

SCAPHOTRAPEZIOTRAPEZOID (STT)-ARTHRODESIS IN KIENBÖCK'S DISEASE

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This study reviews the results of 59 of 84 patients with severe Kienböck's disease who were treated with STT fusion. The average follow-up period was 4 (ranges: 2–8) years.

The average arc of wrist extension and flexion was 67° (60% of the contralateral side, 81% of pre-operative range) and that of ulnar and radial deviation was 31° (52% of the contralateral side, 56% of pre-operative range). Pre-operative pain values (VAS) were 56 (non-stress) and 87 (stress) and were significantly higher than the postoperative values of 12 (non-stress) and 41 (stress). Grip strength improved from 45 kPa pre-operatively to 52 kPa postoperatively. The mean modified Mayo wrist score was 63 points. The patients reported low disability in the DASH scores, with an average of 28 points.

Our data show that STT fusion is a reliable and effective treatment for pain relief and offers a good functional result in advanced stages of Kienböck's disease. However the long-term effect of this procedure on radioscaphoid and other intercarpal joints is yet to be determined.

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INTRODUCTION

Scaphotrapeziotrapezoid (STT) arthrodesis was first suggested as a wrist salvage procedure by Witt (1956) and Peterson and Lipscomb (1967). Watson and co-workers have also recommended the STT arthrodesis as a salvage procedure in Kienböck's disease (Watson et al., 1985, 1996; Watson and Hempton, 1980). Stage IIIb of the Lichtman (Lichtman and Degnan, 1993) classification is considered the ideal indication (Prommersberger et al., 1998; Sauerbier et al., 2000; Trankle et al., 2000). By stabilizing the radial column of the carpus, load transmission occurs through the radioscaphoid joint and the radiolunate joint is unloaded (An, 1993) (Fig 1). Currently there is controversy regarding the usefulness of this procedure as high complication rates have been reported (Kleinman and Carroll, 1990). Additionally, alternative procedures like proximal row carpectomy are available for the treatment of stage IIIb Kienböck's disease (Fortin and Louis, 1993; Larsen et al., 1997; Lin and Stern, 1993; Meier et al., 2002; Shin et al., 1999; Tomaino et al., 1994).

Watson et al. (1999) reported excellent results in a large series of patients with a follow-up of up to 16 years. However there are very few other reports of the results of STT arthrodesis (Sauerbier et al., 2000). In this study we reviewed our series of 84 patients with Kienböck's disease who were treated with STT arthrodesis between 1992 and 1997.

PATIENTS AND METHODS

Eighty-four STT arthrodeses were performed in 84 patients with Kienböck's disease at our centre for between 1992 and 1997. Twenty-five patients were unavailable for follow-up, either because they refused to return for assessment as they lived more than 200 km away, or because they were untraceable. Fifty-nine patients were thus available for follow-up and were included in this study. Stage II disease was present in one of the 59 cases, stage IIIa in 14 cases, stage IIIb in 35 cases and stage IV, with limited radiolunate arthritis, in nine (Lichtman and Degnan, 1993). The average age was 38 (range: 17–65) years. The left hand was involved in 20 cases and the right in 39. Forty patients had involvement of the dominant hand.

All of these patients were examined pre- and post-operatively. Hand and wrist function were assessed clinically, grip strength was measured and pre- and postoperative pain was assessed with a visual analogue scale (VAS: 0=no pain, 100=maximal pain). Radiological examination included conventional radiographs and a CT scan. A functional evaluation was carried out using Krimmer's modification of the Mayo wrist score (Cooney et al., 1987; Krimmer et al., 2000). In this score the maximum of 100 points represents an excellent outcome and the minimum of 0 points indicates severe disability (Table 1). The modifications to Cooney's "Clinical Scoring Chart" were for the assessment of pain and function. In our opinion differentiation between



Fig. 1 STT fusion in Kienböck's disease stage IIIb: (a) right wrist of a 31-year-old man with Kienböck's disease stage IIIb. There is fragmentation of the lunate, early carpal collapse and an increased scapholunate angle. (b) The same wrist following STT fusion. The scapholunate angle is improved. (c) The same wrist 6 years after STT fusion. There has been no further carpal collapse or fragmentation of the lunate.

mild and moderate pain is difficult for the patient, while differentiation between pain after strenuous activity and pain at rest is much easier. The employment of a patient is not always reflective of wrist function because it is influenced by multiple factors and thus usability of the wrist seems to be more specific (Table 1).

