Mid-term results after midcarpal arthrodesis using an iliac crest cortical chip for grade II/III SLAC/SNAC-wrists

Mittelfristige Ergebnisse nach mediokarpaler Teilarthrodese mit kortikospongiösem Beckenkammspan bei SLAC/SNAC-wrist Grad II/III

Abstract

**Purpose:** The four-corner-fusion is an option for grade II/III SNAC-/SLAC-wrists. The case-control study evaluates the results of a four-corner-fusion with a screw-fixed iliac crest cortical chip.

**Methods:** Ten patients with SNAC/SLAC-wrist ≥ grade II were treated. The evaluation occurred after 24 months using a standard study protocol.

**Results:** The mean postoperative active range of motion were 46% (extension/flexion) and 52% (radial/ulnar deviation) of the contralateral wrist respectively. The postoperative mean grip strength was 43% of the contralateral side, and 84% compared to the preoperative values. The mean Cooney-Bussey Score was 63 and the mean DASH score was 25 (p≤0.05). Four of the patients (40%) had to undergo a partial removal of the osteosynthetic material because of radiodorsal impingement.

**Conclusions:** The four-corner fusion using an iliac crest cortical chip represents an alternative operating procedure for treatment, even though the period of immobilisation cannot be reduced.

**Keywords:** SNAC-wrist, SLAC-wrist, midcarpal arthrodesis, four corner fusion, iliac crest

Zusammenfassung

**Hintergrund:** Die mediokarpale Teilarthrodese stellt eine anerkannte Behandlungsmethode bei karpalen Kollaps nach Skaphoid pseudarthrose (SNAC-wrist) oder nach Ruptur des skapholunären Bandes (SLAC-wrist) dar. Anhand der vorliegenden Fall-Kontrollstudie wurden die Ergebnisse nach mediokarpaler Teilarthrodese unter Verwendung eines kortikospongiösen Beckenkammspanes evaluiert.

**Material und Methoden:** Zehn Patienten wurden 24 Monate nach mediokarpaler Teilarthrodese bei mit SLAC/SLAC-wrist Grad II/III mit einem kortikospongiösen Beckenkammspan nachuntersucht.

**Ergebnisse:** Das mittlere postoperative Bewegungsausmaß des Handgelenkes betrug für Extension/Flexion 46% und für Radial-/Ulnaradduktion 52% im Vergleich zur unbehandelten Gegenseite. Die postoperative Griffstärke betrug im Mittel 43% der Gegenseite und 84% der präoperativen Werte. Der mittlere Cooney-Bussey-Score lag bei 63, der mittlere DASH-Score bei 25 (p≤0.05). Bei vier Patienten (40%) erfolgte eine partielle Entfernung des Osteosynthesematerials aufgrund eines radiodorsalen Impingements.

**Schlussfolgerung:** Die mediokarpale Teilarthrodese mit einem kortikospongiösen Beckenkammspan stellt eine mögliche Behandlungsalternative dar, obwohl die Dauer der Immobilisation nicht reduziert werden kann.
Introduction

An instability of the proximal carpal row, caused by an untreated scaphoid pseudarthrosis (SNAC-wrist/Scaphoid Nonunion Advanced Collapse) or scapholunate dissociation (SLAC-wrist/Scapho Lunate Advanced Collapse), leads to carpal collapse and arthritis [1], [2], [3]. The current concept of treatment is carried out in accordance with stage of affection. As a motion retaining operation in grade II and III, partial-wrist-fusion is the application utilised [4]. The fusion possibilities are hereby adequate from the luno-capitate [5], the scapho-luno-capitate [6], to the point of the four-corner fusion with hamato-luno-triqueto-capitate fusion [7]. In the case of the four-corner fusion, the scaphoid is removed and the gaps of the midcarpal bones to be fused are filled with cancellous bone. The cancellous bone would thereby be extracted from the excised scaphoid [8], from the radius [9], or from the iliac crest [10]. In order to be able to secure and fix any corrections in terms of malpositioning with the anatomical positioning of the lunate and the partial arthrodesis, K-wire [4], [11], [12], screws [13], and circular [8], [14], [15] or rectangular plates [16] are used. To be in a position to carry out a comparison of these methods, objective variables such as the AROM, the grip strength, and the radiological findings need to be ascertained. To be able to guarantee a correlation of these values with the patient’s satisfaction, additional functional values have to be ascertained, and an evaluation of the quality of life carried out. In this case study we describe the results of a modification of the mid-carpal arthrodesis in which cancellous bone from the iliac crest was utilised in filling the interarticular gaps and in which stabilisation was achieved via a screwed iliac crest cortical chip.

