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## High reoperation and complication rates 11 years after non-rheumatoid wrist fusion

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3 1 High reoperation and complication rates 11 years after non-rheumatoid wrist fusion  
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9 4 Abstract:

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11 5 Aims: Plate and screw fixation has been the standard treatment for painful wrist disease in non-  
12 6 rheumatoid patients for the last decades. We investigated complications, follow-up surgeries and  
13 7 final outcomes in a consecutive series of non-rheumatoid wrist patients.

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16 8 Patients and methods: 76 patients (53 men), 50 (21-79) years old had their wrist fused.  
17 9 Complications and surgeries during the follow-up were recorded. After 11 (2-18) years 63 patients  
18 10 completed questionnaires and 57 attended a clinical follow-up including radiographs.

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21 11 Results: During the follow-up period 46/76 experienced complications, resulting in 65 reoperations  
22 12 (mainly related to plate-screw problem). At the final follow up the mean QDASH was 36, PRWHE was  
23 13 40 and 14/63 reported no wrist pain. Grip strength, key pinch, pro- and supination was significantly  
24 14 reduced on the operated side. The outcome was worse in patients with prior wrist surgery and  
25 15 patients experiencing complications. 13 are scheduled for further reoperations, giving a total  
26 16 reoperation rate of 40/63 (63%) patients.

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29 17 Take home message: Patients can expect residual wrist pain and substantial functional impairment  
30 18 after wrist arthrodesis. It was not the final wrist surgery for most of our patients. Complications  
31 19 related to the CMC3 dominate. Motion-sparing surgery should be offered prior to wrist arthrodesis if  
32 20 it is possible.

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3 1 Introduction: Arthrodesis has been the salvage procedure for painful pan-arthritis of the wrist for  
4 2 more than a hundred years. In cases with intact articular surfaces limited arthrodesis or fusions can  
5 3 be performed<sup>1,2</sup>. For total wrist arthrodesis, fusion can be achieved by various methods of fixation,  
6 4 with or without bone graft<sup>3</sup>. Stable plate and screw fixation has been the treatment of choice for the  
7 5 last three decades, especially in non-inflammatory wrist disease. Especially rheumatoid patients are  
8 6 reported to be satisfied once they get used to the stiff wrist and the procedure is presumed to have a  
9 7 low rate of complication and to relieve pain at the expense of motion<sup>4-8</sup>. In non-inflammatory wrist  
10 8 disorders the results have not been uniformly good. Increased long-term rates of complication and  
11 9 reoperation question the results seen in rheumatoid patients<sup>9,10</sup>. The purpose of this study was to  
12 10 evaluate the long-term function after total wrist arthrodesis in non-rheumatoid patients and to  
13 11 assess the complications and reoperations during the follow-up.

14 12 Materials and methods: During 2000 to 2013 we operated in total 76 patients (53 men), mean 50  
15 13 (21-79) years old with wrist fusion for painful non-rheumatoid wrist disease (radiocarpal and  
16 14 midcarpal arthrosis excluding more limited procedures). The various causative conditions are shown  
17 15 in Table I.

18 16 The right wrist was operated in 41 patients (40 dominant). Prior to wrist arthrodesis 47 patients  
19 17 underwent 83 wrist surgeries, Table II. 14 had wrist arthrosis bilaterally but no bilateral arthrodesis  
20 18 was performed. Radiographs demonstrated nine additional distal radioulnar joint (DRUJ) arthroses as  
21 19 well as three who had already undergone Darrach's procedure due to DRUJ arthrosis (giving a total of  
22 20 12 wrists with DRUJ arthrosis/Darrach's at the time of surgery). If painful, DRUJ arthrosis was treated  
23 21 with Darrach's procedure. Four out of nine had a Darrachs procedure at arthrodesis surgery and one  
24 22 during the follow-up period (see below). The finger function was normal in all except for one patient  
25 23 with ipsilateral radial nerve paresis. The elbow function was normal in all except one who had  
26 24 sustained an earlier elbow luxation.

