Capitate Pyrocarbon Prosthesis in Radiocarpal Osteoarthritis

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Abstract: Scapholunate dissociation or scaphoid pseudarthrosis may lead to osteoarthritis of the wrist. When osteoarthritis affects the midcarpal joint, proximal row carpectomy is no longer possible and only 4 corners fusion or capitolunate arthrodesis may be indicated. However, in some cases, osteoarthritis or bone necrosis may involve the lunatum, making partial arthrodeses impossible. Total arthrodesis may be proposed in such cases, but with a loss of range-of-motion. Total prosthesis may be considered but the results of this procedure are not always encouraging. Consequently, in these situations, we perform pyrocarbon prosthesis implant, replacing the head of the capitatum. This article describes the procedure and the results of a preliminary study.

Key Words: capitate, pyrocarbon, implant, wrist, osteoarthritis

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HISTORICAL PERSPECTIVE

Scapholunate dissociation or scaphoid pseudarthrosis may lead to wrist osteoarthritis. Watson described the different stages of joint degenerative changes.[1,2] In scaphoid nonunion advanced collapse or scapholunate advanced collapse with midcarpal joint osteoarthritis, proximal row resection is not indicated. In such cases, lunate-triquetrum-hamate-capitate (4 corners) fusion or capitolunate arthrodesis with scaphoid and triquetrum resection is generally proposed.[3] However, in case of lunate osteoarthritis or necrosis, these 2 procedures may no longer be performed. In these cases, total wrist arthrodesis can be proposed to alleviate pain but with a loss of range-of-motion. Besides, to preserve range-of-motion, only total wrist prosthesis may be proposed, but with greater risks than arthrodesis.[4] Consequently, in such case, we propose the replacement of head of the capitate by a pyrocarbon prothesis RCPI (Resurfacing Capitate Pyrocarbon Implant Prosthesis, Tornier SAS, Etablissements Bioprofile, France). This implant has been developed since 10 years. It has been approved by Agence Française de Sécurité Sanitaire des Produits de Santé (French agency for health security concerning medical products) and this implant has been tested on conception, production, and final control according European directive (appendix 2, point 3) with number 93/42 CEE. However, no technical or clinical reviews have been still published. This article describes the procedure and its results at the end of a preliminary study.

INDICATIONS

Scapholunate advanced collapse or scaphoid nonunion advanced collapse with midcarpal arthrodesis and radiolunate osteoarthritis or lunate loss are the principal indications of capitate prosthesis, whatever the condition of the radius cartilage (Fig. 1).

Partial prosthesis may also be proposed when osteoarthritis is discovered on head of the capitate during a procedure of first row carpectomy or few years after first row carpectomy, in case of degenerative changes of the head of the capitatum.

CONTRAINDICATIONS

Adequate implantation of the prosthesis is conditional upon correct quality of the cortical bone. This condition makes rheumatoid arthritis a possible contraindication for capitate arthroplasty. Osteoarthritis resulting from wrist infection may also be a contraindication if infection is not controlled, as there is a risk of infection recurrence.

TECHNIQUE

The patient is installed in the operating room where a regional anesthetic is administered. The wrist and hand is placed prone on the operating table. The extremity is exsanguinated and a tourniquet is inflated to 100 mm Hg above systolic blood pressure.

Dorsal approach is performed. Dorsal retinaculum is open in the fourth compartment. Extensor digitorum communis tendons are retracted on the lateral side. The terminal branch of the posterior interosseous nerve is localized and divided above the radioulnar joint. Hemostasis of the posterior branch of the interosseous artery is performed to prevent hematoma. Once capsulotomy is performed, radiocarpal and midcarpal joints are exposed by placing the wrist in flexion (Fig. 2), which allows investigating cartilage lesions, especially the radiolunate joint. Then, lunate, scaphoid, and triquetrum excision is performed.

FIGURE 1. Standard x-rays showing Kienbock disease with destruction of the lunate and midcarpal arthritis.

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FIGURE 2. Exposition of the capitate lunate through a dorsal approach. The wrist has to be in flexion to expose correctly the head of the capitate. The capitate examination shows cartilage defects, contraindication to first row carpectomy.

