Nonunion of the scaphoid treated by anterior vascularized bone graft: a review of 26 cases

Mohamed Faouzi Hamdi*, Karim Amara, Lamjed Tarhouni and Sayed Baccari

【Abstract】 Objective: To evaluate the clinical and radiological outcome of anterior vascularized bone graft in the treatment of primitive nonunion of the scaphoid.

Methods: This is a retrospective study of 26 scaphoid nonunion cases treated by this technique between 2004 and 2009. The mean age was 38 years. Nonunion was of types IIA and IIB according to the Alnot’s classification and only one case showed a proximal pole necrosis (type IV). The fixation was ensured by K-wire. The mean immobilization period was 9 weeks.

Results: At mean 19 months follow-up, the bone union rate was 88.5%. Failure was noted in three cases. No significant complications secondary to this technique were observed. The mobility in extension and flexion had an average recovery of 18°. Nineteen patients (73%) were free of pain, and the others had occasional pain.

Conclusions: It is a meticulous surgical technique that provides better union rates than those of conventional scaphoid graft. This technique is first adopted in cases of failure of conventional grafts in the treatment of scaphoid nonunion but the encouraging results suggest expanding indications to primitive nonunion.

Key words: Scaphoid bone; Pseudarthrosis; Bone transplantation; Radius

METHODS

Patients
This retrospective study was accomplished with patients’ informed consent. Between 2004 and 2009, 26 cases of primitive nonunion of the carpal scaphoid were treated with vascularized bone graft from the volar surface of lower radius. Among these patients, 23 were men and 3 women. Most of the patients (69%) were manual workers. The mean age at the time of surgery was 32 years (range, 18-43 years) and the dominant hand was involved in 77% of cases. According to the classification of Alnot (Table 1), there were 15 cases of type IIA, and 10 cases of type IIB. One case of scaphoid nonunion with proximal pole necrosis (type IV) was found and confirmed intraoperatively. The mean nonunion evolution time was 17 months (range, 6-38 months). The sites of the scaphoid pseudarthrosis were distributed as follows: 2 high-corporeal, 11 trans-tuberosity and 13 low-corporeal.

Surgical technique
According to Kuhlmann et al, the vascularized bone graft is taken from the anterior side of the distal radial epiphysis. The bone graft is vascularized by a constant artery called volar carpal artery. This vessel arises from the radial artery at the level of the radial styloid and
runs along the palmar aspect of the radius. This real anastomotic network perfuses the graft at the palmar aspect of the distal radius and ulna (Figure 1). The pedicle is long enough for the bone graft to reach the scaphoid without tension. The surgical procedure is performed under local anesthesia, with a tourniquet placed on the arm. The incision is classic: anterior surgical approach with a medial palmar extension, extending more distal to the tubercle of the scaphoid. The nonunion area is prepared by excision of fibrous tissue of both (proximal and distal) fragments facing the nonunion until the viable bone. The graft is obtained using mini-osteotomes, standing on a wide pedicle including the volar carpal artery. The graft and its pedicle are then dissected to the origin of the volar carpal artery (Figure 2). Deflating the tourniquet verifies the vascularization of the graft. The bone graft is deposited to fill the bone defect on the scaphoid, without any strain on the pedicle. The scaphoid and the graft are stabilized with K-wire, which is inserted anteriorly from distal to proximal (Figure 3). The closure is made with the placement of Redon suction tubes. The immobilization of the wrist using the short-arm casting and K-wire will be maintained until bone consolidation. Once bone healing is acquired, the rehabilitation of the wrist is initiated.

Assessment

The clinical outcome was assessed by criteria inspired by the score of Michon, which took into account the wrist motion, the strength of the hand, and the wrist pain. We used the X-ray of the wrist (anteroposterior and lateral views) for the analysis of the radiological criteria, including scaphoid union, scaphoid height, carpal instability, and scaphoid necrosis.