27 25 Operative procedure: The method has been described by Houshian and Schröder<sup>9</sup>. In brief, a dorsal  
28 26 skin incision was used. The extensor retinaculum was divided between the 3. and 4. compartments.  
29 27 Remaining cartilage and subchondral bone were removed from the radiocarpal and intercarpal joints,  
30 28 and a titanium alloy (68) or angular stable steel (8) arthrodesis plate (DePuy-Synthes, Zuchwil,  
31 29 Switzerland) was applied. Bone was transplanted from the iliac crest (54), distal radius (20) or ulna  
32 30 (2). In 11 patients concomitant procedures were done (4 Darrach's procedures, 4 tendon sutures or  
33 31 transfers, 2 removals of plates from previous fracture surgery and one carpal tunnel (CTS) release).  
34 32 Fusion of the third carpometacarpal (CMC 3) joint was performed in 26 of the 76 (surgeons  
35 33 preference), the surgery was performed or assisted by the departments 12 consultants. The  
36 34 consultant's level of expertise was 3-4 according to Tang<sup>11</sup>. Postoperatively a short arm cast allowing  
37 35 free forearm rotation and metacarpophalangeal (MCP) motion was applied for 8 weeks. After  
38 36 radiological healing, active use of the hand was encouraged.

39 37 Follow-up. All patients had a minimum of four appointments after arthrodesis surgery.  
40 38 Complications, wrist problems and reoperations during the follow-up period were registered for all  
41 39 the 76 patients. We categorized complications diagnosed within 6 months after surgery as early and  
42 40 the remainder as late. The patients were invited to a final follow-up where they rated pain on the  
43 41 radial (r) and ulnar (u) sides of the wrist at rest and activity using a visual analog scale (VAS, 0-100,  
44 42 100 denoting unbearable pain). They completed the Quick Disability of Arm, Shoulder and Hand

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3 1 (QDASH)<sup>12</sup> score and the Patient-Rated Wrist and Hand Evaluation (PRWHE)<sup>13</sup>. Active pro- and  
4 2 supination were assessed using a handheld goniometer. Grip- and key pinch strength were measured  
5 3 with hand- and fingerheld JAMAR dynamometers (JA 88 Preston, Corp., Clifton, New Jersey, USA),  
6 4 and compared to the opposite side. Frontal and lateral radiographs of both wrists were taken and  
7 5 compared with previous radiographs, and a CT scan was performed in 29 wrists to confirm bony  
8 6 union or to more clearly show degenerative arthritis in neighboring joints. The study was registered  
9 7 as a quality study by the Data Protection Official for Research at Oslo University Hospital  
10 8 (2013/16882). The patients gave informed consent.

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16 10 Statistical analysis. Histograms and QQ plots demonstrated normal or near normal distribution of the  
17 11 continuous data, therefore Student's t-test was applied. For categorical data Chi-square test was  
18 12 used. The data is presented as mean with range (min-max) and confidence intervals. The p-values are  
19 13 two-tailed, and the statistical level of significance was set at  $p \leq 0.05$ .

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24 15 Results: There were 2 perioperative complications. One lacerated EPL tendon was sutured. One  
25 16 patient suffered from irradiating pain in the arm suspected to be caused by the tourniquet cuff used  
26 17 during surgery. Both resolved uneventfully. Early and late complications are given in table III. In three  
27 18 patients (two men) wrist fusion was not achieved. Reoperation with bone grafting, plate fixation and  
28 19 casting resulted in union. CMC 3 arthrodesis was not performed during the first operation in these  
29 20 three patients; bone grafts were harvested from the radius in two and from the iliac crest in one. At  
30 21 reoperation crista iliaca grafting and CMC 3 arthrodesis were performed in all. A fourth patient fell  
31 22 and sustained a fracture in a previously confirmed wrist fusion where the plate had been removed  
32 23 due to pain and tendon irritation. The wrist healed after plate fixation and bone transplantation.

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37 24 During the follow-up period 46/76 (61%) patients experienced complications/wrist problems, 18  
38 25 early and 43 late (Table III).