Patients and methods

A total of ten patients (nine men and one woman) with an SNAC/SLAC-wrist ≥ grade II via mid-carpal arthrodesis were provided with an iliac crest cortical chip in our clinic in the years 2007 and 2008. Their ages ranged from 45 to 62 years (mean 52 years). The dominant and non-dominant hands were each affected five times. None of the patients had a known previous distal radius fracture in combination with injuries of the scapholunate ligament dissociation or a scaphoid fracture. A notable, albeit untreated trauma, dated back twenty-one years on average. The average time period of the pre-operative soreness was twenty-one months. The post-operative follow-up examination for all patients took place twenty-four months later. The wrist’s active range of motion (AROM) was ascertained by way of a standardised procedure with a goniometer placed dorsal and lateral on the wrist. The grip strength was measured with a dynamometer, and the ascertained degree of strength was given in terms of percentage of the contralateral side. For the purpose of evaluation of the osseous consolidation and progress control, X-rays of each of the wrists were taken postoperatively in two stages – at six and twelve months. For the purpose of evaluation of the functional parameter, the Cooney-Bussey Score [17] was utilised (90–100 points: excellent, 80–90 points: good, 65–80 points: satisfactory, and less than 65 points: poor). In order to estimate the subjective factors of affecting quality of life, the DASH (Disabilities of the Arm, Shoulder and Hand) questionnaire was used [18]. The assessment was carried out in accordance with the scheme in which the value of 0 signifies no restrictions, and the value of 100 signifies maximum impairment.

Statistical analysis

At baseline and the follow-up assessment, mean values and standard deviation of data collected from clinical and subjective measures were calculated. Statistical significance was calculated using Mann-Whitney-U-Test with a critical value of $p \leq 0.05$.

Operation procedure

Via a dorsal s-shaped incision of the wrist, and following preparations of the radially based skin and subcutaneous flap containing the superficial branch of the radial nerve, the opening up of the joint capsule was carried out between the third and fourth extensor tendon compartment. The wrist joint was exposed using a capsular incision through the dorsal intercarpal and radio-carpal ligaments so as to produce a radial based triangular capsular flap [19]. Upon receipt of the palmar radio-carpal ligament, a scaphoidectomy was carried out. Afterwards the cartilage of the joints between the capitale, the hamate, and the triquetrum was removed. The repositioned lunate was held by K-wire via radio-lunate transfixation. Utilising a 15 mm hollow fraise, a bicortical block was removed from the iliac crest and the spongious bone extracted was used to fill the interarticular gaps. In sense of an onlay graft the residual mono-corticular chip was applied with at least one screw in each of the four bones (Figure 1). Finally, a dorsal wrist impingement test was carried out in order to facilitate a correction of the cortical chip in case of dorso-radial impingement. Upon closure of the wound, a palmar cast was applied, and immobilisation lasted for 6–8 weeks. After radiological examination of the osseous consolidation, physiotherapeutic measures were then undertaken.

Results

This operation, which lasted on average 118 minutes, was followed by a five-day (5±2 days) inpatient stay. The average period of disability was five months. Four of the patients (40%) had to undergo a (partial) removal of the osteosynthetic material due to an impingement upon
dorsal extension. None of the patients had any noteworthy complications in relation to the removal of the bone graft from the iliac crest. The mean post-operative active arcs of wrist extension/flexion and radial/ulnar deviation were 46° and 52° of the contra-lateral wrist respectively. The mean range of motion compared to the pre-operative values was 77%. The post-operative mean grip strength comes to 43% of the contra-lateral side and to 84% compared to the pre-operative values. Radiological examination of all patients showed complete osseous consolidation six months after operation (Figure 2). All patients’ results were ascertained with the Cooney-Bussey Scores after 24 months, and none were judged to be suffering from any pain which required treatment or medication. The mean Cooney-Bussey Score at follow up was 63 and the mean DASH score was 25. Table 1 summarises the results after a 24 month follow-up. Statistical analysis on decreased DASH score was significant (p≤0.05).

Table 1: Comparison of pre-operative values for the active range of motion (AROM), grip strength, Cooney-Bussey and DASH scores with the post-operative results. The AROM of the contra-lateral not operated wrist was, on average: extension/flexion 120°; ulnar/radial adduction 60°. The statistical method used was the Mann-Whitney-U-Test; p0,05 was considered significant. Note the significant value (*) in DASH score.

