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Resurfacing Capitate Pyrocarbon Implant for the treatment of advanced wrist arthritis in the elderly: a retrospective study

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Abstract. – OBJECTIVE: Advanced forms of wrist osteoarthritis in the elderly are quite common and often under-treated, preferring a conservative management of the condition due to the age of the patient. However, in elderly people who are still active, sporty and physically demanding, surgical management of wrist osteoarthritis should be considered. Proximal Row Carpectomy associated with a Resurfacing Capitate Pyrocarbon Implant (RCPI), allows the management of a wide range of wrist arthrosis, involving both the radio-carpal and the mid-carpal joints. This treatment has been already reported as a solution in younger people affected by degenerative pathologies of the wrist, giving overall good results. Authors aimed at verifying how this technique could be useful in elderly patients, resolving the severe pain often related to this pathology and letting them recover strength and motion.

PATIENTS AND METHODS: This is a retrospective analysis involving 7 cases of elderly men (mean age = 68 y.o.), suffering from severe wrist arthritis and treated with RCPI between 2016 and 2021.

RESULTS: All patients reported a return to manual activities between 6 and 12 months after surgery, significantly improving pain. Two patients complained moderate pain under strain at follow-up, with residual difficulty in performing manual tasks. In all cases, an increase of strength and improvement in terms of stiffness was registered. No cases of infections or implant mobilization were reported.

CONCLUSIONS: RCPI combined with proximal row carpectomy shows satisfying results in all published studies and it has been confirmed in our series as well. Indications for this procedure should be widened to elderly people, as useful alternatives to more aggressive salvage procedures, such as total prosthesis or arthrodesis.

Key Words:
Wrist arthritis, Capitate pyrocarbon implant, Elderly.

Introduction

Wrist osteoarthritis can be the outcome of injuries and aging of radius and carpal bones surfaces, resulting in joint destruction. These abnormalities include cartilaginous degeneration and hypertrophic bone changes, which lead to swelling, loss of range of motion, decrease of strength and development of chronic pain. Advanced forms of wrist osteoarthritis in the elderly are quite common and often under-treated, preferring a conservative management of the condition due to age. In many cases, conservative treatments, including anti-inflammatory drugs and opioids, the use of orthosis and physiotherapy, are sufficient for the management of pain and daily activities in the elderly with low functional demands and limited activities[1-3]. However, in older people who are still active, sporty and physically demanding, surgical management of wrist osteoarthritis should be considered, according to patients' functional demands. In case of painful osteoarthritis involving both the radio-carpal and mid-carpal joints, as it arrives in long term wrist arthritis evolution, a radiocarpal fusion was traditionally proposed. The most used procedures are total arthrodesis performed with dynamic compression plate, and the four-corner arthrodesis (FCA). Total wrist arthrodesis is a traditional technique which allows to resolve chronic pain caused by the advanced form of arthritis, giving a good recovery of grip strength, but causing a serious loss of function, blocking all wrist movements. Furthermore, this

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condition induces development of secondary arthropathies of the elbow and shoulder[4]. To preserve motion, total wrist prosthesis have been developed, but the results are not as satisfying as expected, and complications, such as implant failure due to early periprosthetic bone resorption, are still present[5,6]. An alternative to joint fusion and total wrist prothesis is the Proximal Row Carpectomy (PRC), a widespread, easy-to-perform surgical technique to manage painful wrist arthritis. This is a safe and effective procedure, which produces pain relief and allows a satisfactory range of motion. Indications for this technique, however, were limited to the early stages of arthritis until a few years ago, because the preservation of the capitate pole on the distal carpal row and radius lunate fossa on the radius surface are mandatory to achieve a new pain-free joint[7]. Since 2010, a new technique has been described in the literature using the resurfacing capitate pyrocarbon implant (RCPI), combined with PRC. This small carpal prothesis has been designed to perform PRC even in the presence of degenerate joint surfaces, and thus widens the limited indications of this procedure. Several papers[8-12] have been recently written about this technique, which has yielded satisfactory results in every respect: resolution of pain, recovery of strength and motion. A retrospective cohort study on RCPI implanted in younger active workers was recently published[13], but no publication reports results on a group of elderly patients.

