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M. Arboucalot, M. Rongières, N. Bonneville, S. Delclaux, M. Mansat, et al.. Radioscapholunate arthrodesis versus radiolunate arthrodesis in rheumatoid wrist surgery: Clinical and radiographic outcomes. *Hand Surgery and Rehabilitation*, 2020, 39, pp.363 - 374. <10.1016/j.hansur.2020.04.002>. <hal-03491997>

HAL Id: hal-03491997

<https://hal.science/hal-03491997v1>

Submitted on 14 Sep 2022

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Radioscapholunate arthrodesis versus radiolunate arthrodesis in rheumatoid wrist surgery: clinical and radiographic outcomes

Arthrodèse radio-scapho-lunaire versus arthrodèse radio-lunaire dans la chirurgie du poignet rhumatoïde : résultats cliniques et radiographiques

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Conflits d'intérêts :

Les auteurs déclare qu'ils n'ont aucun conflit d'intérêt en rapport avec cet article.

Radioscapholunate arthrodesis versus radiolunate arthrodesis in rheumatoid wrist surgery: clinical and radiographic outcomes

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Abstract

Radiolunate arthrodesis is a validated surgical technique in rheumatoid wrist surgery. When the radioscaphoid joint is involved or when there is radiolunate instability, a radioscapholunate arthrodesis must be preferred. The objective was to compare clinical and radiographic outcomes for both types of arthrodesis. Patients were evaluated retrospectively at a minimal follow-up of 12 months after radiolunate arthrodesis (RL-A group) or radioscapholunate arthrodesis (RSL-A group). Mean follow-up was 10.7 years (1–25 years). One hundred and one patients were included in RL-A group and 26 in RSL-A group. At follow-up, pain level was significantly reduced by 3.7 points and by 2.9 points in RL-A and RSL-A groups, respectively. Mobility in flexion/extension was significantly reduced by 25° in both groups. DASH and PRWE scores were 42.9 and 41.4 in RL-A group, 41.8 and 20.6 in RSL-A group, respectively. Larsen stage for the midcarpal joint increased significantly in both groups (+0.8 in RL-A group; +0.9 in RSL-A group), carpal height index decreased (-0.03 in RL-A group (significant); -0.02 in RSL-A group (non-significant)), carpal ulnar translation index increased (+0.038 in RL-A group; +0.037 in RSL-A group), without significant difference between both groups. Nonunion rate was significantly higher in RSL-A group (62%) than in RL-A group (30%). A pain free and functional wrist can be obtained after radiolunate and radioscapholunate arthrodesis. However, arthritis lesions and carpal deformities increased with follow-up similarly with both surgical techniques. Our results have shown that radiolunate arthrodesis remains a reliable surgical procedure for advanced rheumatoid wrist.

Résumé

L'arthrodèse radio-lunaire est une des techniques de référence dans la chirurgie du poignet rhumatoïde dorsal. En cas d'atteinte de l'interligne radio-scaphoïdien ou d'instabilité scapho-lunaire, il est nécessaire d'élargir l'arthrodèse à l'interligne radio-scaphoïdien. L'objectif était de comparer les résultats cliniques et radiographiques de ces deux arthrodèses. Il s'agissait d'une étude comparative rétrospective. Les patients étaient évalués au recul minimum de 12 mois après arthrodèse partielle radio-lunaire (groupe RL-A) ou radio-scapho-lunaire (groupe RSL-A). Au recul moyen de 10,7 ans (1–25 ans), 101 patients ont été inclus dans le groupe RL-A et 26 dans le groupe RSL-A. La douleur était significativement diminuée de 3,7 points et de 2,9 points respectivement dans les groupes RL-A et RSL-A. L'arc de mobilité en flexion/extension était significativement diminué de 25° dans les deux groupes. Au dernier recul, les scores DASH et PRWE étaient respectivement de 42,9 et 41,4 dans le groupe RL-A, de 41,8 et 20,6 dans le groupe RSL-A. On observait dans chacun des groupes RL-A et RSL-A une augmentation significative du stade de Larsen sur l'interligne médiocarpien (respectivement +0,8 ; +0,9), une diminution de l'indice de hauteur du carpe (respectivement -0,03 (significatif) ; -0,02 (non significatif)), une augmentation significative de l'indice de translation ulnaire du carpe (respectivement +0,038 ; +0,037), sans différence significative entre les deux groupes. Le taux de pseudarthrose était significativement plus élevé dans le groupe RSL-A (62%) que dans le groupe RL-A (30%). Les arthrodèses radio-lunaires et radio-scapho-lunaires permettent d'obtenir de façon comparable l'indolence du poignet. La progression des lésions d'arthrite et des déformations du carpe sont similaires pour les deux types d'arthrodèse. L'arthrodèse radio-lunaire reste l'arthrodèse partielle de référence dans la chirurgie du poignet rhumatoïde dorsal.

Keywords: Rheumatoid wrist; Radiolunate arthrodesis; Radioscapholunate arthrodesis;
Clinical outcomes; Radiographic outcomes

Mots-clés : Poignet rhumatoïde ; Arthrodèse radio-lunaire ; Arthrodèse radio-scapho-lunaire ;
Résultats cliniques ; Résultats radiographiques

1. Introduction

Rheumatoid arthritis (RA) is the most common inflammatory disease affecting 0.5% to 1% of the population worldwide [1,2]. In France, RA prevalence is 0.35% [3,4], affecting about 200 000 patients [5]. Wrist and hand lesions are present in 94% of patients during the first years of evolution of the disease [6] due to inflammatory synovial proliferation [7–12]. Despite RA incidence remains stable, the number of surgical procedures is decreasing since the 90s, due to medical advances, allowing the control of the inflammatory process [1,13–15].

Dorsal rheumatoid wrist surgery includes all surgical procedures used to prevent and stabilize wrist lesions and fingers deformities [8,9,16]. In 1980, Chamay et al. [17] underlined radiolunate fusions as « providential fusions ». Radiolunate spontaneous fusion prevents radiocarpal misalignment progression and its consequences on fingers deformations [18–21] while preserving a functional range of motion of the wrist when midcarpal joint remains intact. Since then, numerous studies have acknowledged radiolunate arthrodesis (RL-A) as a referential partial arthrodesis in the surgical arsenal of the dorsal rheumatoid wrist [22–47].