<table>
<thead>
<tr>
<th></th>
<th>preoperative</th>
<th>postoperative</th>
<th>difference</th>
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</thead>
<tbody>
<tr>
<td>AROM (extension/flexion)</td>
<td>75°</td>
<td>52°</td>
<td>−31%</td>
</tr>
<tr>
<td>AROM (ulnar/radial dev)</td>
<td>35°</td>
<td>33°</td>
<td>−6%</td>
</tr>
<tr>
<td>Grip strength in % to the contralateral</td>
<td>46</td>
<td>43</td>
<td>−6%</td>
</tr>
<tr>
<td>Cooney-Bussey Score</td>
<td>54</td>
<td>63</td>
<td>+14%</td>
</tr>
<tr>
<td>DASH score</td>
<td>45</td>
<td>25</td>
<td>−44% *</td>
</tr>
</tbody>
</table>
Discussion

In cases of SNAC and SLAC wrists, the proximal row carpectomy and the four-corner fusion can be taken into consideration as surgical options [20], [21], [22]. With respect to grade II lesions, this procedure is limited due to the presence of mid-carpal arthritis. The aim of the mid-carpal arthrodesis is the restoration of the carpal levels with the restoration of the carpal levels with the formation of a radio-lunate congruency of the joints, which will facilitate the movement of the wrist. The comparison of the completed wrist arthrodesis and the mid-carpal arthrodesis in terms of function and reduction of pain, resulted in a significantly better function after arthrodesis when compared to the same extent of pain previously [23]; yet a full wrist arthrodesis still cannot guarantee complete freedom from pain [24]. K-wires, screws and locking plates are possible fixation techniques after scaphoid excision. The use of K-wires is a low-risk and lowcost treatment option, although an immobilisation of 8 weeks, and a removal of the wires are necessary [20], [25]. After fixing with locking plates a period of immobilisation of over four weeks is recommended, but the results showed that the plates yielded higher non-union rates and less wrist motion [26]. In a series of sixteen patients who had a four-corner fusion using the Spider Limited wrist fusion plate, the authors found a 56% complication rate including a 25% non-union rate. In 25% of the cases they found a dorsal and in 6% a radial styloid impingement. Screws were broken in 13% of cases [27]. With the further development of the circular plates, a decrease in the complications described could be observed. This is according to reports by Mantovani et al. of a notably reduced non-union rate, and of a described fusion which occurred in 19 out of 20 patients [8]. The functional results, which are here laid down after a follow-up of 20.2 months, describe an AROM (flexion and extension) of 49% and an AROM (radial and ulnar deviation) of 60% in comparison to the contra-lateral. The grip strength was 74% post-operative in comparison to the contra-lateral, and in comparison with the pre-operative value, has increased by 55%. The DASH value was also improved by 48%. The technique and the results of mid-carpal arthrodesis with insertion of cancellous bone graft from the iliac crest after scaphoid excision and fixation with 1.5 mm K-wires were described by Sauerbier et al. [12]. Their functional results after 25 months were 54% for the AROM (flexion and extension) and 45% for the AROM (radial and ulnar deviation). They gave the grip strength as 65% in comparison with the contra-lateral. The DASH score was only ascertained within the framework of the follow-up and was 28. Tünnerhoff et al. [28]
forgo the use of removing bone graft from the iliac crest due to the additional operation trauma, and use instead the cancellous bone from the distal radius or from the removed scaphoid. They ascertain an AROM (flexion and extension) of 65° and 32° for the radial and ulnar deviation after 27 months. The average grip strength before surgery was 24 kg, after surgery it was 34 kg. The post-operative DASH scores were also ascertained to be 22. Our present results compare favourably with those of the above series. In our first series [29], after six months we determined a DASH score of 44 points, whereby the degree of movement and grip strength in the subsequent 18 months hardly changed. After 24 months the mean post-operative DASH score was 25 points, and this, in turn, represents a good functional outcome with only a small disability. Contrary to both the above-mentioned studies, we were not able to observe any increase in grip strength within the follow-up, which are reported here as one being an increase of 55% [8] and the other 29% [28] respectively. Via the application of a cortical chip the period if immobilisation cannot be reduced, although the necessity to remove the osteosynthetic material does, as a general rule, not apply. Due to the additional operation trauma to the iliac crest, an unquestionably increased risk exists in terms of post-operative complications such as secondary haemorrhaging or infection. Based on these, the length of the inpatient stay may have to be extended. The stability and the functional outcome, those which could be achieved, turned out well. In our opinion four-corner fusion with cortical iliac crest chip is utilised when treating an SLAC or SNAC wrist in conjunction with cancellous bone to be taken from the iliac crest, and should especially be the case in terms of revision surgery. This way a higher degree of stability can be achieved via the circumferential, compressing, cortical chip and the three-dimensional screw-fixing. In four of our first cases an operative revision became necessary. They showed a dorso-radial impingement not caused by the chip but by too proximally inserted screws. In order to avoid an post-operative active or passive impingement we recommend a critical assessment of the intra-operative X-rays taking the chip’s edges and the screws into account. The midcarpal arthrodesis coupled with scaphoidectomy, spongioplasty, and screw-fixed cortical iliac crest bone grafts in grade II and III of advanced carpal collapse, can retard the progressive process of arthritis. By this method, alleviation of pain in the wrist is achieved, and simultaneously, an acceptable degree of movement and strength is maintained. We would recommend this method when additional cancellous bone is to be removed from the iliac crest.

**Notes**

**Competing interests**

The author declares that he has no competing interests.

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**References**


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