ORIGINAL ARTICLE

High results and lower cost in four-bone arthrodesis with retrograde screws

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ABSTRACT

Aim To describe the technique of the four-corner fusion with two retrograde crossed headless screws in cases of carpal collapse.

Methods This technique is a consolidated procedure performed in cases of scaphoid non- union advanced collapse (SNAC) type II and III, scapholunate advanced collapse (SLAC) type II and III and in other cases of carpal collapse. Between 2017 and 2019 we treated six male patients (a mean age of 55.0 years) with radiocarpal osteoarthritis. Our technique involves the use of two retrograde crossed headless screws; the first screw was placed distally proximally from the uncinate to the lunate and the second screw from the pyramidal to the capitate, crossed at approximately 90 degrees. Clinical and radiographic two-year follow-up was performed. Before the treatment and during the follow-ups VAS, PRWE and DASH Quick score scales, measured wrist range of motion (WROM) were administered and evaluated.

Results In all cases the X-ray consolidation of arthrodesis within five months was noticed; in 50% patients already under 3-month control. No observed signs of mobilization of screws and inflammatory or infectious processes were found. All patients were satisfied (reduction/disappearance of pain). All surgically treated patients resumed normal daily activities. These improvements were confirmed by the results of the evaluation scale and clinical examination.

Conclusion This technique, in our opinion, represents a gold standard. Its low costs of the material used (especially comparing to other technique), a low prevalence of complications of materials and fusion in 100% of cases should be also considered.

Key words: compressive screw, four-corner fusion, SLAC wrist, SNAC wrist

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INTRODUCTION

Four-corner arthrodesis, or partial carpal arthrodesis, is a surgical procedure established in the literature (1) that was first described in 1984 (2). It involves the removal of the scaphoid and the subsequent fixation of the remaining carpal bones (capitate, semilunar, pyramidal, uncinate) with different means of synthesis: kirschner wires, staples, plates and screws (1,3). This procedure is performed in cases of post-traumatic wrist arthrosis resulting from chronic ligament injuries scapholunate advanced collapse (SLAC) and scaphoid non-union advanced collapse (SNAC)

The aim of our study was to illustrate the clinical and radiographic results and describe the technique of the four-corner fusion with two retrograde crossed (90°) headless screws (4), permitting reduced operating costs. In the literature there are several techniques with two or more screws antegrade and retrograde, but not crossed (5-7).

PATIENTS AND METHODS

Patient and study design

At the Orthopaedic and Trauma Unit of Esine Hospital we treated and analysed six cases (five patients) of radio-carpal osteoarthritis treated by four corner arthrodesis using two "crossed" headless screws between 2017 and 2019. All patients were evaluated up to the follow-up at two years. This is the technique we preferred and used it in all cases of SNAC II and III, SLAC II and III.

Methods

Between 2017 and 2019 we surgically treated six cases of radio-carpal osteoarthritis; all the patients were males with a mean age of 55.0 years (between 27 and 74 years). The average time of carpal arthrodesis stabilisation from trauma was 5.3 years (3.7 – 9.1 years). In five cases there was interested the right dominant hand, and in one case the left non dominant hand (in the bilateral case). In three cases these were wrists type SLAC wrist II/III; in the other three SNAC wrist type II/III. Our technique involves the use of two retrograde crossed headless screws through the dorsal access. In one case, a staple was added for poor bone quality (patient with rheumatoid arthritis). In our series, one patient was affected by rheumatoid arthritis, another by osteoporosis, both under drug treatment. One patient claimed to be a former drug addict. No diabetic patients, but four patients were smokers. Three patients were in manual labour, the other two were retired.