In case of radioscapoid arthritis or scapholunate instability, expanding the arthrodesis to the radioscapolunate joint (RSL-A) is required. Few studies of small samples (less than ten patients) have validated radioscapolunate arthrodesis outcome [34,35,38,48,49].

The primary objective of our study was to assess the functional recovery of the rheumatoid wrist after RSL-A compared to RL-A. The second objective was to determine if wrists were better radiographically stabilized by RSL-A compared to RL-A.

2. Materials and methods

A monocentric, retrospective, comparative study was conducted from 1993 to 2017. Adults patients (over 18 years old) suffering from RA and undergoing RL-A or RSL-A surgery were included. Minimal follow-up was 12 months. Patients were divided into two groups: radiolunate arthrodesis group (RL-A) and radioscapolunate arthrodesis group (RSL-A). Exclusion criteria were primary total wrist arthrodesis, partial wrist arthrodesis other than RL-A or RSL-A, wrist disease other than RA. Concerning patients undergoing total arthrodesis

after failed initial partial arthrodesis, the last follow-up of the partial arthrodesis was settled as the last clinical and radiographic evaluation before the total arthrodesis surgery.

2.1. Surgical indications

RL-A was chosen in the following cases:

- Patients with clinical symptoms (functional impairment due to pain and/or deformities) localized on the radiocarpal joint despite a well-conducted medical treatment for at least 6 months, with radiographic lesions higher than or equal to Larsen stage 2 [7,50] of the radiolunate joint with a preserved midcarpal joint;
- Patients with constant evolution of radiographic lesions (carpal ulnar translation and/or carpal palmar translation and/or carpal radial deviation) despite a well-conducted medical treatment for at least 6 months or associated with fingers deformities;
- Patients with a destabilizing type of RA (Simmen and Hubert type III [51]) insufficiently controlled par medical treatment, undergoing fingers realignment surgery or distal ulna resection.

In addition to previous RL-A indications, RSL-A was specifically indicated in the following cases:

- Radiographic lesions higher than or equal to Larsen classification stage 2 on the radioscapoid joint [7,50];
- Scaphoid instability confirmed during surgery for patients with preoperative radiographic scapholunate instability (scapholunate diastasis (scapholunate space higher than 2mm) and/or horizontal scaphoid (radioscapoid angle higher than 69°);
- Intact midcarpal joint.

2.2. Surgical procedure

Surgery was conducted in four steps according to the dorsal rheumatoid wrist surgical technique [8]. Procedure started with a dorsal incision associated with suprafascial denervation of the superficial branch of the radial nerve and the dorsal branch of the ulnar nerve. The extensor retinaculum was incised at the level of the sixth compartment and

elevated from medial to lateral to the second compartment, preserving a radial flap. Distal posterior interosseous nerve was localized and resected. Extensors tenosynovectomy was then proceeded. Secondly, the distal ulna was removed at the level of the neck [52,53] in association with distal radioulnar joint (DRUJ) synovectomy. Thirdly, after a carpal capsulotomy has been performed, partial radiocarpal arthrodesis (radiolunate or radioscapolunate arthrodesis) was achieved with staples or screws after radiocarpal joint synovectomy and bone preparation. Bone graft from the ulna head was usually used. The lunate (with or without the scaphoid) was reduced under the radius correcting ulnar and palmar translation and radial deviation. For radioscapolunate arthrodesis, the distal scaphoid tubercle was preserved. After the carpal dorsal capsule was closed, the DRUJ capsule was sutured tightly ("overcoat suture") to stabilize the resected distal ulna. The dorsal retinaculum was positioned under the extensor tendons to protect them from the bone surface. The extensor carpi ulnaris was dorsally stabilized with a piece of retinaculum flap. Closing was achieved lastly and the wrist was immobilized in a wrist splint for 2 to 3 months.

Associated surgical procedures could be performed. Tendons transfers were realized in case of extensor tendons ruptures at the wrist. When the extensor pollicis longus was ruptured, the extensor indicis proprius was transferred to its distal stump. When 3 extensor tendons were ruptured, the extensor indicis proprius was transferred to the distal stumps of the extensor digiti minimi and the extensor digitorum communis (EDC) of the small finger, and an adjacent suture was realized between the distal stump of the ring finger EDC and the long finger EDC. When 4 tendons were ruptured, the extensor indicis proprius was transferred to the distal stumps of the extensor digiti minimi and the EDC of the small and ring fingers, and an adjacent suture was done between the index EDC and the distal stump of the long finger EDC. When 5 tendons were ruptured, the extensor carpi radialis brevis was transferred to the extensor digiti minimi and the EDC of the small, ring and long fingers, and an adjacent suture was realized between the extensor indicis proprius and the distal stump of the index EDC. In case of extensor tendon dislocation in the intermetacarpal valley, tendon relocation over the dorsal aspect of the metacarpophalangeal joint was achieved by releasing the ulnar sagittal fibers and tightening the radial sagittal fibers. Destructed

metacarpophalangeal joints were replaced by silicone finger arthroplasties. Fusion was performed in case of proximal interphalangeal destruction or thumb metacarpophalangeal destruction. Uncomfortable rheumatoid nodules could be removed.

2.3. Revision criteria

Patients were evaluated and had wrist radiographs before surgery and post-operatively at 15 days, 6 weeks, 3 months, 6 months, 1 year and at last follow-up. Data were prospectively collected on medical records and patients were evaluated specifically at last follow up (between 12 and 301 months post-surgery) by an independent surgeon. All patients were agreed to take part in the present study.

The following clinical criteria were assessed pre-operatively and at last follow-up:

- Satisfaction of the surgery evaluated by the patient (result assessed as "very good", "good", "average", "bad");
- Pain assessed by visual analogue scale from 0 (no pain) to 10 (maximum pain) [54];
- Return to work or not, and time to return after surgery (in weeks);
- Grip strength (in kilograms) assessed par Jamar dynamometer® (Asimow Engineering™, Santa Fe Springs, CA, USA) [55];
- Wrist motion (in degrees) assessed by goniometer: flexion, extension, radial inclination, ulnar inclination, pronation, supination [56];
- Ulnar drift of the fingers clinically assessed by the loss of alignment between the metacarpal bone and the proximal phalanx of the affected finger (metacarpophalangeal ulnar inclination) [18–20];
- DASH score [57,58];
- PRWE score [59,60];
- Clinical post-operative complications.

