Results of Mannerfelt wrist arthrodesis for rheumatoid arthritis in relation to the position of the fused wrist

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Abstract

Purpose The wrist is involved early in rheumatoid arthritis and is often severely affected. A stable wrist is crucial to good hand function, which often necessitates a fusion. One of the most commonly used techniques in rheumatoid patients is the Mannerfelt arthrodesis. In this retrospective study the outcome and the patient's subjective satisfaction are presented and compared to other techniques. Also the influence of the position of the wrist following a fusion procedure is analysed. **Methods** Thirty-four wrists were retrospectively analysed using radiological measurements, functional scores such as the Disabilities of the Arm, Shoulder and Hand (DASH) and a pain assessment. The objective function of the hand with the fused wrist was assessed.

Results In 92.6 % of wrists the patients rated their satisfaction as good or excellent. The mean DASH score post-operatively was 63.3. Of the wrists, 17 were fixed in a median flexed position of 13° and 17 wrists in a median extended position of 8°. There was no statistically significant correlation between the position of the wrist and the satisfaction or objective function. The rate of fusion was 94.1 %.

Conclusions The Mannerfelt arthrodesis achieves good results and provides a high rate of satisfaction and pain relief in our study. It has major advantages compared to other wrist fusion techniques in the rheumatoid patient. We could not

show clear statistical evidence for better results in either a flexed or an extended position, but the ratings of the patients indicated better subjective results with a slightly extended position of the arthrodesis.

Keywords Mannerfelt arthrodesis · Osteoarthritis · Rheumatoid arthritis · Wrist arthrodesis

Introduction

Rheumatoid arthritis (RA) is the most common form of inflammatory arthritis. This autoimmune-modulated disease causes synovitis, which results in significant pain and ultimately in impairment of function caused by joint destruction. The wrist is affected in up to 50 % of patients within the first two years after the onset of the disease, increasing without treatment to over 90 % after ten years [1, 2]. Radiological changes include narrowing of the joint space, cysts, severe bone loss, joint luxation and periarticular osteoporosis. These changes have been compiled in different scoring systems, such as the Larsen classification, which reflect the degree of joint and cartilage destruction according to standard X-rays [3, 4].

Progressive destruction of the wrist by RA leads to a chronically unstable, stiff and painful joint depending on the natural course of the joint destruction type. The advanced destruction of the carpus and the surrounding soft tissue causes instability with palmar subluxation and progressive ulnar translation, which ultimately, together with the pain, is the cause for a recommendation of an arthrodesis of the wrist [5, 6].

There are several techniques described for fusions of the wrist of patients with RA. Because of the condition of the soft tissues, especially the skin, the approach to a wrist fusion is different than that for post-traumatic arthritis. The most commonly performed procedures are Mannerfelt fusion and plate fixation [7, 8]. Mannerfelt and Malmsten introduced their

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technique in 1971 using a Rush pin for transfixation of the wrist from the third metacarpal to the shaft of the radius and one or two staples to prevent rotation of the wrist (Fig. 1a–c). The technique has been well described and leads to good results [9, 10].

The Mannerfelt arthrodesis of the wrist is based on a technique first described by Clayton [11]. Intramedullary Steinmann pins and a sliding radial graft are inserted. It was modified by Millender and Nalebuff in 1973 [12].

The other commonly used technique is the plate fixation. It was introduced in 1974 by the AO Hand Study group. Newer implants use angular stable locking screws. The plate fixation also shows good results in the literature, especially in patients with post-traumatic arthritis [13].

One of the oldest methods of wrist fusions in a rheumatic patient is the Smith-Petersen technique. This uses the resected ulnar head as a bone graft between the radius and the capitate [14]. The disadvantage of this technique is that there is insufficient stabilisation in severely mutilated wrists.

A systematic review comparing fusion of the wrist with total wrist arthroplasty showed that fusion is preferable,

especially if the complications and low survival rates of arthroplasties as well as cost are taken into account [15]. Therefore, wrist arthrodesis is still the method of choice to treat advanced stages of RA with severe joint destruction [5].