The aim of this article is to evaluate indications and outcomes in an elderly population presenting a retrospective study on 7 patients of mean age 68 y.o., treated with RCPI for severe wrist osteoarthritis.

Patients and Methods

The present investigation consists in a retrospective analysis on 7 cases of elderly men (age 62-75 y.o.) suffering from severe wrist arthritis (with both radio-carpal and mid-carpal impairment), treated with RCPI between 2016 and 2021 in two different hospitals in Italy. This manuscript has been created following the STROBE guidelines[14]. All patients were enrolled to perform a further clinical and radiographic evaluation. Demographic data and pertinent information were collected. All of the following data were obtained before surgery and at last follow-up:

- Grip strength (GS) measured using Jamar dynamometer, in position 2, according to Trampisch et al[15]. GS values were obtained as a mean of three consecutive measurements;
- Active range of motion (AROM), measured with a standard goniometer, according to American Medical Association guidelines[16];
- Functionality, assessed through Disabilities of the Arm, Shoulder and Hand (DASH)[17];
- Visual Analogue Scale (VAS) for pain;

All procedures were performed following written informed patient consent and in accordance with the ethical standards of the institutional and/or national research committee and the 1964 Declaration of Helsinki and its subsequent amendments or comparable ethical standards.

The Implant

The RCPI (Tornier, Montbonnot-Saint-Martin, France) is a monoblock pyrocarbon implant designed to be used in combination with PRC when the radius and the capitate bone surfaces are damaged, to prevent a painful motion of the wrist. It consists of a short stem to press-fit into the capitate and a truncated spherical head, which represents the new carpal articular surface (Figure 1). It leans on the radius' lunate fossa, replacing the semilunar bone, which is removed with the proximal row of the carpus.

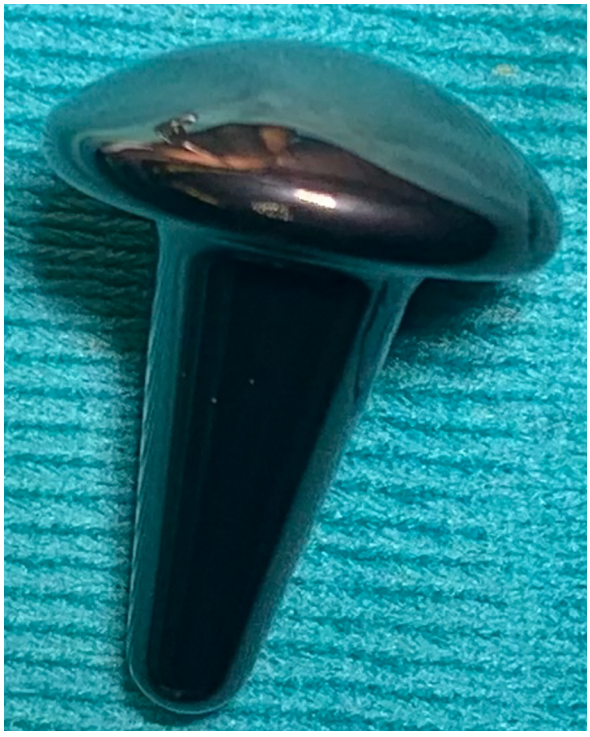

Figure 1. Resurfacing capitate pyrocarbon implant.