The following radiographic criteria were assessed on anteroposterior view of the wrist and the hand pre-operatively and at last follow-up:

- Time for arthrodesis to fuse (in weeks) or non-union at last follow-up;

- Simmen and Hubert classification [51];
- Modified Larsen classification by Alnot [7,61];
- Larsen classification (midcarpal and radioscaphoid joints) [7,50];
- Taleisnik classification [62] ;
- Carpal height index (CHI) according to Youm et al. [63];
- Ulnar translation index (UTI) according to Chamay [42];
- Carpal radial deviation angle (A1) according to Shapiro (in degrees) [64];
- Fingers ulnar deviation angle (A2) according to Shapiro (in degrees) [10];
- Scapholunate space (in millimeters) [65].

The following radiographic criteria were assessed on lateral view of the wrist pre-operatively and at last follow-up:

- Palmar translation index (PTI) according to Pagliei et al. [66];
- Scapholunate angle (SL) (in degrees) [65,67,68].

2.4. Statistical analysis

Statistical analysis was performed with the free online application EasyMedStat® (EasyMadeStat™, Neuilly-sur-Seine, France). The 2-tailed Fisher's exact test for categorical data was used to analyze association between contingency variables. The Chi-square test of independency (two-tailed) was used to analyze association between yes/no variables. The Wilcoxon signed-rank test for paired samples was used to compare numeric variables. Mann-Whitney nonparametric test was used to compare unpaired samples. The Proportion comparison test (with Z-approximation) was used to compare independent proportions. The 2-tailed Student t-test for paired data was used to compare means of continuous variables. Normality of a variable was assessed with the Shapiro-Wilk test. Alpha risk was set to 0.05.

For a given result, mean value, minimum value, maximum value, standard deviation, were presented as follows: mean (minimum–maximum; standard deviation). The level of statistical significance was set to p-value < 0.05.

3. Results

3.1. Patients

From 1993 to 2017, 400 rheumatoid wrists were operated on. One hundred and fifty-three partial arthrodeses were performed among 122 patients, of which 124 radiolunate arthrodeses and 29 radioscapulohumeral arthrodeses. Twenty-six wrists with less than 12 months follow-up were excluded from analyses. One hundred and one RL-A and 26 RSL-A were analyzed at a mean follow-up of 134 months and 102 months respectively. No significant demographic difference was found between the two groups (Table 1).

3.2. Clinical results (Tables 2 et 3)

Post-operatively, pain level was significantly reduced in both groups (-3.7 points in RL-A group; -2.9 points in RSL-A group). No statistical difference was found between the two groups concerning post-operative pain level.

In both RL-A and RSL-A groups, patients had significant loss of wrist motion in extension (-11° and -14° respectively) and flexion (-15° et -12° respectively). Loss of motion in radial and ulnar inclinations was not significant if analyzed separately, but the overall range of motion in RI/UI was significantly reduced by 15° in RL-A group. In both groups, pronosupination range of motion was increased ($+7^{\circ}$ in RL-A group; $+22^{\circ}$ in RSL-A group). At last follow-up, flexion and ulnar inclination were significantly lower in RSL-A group (23° and 15° respectively) than in RL-A group (31° et 22° respectively). All other variables considered, no statistical difference was found between the two groups.

No statistical difference was found concerning strength at last follow up between the two groups.

Rate of patients with fingers lesions increased post-operatively in both RL-A (48%, significant) and RSL-A (44%, non-significant) groups, with no statistical difference between the two groups at last follow-up.

In RL-A group, 80.6% of patients who had a professional activity before surgery returned to work 22 weeks after surgery. In RSL-A group, 100% of them returned to work after 24 weeks. No statistical difference was found between the two groups.

There was no statistical difference between the two groups concerning DASH score. PRWE score was significantly better in RSL-A group (20.6) than in RL-A group (41.4).

Most patients were satisfied or very satisfied with surgery at last follow-up (88.9% in RL-A group; 77.3% in RSL-A group). No statistical difference was found between the two groups. Dissatisfied patients mainly complained about loss of motion in flexion/extension.

3.3. Post-operative clinical complications

At mean follow-up of 5 months (50.5 – 32; 8.2) and 1.8 months (0 – 3; 1.8), 18.81% of patients in RL-A group and 11.54% of patients in RSL-A group presented clinical complications.

Main complication was distal ulna instability. Three patients developed an infection (one superficial infection on K-wire, one traumatic infected hematoma, one septic arthritis). One patient reported ulnar nerve entrapment at the wrist one year after surgery. Five patients developed tendon lesions post-operatively (tendon rupture or functional impairment without rupture) (Fig. 1). Two patients were re-operated with total wrist arthrodesis 12 and 72 months after the initial radiolunate arthrodesis. The first one presented a symptomatic non-union with wrist destabilization, the second one presented painful midcarpal lesions.

3.4. Radiographic results

3.4.1. Rheumatoid wrist radiographic lesions

According to Simmen and Huber classification [52], most of the operated wrists were type II (osteoarthrosis type). In RL-A and RSL-A groups, 4.8% and 27.3% of wrists were type I; 80.7% and 40.9% were type II; 14.5% and 31.8% were type III respectively.

According to Larsen and Alnot classification [7, 61], more than half of the operated wrists had major radiocarpal lesions with frontal plane instability (carpal ulnar translation and carpal radial deviation) and DRUJ dislocation (stages 4 and 5) pre-operatively (64.2% of wrists in RL-A group; 90.92% of wrists in RSL-A group).

Rate of radioscapoid joint lesions was significantly higher in RSL-A group pre-operatively (mean Larsen stage = 3.9 in RSL-A group versus 3.2 in RL-A group). In both RL-

A and RSL-A groups, midcarpal Larsen stage lesions increased significantly at last follow-up (+0.8 and +0.9 respectively) (Fig. 2). Similarly, radioscapoid Larsen stage lesions significantly increased in RL-A group (+0.8) post-operatively (Table 4).

Carpal height index (CHI) according to Youm et al. [63] decreased by 0.03 point in RL-A group and by 0.02 point in RSL-A group. Carpal ulnar translation index (UTI) according to Chamay [42] increased by 0.038 point and 0.037 point in each group respectively. Variations were significant in both groups except for CHI decrease in RSL-A group (Table 4).

Rate of normally aligned wrists according to Pagliei et al. [66] increased from 19.7% to 26.2 % in RL-A group and from 23.8% to 27.5 % in RSL-A group (non-significant) (Table 4, Fig. 3). A decrease number of carpal palmar subluxation was observed parallel to an increase in intracarpal malalignment.

