Osteocartilaginous autograft after proximal resection of the scaphoid for radioscaphoid osteoarthritis

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ABSTRACT

Purpose of the study
Radioscaphoid osteoarthritis is usually a complication of scaphoid pseudarthrosis or chronic scapholunate disjunction. As an alternative to the classical surgical techniques used for this lesion, we propose a novel reconstruction method consisting in partial proximal resection of the scaphoid associated with interposition of a biological spacer composed of a osteocartilaginous rib graft. The purpose of this study was to present the technical aspects of this procedure and to report preliminary results in ten patients with radioscaphoid osteoarthritis treated between 1994 and 2001.

Material and methods
We performed a retrospective analysis of the ten patients who underwent surgery from 1994 to 2001 for early-stage radioscaphoid osteoarthritis associated with scaphoid osteoarthritis in eight and chronic scapholunate disjunction in two. The procedure consisted in partial resection of the proximal portion of the scaphoid and insertion of an osteocartilaginous autograft harvested from a rib. Outcome was based on the clinical results (pain, motion, grip force, activity) and patient satisfaction. Bone healing was measured with plain x-rays and vitality of the osteocartilaginous graft with MRI.

Results
Mean follow-up was 4.6 years. Clinical outcome was considered excellent or good in eight patients, fair in one and poor in one (graft dislocation). All patients were satisfied or very satisfied except one (one failure). Radiological healing was achieved at three months in nine patients. Four patients underwent an MRI examination at thirteen months which demonstrated, in all patients: no sign of necrosis, healing of the graft-scaphoid interface, and no bony metaplasia in the cartilage.

Discussion
Compared with partial carpal arthrodesis and resection of the first row of the carpus, this palliative technique can be used to reconstruct the proximal portion of the carpal scaphoid in young patients with early-stage radioscaphoid osteoarthritis. As for arthroplasty or scaphoid implants, our goal was to achieve a satisfactory scaphoid height using a biological spacer after resection of the proximal ¾ of the bone. The results of this technique are encouraging but must be examined with precaution due to the small number of patients and the short follow-up to date.

Key words: Rib cartilage graft, scaphoid nonunion, scapholunate disjunction, radioscaphoid osteoarthritis.
INTRODUCTION

Degenerative lesions of the wrist often arise as a complication of nonunion of the scaphoid bone or chronic scapholunate disjunction. The initial diagnosis is missed in many patients who are seen after degenerative lesions have developed.

In light of the many surgical techniques proposed to treat radiocarpal osteoarthritis, we propose an original reconstruction method where partial proximal resection of the scaphoid bone is associated with insertion of a biological spacer constituted by an osteocartilaginous autograft fashioned from rib material.

Costal cartilage has long been used for surgical reconstructions. König cited by Ridoux et al. (1) was the first to publish results in humans early in the 20th century. For hand surgery, Ishida et al. (2), Johansson and Engkvist (3) and Katsaros et al. (4) performed digital arthroplasties using a composite costal osteochondral graft. Hentz, cited by Ridoux et al. (1) reported case where cartilaginous homologous grafts were used to treat proximal degenerative lesions. In parallel with these experimental data, and as reported also by Trumble et al. (5), we have applied the concept of a costal osteochondral autograft since 1992 for the treatment of arthrosic wrists [Ridoux et al. (1), Tropet et al. (6, 7)]. In 1998, Sandow (8) proposed this technique for the treatment of proximal necrosis subsequent to scaphoid nonunion.

We report the technical modalities of this method and results obtained in ten patients with radiocarpal degenerative disease who underwent surgery between 1994 and 2001.

MATERIAL

This was a retrospective review of ten patients (nine men and one woman), mean age 43.3 years (range 26-62) who underwent surgery between 1994 and 2001 at the traumatology, orthopedics and reconstructive surgery unit of the Besançon University Hospital. These patients presented early-stage degenerative disease of the radioscaphoid joint complicated by scaphoid nonunion advanced collapse (SNAC stage IIB, IIA as described by Alnot (9)) in eight patients and scapholunate advanced collapse (SLAC stage II or II) in two patients. The dominant side was involved in seven patients.