Surgical Technique

Surgery is performed under brachial plexus anesthesia, with a tourniquet placed on the upper arm for transient ischemia, the forearm leaning on a surgical table. A dorsal skin incision is performed on the wrist. Subcutaneous veins and nerves are identified and protected by retractors. The carpal joint capsule is exposed, and incision is performed following the dorsal radiocarpal and intercarpal ligaments to rise a flap, which allows seeing comfortably the carpus. The bones edges are released, then the intrinsic ligaments are cut to perform proximal row carpectomy. Successively the joint surfaces of the capitate and the radius are inspected to confirm the diagnostic evaluations previously made by imaging techniques, such as radiographies and CT scan. The wrist is then positioned in flexion and a hole is created in the center of the capitate, by the mean of a cannulated reamer, under fluoroscopic control. Trial prosthesis can be checked to be replaced by the definitive pyrocarbon implant. An impactor is used to perform the final impaction of RCPI. By repositioning the wrist in extension, the implant remains included between the distal row and the radius (Figure 2). The capsular suture, approximating and overlapping the edges, stabilizes the implant. Hemostasis is performed and the skin is closed. At the end of surgery, a plaster splint is made to be kept 4 weeks after surgery, to protect the capsular healing.

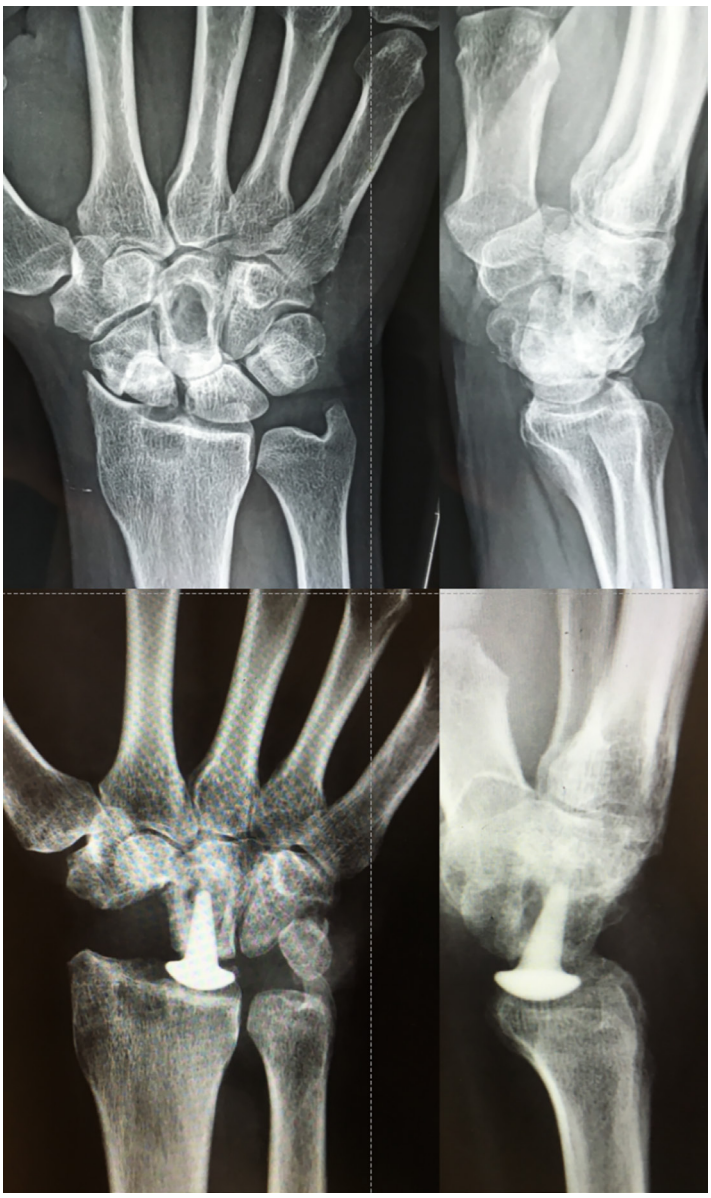

Figure 2. Radiograms of painful wrist arthritis in advanced stage, involving both radio-carpal and mid-carpal joint in a 72 y.o. man. Pre- and post-operative checks. Proximal row carpectomy and RCPI implant was performed.

