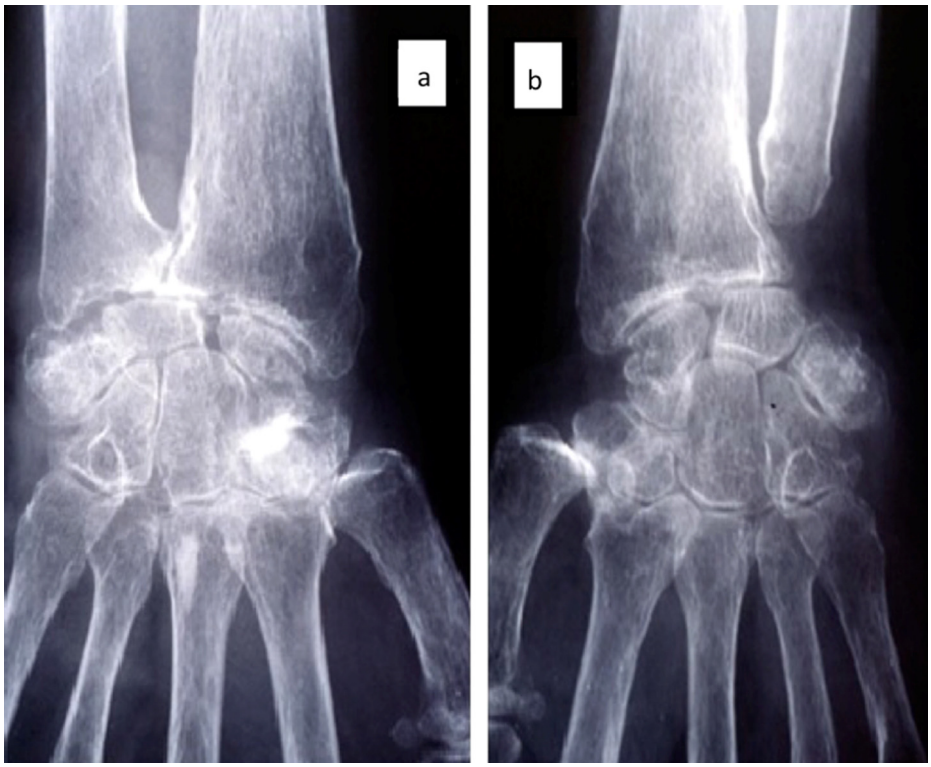

Fig. 2. Antero-posterior radiographs comparing the operated and non-operated wrists 118 months after surgery. a: non-operated wrist: progression of the carpal destruction; b: operated wrist: after extensor carpi radialis longus transfer.

Table 2
Pre- and postoperative radiographic assessment of rheumatoid wrist deformities. The data are mean (SD).

	Carpal height ratio	Ulnar translocation ratio	Radial deviation ratio
Before surgery	0.69 (0.16)	0.11 (0.04)	0.08 (0.04)
After surgery	0.74 (0.22)	0.11 (0.02)	0.09 (0.06)

Table 3
Number of wrists with each radiographic Larsen grade before and after surgery.

	Grade 0	Grade 1	Grade 2	Grade 3	Grade 4	Grade 5
Radio-carpal joint						
Before surgery	4	5	4	2	1	0
After surgery	3	2	4	2	1	0
Medio-carpal joint						
Before surgery	4	1	6	2	3	0
After surgery	3	0	4	1	1	3

and radial carpal deviation remained unchanged, with no worsening. ECR-to-ECU tendon transfer probably avoided translation of the ulna, which is the main drawback of ulnar head resection [17]. It should be acknowledged, however, that our study had a predominance of Simmen class 1 or 2 wrists, for which ulnar carpal translocation is less likely to occur. Nevertheless, radio-carpal destabilisation, with ulnar carpal translocation and radial carpal deviation occur early, at the stage of articular synovitis, due to the distension and alterations in the joint capsules and ligaments, thus usually antedating the development of cartilage damage. Regarding biomechanics, medialisation of the pulling forces applied by the ECRL-to-ECU is more marked than after transfer to the extensor radialis carpi brevis [17,18]. This greater medialisation may provide better carpal bone stabilisation in the coronal plane by improving the lever arm, since the radio-carpal subluxation is antero-medial. In addition, suturing of the ECRL onto the EUC prevents palmar carpal bone subluxation on the ulnar side.

