

SOME ASPECTS OF BONE GRAFTING FOR NON-UNION OF THE CARPAL NAVICULAR

Analysis of 41 Cases

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Forty-one patients with established non-union of the carpal navicular are presented. Forty patients were treated by bone grafting, using the same operative technique in all of them. All operated fractures healed and were free of pain at the time of union. Vascularization did not seem to interfere with union in the different types of fractures. Radial styloidectomy, performed in addition to bone grafting in 26 of the patients, who had arthritic changes, improved their wrist mobility.

Key words: carpal navicular; bone grafting; non-union

Accepted 28.ii.77

There are different points of view concerning open reduction and bone grafting (Gasser 1965, Gordon & King 1961, Graner et al. 1966, Milford 1963, Torngren & Sadqvist 1974, Waugh & Reveling 1945). Most authors are rather reluctant to use this procedure for long standing non-union with arthritic changes in the wrist joint, or fractures involving the upper third of the navicular (Boehler et al. 1954, Gasser 1965, Kessler et al. 1963, Scholder 1953). In view of this, we present our experience with 40 cases of established non-union of the carpal navicular treated by bone grafting.

MATERIAL AND METHODS

Forty-one patients with non-union of the carpal navicular were examined. Forty had open reduction and bone grafting performed and were followed until union was confirmed and wrist motion restored. One patient with a 22 year old

united fracture, with no pain and no radial abduction, was not operated on (see Discussion). The age of the patients varied between 16 and 32 years, with an average age of 24. All of them were healthy normal males.

All patients, except for one, had a history of a minimum of 1 year of painful limitation of wrist motion, affecting daily activity, following fracture of the navicular bone. Radiologically there was definite evidence of non-union of a fractured scaphoid with signs of necrosis of a fragment in 23 of the patients and arthritic changes around the fracture site in 34. Twenty-six fractures were horizontal oblique of the mid-third of the bone (Russe 1960), six being displaced. Ten were fractures of the proximal third, four of which were displaced fractures of the lower third of the bone.

The operative technique was that of Russe (1960). In some cases an additional radial styloidectomy was performed. After surgery an above-elbow circular cast was applied for 6 weeks.

The postoperative management was the same in all patients; the cast was removed after 6 weeks and X-rays were taken prior to the application of below-elbow immobilization. The

casts were changed and X-rays taken every 6 weeks until union was confirmed. When X-ray results were doubtful, tomography was performed.

RESULTS

The shortest period of immobilization was 6 weeks, the longest 10 months with an average of four and a half months. All fractures healed with bone grafting and all patients were free of pain at the time of union regardless of the duration of non-union or the type of fracture. The postoperative mobility was improved in more than half of the cases (24) compared to the preoperative range of motion, and most of the patients returned to their original occupation.

In 26 patients, radial styloidectomy was performed at the time of bone grafting. Indications for this additional procedure were: Painful limitation of radial abduction, radiological evidence of narrowing of the radio-navicular space, and local arthritic changes around the radial styloid. Increased mobility, after this treatment, was observed in 13 of the 26 patients; mobility remained unchanged in four and was reduced in nine. All 23 cases with 18 months or less of non-union increased their wrist mobility after surgery, while only four of the 17 patients with more than 18 months of non-union showed improved mobility.

DISCUSSION

Duration of non-union

The term "non-union" of a fracture is time related. Experience shows that prolonged immobilization decreases the incidence of non-union. Certain authors (Boyes 1964) require a minimal period of 3 months, others (McKim 1944), more than 9 months. However, prolonged immobilization may be damaging to joint mobility and to muscle power.

In our study of non-union, the period



Figure 1. Thirteen year old non-union following failed bone grafting procedure with radio-ulnar styloidectomies.



Figure 2. Same case as Figure 1 after second bone grafting procedure. Healing occurred after 7 months of immobilization.

prior to surgery varied from 1 to 13 years. The duration of the non-union did not affect the final results as far as pain and subsequent union were concerned. In long standing cases (Figures 1, 2) the ultimate result was not influenced by the arthritis which had developed around the radio-navicular joint during this long period. However, our study demonstrates that unlike pain or successful union, the improvement of mobility following surgery was related to the preoperative duration of non-union: Hence, the post-operative mobility of the wrist increased in all 23 cases with 18 months or less of non-union, while only four of the 17 patients with more than 18 months of non-union showed improved mobility.

Vascularization and consolidation

According to Bunnell (1964), the most important reasons for non-union of a fracture are excessive mobility at the fracture site and deficiency of the blood supply. According to Boehler (1954), non-union will occur in about 10 per cent of all fresh cases, even with adequate plaster of paris immobilization and satisfactory blood supply to the



Figure 4. Five year old ununited and untreated fracture of the mid-third of the navicular before surgery.