Clinical Series

Seven male patients, with ages ranging between 62 and 75 years and a diagnosis of painful chronic wrist osteoarthritis, were treated in the last 6 years with the described technique. These were mostly individuals engaged in sports or hobby-type manual activities. Preoperatively, all of them had attempted several conservative treatments, such as wrist orthosis and physiotherapy, as well as the use of anti-inflammatories and other medications for chronic pain. Post-operatively, most of them underwent a cycle of physiotherapy after removing the cast.

Results

Results, shown in Table I, were consistent across the series, with a return to manual activities between six and twelve months after surgery (Figure 3 and 4). Concerning pain, which was the main reason for surgery, all patients had an improvement of their symptomatology in the months following treatment. During follow-up, two patients complained about moderate pain under strain, with some residual difficulty in performing manual tasks. The surgical procedure led to a good improvement in terms of stiffness reduction and increase in strength in all cases. Concerning complications, two cases reported swelling and persistent pain on wrist for 2 and 4 months respectively, with subsequent spontaneous resolution. No case of infection or mobilization of the implant was observed.

Discussion

Arthritis of the wrist that involves radio-carpal, mid-carpal and trapeziometacarpal joints at the same time is quite common in the elderly population.

Trapeziometacarpal and radiocarpal joint arthritis have different treatments that may be performed either simultaneously or in stages[20].

Late-stage arthritis of the wrist in elderly population is commonly characterized by radio-carpal and mid-carpal joint impairment with involvement of capitolunate joint with radiolunate joint tipically spared (stage 3 of Watson and Ballet[21]) or with radiolunate joint involved (stage 4)[22,23].

In the most recent literature, PRC and FCA have been described as effective surgical treatments in radio-carpal joint arthritis, but when degenerative changes affect the capitate or lunate fossa long term outcomes are poor[24-27]. Given that the rate of secondary surgical procedures following FCA was significantly higher compared with PRC, the latter is considered the preferable treatment for wrist arthritis[24]. For many years, dorsal capsular interposition (DCI) was the only surgical procedure accessory to PCR, when the capitolunate joint was damaged.

Salomon and Eaton[28] suggested that lunocapitate and radiolunate disease do not contraindicate a modified proximal row carpectomy and performed DCI with partial capitate resection with the aim of producing a broader distribution of radiocarpal compression forces, considering interposition of the thickened dorsal capsule as a contribute to an improved radiocarpal interface[28].

DCI with or without partial capitate resection allowed to obtain average good results with short- and mid-term outcomes, with a tendency to lose the result over time, due to degeneration of the capsular flap[28,29].

Fowler et al[30] performed osteochondral resurfacing of the capitate in the setting of proximal row carpectomy for patients with capitate

Table I. Results of the study.

	Age	E-F ROM pre	E-F ROM post	Strength pre	Strength post	VAS pre	VAS post	DASH pre	DASH post	Follow-up
Case 1	65	20-15	25-35	7	21	9	2	49	18	24
Case 2	72	25-10	25-60	12	25	6	1	36	16	28
Case 3	62	25-20	35-25	8	17	8	1	32	12	22
Case 4	70	15-10	20-20	4	12	9	0	53	14	18
Case 5	67	35-25	40-30	15	33	7	1	32	16	14
Case 6	68	5-10	10-20	8	18	6	0	28	6	9
Case 7	75	10-5	15-10	11	20	7	2	22	9	9

Age in years, ROM in degrees: E-F extension-flexion, Strength in kilograms, VAS 1-10, DASH score 0-100, follow-up in months, PRE = before RCPI implantation, POST = at latest follow-up.

