

## Capitolunate arthrodesis with scaphoid excision for the treatment of Scaphoid Nonunion Advanced Collapse wrists: a case-series

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Submission: 6 September 2021

Revision: 8 September 2021

Acceptance: 9 September 2021

### Abstract

**Background and objective:** Scaphoid Nonunion Advanced Collapse (SNAC) is a common pattern of degenerative wrist arthritis. Besides the conventional surgical method (4-corner fusion (4CF)), alternative methods have been described as capitoulunate arthrodesis. The objective of this study was to investigate the surgical result of the capitoulunate fusion and the results from the post-surgical one-year follow-up.

**Materials and methods:** From March 2008 to March 2017, among 21 patients with SNAC wrist, stages 2 and 3, 14 were included. Following the scaphoid resection, by preserving capitate convexity and concavity of the lunate's distal face, the lunate was reduced on the capitate, and capitoulunate fusion was done using Herbert screws, in the antegrade direction. All patients were followed for one year. Clinical examinations and wrist x-rays were investigated in each follow-up session. Visual analog score (VAS), Disability of the Arm, Shoulder, and Hand (DASH score) were compared before and after the surgery. Grip strength, flexion and extension were recorded one year after surgery, compared with intact non-operated hand.

**Results and conclusion:** Union occurred in all of the patients. VAS score and DASH score decreased (from 6.5 to 3.3 and from 46.14 to 30.43). The VAS score and DASH score decreased significantly after a one-year follow-up ( $P$ -value  $\leq 0.05$ ). Operated hand flexion was  $34.30^\circ$  (20-80), the extension was  $32.58^\circ$  (20-60), and grip strength was 29.69 Kg (22-40). Non-operated hand flexion was 56.38(30-80), the extension was 61.8 (38-80), and grip strength was 44.54 Kg (28-76). These differences were statistically significant ( $P$ -value  $\leq 0.05$ ). Based on our study results, scaphoid excision and capitoulunate arthrodesis resulted in an acceptable functional wrist with minimal pain. This finding reflects that capitoulunate arthrodesis is a time-saving and easy-to-learn procedure. Minimal morbidity of this method supports the idea that the capitoulunate arthrodesis is an acceptable alternative to 4CF, the conventional surgical method.

**Keywords:** Capitoulunate fusion, DASH, partial wrist fusion, Scaphoid Nonunion Advanced Collapse (SNAC), wrist osteoarthritis

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## 1. Introduction

Scaphoid Nonunion Advanced Collapse (SNAC) is a common cause of developing degenerative wrist arthritis [1]. Pain and daily activity disturbance may occur due to this phenomenon, indicating an alarm for surgical intervention. The diagnosis is made by accurate history, physical examination, and wrist x-rays. Once the diagnosis is confirmed, surgery is indicated. Different surgical methods have been described, but the conventional surgical approach has been four-corner fusion, the fusion of capitate, hamate, lunate, and triquetrum fusion (4CF). Capitolunate arthrodesis, known as a limited intercarpal fusion with the removal of arthritic changes, emerged as an acceptable method [2]. Recent studies have indicated successful results of this method [3-7]. The objective of our study was to investigate the surgical result of the capitolunate fusion and the results from the post-surgical one-year follow-up.

## 2. Materials and methods

From March 2008 to March 2017, 21 patients with SNAC wrist became candidates for surgery in Shariati Hospital, Tehran, Iran. Surgery had not been performed for one patient due to a lack of consent, and six patients did not return for follow-up sessions; therefore, 14 patients were recruited in the present study. History of previous wrist surgery and intraoperative findings of the radiolunate involvement were considered as the exclusion criteria. Our institutional review board approved the study, and informed consent was obtained from all participants. One surgeon performed all surgeries. All cases complained of wrist pain affecting their daily activity. Inclusion criteria were defined as the symptomatic SNAC wrist with degenerative changes (stage 2 and 3). Also, some patients who had computed tomography (CT) scan for more precise staging were included. All patients included in the study were followed at least for one year. In a one-year follow-up, clinical and radio-graphical assess-

ments were done. Postoperative clinical and radiological evaluations were performed one year following the surgery. The last follow-up session was done in the hospital, and the clinical and radiological examination was performed by the same surgeon.