METHOD

The same operative technique was used for all patients, irrespective of the cause of the radioscaphoid degeneration. The technique involved partial proximal resection of the scaphoid bone associated with a costal osteochondral graft and minimal styloidectomy. General anesthesia was required. The operation was conducted in three phases and required two operative fields.

First phase

The first phase was for partial proximal resection of the scaphoid bone. A volar approach was employed for the first eight patients using a three-segment incision. The proximal segment of ran alone the lateral border of the radial flexor of the carpus. The mid section, measuring 5 mm, was in the distal volar fold of the wrist and the distal segment continued onto the thenar skin toward the distal tubercle of the scaphoid palpated subcutaneously.

Deep dissection advanced either through the sheath of the radial flexor of the carpus to avoid the radial artery, or along the lateral border of this tendon.

The anterior ligamentocapsular plane was reached and cut longitudinally. A capsuloperiosteal flap was exposed allowing an approach to the lower end of the radius and the distal pole of the scaphoid under visual control.

For the last two patients, a lateral approach was fashioned obliquely 45° anteriorly and distally centered on the radial styloid process. This approach was used because of the excellent exposure of the radioscaphoid joint achieved after minimal styloidectomy. Minute dissection was necessary to avoid injury to the sensorial branches of the radial nerve as well as the radial cephalic vein and the radial artery. The capsule was opened longitudinally and the styloid process of the radius and the lateral border of the scaphoid exposed with a rugine. The osteotomy cut line lying 2/3 proximal-1/3 distal beyond the nonunion was marked by electric cautery. Osteotomy was performed with an oscillating saw under fluoroscopic guidance. The proximal pole of the scaphoid was then removed with a gouge forceps after fragmentation as needed (fig. 1).

Second phase

The second phase was to harvest the costal graft. A horizontal incision was made to expose the anterior portion of the 7th, 8th or 9th rib cartilage (fig. 2). The junction between bone and chondral tissue was readily distinguished by the change

Fig. 1. – Resection of the proximal pole of the scaphoid bone.
in color. The deep aspect of the 9th rib was exposed prudently with a rugine and separated from the pleura. If the rib was wide enough, the graft could be harvested without rupturing the rib. The integrity of the pleural sac was verified in collaboration with the anesthetist by supplementary insufflation.

The incision was closed with an intradermal overcast stitch with an aspiration drain.

**Third phase**

The cartilaginous autograft was implanted during the third phase.

The graft was remodeled to fit the proximal cavity in the scaphoid bone. The cartilaginous portion of the graft was placed in contact with the scaphoid facet of the radius (fig. 3). The graft was then fixed to the scaphoid with two K wires. The capsule was sutured with resorbable thread (n° 3/0) and the skin sutured with an intradermal overcast stitch. The fixation was immobilized for 90 days with an antebrachial wrist cast holding the hand in a functional position and including the proximal portion of the thumb (free interphalangeal joint).

Pain, wrist motion, and wrist force were noted at last follow-up. Wrist force was measured with a Jamar dynamometer (mean of three measurements, both sides, elbow 90° flexion, wrist in pronation and neutral supination). Patient activity was assessed with the Green and O’Brien score as modified by Sandow (8) (table I). Patient satisfaction was also noted. The time to bone healing was noted on the standard radiographs. For compliant patients, magnetic resonance imaging was performed to determine the status of the implanted graft.

**RESULTS**

Mean follow-up was 4.6 years (range 2-9). Two complications were observed: one type 1 reflex dystrophy and one graft dislocation.

Clinical outcomes, as assessed by the Green and O’Brien score as modified, were: excellent (n = 4), good (n = 4), fair (n = 1), failure (n = 1) (graft dislocation and resection). The detailed score for the nine patients with a graft in place is summarized in table II. All patients excepting the failure patient stated they were satisfied or very satisfied.

Bone healing was achieved at three months in nine patients (fig. 4). At last follow-up, the degenerative lesions had not progressed in any of the patients, particularly at the radiocarpal level.

Magnetic resonance imaging was performed in four patients at 13 months on average and demonstrated the lack of any signs of necrosis and healing of the graft-scaphoid junton. There were no signs of bone metaplasia (fig. 5).