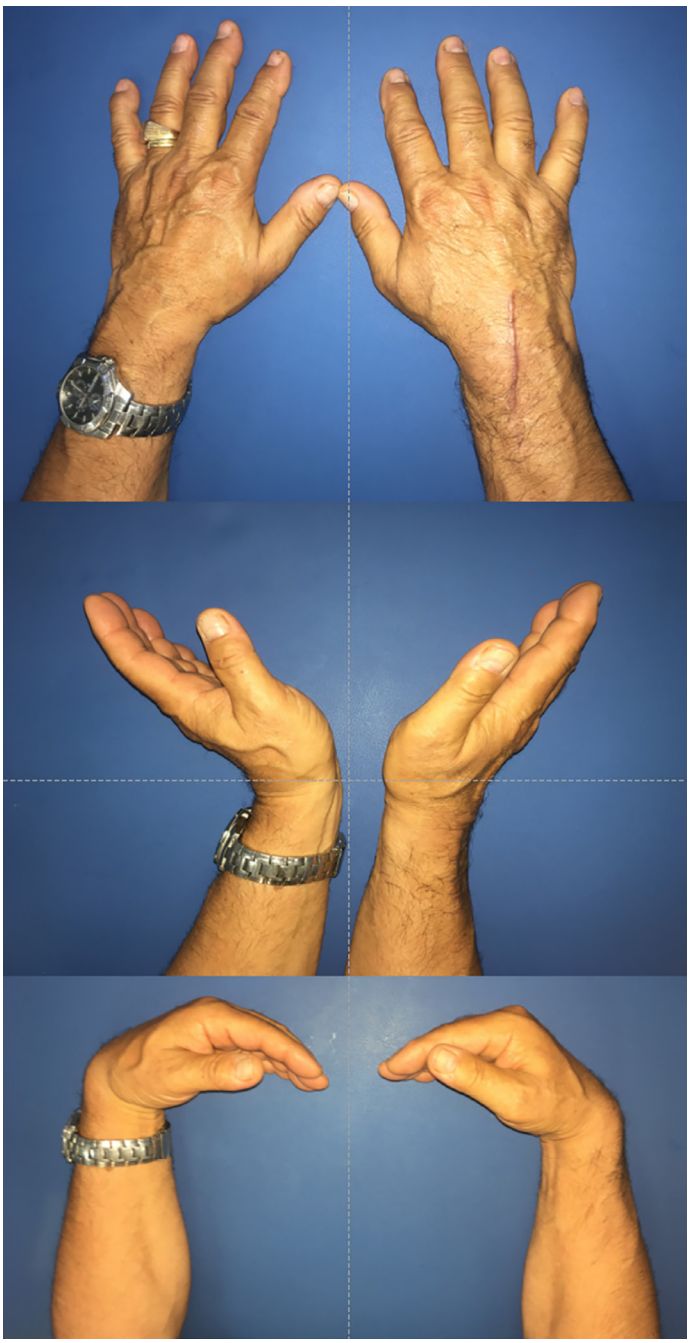

Figure 3. The early clinical result at 6 months. The patient achieved important decrease of pain and restoration of a good grip strength and movement.

chondrosis with good outcomes, compared with standard proximal row carpectomy in patients without capitate chondrosis but only in younger patients[30].

Several modifications have been proposed, including radiocapitate arthroplasty or tissue interposition grafts. Theoretical benefits to these adjuncts include minimizing wear and preserving the radiocapitate articulation as well as expanding the utility of a PRC even in the setting of a wrist with arthritis of the capitate head.

Recently, Rabinovich and Lee[31] have described a technique for managing radiocarpal arthritis with PRC and decellularized dermal allograft with good results but a very short follow-up.

PRC could also be arthroscopically performed, but poor solutions are described when capitate is involved and Artuso et al[32] in 2021 performed an anatomical study on 16 cases describing CARPUS procedure, an arthoscopic proximal row carpectomy replacement by semitendinosus and gracilis graft.