At last follow-up, no statistical difference was found between the two groups regarding CHI, UTI and carpal palmar translation index (PTI) (Table 4).

3.4.2. Scapholunate system

No statistical difference was found concerning Taleisnik classification [62] in RL-A and RSL-A groups (90.1% and 95.5% of wrists were type I respectively).

Scapholunate space was significantly narrowed by 0.2 mm in RL-A group and by 0.7mm in RSL-A group post-operatively. Decrease of the scapholunate angle was more pronounced in RSL-A group (-2.4°, non-significant) than in RL-A group (-0.5°, non-significant). No statistical difference was found post-operatively between the two groups.

3.4.3. Hand analysis in frontal plane

Shapiro A1 and A2 angles did not significantly vary in both groups and between the two groups post-operatively. A1 angle increased by 0.7° in RL-A group et decreased by 1.1° in RSL-A group. A2 angle increased by 2° in RL-A group and by 1.1° in RSL-A group.

3.4.4. Fusion and non-union

Time to radiographic arthrodesis fusion was similar in RL-A group (15.5 weeks (6–100; 11.6)) and RSL-A group (15.5 weeks (4–44; 8.8)). Non-union rate was significantly higher in RSL-A group (61.5%) than in RL-A group (28.9%) ($p = 0.01$). Radiolunate non-union rate was 28.9% in RL-A group and 19.2% in RSL-A group. Radioscaphoid non-union rate was 42.3% in RSL-A group.

4. Discussion

4.1. Strengths and weaknesses of the present study

To our knowledge, the present study relates results of the largest series of RL-A and RSL-A published for rheumatoid wrist surgery. Some weaknesses should be enlightened.

Considering the retrospective aspect of the study, several data were unavailable (loss of pre-operative information about strength and functional scores), impairing statistical results due to lack of power or unachievable tests. Radiographic measures could have been disturbed by surgical procedures (metacarpophalangeal joint replacement), by destructive arthritis lesions (scapholunate angle difficult to measure in the presence of carpal ankylosis), or by unperfected anteroposterior or lateral radiographic views.

4.2. Radioscapholunate arthrodesis indications

RSL-A indications mentioned in literature include RL-A indications with the following additions [8,10,16,34,35,39,48,69]:

- Radiocarpal dislocation with radioscaphoid lesions and intact midcarpal joint;
- Horizontal scaphoid which remains flexed during surgery despite reduction of the lunate, requiring correction to avoid tendon damage and carpal collapse;
- Scapholunate dissociation with scapholunate diastasis greater than 3 mm, requiring correction to avoid carpal collapse by impaction of the capitate in the scapholunate space.

Contrary to the indications previously described, we did not select isolated scapholunate diastasis as a sufficient criterion to perform scaphoid arthrodesis. In our study, patients classified Taleisnik II had mostly RL-A and no difference was found about

scapholunate space between the two groups. Scaphoid stability was mainly assessed during surgery after having reduced the lunate.

In case of RSL-A, distal pole of the scaphoid was preserved to maintain carpal height and to avoid radial carpal collapse, without affecting wrist mobilities which remained similar to those in RL-A.

4.3. Radiolunate arthrodesis: clinical results in literature

Our findings about radiolunate arthrodesis were similar to literature (Table 5): pain level decreased after arthrodesis, wrist motion decreased in flexion, extension, ulnar inclination and radial inclination, motion increased in pronation-supination due to the DRUJ release after distal ulna resection, and good overall results and functional scores were obtained.

4.4. Radioscapholunate arthrodesis: clinical results in literature

To our knowledge, only four studies [34,35,48,49] have reported specific results of small samples of RSL-A (Table 6). In their samples, similar to ours concerning age and mean follow-up, authors reported similar results. All of them noticed decrease pain level [34,35,48,49]. Most of them observed decrease range of motion in flexion/extension and radial/ulnar inclination [34,35,49], except for Raven et al. [48] who noticed a non-significant increase. Wrist strength increased post-operatively [34,35,49]. Bain et al. [49] reported a full return to work after surgery.

We found a more important decrease in flexion arc in RSL-A group than in RL-A group, but this result should be discussed as no significant difference was found concerning the flexion/extension total range of motion in the two groups post-operatively, especially as the decrease of this range was similar in both groups. It seems that the decrease in RI/UI motion range was more important after RSL-A, but this finding is questionable as we lack data about the pre-operative mobilities. No difference was found in literature concerning wrist mobility after RL-A and RSL-A [35,48].

Patients kept functional mobilities (functional mobilities of the wrist evaluated as 30° to 40° of extension, 5° to 40° of flexion, 15° of ulnar inclination and 10° of radial inclination [70–72]), even if range of motion was not normal.

Significant better PRWE score obtained in RSL-A group was discordant with DASH score which was similar in both groups, with patients' average satisfaction rate lower in RSL-A group (non-significantly).

4.5. Radiolunate arthrodesis: radiographic results in literature

In our study, outcomes of RL-A were consistent with literature (Table 7): with follow-up, Larsen stage progressively increase, carpal height decrease despite partial arthrodesis. Contrary to our findings, most authors have reported decrease of carpal ulnar translation at last follow-up. Carpal ulnar translation index was not significantly modified just after surgery in our study, higher non-union rate could explain persistence of ulnar translation by enabling a certain radiocarpal joint mobility. Few studies have related carpal palmar translation or carpal radial deviation. Non-union rate was higher in our study than in literature. This could be explained by our criteria of nonunion as we have considered all non-union type, including « fibrous tight non-union ».

4.6. Radioscapholunate arthrodesis: radiographic results in literature

To our knowledge, only three studies [34,35,48] have related specific results of small samples of RSL-A (Table 8). All authors noticed asymptomatic midcarpal arthritis progression. Unlike Ishikawa et al. [34], we found an increase of post-operative carpal collapse and ulnar translation in RSL-A group which could be explained by progression of midcarpal lesion and a higher non-union rate. As Ishikawa et al. [34], we found a non-significant increase of normally aligned wrists. Although we found a decrease of palmar translation, we noticed an increase of intracarpal malalignment, which could be related to midcarpal arthritis progression, associated with stress increase in midcarpal joint after partial radiocarpal arthrodesis [73–75].