The surgical procedure was performed by means of a longitudinal curvilinear dorsal incision targeted at the mid-carpal joint and extended proximally up to the radio-carpal joint (about 6 cm). Once the capsule was reached, the following was carried out: dorsal U-shaped capsulotomy with a distal base (8), electrocaution of the posterior interosseous nerve, scaphoidectomy, and finally the preparation of the articular surfaces was performed by removing the residual cartilage until adequate congruence was obtained. Once the carpal bones were faced, they were temporarily stabilized with kirschner wires and, subsequently, the first screw was placed distally proximally from the uncinate to the lunate and the second screw from the pyramidal to the capitate, crossed at approximately at 90 degrees (4). Before bringing the screws to full compression, the spongiosa taken from the scaphoid was inserted in order to facilitate arthrodesis. Intra-operative radiographic checks were performed in antero-posterior, latero-lateral and oblique, pronated and supinated at about 30°, to assess the correct position of the carpal bones and screws. At the end tested stability of the arthrodesis "*de visu*" with passive mobilization and accurate haemostasis was carried out. Finally, anti-brachiometacarpal protection plaster was placed for 30 days, with free metacarpal and phalanx joints.

X-ray checks and targeted CT scans were performed with three-dimensional reconstruction before surgery in all cases. All patients underwent periodic clinical follow-ups at one month postoperatively, approximately every three months and at the final follow up.

Before the treatment and during the follow up VAS (9), DASH Quick score (10), and PRWE (11) were used for measuring wrist range of motion (WROM). VAS is a **psychometric response scale consists of** a 100-mm horizontal line on which the patient's pain intensity is represented by a point between the extremes of "no pain at all" and "worst pain imaginable" (9). DASH Quick Score is a questionnaire (contains 11 items) that measures an individual's ability to complete tasks, absorb forces, and severity of symptoms: the patient can select an appropriate number corresponding to his/her severity/function level (10). PRWE is a 15-item

questionnaire designed to measure **wrist** pain and disability in activities of daily living. It is used for specific **wrist** problems and is one of the reliable upper extremity outcome instruments (11).

The post-operative rehabilitation program provided for the maintenance of the plaster cast valve for 30 days and then the use of a brace for further two - four weeks (depending on the X-ray control), the use of pulsed electromagnetic fields (CEMP, BIOSTIM IGEA 8 hours per day for about 30 days), pharmacological (ibuprofen 600 mg, two times for a day, for 5 days and clodronate 100 mg, 1 injection every seven days for 2 months). Upon removal of the plaster cast, cautious and progressive physiotherapy and hydro-kinesis therapy are initiated. The return to work was granted after clinical and radiological bone fusion was obtained.

RESULTS

Patients underwent dressing at 7 days, desuture at 14 days and clinical and radiographic control at 30 days without plaster casts and X-ray checks at subsequent follow-ups according to evolution. At the clinical controls the active and passive range of motion (ROM) was evaluated; in all cases VAS scale reduction was obtained (Table 1); in all cases a reduction of VAS was observed comparing the valuation before and three months after arthrodesis. When evaluating the range of motion, a good recovery of the flexion-extension of the radiocarpal joint was observed: on average 53.6° total (minimally 34° and maximally 63° total). Pronesupination, radialization and ulnarization preserved. One case presented a block in ulnar deviation (SNAC case) with total recovery of 25° of ROM.

At the 24-month follow-up, Quick DASH score had a mean value of 7.5 (min. 2.3 – max. 11.4); PRWE score of 6.4 (min. 0 – max. 14) (Table 2)

All surgically treated patients resumed normal daily activities. Of three manual workers patients two returned to their previous job within 4 months; only one patient requested a change of job due to persistence of pain under exertion. The radiographic examination showed the bone fusion, on average 60 days (range 30-90 days) (Figure 1).

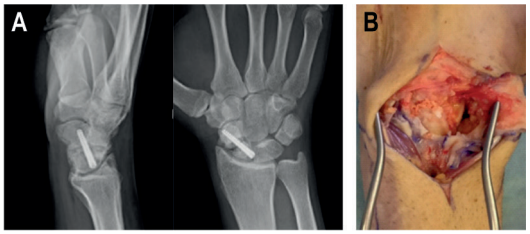

Figure 1.A) Initial radiographic, scaphoid non-union advanced collapse (SNAC) wrist; B) intraoperative picture of arthrodesis (Ghargozloo D, 2017)