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40 26 The complications/wrist problems resulted in 65 reoperations in 40 out of 76 (53%) patients during  
41 27 the follow-up period (25 once, 8 twice, 7 thrice and 1 four times). The surgeries included plate/screw  
42 28 removal (41, four patients removed plates 2 times), tenolysis/synovectomy (5), non-union/refracture  
43 29 (4), Darrach/DRUJ arthroplasty (4), removal of long screw/screw remnants (4), arthrodesis  
44 30 triscaphe/CMC/MCP (3), CTS (2) and miscellaneous (2).

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48 32 At the final follow-up after mean 11 (2-18) years eight patients were deceased and one had  
49 33 emigrated. Out of 67 eligible, 4 did not want to attend a final follow-up. The remaining 63 patients  
50 34 completed the subjective outcome measures (QDASH, PRWHE and VAS scores). Fifty-seven attended  
51 35 a clinical examination and had updated radiographs taken. The 63 patients reported reduced hand  
52 36 function and residual pain, 11 patients reported QDASH or PRWHE < 10. No pain at rest or activity  
53 37 was reported by 14 patients (Table IV).

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57 39 Grip-strength, key-pinch strength and forearm rotation in 57 patients were significantly reduced  
58 40 compared to the non-operated side (Table V).

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3 1 Comparing the operated and non-fused side in the 42 patients with a normal opposite wrist  
4 2 demonstrated an increased difference in function (Table VI).  
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8 5 Five patients presented painful flexion-extension motion of the hand through the CMC joints or the  
9 6 preserved perihamate joints at clinical examination, with up to 30° (Figs. 1a-b) of motion. One is  
10 7 scheduled for an arthrodesis in the CMC2-5, while the others have postponed or declined surgery.  
11 8

12 9 The 39/63 patients who had been operated in the wrist prior to arthrodesis reported reduced wrist  
13 10 function and higher pain scores at follow up (Table VII) as compared to those without prior wrist  
14 11 surgery.

15 12 The same was observed for the 35 patients who experienced complications and/or reoperations  
16 13 during the follow-up period. They reported worse function and higher pain scores (except ulnar sided  
17 14 pain) compared to the others even though these complications had been treated (Table VIII).  
18 15

19 16 Radiological examination confirmed bony radiocarpal union in all patients. 35/63 patients still have  
20 17 their plates/screws in situ. CMC 3 arthrodesis was intended in 21/63 patients and left alone in 42/63  
21 18 seen at follow-up. CMC 3 union rate was 71% and these patients reported a QDASH=33 (0-89) and  
22 19 PRWHE=36 (0-91). 9/21 had complications resulting in 17 reoperations. The 42 patients where the  
23 20 CMC 3 was left alone reported a QDASH= 37 (0-91) and a PRWHE = 41 (0-96). 26/41 experienced  
24 21 complications resulting in 32 reoperations. The 15 patients where successful CMC 3 arthrodesis was  
25 22 performed had a significantly reduced complication rate (3 in 15 (20%) as compared to 32 in 48  
26 23 (67%), p=0.002) and reoperation rate (3 in 15 versus 47 in 48) as compared to the unsuccessful CMC  
27 24 3 arthrodesis or no attempt to fuse CMC 3 (Figs 2 a-b). 22/42 patients where CMC 3 arthrodesis was  
28 25 not intended had the plate/screws in situ, nine of these had broken plates/screws (Figs. 1a-b and 3a-  
29 26 b).  
30 27

31 28 Degenerative changes in the distal radio ulnar joint (DRUJ) were seen radiologically in 24 out of 57  
32 29 wrists (42%, including eight who had DRUJ procedures prior to final follow-up), 7 out of these 57  
33 30 (12%) had DRUJ arthrosis at the time of wrist arthrodesis (6 out of these 7 had an ulna shortening  
34 31 procedure 3 prior to wrist arthrodesis, 2 at wrist arthrodesis and 1 during follow-up). The remaining  
35 32 17 developed DRUJ arthrosis during the follow-up. Four patients had suboptimal wrist positions with  
36 33 oblique plate positionings demonstrated radiologically, but without complains about the hand  
37 34 position or function (Fig. 4).  
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39 36 The working status at surgery and follow-up is given in Table IX.  
40 37