Clinical investigations consisted of measurements of range of motion in wrist flexion and extension by a clinical goniometer and grip strength by a dynamometer. The pain was analyzed by visual analog pain score (VAS score), and patients were asked to fill the "Disability of the Arm, Shoulder, and Hand" (DASH) questionnaire, indicating arm disability from 0 to 100, that 0 indicated the minimal and 100 showed the maximal disability. Pre-op and post-op radiographs, anteroposterior and lateral views were assessed in all patients. The radiographic staging was done based on Watson classification [8]. Complications, such as nonunion, hardware migration, infection, and Complex Regional Pain Syndrome (CRPS), were investigated. The complete union was assessed based on loss of tenderness in the fusion site on physical examination and callus presence at the fusion site on x-ray. The VAS score, DASH score were assessed before the surgery and after the last follow-up surgery. The wrist range of motion and grip strength was evaluated in the last follow-period visit, compared with the other non-operated hand. The x-ray and physical examinations on the non-operated hand showed no degenerative changes in all patients, except the one who had bilateral SNAC.

Through the dorsal approach, the partial posterior interosseous nerve neurectomy was done for all of the patients. All the cases underwent total scaphoidectomy from the same dorsal approach at the beginning of the surgery, without triquetrum excision. By preserving capitate convexity and concavity of the lunate's distal face, the lunate was reduced on the capitate; the correct position of lunate and capitate was assessed by intraoperative x-ray,

and capitolunate fusion was done, using Herbert screws, in the antegrade direction. Whenever possible, the usage of two screws was preferred over one. One screw was applied for one patient and two for the others. In one patient, due to the screw's hamate involvement, the hamate was fused inadvertently; therefore, Lunohamte fusion was performed. Autologous cancellous bone graft from scaphoid was used for packing the capitolunate interval. Radioscapholunate and long radiolunate ligaments were protected during the scaphoid excision.

All the patients followed the same postoperative protocol, using a short arm splint for 8 weeks; free wrist movements and strengthening exercises were allowed. The presence of the union was assessed 12 weeks after surgery for all patients. Wilcoxon test was used for the comparison of the measured parameters before and after the surgery. A P-value of less than 0.05 was considered significant.

### 3. Results and discussion

Among our patients, 2 (14.3%) were female, and 12 (85.7%) were male, with a mean age of 46.43 (30-60 years). Operated hand in 6 (42.9%) of patients was right, 7 (50%) left, and one (7.1%) was bilateral. Based on Watson classification, five patients (35.7%) were stage 2, and 9 patients (64.3%) were stage3 SNAC wrist. All of the patients had clinical and radiographic signs of capitolunate fusion 12 weeks after the surgery. Although one patient had screw breakage, for which one screw was applied, the union was achieved. It seems that the union process had been continued despite the screw breakage. No intervention was done in this regard due to the absence of signs and symptoms. The average VAS score and DASH score after one year follow-up were 6.5 (4-9), 46.14 (22-62), which decreased to 3.3 (2-7), and 30.43 (18-60), (p-value: 0.003 and 0.005). The mean flexion of the non-operated hand was

56.38 (30-80), and the extension was 61.8 (38-80). The average flexion and extension of the operated hand after one-year follow-up were 34.30(20-80) and 32.58 (20-60), respectively; this difference was statistically significant (p-value: 0.013 and 0.021). Mean grip strength in the operated and non-operated hand were 29.69 Kg (22-40) and 44.54 Kg (28-76), respectively (Table1) (p-value = 0.011). There was no screw loosening, hardware migration, and further degenerative changes during the follow-up period.