A Kirschner wire (K-wire) is placed in each bone as a "joystick." Using the K-wires, lunatum, scaphoid, and triquetrum may be mobilized in different positions, so as to divide the ligaments. When the lunate, the scaphoid, and the triquetrum are removed, a part of the head of the capitate is horizontally cut at the level of the proximal pole of the hamate with a "rongeur" or an oscillating saw. A small piece of bone is cut first. Then, the center of the capitate is prepared with a spike and a small scoop. To prepare the capitate, 14 or 16 mm rasps are used, depending on the size (Fig. 3). Such preparation necessitates great care to prevent injuring the cortical bone of the capitate or going through the carpometacarpal joint. Then, the trial prosthesis can be tried. Two sizes are available: 14 and 16 mm diameter (Fig. 4), to be selected depending on the size of the capitate. The dorsal laser mark of the prosthesis must be placed on the dorsal part of the capitate. When the prosthesis is implanted (Fig. 5), fluoroscopic lateral and frontal views allow controlling the axis of the prosthesis. The prosthesis stem must be placed in the center of the capitate in frontal and lateral view. The distal part of the stem must be placed 2 of 3 mm above the joint between the capitate and the third metacarpal bone. If position and size fits, the trial prosthesis is replaced by the pyrocarbon prosthesis and a last fluoroscopic control is performed (Fig. 6).

Finally, capsule and extensor retinaculum are closed with absorbable sutures. A suction drain is placed for the prevention of hematomas. Then, the skin is closed with separated sutures. The wrist is immobilized in a palmar splint during 1 week and rehabilitation is started.

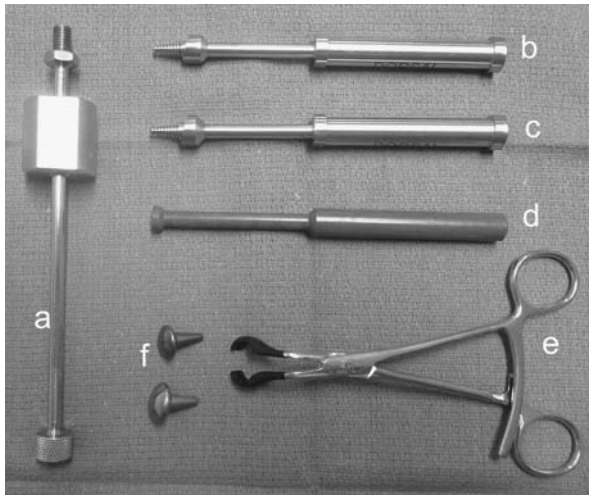

FIGURE 3. Illustration of the Resurfacing Capitate Pyrocarbon Implant set. a, Extractor to remove the rasps; b and c, The 2 rasps (sizes 14 and 16 mm); d, Implant impactor; e, Claw to hold the trial and pyrocarbon prosthesis; and f, The trial prosthesis (sizes 14 and 16 mm).

COMPLICATIONS

Attention must be paid to potential injuries of the dorsal sensory branch of the radial and ulnar nerve. However, nerve lesions are rare because the skin incision is performed in the middle part of the dorsal aspect of the wrist between the radial and the ulnar territory. During scaphoid excision, anterior anatomic structures need to be handled with much caution. In line with this, joystick K-wires are useful when exposing the deep tubercle of the scaphoid. No median nerve or flexor tendons have been injured in our series.

Caution is necessary also to prevent going through the joint between the capitate and the third metacarpal bone. To rule out such potential complication, the head of the capitate must be cut prudently. Moreover, fluoroscopy may be necessary to control the position of the prosthesis and prevent carpometacarpal disruption.

DISCUSSION

When osteoarthritis affects the hamate and the lunate bones, 4 bones or capitolunate arthrodesis cannot be proposed.[3] Only total arthrodesis or total wrist prosthesis may be performed currently in these situations. However, it should be taken into consideration that the former procedure is generally efficient

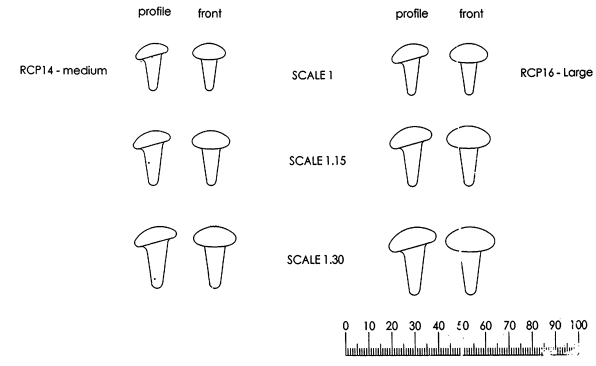

FIGURE 4. X-ray templates of the Resurfacing Capitate Pyrocarbon Implant (RCPI). Showing the 2 sizes that are available: 14 and 16 mm.

