

## Treatment of Scaphoid Nonunion Advanced Collapse Stage III with Proximal Row Carpectomy and Resurfacing of Capitate with Pyrocarbon Implant - Results of 2-Year of Follow-Up

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### Abstract

**Objective:** We intend to demonstrate the functional results of a patient with post-traumatic radiocarpal arthrosis due to a scaphoid nonunion advanced collapse who underwent surgical treatment with proximal row carpectomy and capitate resurfacing with pyrocarbon implant.

**Material and Methods:** A 51-year-old male patient, working as a sculptor, presented to our consultation with a scaphoid nonunion advanced collapse due to a non-treated scaphoid fracture 20 years before. Clinically he had pain and radiocarpal instability. Radiographically, there was collapse of the scaphoid and lunate, advanced radiocarpal osteoarthritis and proximal migration of capitate. In 2018, he underwent proximal row carpectomy and capitate resurfacing with pyrocarbon implant through a dorsal approach. The patient was immobilized with a wrist cast for 4 weeks. physical rehabilitation started after remove of the cast. Unrestrained activities were allowed at 12 weeks after surgery. Every 6 months the patient was observed in our consultation.

**Results:** After two and a half years of follow-up, the patient presents a presented a significant improvement on wrist pain, with an initial Visual Analogue Scale score of 9/10 and a current one of 3/10 and a satisfactory wrist mobility, with approximately 20° of extension and 30° of flexion, which allows the execution of his work activity. He refers, however, to a decrease in grip strength. On reassessment radiographs, there is a periprosthetic radiolucent line of 1mm, with progression of radiocarpal arthrosis.

**Conclusion:** Post-traumatic radiocarpal arthrosis has a negative impact on patients' quality of life. There are several surgical treatment options varying from proximal row carpectomy, total wrist prosthesis, partial or total arthrodesis. In the present case, capitate resurfacing with pyrocarbon implant associated with proximal row carpectomy proved to be a good surgical option, with satisfactory results, especially in the reduction of pain, providing the patient wrist mobility compatible with the daily living activities.

**Keywords:** Scaphoid Fracture; Scaphoid Nonunion; Wrist Arthritis; Proximal Row Carpectomy; Capitate; Pyrocarbon Implant

## Abbreviations

NSAIDs: Non-Steroidal Anti-Inflammatory Drugs; PRC: Proximal Row Carpectomy; ROM: Range of Motion; SLAC: Scapholunate Advanced Collapse; SNAC: Scaphoid Nonunion Advanced Collapse; RCPI: Resurfacing of Capitate with a Pyrocarbon Implant; VAS: Visual Analogue Scale

## Introduction

Wrist osteoarthritis is a chronic joint disease with cartilaginous degeneration and bone changes, that results in pain, swelling, loss of motion and reduced grip and pinch strength. It can be degenerative, inflammatory, congenital, idiopathic, but it is mostly a post-traumatic lesion [1].

The most common types of posttraumatic wrist osteoarthritis are secondary to scaphoid nonunion, a condition known as scaphoid nonunion advanced collapse (SNAC) and secondary to rupture of scapholunate ligament, a pathology called scapholunate advanced collapse (SLAC) [1-3].

SNAC describes the specific pattern of wrist arthritis that results from an untreated chronic scaphoid nonunion, with intact scapholunate ligament. The Watson and Ballet classification defines three progressive stages based on radiographic changes: Stage I - osteoarthritis between the radial styloid and the radial portion of the scaphoid; Stage II - involvement of proximal scaphocapitate joint; Stage III - changes at capitulate joint [4,5].

Conservative treatment should be tried first in asymptomatic patients, with non-steroidal anti-inflammatory drugs (NSAIDs), wrist splints and corticosteroid injections. When it becomes a non-resolution, surgical intervention is mandatory. Various surgical options have been proposed, depending on the stage of the disease. In stage I SNAC wrist, radial styloidectomy is a reasonable choice, preserving the most extrinsic ligamentous support of the wrist. Excision of the proximal pole of the scaphoid is another option in early stages of SNAC wrist. When the arthritis progresses to stage II and III, more aggressive techniques are necessary such as proximal row carpectomy (PRC), four corner arthrodesis, total wrist arthroplasty and total wrist arthrodesis [1,3].