One patient had Complex Regional Pain Syndrome (CRPS), with pain, swelling, and vasomotor dysfunction in the operated extremity. Nonsteroidal anti-inflammatory drugs (NSAID) and physiotherapy were administered and healed in the final follow-up. No patient experienced a postoperative infection.

Considered as one of the most common types of degenerative wrist arthritis [1], scaphoid non-union advanced collapse (SNAC) is defined as degenerative arthritis with carpal collapse as a result of scaphoid nonunion [9]. The SNAC and Scapholunate Advanced Collapse (SLAC) concept was first introduced in 1984 when Watson and Ballet found 210 wrist arthritis cases by reviewing 4000 wrist x-rays. Watson and colleagues [10] classified the problem into four stages based on the affected area: stage1: the interface between radial styloid and scaphoid junction, Stage 2: the entire radioscaphoid joint, Stage 3: lunate-capitate interface involvement, besides the radioscaphoid joint, stage 4: pan arthritis of the wrist. Pain and osteoarthritis are the main indications for surgery [11]. Finally, advanced degenerative osteoarthritis of the wrist, caused by SNAC, may become symptomatic, and surgical treatment is required in this situation. In our study, only stages 2 and 3 were included, all of them complained of pain during daily activity that caused impaired daily function, and degenerative changes were present in all cases.

Table 1 - The results of 14 patients were recruited in the current study

Patient number	Age	Gender	Stage	Operated hand	VAS score	DASH score	Grip strength		Flexion		Extension		
							Pre-op	Post-op	Right	Left	Right	Left	Right
1	31	Male	3	Right	4	22	40	30	42	28	42	25	38
2	51	Male	3	Right	7	50	23	32	52	30	45	20	50
3	30	Male	3	Right	5	50	40	31	47	46	70	30	60
4	31	Male	3	Right	7	51	32	30	45	80	80	46	80
5	60	Male	3	Right	6	54	24	30	40	24	42	29	47
6	50	Male	2	Right	7	50	32	32	47	30	60	30	80
7	43	Male	2	Left	6	23	20	45	22	70	42	60	30
8		Male	3	Left	8	59	27	40	30	44	20	68	32
9	52	Female	3	Left	9	62	60	28	22	30	20	80	20
10	60	Male	3	Left	6	48	33	45	40	46	20	52	40
11	48	Male	2	Left	6	46	31	76	36	74	28	46	27
12	53	Female	2	Left	7	55	22	30	23	70	34	80	60
13	60	Male	2	Left	8	48	24	42	28	60	44	62	34
14	45	Male	3	Right	5	25	18	32	32	40	36	30	35

Surgical options are excision of the distal scaphoid fragment [12], scaphoid excision with limited intercarpal arthrodesis [13,14], total wrist arthrodesis [15], proximal row carpectomy [14,15], distraction resection arthroplasty [13], fascial implant arthroplasty [14] and radiocarpal arthrodesis [2]. Excision of the distal scaphoid fragment may be necessary for painful wrist arthritis caused by SNAC. According to a study conducted by Malerich and colleagues on 19 patients with SNAC that undergone excision of the distal scaphoid fragment, pain, range of motion, and grip have been improved in all patients, and 13 of 19 cases had complete pain relief [12]; on the other hand, exclusive scaphoidectomy leads to midcarpal joint destabilization, as capitate moves into the gap created by missing scaphoid. The conventional surgical method, first described by Watson and Ballet, includes scaphoid excision and capitate, hamate, lunate, and triquetrum fusion with k-wire and distal radius bone grafting, known as the four-corner fusion (4CF) [10]. Giannikas and colleagues indicated proximal scaphoid resection, insertion of one cannulated headless screw from the distal scaphoid to the capitate, and one from the capitate to the lunate without any intervention triquetrum. They reported no nonunion, and 3 of 8 cases had persistent pain [5]. Triquetrum fusion in midcarpal fusion results in helicoidal movement impairment and ulnocarpal impingement in ulnar deviation, and an ulnocarpal gap in radial deviation. According to Hagert and colleagues, the ligament inserting into the triquetrum contains mechanoreceptors [16], thus fusing the triquetrum to the distal row in 4CF results in a disturbance in wrist proprioception and problem in detection of nociceptive stimulations of the wrist; also, painful pisotriquetral joint may occur as a result of triquetrum fusion with the other carpal bones [17]. As an alternative to 4CF, Calandruccio and colleagues presented scaphoid and triquetrum excision with capitolunate arthrodesis by