Wrist arthritis progressed similarly in both of our study groups: progressive midcarpal joint destruction, carpal collapse, ulnar translation and intracarpal malalignment increase. As Doets et al. [39], we found that radioscapolunate arthrodesis did not confer more wrist stability than radiolunate arthrodesis. Both RL-A and RSL-A have slowed down radiographic lesions evolution without fully stopping them.

Non-union rate ranged from 0% to 75% according to different studies [35,38,39,48,49], despite not being correlated with poor functional outcomes.

Although decrease of the scapholunate angle and scapholunate space narrowing were more important in RSL-A group, this could be related to scaphoid instability correction. Scaphoid instability did not appear to progress in RL-A group, radioscapoid angle being similar in both groups at last follow-up.

4.7. Hand and fingers lesions

Although wrist arthritis lesions increased, surgery enabled fingers ulnar deviation stabilization (no increase in Shapiro A1 and A2 angles). Nonetheless, clinical fingers lesions progression was observed at last follow-up (MCP arthritis requiring joint replacement, swan neck fingers deformities, thumb lesions).

5. Conclusion

Although advancements in RA medical treatments have enabled a decrease in patients requiring surgery, surgery remains relevant for patients contraindicated or escaping medical treatments with advanced wrist lesion. RL-A and RSL-A are satisfactory surgical options to stabilize wrist deformation and to obtain a pain free and functional wrist, without difference between the two type of arthrodesis. It seems unnecessary to fuse the radioscapoid joint if not damaged, this joint not becoming symptomatic even if progression of arthritis lesions is noted. Furthermore, fusion of the scaphoid will cause decrease of wrist motion and increase of midcarpal joint stress. Although RSL-A has specific indications, RL-A remains the referential partial arthrodesis in dorsal rheumatoid wrist surgery.

Conflicts of interest:

The authors declare that they have no conflict of interest in connection with this article.

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Figures legends

Fig. 1. Clinical complications in RL-A and RSL-A groups.

Fig. 2. Progression of arthritis lesions without carpal nor fingers deviation after radioscapholunate arthrodesis. Right wrist anteroposterior view, before surgery (A), 9 months after surgery (B), 11 years after surgery (C).

Fig. 3. Palmar translation of the carpus corrected after radiolunate arthrodesis. Left wrist lateral view, before surgery (A), just after surgery (B), 3 years after surgery (C).

Table titles

Table 1. Demographic characteristics in RL-A and RSL-A groups.

Table 2. Clinical results in RL-A and RSL-A groups.

Table 3. Mobility details in RL-A and RSL-A groups.

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Table 5. Clinical results for rheumatoid wrist radiolunate arthrodesis in literature.

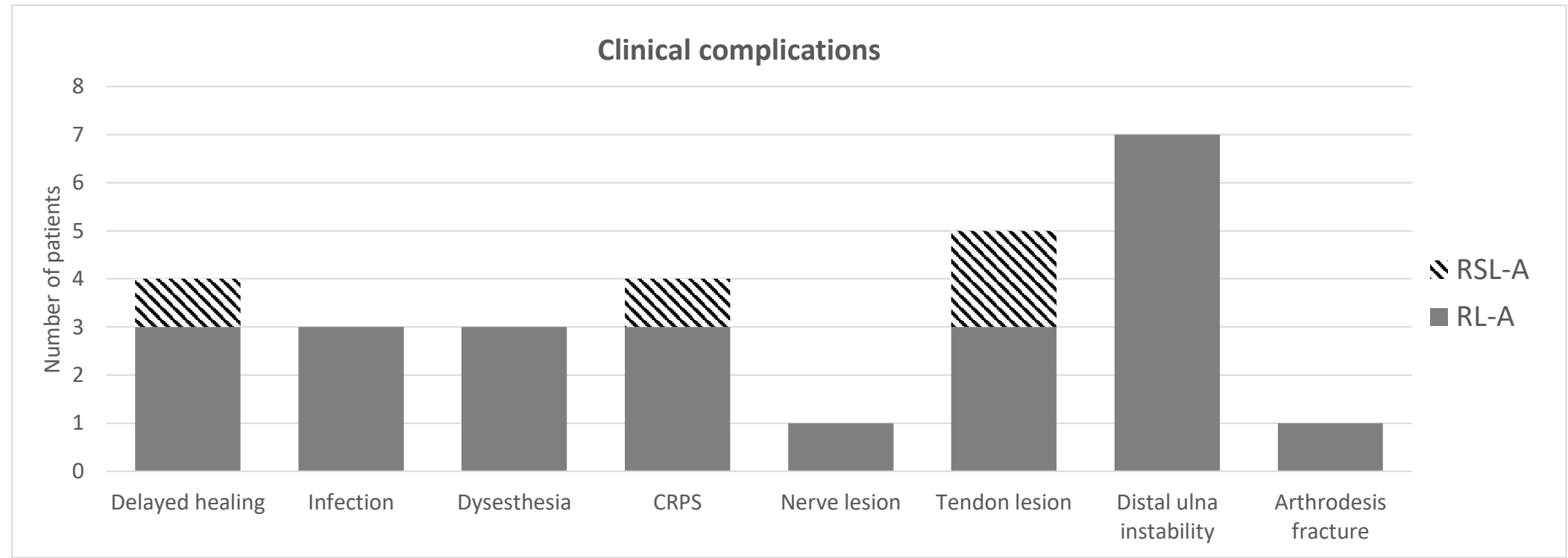
Table 6. Clinical results for rheumatoid wrist radioscapholunate arthrodesis in literature.

Table 7. Radiographic results for rheumatoid wrist radiolunate arthrodesis in literature.

Table 8. Radiographic results for rheumatoid wrist radioscapholunate arthrodesis in literature.

	RL-A	RSL-A
Delayed healing	3	1
Infection	3	0
Dysesthesia	3	0
CRPS	3	1
Nerve lesion	1	0
Tendon lesion	3	2
Distal ulna instability	7	0
Arthrodesis fracture	1	0

Figure 1. Clinical complications in RL-A and RSL-A groups.



RL-A : radiolunate arthrodesis group; *RSL-A* : radioscapolunate arthrodesis group; *CRPS* : chronic regional pain syndrome

Fig. 2. Progression of arthritis lesions without carpal nor fingers deviation after radioscapholunate arthrodesis. Right wrist anteroposterior view, before surgery (A), 9 months after surgery (B), 11 years after surgery (C).



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Table 1. Demographic characteristics in RL-A and RSL-A groups.