The aim of this study is to present our results with the Mannerfelt wrist arthrodesis and to compare them with the results of other techniques. Since the optimal position for the fusion remains a matter of debate we also analysed the outcome and the patient's subjective satisfaction depending on the position of the wrist.

Patients and methods

This retrospective study included 34 consecutive wrists with RA which were treated by arthrodesis according to Mannerfelt's technique. Patients had been diagnosed with RA for a mean of 19 years (range five to 33 years). All had previously been treated with physiotherapy, non-steroidal anti-inflammatory drugs, intra-articular and oral steroids and disease-modifying medication. Surgery was only performed on patients who were not experiencing an acute episode of RA. All of the patients were treated by the author (ML).

Indications for the arthrodesis of the wrist were therapy-refractory pain around the wrist in 27 patients and/or instability of the carpus in 17 patients caused by deformation of the carpus. Radiological imaging, including postero-anterior and lateral views of the wrist, was performed pre-operatively.

The median age of the patients at the time of arthrodesis was 60 years (range 41–77 years). There were 23 female and four male patients. In 17 cases the right hand was involved and in 17 the left. Seven patients were affected in both hands and underwent consecutive surgical treatment. In 18 of 34 cases, it was the dominant hand that was treated with arthrodesis. The mean duration of post-operative follow-up was 34 ± 28 months.

The specific operative intervention was first described in a publication by Mannerfelt and Malmsten in 1971 [8]. Briefly, the damaged rheumatoid wrist joint is fused in an open approach to the carpus, after complete removal of the cartilage using a Rush pin from the ulnar side of the third metacarpal into the radius and secured against rotation by two or more staples between the carpal bones and the radius. We chose, unlike the original description, an entry point for the Rush pin near the base of the third metacarpal to retain the possibility of a further arthroplasty of the metacarpophalangeal joint, which is often necessary in rheumatoid patients. There is no need for a bone graft. The arthrodesis is placed in a protective forearm splint for six weeks. After confirmed radiological consolidation of the fusion the wrist is released. There is no need for a planned removal of the implants. The position of the arthrodesis depended on the time of operation, for we started with

Fig. 1 a–c Preoperative posteroanterior and lateral views of a wrist destroyed by RA and of a Mannerfelt arthrodesis using a Rush pin and two staples for rotational fixation

flexed fusion and then turned to an extended position because of our experiences and the individual wishes of the patient.

Preoperatively the destruction of the hand was rated according to Larsen et al. [4]. Every patient had a Larsen score of IV or V at the time of the operation. Using preoperative and follow-up X-rays in postero-anterior and strict lateral views, which were confirmed by a parallel depiction of the radius and ulna, the carpal height (according to Youm et al.), carpal translocation (according to Chamay et al.), the extension/flexion angle and radial/ulnar deviation of the wrist were analysed [16, 17].

During follow-up the patients were questioned about their satisfaction and the function of the upper extremity after their operation. They could rate it as an excellent, good or poor improvement. Those findings were documented using the visual analogue scale (VAS) score for measuring the pain level and the Disabilities of the Arm, Shoulder and Hand (DASH) score for a subjective functional evaluation. The clinical examination included a thorough history as well as a recording of the joint movements using a goniometer and of grip strength using a Jamar dynamometer (Jamar, Jackson, MI, USA). X-rays of the wrist in postero-anterior and strict lateral views were taken to confirm the consolidation of the fusion and to analyse the radiological features outlined above.

SPSS statistical software (version 11.5) was used to analyse the data. Differences between groups were analysed using Wilcoxon and Mann-Whitney tests. Spearman's correlation coefficient was used to analyse the strength of the association for skewed variables, whereas Pearson's r was used for normally distributed variables.

Results

At post-operative follow-up 25 of the 27 patients rated their subjective improvement and their satisfaction after surgery as good or excellent (92.6 %). Only two patients rated their improvement as poor. These two patients had a long history of RA with involvement of various other joints of the affected upper extremity. Twenty-three patients (85 %) would repeat the operation. Of the four patients who would not two rated their subjective improvement as good. The reasons in those cases were the amount of operations overall.