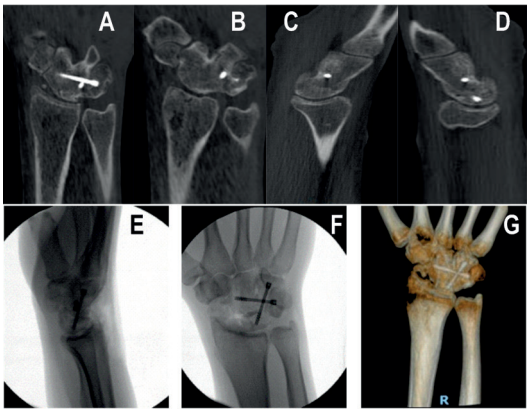

Figure 2. A-D) CT scan at 2 years and 3 months after surgery showing the placement of the screws and the rooting of arthrodesis; E, F) Radiographic evaluation at 1 year after surgery confirming screws position; G) CT 3D scan at 2 years and 3 months after surgery which confirms the positioning of the screws (Ghargozloo D, 2020)

Table 1. Clinical evaluation before and after surgical treatment

Ordinal number of patient	VAS		DASH QUICK		PRWE	
	Before surgery	Three months follow-up)	Before surgery	Two years follow-up)	Before surgery	Two years follow-up
1	7	0	43.2	4.5	46/100	2.5/100
2	6	0	59.1 right side, 59.1 left side	2-3 right side, 2,3 left side	46.5/100 right; 46.5 left side	0/100 right side; 0/100 left side
3	7	1	56.8	11.4	86/100	11/100
4	9	3	65.8	11.4	86/100	14/100
5	8	1	67.3	13	78/100	10/100

VAS, Visual Analogic Scale; DASH QUICK, Disabilities of the Arm, Shoulder and Hand (DASH) scale Quick score; PRWE, Patient-Rated wrist Evaluation

Table 2. Description of five patients with radio carpal osteoarthritis

Ordinal number of patient	Age	Gender	Wrist	Pathology	Operation technique	Bone graft	Date of surgical treatment	Last follow-up
1	27	M	Right (Dominant)	SNAC II	Two screws	Yes	15. 10. 2018	27 months
2	58	M	Right (Dominant)	SNAC II	Two screws	Yes	19.10. 2017	42 months
			Left	SNAC III			10. 05. 2019	24 months
3	74	M	Left	SLAC III	Two screws, one staple	Yes	05. 04. 2018	33 months
4	65	M	Left (Dominant)	SLAC III	Two screws	Yes	19. 02. 2018	25 months
5	51	M	Right (Dominant)	SLAC II	Two screws	Yes	31. 07. 2018	30 months

M, male; SNAC, scaphoid non- union advanced collapse; SLAC, scapholunate advanced collapse;

The average surgical time was 97 minutes (range: 90-115 minutes) and the costs of the implanted material were significantly reduced (2 screws at 90 euro each) compared to the use of the dedicated plate and screws for arthrodesis. As for complications: in one case, out of six, there was moderate pain in the radio-carpal and ulnar site, associated with loss of strength. Fusion of the carpal bones occurred in all cases (100% of treated patients).

The existing joint limitation observed in the preoperative has improved in follow-up controls; this is because a part of the limitation depended on painful symptomatology.

DISCUSSION

The four corners fusion or partial carpal arthrodesis is a surgical procedure widely used in cases of radiocarpal arthrosis, SLAC or SNAC type II or III. Established for many years as the abundant literature shows, this procedure involves the use of different techniques and various means of synthesis: K-wires, staples, spider-type plate and concealed head screws (1,3,8). The technique used by us (4) has the advantage of having reduced costs; it does not damage the articular surface of the lunate and does not lead to its collapse as can happen in the placement of screws via antegrade. From the literature data and from our experience, a higher percentage of fusion is confirmed compared to what is evidenced in the case of using staples and/or K wires, no implant impingement can occur in the use of plates (1). Complications were evidenced in one case (out of six) with moderate pain in the radio-carpal and ulnar site, and associated with loss of strength with results comparable to the data found in the literature (4,5,6).

In conclusion, the results show a reproducibility of the technique we used (4), correlated to the number of cases performed, a fusion in 100% of cases, a low prevalence of complications and very low cost of materials. This technique, in our opinion, is a good method for the partial carpal arthrodesis, but it should be born in mind that these are short- medium term results on a small non-homogeneous sample. Further studies with a larger number of patients enrolled are needed to confirm the excellent results observed.

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TRANSPARENCY DECLARATION

Competing interests: None to declare.

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