The disabilities of the arm shoulder and hand (DASH) score (Amadio, 1997; Hudak et al., 1996) was used to further assess the outcome from the patients'

point of view. We used part A (function) and part B (symptoms) of version 1 in German (Germann et al., 1999). In this a score of 100 points indicates maximal disability and 0 points indicates no disability at all.

Operative technique

The STT joint is approached by a oblique incision on the dorsum of the wrist (Buck-Gramcko and Lankers,

Table 1—Modified Mayo wrist score (Krimmer et al., 2000)

<i>Grip strength</i>			
per cent of contralateral side			Points
0–25			0
> 25–50			10
> 50–75			20
> 75–100			30
<i>Range of motion (ROM)</i>			
Ex/Flex	Rad/Uln	Pro/Sup	Points
≤ 30°	≤ 10°	≤ 80°	0
> 30–60°	> 10–35°	> 80–110°	10
> 60–100°	> 35–50°	> 110–140°	15
> 100°	> 50°	> 140°	20
<i>Pain</i>			
	<i>Verbal analogue scale (1–4)</i>		Points
Severe to intolerable	4		0
Pain after activities and at rest	3		10
Pain after strenuous activities	2		15
No pain	1		20
<i>Functional status</i>			
Severe disability			0
Moderate disability			10
Limited only in special situations			20
Normal no disability			30

The maximal reachable score of 100 points indicates no limitations. Surgery for Kienböck's Disease can limit extension–flexion (E/F) and radial–ulnar deviation (R/U), but pronation–supination (P/S) is not affected. The point assignment is done by summation of the results for E/F and R/U and division of this result by 2.

Ranking	Points
Excellent	> 80 – 100
Good	> 65 – 80
Moderate	> 50 – 65
Poor	0 – 50

1990). The joint is entered through a transverse capsulotomy between the extensor carpi radialis brevis and longus. The articular cartilage of the STT joint is excised until cancellous bone is visible. The scaphoid is then aligned in about 60° flexion to the lunate and is fixed with at least two 1.6 mm Kirschner wires which pass from the trapezoid into the scaphoid. Cancellous bone graft is harvested from the distal radius and is packed into the fusion site before the tips of the Kirschner wires are advanced into the scaphoid. The Kirschner wires are cut and their bent ends are buried subcutaneously. Division of the posterior interosseous nerve is always performed. The radial styloid process is not routinely removed (Rogers and Watson, 1989).

The wrist is immobilized in-below-elbow arm plaster for a period of 6 weeks and the Kirschner wires are removed after 10 to 12 weeks.

Statistical analysis

Differences between the pre- and postoperative ranges of motion, grip strength and pain values were assessed for statistical significance with Student's paired *t*-test. Scores were evaluated by Pearson product moment correlation.

RESULTS

The mean follow-up was 4 (range 2–8) years.

The mean pre-operatively pain scores were 56 (non-stress) and 87 (stress), and these both improved significantly postoperatively to 12 (non-stress) and 41 (stress) ($P < 0.05$; 95% CI for difference of means: 29 to 50 and 36 to 53 respectively). The postoperative arc of extension/flexion of the wrist averaged 67° (range: 25–120°, 60% of the contralateral side, 81% of pre-operative range), and the arc of ulnar and radial deviation averaged 31° (range: 10–60°, 52% of the contralateral side, 56% of pre-operative range). Radial deviation was most restricted (to approximately 7°). The mean grip strength improved from 45 kPa presurgical to 52 kPa ($P < 0.05$, 95% CI for difference of means: 2 to 26) post surgery.

Non-union occurred in nine cases (15%) radiologically, and in six cases, revision fusion surgery was successful. Radioscaphoid degeneration was found in 13 patients. In 10 of these 13 patients the degenerative change was only at the radial styloid process and a secondary styloidectomy was necessary in five cases. Irritation of the superficial radial nerve occurred in two cases and was only transient. There were no tendon ruptures and the modified Mayo wrist score averaged 63 points (range: 30–98). The average DASH score was 28 (range: 2–73). There was an inverse correlation between these two scores (Pearson's correlation coefficient of 0.513; $P < 0.05$).