FIGURE 5. The head of the prosthesis replaces perfectly the head of the capitate.

against pain but with a loss of range-of-motion,[5] whereas the latter one, although preserving the range-of-motion, its use must be restricted to patients with a low-demand lifestyle who requests relief of pain and modest wrist motion to retain ease of function for nonstressful activities. Elderly patients with generalized rheumatoid or osteoarthritis are typical candidates.[3] Moreover, previous surgery or first row carpectomy are relative contraindications, as these patients must have kept adequate carpus and intact wrist extensors.[4]

Partial prosthesis is the ultimate option to propose before total wrist fusion. Silicone implant have been developed to replace the lunate bone in Kienbock disease.[6,7] However, most of the implants have to be removed because of silicone synovitis. Currently, authors do not recommend this implant.

Partial pyrocarbon prosthesis allows preserving range-of-motion and decreasing pain. This prosthesis may be placed in front of an injured radial cartilage. As a matter of fact, the elastic modulus of pyrocarbon is very close to bone modulus and the experience in other localizations of implanted pyrocarbon showed that no bone loss occur.[8–14]

The longevity of this prosthesis is not questioned currently. Pyrocarbon has been used as prosthetic cardiac valves for 20 years. No complications related to this material have been described to date.

TABLE 1. Informations Concerning Age, Sex and Follow-up of the Patients

Patient No.	Sex	Age (y)	Follow-up
1	M	45	24
2	F	53	72
3	M	40	50
4	M	37	24
5	M	53	18
6	M	63	6
7	M	54	12

F indicates female; M, male.

RESULTS

Seven patients, 6 men and 1 woman, with midcarpal arthritis and radiolunate osteoarthritis were operated (Table 1). Their average age was 49 years (range: 37 to 63 y). All patients had a painful wrist. In terms of visual analog scale staging, the average pain was 7 (range: 6 to 10) and the average grasp

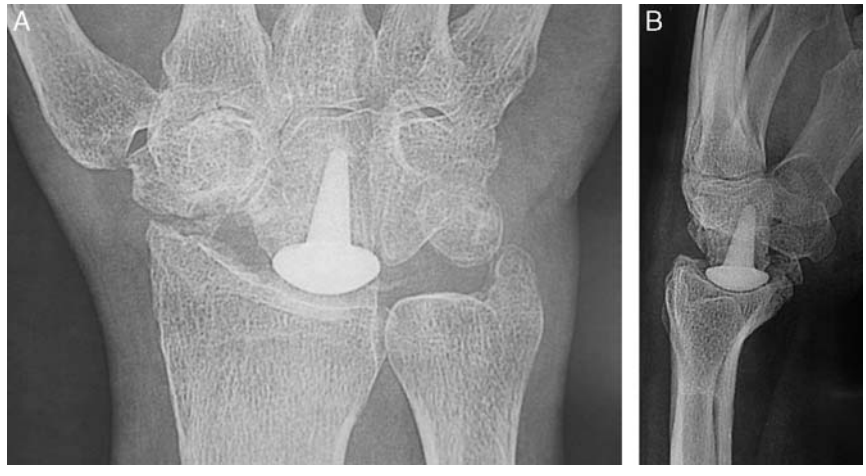

FIGURE 6. The anteroposterior (A) and lateral (B) views show the length and axis of the prosthesis. Implant axis matches the center of the capitate. The stem of the implant must not exceed the carpometacarpal joint.

strength was 19 kg (range: 10 to 38 kg). The average range-of-motion was 36 degrees for wrist flexion (range: 10 to 70 degrees) and 33 degrees for wrist extension (range: 10 to 40 degrees). All patients underwent pyrocarbon implant to replace the head of the capitatum.

The average follow-up was 30 months (range: 6 to 72 mo). Average postoperative pain was 4 (range: 2 to 5), average grasp strength 16 kg (range: 5 to 20 kg), and average range-of-motion 25 degrees (range: 20 to 40 degrees) for flexion, and 30 degrees (range: 10 to 45 degrees) for extension. No carpal dislocation or radius bone loss was observed in our series. Six patients were satisfied of the operation.

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