A technique for anterior wedge-shaped grafts for scaphoid nonunions with carpal instability

This article presents a brief description of the following modifications of the original Fisk procedure for navicular nonunions with carpal instability: (1) preoperative calculation of exact scaphoid length and form based on comparative roentgenograms of the opposite wrist, (2) the use of a palmar approach, (3) the insertion of a wedge-shaped corticocancellous graft from the iliac crest after resection of the pseudarthrosis, and (4) the use of internal fixation. Preoperative planning is considered essential to restore the anatomic length, analyze the angular deformity, evaluate the pathologic scapholunate angle, and calculate the resection and size of the graft needed. The palmar approach reduces the danger of iatrogenic damage of the vascular supply of the scaphoid and accidental lesions of the superficial branches of the radial nerve. Furthermore, it provides a better exposure of the scapholunate joint to correct lunate rotation. Iliac bone is preferred to the radial styloid graft, as proposed by Fisk, because of its better ability to resist compression forces. Internal fixation adds rotational stability so that continued postoperative plaster immobilization can be reduced to a minimum of 8 weeks. (J HAND SURG 9A:733-7, 1984.)

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On the other hand, the Russe9-10 palmar inlay grafting procedure is a reliable and universally accepted method for achievement of union of the scaphoid, even in the presence of avascular necrosis of the proximal fragment. Russe has reported a 100% union rate in a series of 40 cases treated operatively during 1973 and 1979.10 In our department, this is the preferred method of treatment for scaphoid waist nonunions without carpal instability.

However, in cases with severe scaphoid shortening, cystic nonunions with bone resorption, and important flexion deformity, we have found it difficult to restore accurate scaphoid length with inlay grafting techniques. Insertion of a longer graft usually distracts the nonunion site, creating a ring-like bone defect that renders the nonunion unstable, therefore increasing the failure rate because of recurrence of the flexion deformity.

In six consecutive cases, resection of the nonunion site and insertion of a tight-fitting wedge-shaped corticocancellous graft has rendered satisfactory results in terms of union and correction of the dorsal instability pattern (Table 1).

In a recent report, Linscheid et al.11 presented six cases of palmar wedge grafting combined with cancellous bone grafting of the proximal and distal fragments.
They advocated transfixation of the reduced lunate to the radius, and additional Kirschner wires were used to stabilize the intercarpal joint. With radial wedge grafting, Fisk obtained union in 27 of 37 nonunions. Detailed information on restoration and maintenance of carpal alignment with roentgenographic measurements of the SL angle is not given.

The purpose of this article is to describe four technical modifications of the original Fisk procedure, these being: (1) the use of a preoperative plan based on comparative roentgenograms of the opposite wrist, (2) the use of a palmar approach, (3) the resection of the nonunion site and insertion of an iliac graft, and (4) the use of internal fixation. We will also discuss their advantages.

**Technique**

To restore the exact anatomic length and form of the navicular, the amount of resection and size of the graft needed as well as the angular deformity are calculated preoperatively on tracing paper by means of roentgenographic findings of the uninjured wrist (Fig. 1). Comparative x-ray films also help to determine the degree of intercarpal collapse of the affected wrist and the normal SL and lunocapitate angles for each particular patient. The scaphoid is approached between the flexor carpi radialis and the radial artery according to the classic Russe procedure. The palmar capsule of the wrist is then incised longitudinally in line with the skin incision and the incision is extended to the scaphoid tubercle. This gives a clear exposure of the nonunion, the proximal and distal fragments, and the SL junction (Fig. 2). Then the resection is carried out with an oscillating saw according to the preoperative plan. If there are signs of avascular necrosis of the proximal fragment, multiple 1 mm drill holes are placed within the sclerotic cancellous bone. Then the flexion deformity and shortening are corrected by distracting the osteotomy site on the palmar-radial aspect with two small bone hooks or a spreader clamp. As this is done, the assistant simultaneously corrects the dorsal rotation of the lunate by pushing the palmar pole toward the radius with a fine bone spike. The corticocancellous graft obtained from the iliac crest is shaped to fit the defect. In most instances the graft is triangular. However, in cases in which considerable lengthening is desired, the graft will be trapezoidal to bridge the defect that appears on the dorsal aspect of the navicular (Fig. 3). The graft is oriented so that its cortical part lies palmarly (Fig. 2, C). After insertion of the graft, the protruding edges are shaped flush with the proximal and distal fragments. The image intensifier is used to control correction of lunate rotation. Then internal fixation of the scaphoid is carried out with two or three 1.2 mm Kirschner wires, which are power driven percutaneously into the palmar aspect of the distal fragment across the graft into the dorsal aspect of the proximal fragment. Again the image intensifier is used to guarantee the correct placement of the internal fixation material. Careful closure of the palmar capsule completes the operation, and the Kirschner wires are cut short, 5 mm below the palmar skin of the thenar area.

After operation a palmar plaster splint that includes the thumb is applied for 2 weeks, at which time the sutures are removed. Thereafter the wrist and thumb are immobilized in a short navicular cast for 6 weeks. Immobilization is discontinued 8 weeks after operation and a palmar Orthoplast removable splint is applied, with which the patient can perform active exercises of the wrist three times a day for 15 minutes. Tomograms of the navicular are obtained at the tenth week, and if bony union is confirmed, the internal fixation material is removed through a small incision under local anesthesia.
Wedge-shaped grafts for scaphoid nonunions

Fig. 2. A, Wide exposure of whole scaphoid and palmar pole of lunate through Russe’s palmar approach. Hypertrophic nonunion with flexion deformity shown with bone hook. B, Wedge-shaped triangular iliac graft to fit the resected nonunion. C, Graft in place. Notice that the cortical part of the graft faces palmarly. D, Position of Kirschner wires used for internal fixation.