Overall patients experienced a significant reduction in pain from a preoperative mean VAS score of 7.9 (range 0–10) to a post-operative mean VAS score of 1.9 (range 0–9) ($p < 0.01$). All of the patients improved their pain level except for a single patient with a pre- and post-operative VAS of 9, who was one of the patients with a poor result due to very advanced RA. The mean DASH score post-operatively was 63.3 ± 25.3 . A clear correlation was shown between the post-operative VAS and the DASH score ($r = 0.63$).

Post-operative grip strength showed a median of 21 kPa (range 0–46 kPa). Twenty patients achieved a grip strength of more than 15 kPa, of whom ten were fused in a flexed and ten in an extended position. There was a slight correlation of $r = 0.20$ between higher grip strength and patients who were fixed in ulnar deviation.

The position of flexion/extension and the radial and ulnar deviation of the arthrodesis were measured radiographically by two independent observers. Of the wrists, 17 were fixed in a median flexed position of 13° (range $3\text{--}20^\circ$) and 17 wrists in a median extended position of 8° (range $2\text{--}12^\circ$); 16 wrists were fixed in a median of 8° of radial deviation (range $4\text{--}23^\circ$) and 14 wrists in 8° of ulnar deviation (range $4\text{--}17^\circ$). Four wrists were fixed in a neutral position of 0° radial/ulnar. Subjective improvement in the questionnaire after surgery was not statistically different between a flexed or extended position of the arthrodesis or between a radial or ulnar deviation ($p > 0.05$). However, it was shown that all patients who rated their satisfaction as excellent were fixed between 14° flexion and 10° extension. Based upon the opinions of these patients, we prefer arthrodesis of the wrist in a slightly extended position, since they reported better mastery of their activities of daily life. For example, they found it easier to write if they could rest their hand on the hypothenar eminence.

The ergonomic skills improved in 19 patients. The eight patients who rated their ergonomic skills as worse were mostly fused in flexed positions.

Preoperatively, the carpal height index showed a median of 0.31 (range 0.2–0.45), which did not change post-operatively, with a median of 0.31 (range 0.1–0.5). There was a positive correlation between a near normal carpal height and the range of motion of the metacarpophalangeal joints ($r = 0.49$).

Complications included delayed healing of the wound in five patients, one of whom needed an operative intervention. Of the 34 arthrodeses of the wrist only two were not radiologically fused in the follow-up X-ray. One of those two patients was nevertheless satisfied and had a good functional result.

There was one patient with numbness around the scar after the surgery and another who needed a revision of the Rush pin because of a metal allergy (each 2.9 %). The revision was a removal of the pin and the staples after a radiologically confirmed consolidation of the arthrodesis.

All patients ($n = 7$) who underwent bilateral fusions rated their subjective improvement as excellent or very good and were fixed between 6° of extension and 10° of flexion. One patient was fused with one hand in extension and the other in flexion, two patients had both hands fused in extension and the remaining eleven in flexion. There were no complications in the post-operative follow-up. The reduction of their pain from a mean VAS of 8.8 ± 1.8 to a mean VAS of 2.1 ± 2.3 was statistically highly significant ($p < 0.01$). The best subjective ergonomic skills were described by the patients with at least one hand in extended position.

Discussion

RA is a common disease affecting especially the musculoskeletal system. Because of the autoimmune-modulated inflammation, especially of the wrist, it often leads to an early destruction of the joints of the upper extremity. The resultant pain and instability with subsequent loss of function often necessitate an arthrodesis of the wrist [5]. One of the common arthrodesis techniques is the Mannerfelt fusion.

Our retrospective analysis of 34 wrists showed a high rate of excellent or good subjective satisfaction among 25 patients. Possible reasons for dissatisfaction on the part of two patients were the advanced state of their RA and thus their overall incapacity to compensate for the function of the upper extremity. We think that it is important to take the function of the elbow and shoulder into consideration before fusing a wrist. Although we only used the DASH instead of for example the disease activity score for 28 joints (DAS28) as a questionnaire we could show an improvement with a fusion of the wrist. This is mainly because of the high relevance of the wrist in the function of the upper extremity.