**DISCUSSION**

These results are encouraging. All patients except one were satisfied with the clinical improvement. Radiolical
healing was achieved in all patients at three months (excepting the one failure). Again excepting the failure patient, all patients were able to resume their occupational activities, within an average delay of four months ten days.

Instead of partial carpal fusion or resection of the first carpal row, we have proposed, since 1994, this novel option designed to reconstruct the proximal pole of the scaphoid in early-stage degeneration of the radioscaphoid joint. Our patients are relatively young with a significant functional demand so that a surgical technique which does not reduce force, as does resection, or joint motion, as does partial fusion, is crucial.

We have used a costal cartilage graft since 1992 [Ridoux et al. (1)] for the interposition graft after partial resection of the trapezium and have proposed the same method for early-stage osteoarthritic lesions of the wrist limited to radioscaphoid degeneration. The purpose of this technique is to reconstruct the radioscaphoid joint before the degenerative lesions reach the neighboring compartments and to re-establish a satisfactory scaphoid height.

Furthermore, for patients presenting nonunion of the scaphoid, reconstruction using a graft with the method described by Matti (10) and Russe (11) or with a vascularized or trapezoidal graft, would be counter-indicated for early-stage degeneration.

Intracarpal arthrodesis is a well described technique but has provided less than satisfactory results. In 1991, Voche et al. (12, 13) reported 36 cases of triscaphoid fusion including 13 for chronic scapholunate dissociation. The results in terms of pain, force and motion were fair. With this operation, the height of the carpus can be maintained but at the cost of lost range of motion. In addition, complications such as nonunion are not uncommon and these

### TABLE I. – Green and O’Brien score as modified by Sandow (8); 90: excellent; 78-89: good; 60-74: fair; < 60: mediocre.

<table>
<thead>
<tr>
<th>Score</th>
<th>0</th>
<th>10</th>
<th>15</th>
<th>20</th>
<th>25</th>
</tr>
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<tbody>
<tr>
<td>Pain</td>
<td>Severe + at rest</td>
<td>Moderate reduction in activity, no pain at rest</td>
<td>Mild, regular, no decrease in activity</td>
<td>Mild, occasional</td>
<td>Absent</td>
</tr>
<tr>
<td>Range of motion</td>
<td>&lt; 40°</td>
<td>40-69°</td>
<td>70-99°</td>
<td>100-140°</td>
<td>&gt; 140°</td>
</tr>
<tr>
<td>Force/opposite side</td>
<td>&lt; 50%</td>
<td>-</td>
<td>50-74%</td>
<td>75-90%</td>
<td>Normal</td>
</tr>
<tr>
<td>Activity</td>
<td>Unable to work</td>
<td>Reduced activity</td>
<td>Normal, few changes</td>
<td>No limitation because of wrist function</td>
<td></td>
</tr>
</tbody>
</table>

### TABLE II. – Green and O’Brien score as modified by Sandow (8) for the nine patients with a graft in place.

<table>
<thead>
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<th>Score</th>
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<th>15</th>
<th>20</th>
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<td>3/9</td>
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<tr>
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<td>3/9</td>
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<td></td>
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<tr>
<td>Force/opposite side</td>
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<td>5/9</td>
<td>2/9</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Activity</td>
<td>6/9</td>
<td>3/9</td>
<td></td>
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Fig. 4. – Preoperative (a), early postoperative (b), and last follow-up (c and d) radiographs of a 49-year-old patient presenting radioscaphoid osteoarthritis subsequent to scaphoid nonunion.
authors propose reserving the technique for scapho-trapezoid lesions.

Four-bone athrodesis is usually associated with scaphoid resection. Saffar and Fakhoury [14] compared the results of this technique with those obtained after resection of the first row and found rather disappointing results for wrist force and motion which were decreased 50% compared with the healthy side. This technique is especially effective in providing pain relief. Dap (15) was much more critical of the method and reported mediocre results for pain with relief achieved in only 8/36 (22%) patients. This author found that force decreased 41% compared with the opposite side and that blocking the wrist was particularly bothersome for many daily activities.

Resection of the first row is another solution proposed by many authors, particularly Schernberg (16) and Alnot and Bleton (17), but opinions vary. In a multicentric retrospective study, Legre and Sassoon (18) showed that resection of the first row gives very good pain relief but that postoperative motion and force were not greatly improved in 33 of 143 patients.