	RL-A	RSL-A	RL-A vs. RSL-A p
Wrists number (total = 127)	101	26	
Follow-up duration (months)	134 (12–301 ; 87.5)	102 (12–269 ; 82.2)	NS
Age at surgery (years-old)	52.4 (29–77 ; 12.9)	51.4 (29–70 ; 11.3)	NS
RA duration (years)	10.8 (0–46 ; 7.5)	10.8 (2–31 ; 6.7)	NS
Patients with professional activity	47.30 %	63.60 %	NS
Long-term treatment (biotherapy excluded)	94 %	92.30 %	NS
Biotherapy	18.00 %	30.80 %	NS

RL-A: radiolunate arthrodesis group; RSL-A: radioscapulohunate arthrodesis group; RA: rheumatoid arthritis; NS: non-significant. Results presented as follows: mean (minimum – maximum ; standard deviation). Statistical significance level set to p-value < 0.05.

Table 2. Clinical results in RL-A and RSL-A groups.

		RL-A	RSL-A	RL-A vs. RSL-A p
Pain	pre-op	5.3 (2–9 ; 1.7)	4.3 (0–8 ; 2.8)	NS
	post-op	1.9 (0–9 ; 2.4)	1.1 (0–5 ; 1.6)	NS
	difference	- 3.7 *	- 2.9 *	
Flex/Ext (°)	pre-op	87 (15–180 ; 36.8)	81 (25–160 ; 38.0)	NS
	post-op	63 (0–130 ; 28.8)	50 (10–100 ; 28.5)	NS
	motion loss	-25° * (-29 %)	-25° * (-33 %)	
RI/UI (°)	pre-op	36 (15–65 ; 14.8)	55 (50–60 ; 7.1)	NS
	post-op	27 (0–60 ; 16.1)	15 (0–25 ; 7.6)	< 0.05
	motion loss	-15° * (-51 %)	NA	
Pro/Sup (°)	pre-op	145 (90–170 ; 21.7)	137 (60–165 ; 36.7)	NS
	post-op	152 (70–180 ; 17.4)	155 (120–180 ; 14.1)	NS
	motion gain	+ 7° * (+5 %)	+ 22° (+16 %)	
Strength post-op (kg)		13 (0–40 ; 8.4)	14 (0–30 ; 9.2)	NS
Fingers lesions	pre-op	30 %	25 %	NS
	post-op	48 %	44 %	NS
	progress	*	NS	
Return to work		80.6 %	100 %	NS
Time to work return (weeks)		22 (0–108 ; 28)	24 (12–44 ; 9)	NS
DASH post-op		42.9 (0.8–85.6 ; 23.3)	41.8 (2.5–96 ; 28.1)	NS
PRWE post-op		41.4 (0–86.5 ; 26.3)	20.6 (0–59 ; 20.4)	< 0.05

RL-A: radiolunate arthrodesis group; *RSL-A*: radioscapulohumeral arthrodesis group; *NS*: non-significant; *pre-op*: pre-operative; *post-op*: post-operative; *: significant variation with $p < 0.05$; *Flex/Ext*: flexion/extension range of motion in degrees; *RI/UI*: radial inclination / ulnar inclination range of motion in degrees; *Pro/Sup*: pronation-supination range of motion in degrees. Results presented as follows: mean (minimum – maximum ; standard deviation). Statistical significance level set to p -value < 0.05 .

Table 3. Mobility details in RL-A and RSL-A groups.

		RL-A	RSL-A	RL-A vs. RSL-A p
Ext (°)	pre-op	44 (0–90 ; 18)	43 (0–70 ; 19)	NS
	post-op	32 (-10–70 ; 17)	27 (-5–60 ; 17)	NS
	motion loss	- 11° *	- 14° *	
Flex (°)	pre-op	42 (5–90 ; 20)	38 (-10–90 ; 24)	NS
	post-op	31 (-10–70 ; 16)	23 (-15–45 ; 15)	0.044
	motion loss	- 15° *	- 12° *	
UI (°)	pre-op	25 (10–35 ; 7)	35 (30–40 ; 7)	NS
	post-op	22 (0 – 45 ; 12)	15 (0–35 ; 11)	< 0.05
	motion loss	- 4°	NA	
RI (°)	pre-op	11 (0–30 ; 8)	20 (20–20 ; 0)	NS
	post-op	4 (-30–25 ; 10)	1 (-20–10 ; 8)	NS
	motion loss	- 11°	NA	
Pro (°)	pre-op	73 (50–90 ; 10)	68 (30–85 ; 18)	NS
	post-op	75 (45–90 ; 9)	75 (60–90 ; 10)	NS
	motion gain	+ 5° *	+ 12°	
Sup (°)	pre-op	72 (15–80 ; 15)	69 (30–90 ; 19)	NS
	post-op	77 (10–90 ; 12)	80 (60–90 ; 8)	NS
	motion gain	+ 3°	+ 10°	

RL-A: radiolunate arthrodesis group; *RSL-A*: radioscapulohumeral arthrodesis group; *NS*: non significant; *pre-op*: pre-operative; *post-op*: post-operative; *: significant variation with $p < 0.05$; *Ext*: extension in degrees; *Flex*: flexion in degrees; *UI*: ulnar inclination in degrees; *RI*: radial inclination in degrees; *Pro*: pronation in degrees; *Sup*: supination in degrees. Results presented as follows: mean (minimum – maximum ; standard deviation). Statistical significance level set to p -value < 0.05 .

Table 4. Radiographic results in RL-A and RSL-A groups.

		RL-A	RSL-A	RL-A vs. RSL-A p
Larsen MC	pre-op	3.0 (1–4 ; 0.8)	3.1 (2–5 ; 0.8)	NS
	post-op	3.8 (2–5 ; 0.7)	4.1 (3–5 ; 0.8)	NS
	progression	+ 0.8 *	+ 0.9 *	
Larsen RS	pre-op	3.2 (1–4 ; 0.8)	3.9 (2–5 ; 0.9)	0.002
	post-op	4 (1–5 ; 0.7)	NA	NA
	progression	+ 0.8 *	NA	
CHI	pre-op	0.47 (0.19 – 0.65 ; 0.06)	0.47 (0.35–0.57 ; 0.06)	NS
	post-op	0.44 (0.14–0.65 ; 0.09)	0.45 (0.29–0.58 ; 0.08)	NS
	height loss	- 0.03 *	- 0.02	
UTI	pre-op	0.305 (0.129–0.4 ; 0.045)	0.326 (0.243–0.444 ; 0.056)	NS
	post-op	0.349 (0.231–0.5 ; 0.054)	0.370 (0.228–0.517 ; 0.069)	NS
	increase	+ 0.038 *	+ 0.037 *	
PTI normally aligned pre-op		19.74 %	23.8%	NS
	post-op	26.23 %	37.5%	NS
	variation	NS	NS	

RL-A: radiolunate arthrodesis group; *RSL-A*: radioscapulohunate arthrodesis group; *MC*: midcarpal joint; *RS*: radioscapoid joint; *NS*: non-significant; *NA*: non-analyzable; *pre-op*: pre-operative; *post-op*: post-operative; *: significant variation with $p < 0.05$; *CHI*: carpal height index according to Youm; *UTI*: carpal ulnar translation index according to Chamay; *PTI*: carpal palmar translation index according to Pagliei. Results presented as follows: mean (minimum – maximum ; standard deviation). Statistical significance level set to p -value < 0.05 .