Furthermore, the ECRL-to-ECU tendon transfer results in dorsalisation of the ECU tendon, which contributes to stabilise the ulnar stump. Thus, no cases of ulnar instability occurred in our study.

In most previous studies, synovectomy failed to change the radiographic progression of the carpal abnormalities [4,18,19]. The abnormalities at the joint lines worsen, but the wrist remains normally aligned. Vahvanen et al. [20] reported however that isolated synovectomy was followed in 40% of cases by a decreased rate of radiographic progression compared to the contra-lateral non-operated wrist. In our study, the Larsen grade of the mid-carpal and radio-carpal joints was no greater than 2 before surgery in 81% and 69% of wrists, respectively, and remained no greater than 2 after surgery in 75% and 58% of wrists, respectively. In the 4 wrists managed without mid-carpal and radio-carpal synovectomy, the Larsen grades for these joints after a mean follow-up of 51.5 months were unchanged compared to the preoperative values. Thus, the radiographic abnormalities of the joint lines remained stable. Consequently, progression of joint line abnormalities is not affected by isolated synovectomy but is diminished by ECRL-to-ECU tendon transfer (Fig. 2). In other words, at an early stage, before the development of joint erosions, synovectomy may protect against joint destruction, and concomitant stabilisation-realignment by ECRL-to-ECU tendon transfer may protect against joint damage due to mechanical factors induced by wrist destabilisation. These effects may be obtained even in wrists with severe mid-carpal disease. In our study, in the 3 wrists managed by mid-carpal arthrodesis, the Larsen grade of the radio-carpal joint remained unchanged after surgery (Fig. 3). Carpal height, in contrast, may be independent from the surgical procedure and may change only according to RA activity [18]. In our study, carpal height decreased despite the synovectomy and stabilisation procedure. Thus, ECRL-to-ECU tendon transfer does not seem to preserve carpal height.

The main limitations of this study are the retrospective design and absence of a control group managed without the procedure

Fig. 3. Antero-posterior radiograph of a rheumatoid wrist after extensor carpi radialis longus transfer and mid-carpal arthrodesis. The radio-carpal joint is preserved 11 months postoperatively.

under study. The effects of the surgery cannot be readily ascribed to any specific component of the procedure, particularly as RA is a polymorphic disease that runs a highly variable course. Although promising, the results reported here should be interpreted only as observations about an original surgical technique used in combination with conventional synovectomy.

5. Conclusion

Synovectomy combined with wrist stabilisation-realignment by ECRL-to-ECU tendon transfer provides pain relief and prevents wrist deformities by stabilising the distal ulnar stump, while protecting against radiographic progression at the joint lines, when used for wrists that meet the classical criteria: synovitis refractory to non-operative treatment, symptomatic DRUJ and/or teno-synovitis refractory to non-operative treatment, and Larsen grade 2 or even 3 radiographic mid-carpal and radio-carpal joint abnormalities.

Another indication for this procedure is symptomatic mid-carpal joint destruction with at least partial preservation of the radio-carpal joint line. Mid-carpal arthrodesis can be performed in this situation. The clinical and radiographic outcomes seem identical to those obtained in other indications.

ECRL-to-ECU tendon transfer thus has a legitimate place in the therapeutic armamentarium for the rheumatoid wrist. This procedure prevents further destruction of the radio-carpal joint and decreases the need for total wrist arthrodesis, which is performed less and less often and increasingly late, probably due in part to the introduction of new biotherapies for RA.

Disclosure of interest

The authors declare that they have no competing interest.

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None.

Contributions

JB: acquired and analysed the data and wrote and revised the manuscript.

SR and NM: wrote the manuscript.

EM and GB: revised the manuscript.

JL: senior surgeon, conceived the study and revised the manuscript.

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