Our results concur with Toma et al. who reported a satisfaction rate of 73 % in 2007 [18]. A retrospective study by Barbier et al. from 1999 also showed a very high rate of satisfaction in an overall subjective functional evaluation [19]. The most important factor for the subjective improvement is the reduction of the pain and increase in strength in addition to stability and aesthetics.

In our study, therapy-refractory pain was the primary indication for fusion of the wrist. We demonstrated statistically significant pain reduction from a preoperative VAS of 7.9 to a post-operative VAS of 1.9. Toma et al. reported no pain in 12 patients post-operatively and mild pain with movement in seven of 19 patients treated with a Mannerfelt arthrodesis. The patients in their study with a plate fusion of the wrist showed no pain in 12 and mild pain in ten of 23 patients, a difference that was not statistically significant [18].

Millender and Nalebuff improved the technique of the wrist arthrodesis by Clayton using Steinmann pins as well as staples and bone graft [11, 12]. Kobus and Turner reported in 1990 on 79 patients who were fused with that technique of which 97 % had excellent or good results [20]. The complication rate was 23 % of which the majority related to irritation of the soft tissue by the prominent Steinmann pin or staple.

The results of a plate fixation of the wrist arthrodesis are also promising. In recent studies by Nydick et al. and Adey et al. a satisfaction rate of 60–70 % in patients with post-traumatic arthritis was shown [13, 21]. Toma et al. reported in their comparison a satisfaction rate of 91 % in rheumatoid patients. They also reported a higher complication rate with plate fixation of 26 % than with the Mannerfelt technique, although it was not statistically significant. The disadvantages of the plate are the irritation of the soft tissues by the plate and

the dependence on the bone structure for the screws. There are no long-term results of plates with locking screws to date. Therefore, when there is an indication for a fusion of the wrist in patients with RA the predictable results are mostly good.

One of the most important factors that determine the outcome and the patient's subjective satisfaction after the operation is the position of the fused wrist. The optimal position of the fusion is still the subject of an ongoing debate. Some authors consider that the optimal position is slight extension of 10–20° and ulnar deviation of 5–10° [19, 22]. Fusion in a neutral to slightly flexed position is also recommended, for it may allow a better control of body hygiene in cases of additional elbow destruction [23]. For patients needing bilateral arthrodesis, it is recommended that one side be fused in slight extension and the other in slight flexion or both in a neutral position [24].

We showed that there is no effect on subjective satisfaction or functional outcome if the wrist is fused in a flexed position or an extended position. It could be demonstrated that all patients who rated their post-operative outcome as excellent were fused between 14° flexion and 10° extension. Most of the studies agree that ulnar deviation of the arthrodesis is preferable, since it may prevent some causes of further ulnar deviation of the phalanges [8, 25].

Our study showed that a Mannerfelt arthrodesis performed on a wrist destroyed by RA improved overall quality of life by decreasing pain and enhancing function. It is a reliable technique with a low complication and high fusion rate. The extended position is easily achievable with the Mannerfelt arthrodesis by bending the Rush pin. We have shown that there is no need for a reconstruction of the carpal height, because it has no impact on the function for the rheumatoid patient. Therefore there is no need for bone grafts. One of the major advantages of the Mannerfelt arthrodesis, with the adapted technique that we have described, is the possibility of a metacarpophalangeal arthroplasty, which is more difficult after a fusion with Steinmann pins or plate fixation.

We could not show clear statistical evidence for better results in either a flexed or an extended position, but the ratings of the patients indicated better subjective results with a slightly extended position of the arthrodesis. From our experience we choose to fuse the destroyed rheumatoid wrist in a slightly extended position with the Mannerfelt technique. Further studies would be necessary with a larger number of patients and a smaller range of fusion positions.

Conflict of interest The authors declare that they have no conflict of interest.

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