41 38 Four out of the blue collar workers had disability pension due to the wrist arthrodesis, two changed  
42 39 to less strenuous work due to difficulties in completing working tasks with a stiff wrist. In  
43 40 Scandinavian countries disability pension is easily accessible and provided by the government  
44 41 independent of cause. High/low function diagnosed by the treating doctor at follow-up does not  
45 42 influence compensation after disability pension has been granted, and there is no financial incentive  
46 43 to exaggerate symptoms or problems at follow-up.  
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3 1 13 out of the 63 patients involved in the study have been scheduled for reoperations (5 had no  
4 2 reoperations prior to the follow-up) related to their wrist arthrodesis after the final follow-up. These  
5 3 surgeries comprise plate removal and/or Darrach procedure (4), rearticulation with a wrist  
6 4 arthroplasty (6), removal of loose Aptis™ (Aptis Medical, Glenview, KY, USA) DRUJ arthroplasty and  
7 5 rearticulation of the wrist (1), implantation of an Aptis™ DRUJ arthroplasty after failed Darrach  
8 6 procedure (1) and CMC 2-5 arthrodesis (1). Including the scheduled reoperations, 40 out of 63  
9 7 patients (63%) followed-up had complications/reoperations and 7/63 (11%) patients (including the  
10 8 three patients experiencing non-union) were scheduled for rearticulation (Figs 5a-b).  
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#### 16 11 Discussion:

17 12 This long term follow-up study of patients suffering from non-inflammatory wrist arthritis treated  
18 13 with total wrist fusion using a plate demonstrated a higher complication and reoperation rate than  
19 14 previous reports. Almost 20% are scheduled for further surgery. Seven patients are scheduled for  
20 15 rearticulation due to pain, dissatisfaction and functional problems with their stiff wrists. Even though  
21 16 reoperations were performed through the whole follow-up period, many were still interested in  
22 17 further surgery at the final follow-up due to the functional impairment they experienced.  
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26 19 Field et al reported a high complication rate (45%), and a high plate removal rate (65%, not  
27 20 considered a complication) in 20 post-traumatic wrist arthrodesis patients using different dorsal  
28 21 plates followed for two years. They also found reduced finger motion (due to metacarpophalangeal  
29 22 stiffness) compared to the non-operated side and 50% reported residual pain. Most of their patients  
30 23 resumed their previous work<sup>14</sup>. De Smet et al found a similar trend after 7 years follow-up in non-  
31 24 inflammatory wrist patients. They used 2 screws and bone graft in 24 and plate fixation in 12  
32 25 patients. Reoperation was performed in 21/36 patients, and DASH score and grip strength were  
33 26 similar to our study<sup>10</sup>. Adey et al reported average DASH scores of 25 and persistent or severe pain in  
34 27 18/22 wrist arthrodesis patients (22 out of 36 operated were reviewed, with questionnaires, 19 also  
35 28 had a clinical examination). 20 out of 22 were interested in a procedure that could restore hand  
36 29 motion<sup>15</sup>. Plate removals were done in five patients due to tendon irritation, CMC 3 fusion was not  
37 30 part of the procedure. Other complications or reoperations were not reported. They concluded that  
38 31 wrist arthrodesis does not eliminate wrist pain. Sauerbier et al reported high DASH (average = 51)  
39 32 and pain scores in 60 post-traumatic arthrodesis patients<sup>16</sup>. The reoperation rate was 35%, and  
40 33 included hardware removal, tenolysis and CTS release. The grip strength was 50% compared to the  
41 34 opposite side after three years follow-up.  
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48 36 More satisfied patients were reported by Meads et al<sup>17</sup>. All 32 mainly non-inflammatory wrist  
49 37 patients were satisfied with the procedure, experiencing increased grip strength compared to  
50 38 preoperatively, reaching 66% of the opposite side, and reporting a substantial reduction in pain score  
51 39 after 2 years follow-up. 10 complications, mostly minor, were seen and 6 patients removed their  
52 40 plates due to tendon irritation. The procedure included CMC 2 and 3 fusions, and no radiocarpal non-  
53 41 unions were seen. The follow-up however was short (15 months average). Owen et al reported a  
54 42 lower DASH score (19) and PRWHE (13) in 62 patients with mixed inflammatory and non-  
55 43 inflammatory arthritis<sup>18</sup>. They also had a low complication (16%) and reoperation rate (12%) after 6  
56 44 years follow-up, and constitutes the better results obtained. Seven patients who were working prior  
57 45 to surgery returned to their original work, while 13 had to change occupation or were retired due to  
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1 wrist problems. The follow-up was limited to postal schemes and telephone interview, and no  
2 objective or radiological assessment was done. The patients were older at surgery (62 years) than the  
3 previous mentioned papers where posttraumatic wrist arthrodesis patients average around 50 years  
4 (similar to ours) at surgery. All the surgeries were performed by one senior surgeon, and their results  
5 have been difficult to replicate by others. We found a painfree wrist in 25% of our patients, the  
6 remainder reported pain at rest, activity of both. Less than 20% had QDASH/PRWHE < 10, although  
7 most of the patients had unilateral wrist problems. A pain free wrist cannot be expected after wrist  
8 fusion in non-rheumatoid patients.