compression screw fixation [4]. Nonunion occurred in two patients, and the mean flexion-extension arc was 53. Our study showed better results regarding both ROM and nonunion rates. Elimination of pain and preservation of a range of motion, as much as possible, are the main goals of the surgery. Hegazy, in 2015 had performed capitolunate arthrodesis for 12 patients with headless compression screws. The study indicated a stable, functional wrist was restored in all cases following the capitolunate arthrodesis [18]. The postoperative gripe strength, flexion, and extension in the study of Hegazy were reported to be 40.3 Kg, 43.2°, and 32°, respectively. The variables mentioned above in Goubier et al. [3] were 22Kg, 35°, and 29°; moreover, the VAS score in the study of Goubier et al. was reported as 1.25. Our study variables were 29.69 Kg, 34.3°, and 23.58°, respectively, with a VAS score of 3.3. An optimal functional outcome is obtained by fixing capitate and lunate alignment [19]. In two other case series, capitolunate arthrodesis with complete scaphoid excision performed on 23 patients with a history of SNAC or SLAC reported successful results [3,20]. Like the studies mentioned above, total scaphoidectomy was performed in all of our patients, and the joint destabilization was prevented by capitolunate arthrodesis: the VAS score and grip strength. Based on our findings, the VAS score and DASH score decreased significantly one year after the surgery, demonstrating diminished pain and functional improvement, therefore the main goals are achieved. In this regard, limited wrist arthrodesis is useful, as the painful component is fused and wrist range motion is provided by the intact components of the joint. Comparing 4CF with capitolunate arthrodesis, neither high-quality evidence nor a definite answer is available. Scorbecea and colleagues, in a cadaveric study, reported an improved range of motion and increased radiolunate contact pressure on capitolunate arthrodesis, compared

with 4CF [21]. In a literature review in 1996, Siegel and Ruby found capitolunate arthrodesis to have a more nonunion rate than 4CF (35% vs. 4%) and a higher rate of complications (62% vs. 26%) [22]. In contrast, Gaston et al. compared 16 cases of capitolunate arthrodesis, with 18 of 4 CF retrospectively. They found no significant difference in ROM, Strength, DASH, and VAS scores between the two groups. There were 2 cases of nonunion in 4CF compared with none in capitolunate arthrodesis [23].

The nonunion rate of capitolunate arthrodesis ranges from 15% to 50% [24]. It is believed that the high rates of nonunion are probably due to inadequate fixation techniques [9,25]. In this regard, recent studies that demonstrated compression techniques with compressive screws placement parallel to the loading axis of capitolunate joint reported significantly lower rates of nonunion, lower or equal, than the rate of nonunion in the 4CF procedure [5-7, 23]. Of note, we used Herbert screws; 2 screws were used in 13 out of 14 cases to provide better stability.

#### 4. Conclusion

Based on our study and other similar reports mentioned above, capitolunate arthrodesis is a well-defined, easy to learn, and reproducible surgery. The fusion is stable by headless compression screws; morbidity is minimal, and the fusion rate is high. Improved post-operation function is obtained because of restoring carpal alignment and height in this procedure; therefore, it could be considered an acceptable alternative to 4CF due to lower complications and improved wrist function.

#### 5. Conflict of interest

The authors declare no conflict of interest.

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