Table 5. Clinical results for rheumatoid wrist radiolunate arthrodesis in literature

		n wrists	Mean age (years old)	Mean follow-up (months)	Rate of painful wrists pre-/post-op	Pain score /10 pre-/post-op	Ext (°) pre-/ post-op	Flex (°) pre-/post-op	UI (°) pre-/ post-op	RI (°) pre-/ post-op	Pro (°) pre-/ post-op	Sup (°) pre-/ post-op	Grip strength pre-/post-op	Post-op scores	% Clinical complications/A additional surgery
1	Chamay et al. [43]	7	59	12	100%/14%		53/34	38/22	25/19	17/9	71/82	78/82	-/86% improved		
2	Linscheid & Dobyns [32]	17	17 to 69 years old	28			50/32	48/36	22/15	15/9			9°/10°	76% excellent or good results	23%
3	Stanley & Boot [26]	16	54	24		5 to 6.5/1 to 2.5	Flex + Ext 56/52		RI + UI 39/34		Pro + Sup 140/130		2.5 pounds/3.2 pounds	75% excellent or good results 73% very satisfied or satisfied	6%
4	Chamay & Della Santa [42]	21	29 to 79 years old	49	-/27%		-/41	-/28	-/23	-/8			-/9 to 13 kg increase	61% very satisfied or satisfied	14%
5	Allieu et al. [48]	35	43	39	-/9%		36/23	26/18	16/12	7/5				89 % very satisfied or satisfied	6%
7	Wetzel et al. [46]	33		51	-/47%		28/26	28/22	20/22	18/14	78/84	75/84		100% very satisfied or satisfied	15%
8	Rittmeister et al. [29]	27	49	39	100%/75%		Flex + Ext -/27		RI + UI -/11		Pro + Sup -/138		-/42.5 to 45 kg	58% very satisfied or satisfied	4%
9	Borisch et al. [47]	91	53	60	-/14%		35/28	39/18	18/11	11/5	75/87	71/85			8%
10	Schill et al. [27]	57	54	84	-/37%		41/29	46/19	RI + UI 30/20		Pro + Sup -/gain of 20°		-/2.6 kg	Clayton score = 74.2 70% excellent or good results	7%
11	Jüsten & Wessinghage [33]	19		23			-/34	-/18	-/16	-/8				95% very satisfied or satisfied	
12	Uchida et al. [24]	29	60	62	92%/21%		Flex + Ext 62/43		RI + UI 25/17		Pro + Sup 149/166				3%
13	Ishikawa et al. [35]	16	52	156			30/25	27/14	21/13	7/1	66/79	72/84	104/143 mm Hg		
14	Honkanen et al. [36]	16	50	62	-/25%		36/36	42/29	16/24	14/11	78/82	78/82	16 kg/18 kg		19%
15	Welby & Alnot [23]	10	52	124			31/25	25/13			Pro + Sup 144/146				2%
16	Gaulke et al. [38]	20		19	-/30%	7.5/2	Flex + Ext 108/73						0.17 bar/0.28 bar	90% excellent or good results	
17	Masuko et al [31]	12	53	68	-/0%		46/40	42/28			78/75	77/81	12 kg/18 kg	100 % excellent or good results	17%
18	Motomiya et al. [30]	22	49	84			43/36	40/25			74/77	74/85	12 kg/18 kg	Mayo Wrist score = 72 (pre-op = 37) 100 % excellent or good results ADL: improved	14%
19	Trieb et al. [25]	27	46	65	100%/-		22/24	20/26	10/12	5/6	73/80	75/80	-/31 kPa	96% excellent or good results 93% return to work	7%
20	Arboucalot et al.	101	52	134		5.3/1.9	44/32	42/31	25/22	11/4	73/75	72/77	-/13 kg	DASH score = 42.9 PRWE score = 41.4 89% very satisfied or satisfied	19%

n: number; *pre-op*: pre-operative; *post-op*: post-operative; *Ext*: extension in degrees; *Flex*: flexion in degrees; *Flex+Ext*: flexion/extension range of motion in degrees; *UI*: ulnar inclination in degrees; *RI*: radial inclination in degrees; *RI+UI*: radial inclination / ulnar inclination range of motion in degrees; *Pro*: pronation in degrees; *Sup*: supination in degrees; *Pro+Sup*: pronation-supination range of motion in degrees

Table 6. Clinical results for rheumatoid wrist radioscapholunate arthrodesis in literature.

	Ishikawa et al. [35]	Honkanen et al. [36]	Bain et al. [50]	Raven et al. [49]	Arboucalot et al.
Study design	retrospective	prospective	prospective	retrospective	retrospective
n RSL arthrodesis	6	7	7	4	26
Mean age	52 years old #	48 years old	47 years old #	52 years old #	51 years old
Mean follow-up	156 months #	82 months	32 months #	137 months #	102 months
Pain pre-op	-	-	5.5 / 10	-	4.3 / 10
post-op	88% painless#	71% painless	1.9 / 10	2 / 10 #	1.1 / 10
Flex/Ext pre-op	32° / 18°	45° / 40°	Flex + Ext = 68°	33° / 35°	43° / 38°
post-op	13° / 13°	30° / 29°	Flex + Ext = 54°	25° / 55°	27° / 23°
RI/UI pre-op	-1° / 21°	17° / 21°	7° # / 12° #	10° / 14°	20° / 35°
post-op	-4° / 18°	9° / 23°	16° # / 27° #	19° / 28°	1° / 15°
Pro/Sup pre-op	60° / 80°	85° / 80°		88° / 85°	68° / 69°
post-op	66° / 86°	83° / 87°		80° / 73°	75° / 80°
Strength pre-op	81 mmHg	17 kg	19 kg	-	-
post-op	102 mmHg	20 kg	32 kg	13 kg #	14 kg
DASH post-op				41,0 #	41.8
Return to work			100 %		100 %
Satisfaction: very good or good		87% #	86%		77 %
Complications or need for additional surgery		1 wound infection		2/6 re-operated with total wrist arthrodesis (not included)	1 delayed healing 1 CRPS 2 tendon lesions