PRC, a technique performed since 1939, is a motion-preserving and frequently performed surgical option for the treatment of SNAC wrist in a relatively low-demand patients older than 40 years old

with stage II or III SNAC wrist. However, when articular surfaces of the capitate and radius are damaged, PRC alone is contraindicated [1,6]. In 2010, Goubier, *et al.* performed a study in seven patient where a pyrocarbon implant was used to replacement the head of the capitate in addition to PRC for the treatment of midcarpal arthritis [7]. In fact, resurfacing of capitate head with a pyrocarbon implant (RCPI) in association with PRC it seems to lead to good results, preserving wrist motion in SNAC wrist stage III [3,6,8-10].

In the current paper, the authors report a case of 51-year-old man who was submitted to a PRC and RCPI for the treatment of a SNAC wrist stage III.

## Methods

We evaluated and treated a 51-year-old man with a scaphoid nonunion advanced collapse, due to a scaphoid fracture with twenty years of evolution. We performed a proximal row carpectomy and capitate resurfacing with pyrocarbon implant. The surgical technique and postoperative care are described in the section below. The follow-up time was two and half years. The outcomes, pain, function, and radiographic changes were evaluated in an orthopedic consultation, every six months. The VAS for pain and measurement of extension/flexion degrees were evaluated at every evaluation. Clinical and radiological data were also reviewed at the follow-up time. Global hand function was evaluated using the Quick Disabilities of the Arm, Shoulder and Hand (Quick DASH) questionnaire validated for the Portuguese population, only applied at the final follow-up time. Extension and flexion of the wrist were measured with a simple goniometer. Grip strength (measured in kg) was obtained by the mean of three repeated measures using the Jamar<sup>®</sup> hydraulic hand dynamometer.

## Clinical Case

A 51-year-old right-handed man, working as a sculptor, with an undiagnosed scaphoid waist fracture, with twenty years of evolution, that has never been treated, either conservatively or surgically, presented at consultation with persistent pain and disability of his right wrist mainly during daily activities (VAS 9/10). There were no history of smoking, diabetes or inflammatory disease. Wrist flexion and extension angles before surgery were not registered. Radiographies showed a non-union of scaphoid, with collapse of both scaphoid and lunate and advanced mediocarpal and radiocarpal arthritis mainly on articular surface of capitate. Having

this in mind, the patient was first proposed for wrist arthrodesis, which he strictly refused. Other options were then presented, including its benefits and risks.

Once PRC was contraindicated in this case, due to advanced involvement of articular surface of capitate, we decided to perform an PRC together with RCPI (Figure 1).

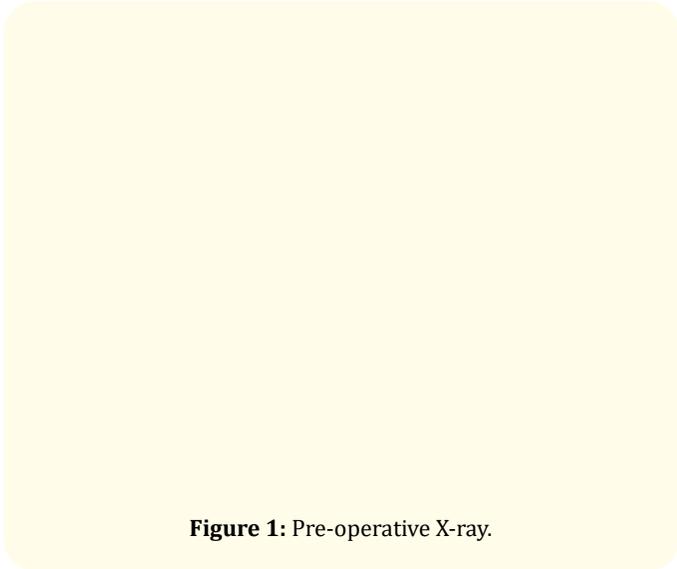


Figure 1: Pre-operative X-ray.

and physical rehabilitation started after remove of the cast, in a specialized center. We had not access to the specific exercises performed during rehabilitation period. Unrestrained activities were allowed at 12 weeks after surgery. Every 6 months, the patient was observed in an orthopedic consultation (Figure 2).