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10 Numerous different partial fusions or resections (including four corner fusion, proximal row  
11 carpectomy, radio-scapho-lunate arthrodesis, triscaphe arthrodesis, scapho-capitate arthrodesis,  
12 luno-triquetral arthrodesis and other) have been used to avoid total wrist fusion in patients with  
13 destroyed intracarpal joints<sup>19</sup>. Absence of wrist motion decreases hand function substantially and  
14 increases the strain on the remaining joints in the upper extremity. Retaining some motion  
15 significantly increases the range of tasks possible for the patients<sup>20</sup> as compared to the stiff wrist, and  
16 the latter patients requests procedures to restore wrist function<sup>15</sup>.

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18 We performed CMC 3 fusion in about 1/3 of our patients and did two plate removals during follow-  
19 up of the 15 successful CMC 3 arthrodesis patients. Plate removal was the only reoperation  
20 performed in these patients. Twenty-eight of the failed CMC 3 arthrodeses (6) and the non-fused  
21 CMC 3 (22) patients where reoperated altogether 45 times, emphasizing the problems around the  
22 CMC 3 joint. Nagy and Büchler examined pain in the CMC 3 joint after wrist arthrodesis and plate  
23 removal in patients with an open CMC 3 joint comparing CMC 3 plate bridging to CMC 3 non-union  
24 after failed fusion<sup>21</sup>. They concluded that a failed fusion of the CMC 3 gave more follow-up pain and  
25 reoperations, advocating bridging of the CMC 3. An important limitation in their study was the  
26 exclusion of 64 patients with the plate in situ over fused CMC 3 joints.

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28 Our CMC 3 non-union rate was 30%, necessitating implant removal in all. Still the reoperation and  
29 complication rate was higher among our bridging CMC 3 patients. In our opinion it is difficult to treat  
30 all the patients the same way, and we believe that an individual approach to the CMC 3 joint could  
31 reduce some of these problems. For patients with less soft tissue coverage and smaller bones a  
32 protruding plate is more likely to give symptoms. For these patients we bridge the CMC 3 joint, and  
33 schedule them for plate removal. CMC 3 arthrodesis should be performed in the majority of patients  
34 with good soft tissue and normal sized hands as it is more probable the plate could be left in situ. We  
35 focus more on the CMC 3 now during the primary surgery, striving to remove more cartilage and do  
36 bone transplantation to reduce the non-union rate. Although some CMC 3 non-unions can be  
37 expected, we believe that a successful arthrodesis of the CMC 3 will reduce complication and  
38 reoperation rates. This was also observed by Nagy and Büchler<sup>21</sup>. Still, the fate of the CMC 3 is one of  
39 the major obstacles in total wrist fusion. Newer fixation methods include shorter plates avoiding  
40 CMC 3 bridging, and intramedullary devices. The former has to our knowledge no published clinical  
41 results although mechanical results are promising<sup>22</sup>. The latter has demonstrated high union rate in a  
42 small case series (seven wrists), but the follow-up was less than 6 months<sup>23</sup>. These newer implants  
43 might solve the problem of bridging the CMC 3 joint.