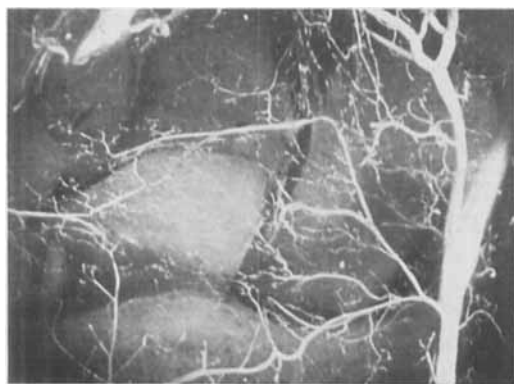


Figure 3. Injected specimen in Spalteholz, volar aspect radio-carpal joint. Anastomosis between radial and anterior interosseous arteries, showing branches to the proximal areas of the navicular and lunate bones (Herness & Le Winn, in preparation).

fractured fragments. Kessler (1963) maintains that marked displacement of fragments, interposition of soft tissues, and incorrect treatment, are the factors responsible for non-union and not the vascular insufficiency. In 100 cases of bone grafted scaphoides, Murray (1946) reported a 40 per cent incidence of pre-operative aseptic necrosis and yet, all healed following surgery. Trueta (1968) reviewing injected carpal naviculars found the proximal half of the bone to be supplied by some little arterioles "scattered about". It was evident to him that slowness of union of a fracture across the neck of the navicular is due to the poor blood supply to the proximal fragment. Taliesnik et al. (1966) demonstrate in their anatomical study of the carpal navicular vascular anatomy that three branches of the radial artery penetrate the bone from three different

directions; a lateral volar vessel, at the radial articular surface; a dorsal branch, in the area of the insertion of the dorsal radio-carpal ligament, and a more distal branch at the insertion of the lateral radio-carpal ligament. A proximal vessel was also seen in one of the 11 specimens studied.

Our own radio-anatomical studies of injected specimens support the findings of Logroscino & DeMachi (1938), Scholder (1953) and Travagline (1959) of the direct participation of the volar and dorsal interosseous arteries in supplying the proximal areas of the navicular and lunate bones (Herness & Le Winn, in preparation), in addition to the radial artery vascular supply (Figure 3). These various studies show that the proximal, mid, and distal thirds of the bone each has its own source of blood. Hence, vas-



Figure 6. One year old untreated fracture of the proximal third of the navicular.



Figure 5. Same case as Figure 4 after bone grafting. Healing occurred after 4 months of immobilization.



Figure 7. Same case as Figure 6 following bone grafting. Union occurred after 4 months of immobilization.

cularization of the separated fragments of the fractured bone is only rarely interrupted in most types of fractures. Thus, 5 year old, untreated and ununited fractures of the mid-third of the bone with a theoretically adequate blood supply

(Russe 1960), necessitated the same immobilization time following surgery as 12 month old fractures of the proximal third, with a supposedly poor vascular supply (Figures 4, 5, 6, 7) of the proximal fragment (Russe 1960). This implies that the graft acts as a bridge or a vascular "short cut" (Boyes 1964) for regenerating bone formation between the separated fragments.

Styloidectomy

Arthritic changes around the radio-navicular joint so often seen in radiographies of wrists with ununited fracture of navicular bone are due to changes in the joint stability. This seems to be caused primarily by the displaced and unstable fragments of the fractured navicular bone which cause an abnormal motion at the radio-navicular joint (Gray 1959). Limitation of motion at the radio-navicular joint, especially radial abduction, is progressive and causes pain. Hence arthritis with pain and limitation of motion will continue to progress until the fracture is united. Simple styloidectomy will probably not resolve these mutually dependent developments, and may even interfere with the natural course of healing. In fact it may further deteriorate wrist mobility. However, styloidectomy combined with bone grafting may be indicated when radial abduction is severely limited.

This is illustrated by the following two cases: The first one shows the natural course of an untreated fracture. A 22 year old ununited, displaced fracture of the upper third of the right navicular was discovered accidentally in a patient seen for other reasons. On examination, the patient had no radial abduction of the wrist. X-rays of the wrist showed, in addition to the fracture, marked arthritic changes with narrowing of the radio-navicular joint and calcifications along the lateral collateral ligament (Figure 8). The patient reported that pain had



Figure 8. Twenty-two year old ununited displaced fracture of the navicular. Marked arthritic changes around the fracture site and the radio-navicular joint. Arrow points to calcification along the lateral collateral ligament.

decreased over the years as limitation of radial abduction developed and it had subsided 10 years previously when this motion was entirely abolished.

The second patient (Figure 1) was seen for increasingly severe pain and progressive limitation of motion following an unsuccessful bone grafting of an ununited fracture of the navicular bone, with ulnar and radial styloidectomies, performed elsewhere. This can be explained by the increased mobility at the fracture site caused by the styloidectomies. Following a second bone graft the fracture united, the pain subsided, and the motion improved (Figure 2).

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