I. Patient data

<table>
<thead>
<tr>
<th>Sex</th>
<th>Age (yr)/sex</th>
<th>Duration of nonunion (mo)</th>
<th>Localization</th>
<th>Preop. SL angle (degrees)</th>
<th>Postop. SL angle (degrees)</th>
<th>Time to healing (wk)</th>
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<tbody>
<tr>
<td>M</td>
<td>31/M</td>
<td>12</td>
<td>Waist</td>
<td>50</td>
<td>38</td>
<td>40</td>
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<tr>
<td>M</td>
<td>17/M</td>
<td>8</td>
<td>Distal one third</td>
<td>72</td>
<td>43</td>
<td>41</td>
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<tr>
<td>M</td>
<td>21/M</td>
<td>14</td>
<td>Waist, avascular necrosis, (peri-lunate dislocation)</td>
<td>60</td>
<td>45</td>
<td>47</td>
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<tr>
<td>M</td>
<td>22/M</td>
<td>6</td>
<td>Waist</td>
<td>55</td>
<td>47</td>
<td>45</td>
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<tr>
<td>M</td>
<td>23/M</td>
<td>10</td>
<td>Waist</td>
<td>42</td>
<td>35</td>
<td>32</td>
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<tr>
<td>F</td>
<td>22/M</td>
<td>7</td>
<td>Proximal one third, avascular necrosis</td>
<td>63</td>
<td>52</td>
<td>55</td>
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Average age: 22.6, Average duration of nonunion: 9.5

Discussion

A review of the first six cases treated with this technique since 1981, with an average follow-up of 12.1 months (Table I), showed that correction of the radiologic dorsal tilt of the lunate with normalization of the SL angle and union of the pseudarthrosis in an average of 10.2 weeks was achieved in all six cases with the proposed postoperative management. All malunions had a dorsal instability pattern with an average increase of the SL angle of 13.6° as compared...
Fig. 3. Cystic unstable nonunion with avascular necrosis of proximal pole after transscaphoperilunate dislocation (case 3, Table I). Nonunion healed with satisfactory correction of lunate rotation with interposed trapezoidal graft after resection of pseudarthrosis.

with the uninjured wrist. Four nonunions were located at the waist, one in the distal third and one in the proximal third of the scaphoid. Two had avascular changes in the proximal fragment. As shown in Table I, postoperative restoration of the SL angle resulted in measurements comparable to those of the opposite wrist, producing near symmetry. Intraoperative simultaneous correction of the dorsiflexed lunate and restoration of scaphoid length with tightening of the palmar radiocarpal ligaments resulted in spontaneous stable reduction of the lunate in all cases.

In none of the cases was additional Kirschner-wire fixation of the lunate to the radius necessary to maintain the corrected rotation of the lunate.

The roentgenographic follow-up showed that correction of the instability with serial measurements of the SL angle remained unchanged (Figs. 3 to 5).

We believe that the comparative x-ray films of the uninjured wrist are essential to determine the normal SL angle for each particular patient, as it may vary between 30° and 60° in normal wrists, with an average of 46°. The palmar approach is preferred because it provides adequate exposure of the whole scaphoid bone and the SL junction and avoids both iatrogenic damage of the nutrient arteries of the scaphoid and accidental injuries to the superficial branches of the radial nerve. Furthermore, most of the cases of scaphoid nonunions with a pattern of dorsiflexed intercalated segmented instability of the carpus result in a palmar flexion deformity of the scaphoid that requires a palmar opening wedge grafting rather than a palmar-radial grafting. We believe that, for this purpose, the palmar approach is more direct, easier, and less traumatizing than a radial incision with radial styloid osteotomy. Iliac bone graft is preferred to local grafts taken from the distal radius because of the better quality and compression resistance of the cancellous bone. Furthermore the radial styloid has a limited bone stock if larger grafts are needed. Since the graft is inserted under distraction of the scaphoid fragments, the nonunion is perfectly stabilized by capsular and ligament tension, provided that there is perfect apposition of the osteotomized surfaces. A simple form of internal fixation with two or three Kirschner wires ensures rotational stability so that continued postoperative immobilization is reduced to a minimum of 8 weeks in a short navicular cast. We believe that preoperative planning to calculate the exact amount of resection and size of the graft needed based on the study of the x-ray films of the opposite wrist is essential to restore the exact anatomy and length of the scaphoid.

Conclusions

Normal realignment and restoration of anatomic length of the scaphoid is a measure to prevent late intercarpal collapse in established nonunions with associated dorsal instability patterns. In our hands, a conventional Russe procedure has proved insufficient to restore anatomic length without creating a peripheral bone defect and instability. Initial results of a modified palmar wedge grafting technique of the scaphoid combined with internal fixation, based on the original Fisk procedure, are encouraging.

REFERENCES

3. Linscheid RL, Dobyns JH, Beabout JW, Bryan RS: Traumatic instability of the wrist. Diagnosis, classifica-
9A. No. 5
bet 1984
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Fig. 4. Nonunion of distal third of the scaphoid. Oblique view (top middle) shows palmar displacement of distal fragment. Nonunion healed with 30° correction of SL angle (case 2, Table I).

Fig. 5. Oblique waist nonunion of the scaphoid. Frontal tomogram clearly shows palmar displacement of the distal fragment. Nonunion healed with correct carpal alignment (case 1, Table I).

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