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3 1 Many of our patients had difficulties in performing their occupation after total wrist fusion, especially  
4 2 manual laborers. In our material only one third were working at follow-up and 6/11 had to change  
5 3 profession or were disabled due to their stiff wrist. Arthrodesis in manual laborers should be  
6 4 postponed as long as possible and the patients should be warned about reoccupation difficulties.  
7 5

8 6 Wrist arthrodesis is considered end stage treatment for degenerative wrist disorders. Still, a high rate  
9 7 of complications and reoperations can be expected. Preserving motion should be the first priority,  
10 8 either by limited resections/arthrodesis or by modern wrist arthroplasties<sup>24-26</sup>. Failed painful partial  
11 9 wrist fusion or resections can be converted to wrist arthrodesis. Due to the relatively high  
12 10 complication and reoperation rate we and others experienced choosing a limited motion preserving  
13 11 procedure can postpone or prevent the need for a total wrist arthrodesis. Even a modern wrist  
14 12 arthroplasty could be the first treatment of choice, results have been encouraging<sup>24</sup> and conversion  
15 13 of a failed wrist modern wrist arthroplasty has an acceptable complication rate<sup>27</sup>. The particular  
16 14 complications of arthroplasty surgery (especially loosening and instability) must however also be  
17 15 taken into consideration<sup>24,28</sup>. On the other hand, conversion from arthrodesis to arthroplasty may  
18 16 also be an option. In the study by Adey et al 90% of the patients were interested in a procedure  
19 17 which could restore some wrist motion<sup>15</sup> patients.  
20 18

21 19 We observed complications and reoperations throughout the follow-up period and we consider wrist  
22 20 arthrodesis more complicated than previously assumed. Many of the patients never got used to and  
23 21 accepted their stiff wrists and requested rearticulation (converting the fused wrist to a wrist  
24 22 arthroplasty) years after the primary surgery. A more systematic follow-up could have reduced the  
25 23 complication rate. The patients should be followed until union is achieved and a steady functional  
26 24 state is reached, with focus on tendon function, plate-screw stability and the distal radio-ulnar joint.  
27 25 We advocate arthrodesis of the CMC 3 or routine removal of the arthrodesis plate when the fusion is  
28 26 radiologically healed if the CMC 3 is bridged.  
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30 28 The major limitation of our study is the retrospective design and the lack of a comparative treatment  
31 29 group. The patients were treated as they came according to the best intentions of the treating  
32 30 surgeon. Preoperatively we did not systematically evaluate wrist or forearm motion, grip or key pinch  
33 31 strength nor pain levels. QuickDASH and PRWHE was not available at the time of surgery. The overall  
34 32 effect of the surgery (especially change in pain levels and function) compared to preoperative could  
35 33 therefore not be evaluated. The strength of the study is the high number of patients and high follow-  
36 34 up rate, the long follow-up period and the combination of subjective, objective and radiological  
37 35 parameters evaluated.  
38 36

39 37 Conclusion: Total wrist arthrodesis may reduce hand function and render residual pain and  
40 38 complications. Patients should therefore receive the appropriate preoperative counseling before  
41 39 proceeding with this operation. We found that wrist arthrodesis reduces hand function and the  
42 40 majority of patients report residual pain both at rest and under activity. Complications and  
43 41 reoperations can be expected years after wrist arthrodesis. For the majority of patients' wrist  
44 42 arthrodesis was not the final surgery.  
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Figure legends

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3 1 Tables4  
5 2 Table I. Diagnosis at surgery.  
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	Frequency	%
SNAC wrist	20	26
SLAC wrist	17	22
Sequele distal radius fracture	16	21
Perilunate fracture-dislocation	8	11
Other (primary arthrosis, mid-carpal instability, iatrogenic injury)	8	11
Lunatomalacia	7	9
Total	76	100

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6 Table II. Wrist surgery prior to wrist arthrodesis.