n: number; *RSL*: radioscapholunate; *pre-op*: pre-operative; *post-op*: post-operative; *Ext*: extension in degrees; *Flex*: flexion in degrees; *Flex+Ext*: flexion/extension range of motion in degrees; *UI*: ulnar inclination in degrees; *RI*: radial inclination in degrees; *Pro*: pronation in degrees; *Sup*: supination in degrees; #: results including other partial arthrodesis types (radiolunate or radiolunotriquetral)

Table 7. Radiographic results for rheumatoid wrist radiolunate arthrodesis in literature

		n wrists	Mean age (years old)	Mean follow-up (months)	Simmen classification	Mean Larsen pre-/post-op	CHI pre-/ post-op	UTI pre-/ post-op	PTI pre-/ post-op	Radial deviation pre-/ post-op	Non-union rate
1	Chamay et al. [43]	7	59	12			Youm 0.43/0.41	Chamay 0.33/0.32			
2	Linscheid & Dobyns [32]	17	17 to 69 years old	28			Youm 0.47/0.47	Chamay 0.34/0.31			5%
3	Stanley & Boot [26]	16	54	24		-/75% with post-op increase					6%
4	Chamay & Della Santa [42]	21	29 to 79 years old	49		MC Larsen 2.8/-	Youm 0.45/0.39	Chamay 0.35/0.34		-/radial deviation corrected	5%
5	Allieu et al. [48]	35	43	39		2.9/-	Youm 0.46/0.45	? 0.15/0.11			3%
6	Della Santa & Chamay [41]	23	62	58	Type I: 3 Type II: 14 Type III: 6	2.7/3.6	Youm 0.47/0.43	Chamay 0.32/0.37	Pagliei d2/d3 1.04/1.23	-/ radial deviation corrected	0%
7	Wetzel et al. [46]	33		51		2.7/66% with post-op increase	Youm 0.49/0.46	Chamay 0.31/0.36			3%
8	Rittmeister et al. [29]	19	49	39		68% with post-op increase		Chamay -/0.35			5%
9	Borisch et al. [47]	91	53	60		3.2/3.8	Youm 0.43/0.38	Chamay 0.32/0.30		Gainor -3.2/-2.4	4%
10	Schill et al. [27]	57	54	84	Type I: 17 Type II: 30 Type III: 10	2.9/3.6	Dinges 0.68/0.71	Dinges 0.41/0.37			2%
11	Jüsten & Wessinghage [33]	19		23		4/-	Youm 0.47/0.50	Chamay 0.35/0.30			5.3%
12	Uchida et al. [24]	29	60	62	Type I: 8 Type II: 12 Type III: 9	2 to 4/-	Youm 0.43/0.42	Ishikawa 0.15/0.17	Ishikawa 0.19/0.19		3%
13	Ishikawa et al. [35]	16	52	156			Trentham 0.49/0.46	Ishikawa 0.18/0.17	Ishikawa 0.25/0.25		
14	Honkanen et al. [36]	16	50	62	Type III: 16	2.4/-					0%
15	Welby & Alnot [23]	10	52	124		3.9/4.1					
17	Masuko et al [31]	12	53	68		3/3.2	Borisch 0.46/0.48	Borisch 0.36/0.32			
18	Motomiya et al. [30]	22	49	84		MC Larsen 2.2/3.0	Borisch 0.45/0.48	Borisch 0.36/0.32			
19	Trieb et al. [25]	27	46	65	Type I: 15 Type II: 12	3.1/-	Youm 0.36/0.35	Youm 0.29/0.30		Shapiro A1 < 125° 71%/79% of cases	0%
20	Arboucalot et al.	101	52	134	Type I: 5% Type II: 81% Type III: 14%	MC Larsen 3.0/3.8	Youm 0.47/0.44	Chamay 0.31/0.35	Pagliei (normally aligned) 20%/26%	Shapiro A1 122°/122°	30%

n: number; pre-op: pre-operative; post-op: post-operative; MC: midcarpal joint; CHI: carpal height index (method of measure related in the corresponding line); UTI: carpal ulnar translation index (method of measure related in the corresponding line); PTI: carpal palmar translation index (method of measure related in the corresponding line).

Table 8. Radiographic results for rheumatoid wrist radioscapulunate arthrodesis in literature

		Ishikawa et al. [35]	Honkanen et al. [36]	Raven et al. [49]	Arboucalot et al.
Study design		retrospective	prospective	retrospective	retrospective
n RSL arthrodesis		6	7	4	26
Mean age		52 years old #	48 years old	52 years old #	51 years old
Mean follow-up		156 months #	82 months	136 months #	102 months
Simmen			type III: 100%		Type I: 27% Type II: 41% Type III: 32%
Larsen pre-op		3.0 #	2.3	2.2	MC Larsen 3.1
CHI	pre-op	Trentham: 0.44	Youm: 0.51 #	Youm: 0.44 #	Youm: 0.47
	post-op	0.49	0.49 #	0.45 #	0.45
UTI	pre-op	Ishikawa: 0.16	Gainor: 0.26#	Chamay: 0.34 #	Chamay: 0.33
	post-op	0.07	0.30 #	0.28 #	0.37
PTI	pre-op	Ishikawa: 0.25			Pagliei (normally aligned): 24 %
	post-op	0.24			38%
Non-union rate		12% #	0%	75 % (RS joint)	62%

n: number; *pre-op*: pre-operative; *post-op*: post-operative; *RSL*: radioscapulunate joint; *RS*: radioscapuloid joint; *MC*: midcarpal joint; *CHI*: carpal height index (method of measure related in the corresponding line); *UTI*: carpal ulnar translation index (method of measure related in the corresponding line); *PTI*: carpal palmar translation index (method of measure related in the corresponding line); #: results including other partial arthrodesis types (radiolunate or radiolunotriquetral).