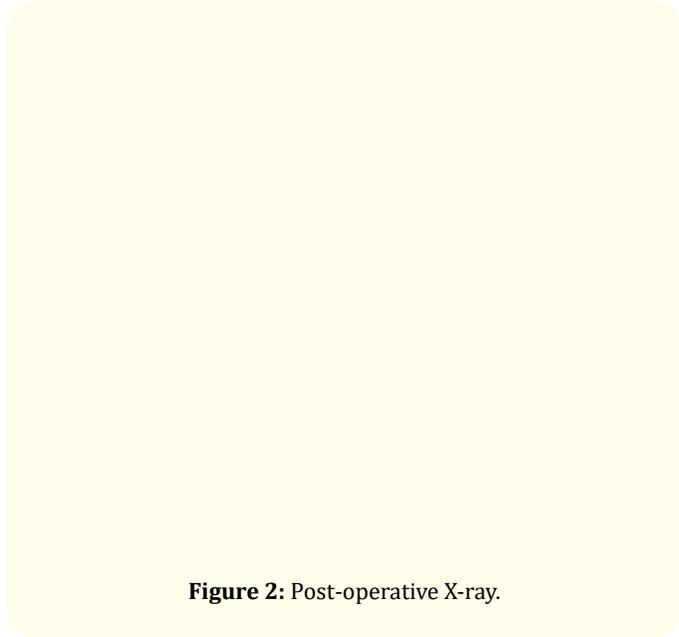


Figure 2: Post-operative X-ray.

### Surgical technique and post-operative care

The patient was in supine position, with the affected limb on a lateral table. A pneumatic tourniquet was inflated to 250mmHg. A dorsal approach of the hand was performed, centered to the third ray. Skin and subcutaneous tissue were first incised, then the extensor retinaculum was open between the third and fourth compartments. Capsulotomy according to Berger was performed, allowing exposure of the radiocarpal and midcarpal joints [11]. A PRC was then performed, with excision of the scaphoid, lunate and triquetrum. Using an oscillating saw, an osteotomy of the proximal convexity of the capitate was performed, parallel to the lunate fossa. The center of the capitate was prepared with progressive rasps. A trial prosthesis was first inserted to check size and position, and finally the prosthetic implant of pyrocarbon (Tornier/Wright Medical®) was implanted. Capsule and retinaculum were closed followed by skin closure.

The patient was immobilized with a wrist cast for 4 weeks. The sutures were removed at 15 days. Active range of motion (ROM)

### Results

In every orthopedic consultation following surgery the patient reported gradual improvement of pain and wrist motion. At the first consultation after removing the cast (two months postoperative), the patient showed a ROM of 30° of extension and 40° of flexion. There were no radiographic changes. One year after surgery, the patient was without pain and so satisfied with the results that started to carve again.

After two and half years of follow-up the patient presented a significant improvement on wrist pain compared with the pre-operative period, with an initial VAS score of 9/10 and a current one of 3/10. Final wrist range of motion was satisfactory, regarding the initial extensively degenerated wrist, with 20° of extension and 30° of flexion on the operated side, compared with extension 70° and flexion 80° on the contralateral extremity. Diminished grip strength was reported, which limits the worktime with heavier objects like a hammer. Grip strength on the operated hand (right and

dominant hand) was 20kg compared to 50kg on the left hand, a difference more than 50%. On Quick-Dash, the patient obtained a score of 51%, meaning a moderate disability index.

Regarding radiologic outcomes, we looked for periprosthetic fracture, periprosthetic lucency and evolution of carpal arthritis. Periprosthetic lucency was measured using a system described by Herren., *et al.* 0-radiolucent line (0.5mm) around the implant on a plain radiograph from the pyrolytic carbon coating; 1-radiolucent line present measuring 1mm in width at any point around the implant; 2-radiolucent line > 1mm in width at any point around the implant; 3-macroscopic displacement of the implant (more than one-fourth of the base of the first metacarpal bone) [12,13]. In the plain radiographies, periprosthetic lucency of 1 mm in width (Herren grade I) was observed [12]. No macroscopic displacement nor periprosthetic fracture was observed (Figure 3 and Table 1).

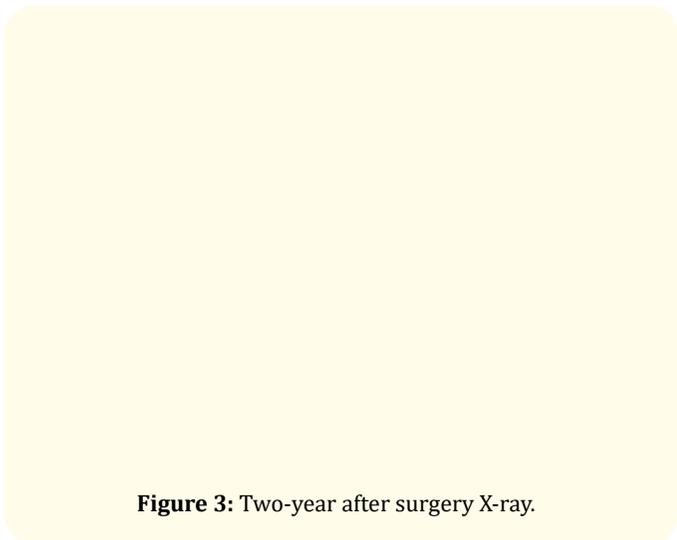


Figure 3: Two-year after surgery X-ray.