	Surgeries (n)
Fracture treatment/osteotomies	24
Partial arthrodesis/resections	19
Arthroscopic wrist procedures	15
Scaphoid non-union surgery	12
Nerve surgery (CTS/denervation/exploration)	7
Ligament reconstruction	5
Tendon reconstruction	1
Total	83

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9 Table III Early and late problems and complications.  
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Early complications			Late complications		
	N	%		N	%
No early complication	58	77	No late complications	33	44
Longstanding pain	4	5	Pain over plate/breakage/3CMC	32	42
CRPS	3	4	Non-union	3	4
Flexion contracture fingers	3	4	DRUJ problems	3	4
Tendinitis/tendon rupture	3	4	Tendon adhesions/rerupture	3	4
CTS	1	1	CTS	1	1

Other (Long screw, hip hematoma, metacarp fx, rotational deformity)	4	5	Hematogenous infection	1	1
<b>Total</b>	<b>76</b>	<b>100</b>	<b>Total</b>	<b>76</b>	<b>100</b>

Table IV Subjective outcome, N= 63 (range).

QDASH	36 (0-91)
PRWHE	40 (0-96)
Radial pain at rest	21 (0-90)
Radial pain at activity	35 (0-100)
Ulnar pain at rest	17 (0-90)
Ulnar pain at activity	31 (0-100)

Table V Objective outcome, N=57, compared to the non-fused side. (range), CI= confidence interval. \* Statistically significant.

	Operated side	Non-fused side	CI	p-value
Supination(°)	77 (0-90)	87 (70-100)	4-15	0.01*
Pronation(°)	79 (0-90)	85 (60-90)	1-10	0.02*
Grip strength (kgs)	24 (0-56)	33 (2-74)	3-14	0.002*
Key pinch (kgs)	7 (0-15)	9 (2-17)	1-3	0.002*

Table VI Objective outcome in (N=42) in patients with a normal non-operated side. (range), CI= confidence interval. \* Statistically significant.

	Operated side	Non-fused side	CI	p-value
Supination(°)	75 (0-90)	88 (70-100)	4-18	0.002*
Pronation(°)	79 (0-90)	86 (62-90)	2-13	0.02*
Grip strength (kgs)	25 (0-56)	37 (2-74)	5-18	0.001*
Key pinch (kgs)	8 (0-15)	10 (3-17)	1-3	0.003*

Table VII Comparing prior wrist surgery to wrist function at follow-up. \* Statistically significant.

	No prior wrist procedures	Prior (1-4) wrist procedures	CI	p-value
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QDASH	28 (2-71)	40 (0-91)	-1-24	0.06
PRWHE	28 (0-76)	47 (0-96)	5-33	0.007*
Radial pain at rest	9 (0-80)	29 (0-90)	7-33	0.003*
Radial pain at activity	22 (0-90)	43 (0-100)	6-37	0.008*
Ulnar pain at rest	11 (0-80)	21 (0-90)	-2-23	0.1
Ulnar pain at activity	21 (0-90)	37 (0-100)	-1-33	0.06
N	24	39		

Table VIII. Comparing function at follow-up between patients experiencing complications and patients not experiencing complications. \*Statistically significant.

	No complications/ reoperations	Complications/ reoperations	CI	p value
QDASH	27 (0-75)	43 (2-91)	4-28	0.01*
PRWHE	30 (0-96)	48 (0-91)	4-32	0.01*
Radial pain at rest	13 (0-90)	28 (0-90)	2-28	0.02*
Radial pain at activity	25 (0-80)	43 (0-100)	2-33	0.02*
Ulnar pain at rest	12 (0-80)	21 (0-90)	-3-21	0.13
Ulnar pain at activity	24 (0-100)	36 (0-100)	-4-29	0.15
N	28	35		

Table IX. Working status at surgery and follow-up (%).

	Preoperatively	At follow-up
Blue collar	17 (27)	6 (9)
White collar	21 (33)	12 (19)
Retired	3 (5)	18 (29)
Disabled	9 (14)	19 (30)
Long-term sick leave	13 (21)	8 (13)
Total	63 (100)	63 (100)





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