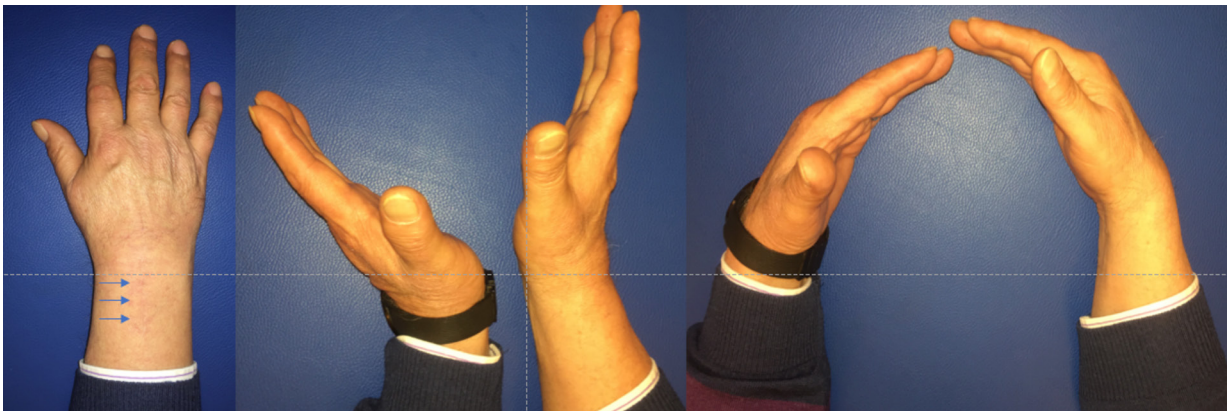

Figure 4. The clinical result at 9 months. The scar turns out to be almost invisible. The patient achieved disappearance of pain, improvement of strength and an acceptable wrist motion.

RCPI prosthesis has emerged in the field of wrist surgery since its appearance in the early 2000s. Pyrocarbon is an inert material, used in the medical field, for mechanical heart valves, since 1969[9]. This material was then extended to the orthopedic surgery because of its tribological properties and its biocompatibility. The main characteristic of this material is a modulus of elasticity overlapping that of the bone; this feature eliminates the problem of peri-prosthetic bone resorption typical of traditional steel prostheses[6]. Neither osteointegration nor soft tissue healing to this material has been described[26]. The reliability of this prosthesis in the carpus is proven by published works since 2010, with follow-ups exceeding ten years with no known material-related complications[8-9,12,33]. Indications for using RCPI combined with PRC are well described in the literature and mainly regard the advanced stages of wrist arthritis, where PRC alone would not be indicated.

PCR with RCPI has been commonly performed and is indicated in younger patient and active workers[13], but Giacalone et al[12] recommended not to use RCPI when there is an "inadequate strength of the cortical bone"; this may be a contraindication to use in the elderly.

There is no literature about PCR with RCPI in elderly patients and, according to our knowledge, this is the first article on this topic. We believe that the technique is indicated in patients with good bone stock in accordance with Giacalone et al[12]. In fact, all cases in the series were active and motivated average elderly people, not suffering from osteoporosis. A careful evaluation of this aspect is advisable before the treatment.

Limitations

The most relevant limitation to our study was the size of the population analyzed. Since our results are already promising, a study on a bigger group of patients could help growing consensus on using this technique on elderly patients in many more centres. Moreover, follow-ups of the patients and their functional assessments are not homogeneous; for this reason, it could be useful to perform an additional study with the missing data.

Conclusions

In case of wrist arthritis with capitate head and lunate fossa osteoarthritis involvement, Resurfacing Capitate Pyrocarbon Implant combined with proximal row carpectomy showed satisfying results in all the studies published in literature, compared with those obtained with just carpectomy.

Data show that indications for proximal row carpectomy can be widened by using the implant, without worsening outcomes. The implant could be a useful alternative to more aggressive salvage procedures. Considering the results obtained from this study, in the authors' opinion the use of this small carpal prosthesis can be considered a balanced solution among the procedures proposed in the literature (ranging from total prosthesis to arthrodesis) for the management of severe wrist osteoarthritis also in the elderly patients. An expansion of the case studies and follow-up will allow us to confirm these results in the future.

Conflict of Interest
The Authors declare that they have no conflict of interests.

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Data Availability Statement
The datasets generated during and/or analysed during the current study are available from the corresponding author on reasonable request.

Ethics Approval
The study was conducted according to the guidelines of the Declaration of Helsinki and approved by the Institutional Review Board of Orthopedic and Traumatology Institute.

Informed Consent
All procedures were performed following written informed patient consent.

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