RESULTS

We had no intraoperative damage such as a fracture at the donor site. Postoperatively one case of K-wire migration was noted while bony union was already achieved (Figure 4). At a mean follow-up period of 19 months (range, 6-48 months), the bony union rate was 88.5% (Figure 5). Indeed, procedure success was observed in 23 patients and union was obtained after 12 weeks (range, 8-15 weeks). Failure was noted in three cases: one corresponded to a proximal pole necrosis (type IV) and the other two were pseudarthrosis type IIa and type IIb.
Overall, the strength of the hand was improved in six patients. The recovery of the mobility in extension and flexion had an average of 18°. Nineteen patients (73%) were free of pain, and the others had occasional pain.

The restoration of scaphoid height, which concerned the 10 cases of stage IIIB, was complete in 6 cases and inadequate in 4 cases. We did not identify scaphoid necrosis after this surgery.

**DISCUSSION**

In cases of large loss of bone substance over 6 cm, the value of vascularized bone grafting is well established. Indeed, compared with the conventional bone graft, it allows a better incorporation of the graft, revascularization of the recipient site, and a faster bony union. The loss of bone carpal is usually small and often solitary in the case of scaphoid pseudarthrosis. The vascularized bone graft is likely indicated in such situation, particularly when the conventional option has few chances to provide a union.

According to published series about the treatment of scaphoid nonunions, successful rates vary from 70% to 100% either with or without vascular grafts. The use of vascularized bone grafting techniques for scaphoid nonunion had successful rates slightly higher than conventional grafting with Matti-Russe technique (Table 2).

**Table 1.** Pseudarthrosis of the scaphoid according to the Alnot classification

<table>
<thead>
<tr>
<th>Types</th>
<th>Pseudarthrosis of the scaphoid</th>
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<tr>
<td>I</td>
<td>Linear pseudarthrosis</td>
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<tr>
<td>IIA</td>
<td>Scaphoid bone loss without unstable pseudarthrosis</td>
</tr>
<tr>
<td>IIIB</td>
<td>Scaphoid bone loss with unstable pseudarthrosis</td>
</tr>
<tr>
<td>IIIA</td>
<td>Radioscaphoid arthritis</td>
</tr>
<tr>
<td>IIIB</td>
<td>Radiocarpal arthritis</td>
</tr>
<tr>
<td>IV</td>
<td>Necrosis of proximal pole of the scaphoid</td>
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Kuhlmann's technique used by several authors allowed a bony union of the scaphoid with rates above 92%. Through a single palmar approach, this technique allows both the graft harvest and the nonunion treatment.

The surgery is often done on an outpatient basis under regional anesthesia. Noting that the bone loss for the carpal scaphoid is always palmar with an anterior bending, so correction of the deformity of the scaphoid would be easier. The constancy and the length of the volar carpal artery provide a reliable technique and allow the graft to easily reach the scaphoid.

Despite its advantages, this surgical technique has some deficiencies. It is difficult to assess the vitality of the graft during surgery; bleeding from the graft does not necessarily mean a good venous return; the graft is often small, hard to handle and adjust to the bone loss; and the incorporation of the graft to the nonunion site associated with synthesis could affect the graft vascularization. Graft harvest from the lower end of the radius does not provide sufficient graft size for larger bone loss.

The type of fixation does not appear to be a predictive factor for bony union. In fact, Jessu et al who performed a study in 30 cases of vascularized grafting of the scaphoid using K-wires or screws found no significant difference without giving biomechanical explanation to these findings.

Merrell et al concluded that the vascular graft is the best alternative for the proximal necrosis. However, in such situation, the bony union ratios in the application of a vascularized graft vary widely from 100% to 12.5%. This ratio was 100% for some authors, not exceeding 50% in the series by Chang et al, whereas it was 12.5% in the series of Straw et al. In our series, this treatment failed in the only case of proximal pole necrosis confirming the findings of Jessu et al.

All authors agree on the deleterious effect of age and smoking. Little et al found a significant association between smoking and delayed healing. Well advanced age is a negative factor for the vascular condition.

The anterior vascularized bone graft taken from the volar surface of the lower radius is a tactful technique, which offers, under experienced hands, higher rates of
success than conventional grafting. This surgical procedure was first used in cases of failure of conventional techniques in the treatment of nonunion of carpal scaphoid. The encouraging results should expand indications to type II primitive nonunion although this technique cannot solve the problem of proximal pole necrosis.

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REFERENCES


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