DISCUSSION

The treatment of Kienböck's disease differs according to the stage of the disease and ulnar variance. A salvage procedure should prevent advancement of the disease process and provide acceptable wrist function. STT fusion may achieve these goals by repositioning and stabilizing the carpal rows and preventing or slowing down the development of arthritis. It can successfully unload the lunate by transferring the carpal load to the radioscaphoid joint (Iwasaki et al., 1998; Short et al., 1992; Werner and Palmer, 1993). Our data show that, in addition to pain reduction, STT fusion also preserves wrist mobility and adequate hand strength. However load transfer to the radial column might result in degenerative arthritis of the radioscaphoid joint. Reports on the development of clinical and radiological

degenerative arthritis following STT arthrodesis are confused because of different definitions of arthritis, different interpretations of the radiological and clinical signs and modifications of the surgical treatment. Kalb et al. (2001) recently found radiological evidence of degeneration in 78% of cases on CT scans, but only in 51% of cases on plain radiographs. They pointed out that half of the radiographic findings were minor, though did not differentiate between secondary and pre-existing arthritis. Furthermore they did not precisely localize the radioscaphoid arthritis. However, as radioscaphoid arthritis is not common in Kienböck's disease (except in stage IV), it can be assumed that it developed as complication of fusion of the STT joint. In these cases it is usually localized to a small area of the radial styloid and has minor clinical impact. Watson et al. (1999) found no secondary degenerative arthritis in any of his 800 cases of STT arthrodesis with a follow-up of up to 16 years. In our study we found 13 patients with radioscaphoid arthritis, and it appeared more common if the alignment of the scaphoid incorrect. Minimakawa et al. (1992) demonstrated that the optimum amount of scaphoid flexion was between 41° and 60°. Kleinman and Carroll, (1990) fused the scaphoid in 45° while, in contrast to the normal radioscaphoid angle of 47°, Watson recommends an angle of 55° to 60°.

The degeneration was found only at the radial styloid in 10 of the 13 patients with radioscaphoid arthritis, and was treated successfully with a styloidectomy in five cases. This radialstyloid impingement is the reason why some authors recommend resection of the radial styloid routinely (Kalb et al., 2001; Kleinman and Carroll, 1990; Rogers and Watson, 1989). However many patients with radiological signs of radiostyloid degeneration have no clinical signs and a secondary resection of the radial styloid is easily performed if clinically relevant radial styloid impingement develops. We thus do not think it necessary to resect the radial styloid process routinely and consider an 8% rate of secondary styloidectomy acceptable. Further biomechanical studies have shown that there is a definite risk of increased carpal instability after radial styloidectomy (Nakamura et al., 2001; Siegel and Gelberman, 1991). This risk of instability could probably be reduced by only excising the dorsal aspect of the radial styloid, leaving the palmar aspect untouched. However we have no personal experience with this technique and have found no reports of its use.

The incidence of non-union after STT fusion is low in recently published series. Watson et al. (1999) observed a 4% rate of non-union in 798 patients, while Sauerbier et al. (2000) observed one non-union in 26 patients. Kalb et al. (2001) reported only one non-union in 39 patients following STT fusion for Kienböck's disease, but a meta-analysis of STT fusions for various indications suggests a non-union rate of between 0% and 33% (Larsen et al., 1997). Siegel and Ruby (1996) found a 0% to 43% rate of pseudarthrosis in their critical review of

the literature. In our series union was assessed using a very sensitive CT scan technique and nine nonunions were found. Some authors suggest that there is a lower incidence of non-union for STT fusion in patients with Kienböck's disease (Kalb et al., 2001). We agree with this and concur with Kalb et al. (2001) who suggest that technical problems, such as incomplete removal of the cartilage, unstable fixation and incorrect carpal bone alignment are frequently found in cases of non-union.

STT fusion can prevent progressive carpal collapse in Kienböck's disease stage IIIB and in stage IV cases without radioscaphoid arthrosis. In some cases it may allow recovery of the lunate. The procedure provides pain relief, preserves an acceptable range of motion and improves grip strength. However STT fusion is a salvage procedure and further research is necessary to find a predictably successful treatment which preserves the normal anatomy of the wrist.

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