Malerich et al. (19) proposed resection of the distal pole of the scaphoid for patients with a SNAC wrist. Their results were interesting since 19 patients achieved 85% improved mobility and 134% improved force with 13/19 being pain free.

Other teams have proposed arthroplasty using scaphoid implants to avoid fusion and bone resection for advanced-stage nonunion of the scaphoid. Silicone implants are generally proposed. Since the observation of significant synovial reactions [Carter et al. (20), Smith et al. (21), Moutet et al. (22), Haloua et al. (23)], these partial or complete implants have been abandoned. In 1983, Michon et al. (24) advocated the use of silicone beads and Haussmann (25) proposed an allograft with a custom-sized total scaphoid implant. In 1953, Picaud (26) introduced an acrylic implant, then in 1970 Swanson (27) proposed a silicone implant. Excepting the problem of "siliconitis", there has not been any major series published in the literature concerning the efficacy of these implants. Pequignot et al. (28) recently reported interesting preliminary results concerning the use of a pyrocarbon spacer for SNAC wrists. These authors however advised against the use of this implant for SLAC wrists with severe ligament injury.

Regarding the outcome of the cartilaginous graft, our magnetic resonance study demonstrated the absence of any signal suggestive of necrosis. In our series for the treatment of wrist osteoarthritis with this method, a pathology study in four patients demonstrated the absence of necrosis in two patients and partial necrosis in two others [Ridoux et al. (1), Tropet et al. (6, 7)].

These results suggest the chondral graft survives well despite the absence of vascularization at implantation. They are also in agreement with the radiological findings showing bone healing between the distal pole of the scaphoid and the bony part of the osteochondral graft in nine of ten patients.

In the literature, Dingman and Crabb (29) report 2/30 cases of partial resorption at 3.5 years of a costal graft used for facial reconstruction. Muhlbaier et al. (30) concluded from 40 cases that resorption is absent in 75% with severe resorption in 5% at a mean follow-up of six years (bank costal cartilage).

Even though results obtained with this technique appear quite promising, they must be considered prudently. First of all, this was a small series with a short follow-up. The surgi-

Fig. 5. – Magnetic resonance imaging of the wrist. Frontal slices. T1 (a) and T2 (b) sequence 24 months after an osteochondral graft for radioscapoid osteoarthritis subsequent to scaphoid nonunion: absence of signs of graft necrosis (low intensity signal in T1 and intermediate high intensity signal in T2.
cal technique requires harvesting graft material from the thorax and general anesthesia. We did not have any complaints however concerning the harvesting site and no pleuropulmonary complications.

In addition, our surgical technique does not resolve the problem of the scapholunate interosseous ligament in SLAC wrists and does not enable scapholunate congruency in SNAC wrists. Postoperatively, scapholunate dissociation persists. It is difficult with our short follow-up to confirm the persistence of this dissociation which could be a new source of radioscaphoid osteoarthritic degeneration. Nevertheless, we believe that the significant chondral graft can enable morphological remodeling so as to avoid a conflict with the scaphoid facet of the radius. The spacer gives the scaphoid sufficient height to avoid radial collapse. Like intracarpal arthrodesis or resection of the first row, this technique remains a palliative measure. It is less aggressive and attempts to achieve an anatomic reconstruction of the wrist without resolving the biomechanical problems.

CONCLUSION

Proximal resection of the scaphoid associated with an osteochondral costal spacer graft appears to be an attractive alternative to classical techniques such as resection of the first carpal row or intracarpal fusion. These later techniques do not allow ideal reconstruction of the radiocarpal joint to enable recovery of pain-free motion and force. This result is particularly important for young active patients.

The clinical results obtained in this series are encouraging and appear to be superior to those obtained with classical techniques. This technique can be applied in all cases of localized osteoarthritis of the radial aspect of the scaphoid bone.

Prudence is however necessary when interpreting these results since follow-up was at best mid-term and remains insufficient. Magnetic resonance imaging studies in a few patients demonstrated the good osteointegration of the graft.

Due to the insufficient follow-up it remains difficult to foresee how the osteoarthritic lesions will evolve. In any case, this technique leaves room for returning to more conventional techniques if needed.

References

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