Clinical and radiographic results at final follow-up time	
VAS	3/10
Extension/Flexion	20°/30°
Grip strength	20kg
Quick-Dash	51% (moderate disability)
Radiographic changes	Periprosthetic lucency 1mm width

Table 1: Clinical and radiographic results at final follow-up time.

## Discussion

The main objective of this article was to present the clinical and radiographic outcomes after a PRC and RCPI in a patient with a SNAC wrist. The authors also wanted to show that RCPI is a good option to extend the indications of PRC in the treatment of wrist arthritis.

Misdiagnosed or mistreated fractures of carpal bones may lead to wrist degeneration. SNAC wrist is a posttraumatic wrist osteoarthritis secondary to scaphoid nonunion, causing pain, carpal instability and major function impairment [1,6,8,14,15].

Treatment options mainly pursue pain relief and wrist motion preservation as much as possible. They vary widely from conservative management, with NSAIDs and orthosis, to surgical intervention with motion-preserving techniques such radial styloidectomy, distal pole of scaphoid resection and PRC or even more aggressive techniques like four-corner fusion and wrist arthrodesis [1,15,16].

PRC requires a short period of immobilization and patients can achieve grip strength of approximately 70% with a wrist range of motion of 50% of contralateral wrist [16,17]. Nonetheless, in the presence of capitate osteoarthritis, PRC is contra-indicated. The use of a resurfacing capitate pyrocarbon implant broadens the indications of PRC in SNAC wrist stage II and III, preserving motion and avoiding wrist arthrodesis [6,9].

In the presented case, the combination of PRC with RCPI showed good results. The patient reported a high improvement in pain and also for function and grip strength, although in a lesser degree for the latter ones. In fact, the best outcome referred by the patient was the almost absence of pain in daily living activities, which reflects the significant decrease of VAS score from 9/10 to 3/10 before and after surgery, respectively. Our results overlap literature, as Giacalone., *et al.* observed VAS score of 2 ± 0.5 after surgery in a group of 25 patients submitted to PRC plus RCPI [9].

Regarding wrist range of movement, our results were similar with some other studies published till now. In the current case, after two and half years of follow-up, extension was 20° and flexion 30° on the operated wrist. Marcuzzi., *et al.* observed improvement in flexion and extension degree in patients with SNAC or SLAC stage III treated with PRC plus RCPI, with a post-operative value of 33° flexion and 34° extension [8]. In spite of being a limited range,

this functional motion gives the patient more mobility for daily activities than other more invasive and definitive options, such as four-corner fusion or total wrist arthrodesis.

Goubier, *et al.* in 2011, studied 7 patients that underwent RCPI. Grip strength after surgery was 16kg, mean angle of flexion was 25° and extension 30°. These results were similar to those observed in our patient (grip strength of 20kg) [7].

Szalay, *et al.* reported signs of loosening in two of five patients with RCPI [8]. However, in the post-operative x-rays we observed only a thin line with 1mm of radiolucency without progression during follow-up, which is expected with this type of implants.

In 2020, Fulchignoni, *et al.* published a literature review about RCPI after PRC. Although few studies were included [5], in all of them there was a marked improvement in pain, ROM of the wrist, grip strength and DASH/Quick-DASH scores after surgery [3].

In the literature, there are not many reported cases of RCPI after PRC. The authors believe that this case reinforces the importance of add RCPI to PRC before more aggressive procedures to treat advanced stage SNAC wrist.

## Conclusion

The presented case pretend to show that RCPI extends PRC indication, mainly when capitate osteoarthritis is already present. This surgical technique allows improvement in wrist pain and in lesser degree in flexion and extension angles and grip strength. It is an alternative to more aggressive and mobility restrictors techniques such as four-corner fusion or wrist arthrodesis.

## Conflict of Interest

No existing conflict of interest to declare.

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