

Vascularised pisiform bone graft Indications, technique and long-term results

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The authors report their experience with the use of a vascularised pisiform bone graft based on the dorsal branch of the ulnar artery to provide osseous support and an efficient vascular aid especially in non-unions of the carpal navicular bone with avascular necrosis of its proximal pole and in stage III Kienböck's disease. The pisiform can replace the proximal pole of the navicular bone in totality. When implanted into the lunate, it stops its collapse and helps to revascularise it. The authors present the results achieved in 14 patients (12 male, 2 female), of which eight had a follow-up longer than 5 years. The technique appears as an interesting alternative to carpectomies and partial intracarpal fusions which are usually proposed in advanced cases of these conditions.

INTRODUCTION

In advanced cases with bone collapse, avascular necrosis (AVN) of the carpal navicular or lunate bone is usually treated by proximal row carpectomy or by partial or total fusion of the wrist. The aim of this study was to evaluate a less aggressive alternative consisting in the use of a vascularised pisiform graft based on the dorsal branch of the ulnar artery.

Two points appear essential to us : the integrity of the dorsal ulnar vessels to secure the vitality of the transplant and the durability of the results.

PATIENTS AND METHODS

Avascular necrosis with bone collapse in the carpus is rare. We operated seven patients for AVN of the proxi-

mal pole of the carpal navicular bone and seven others for AVN of the lunate bone, using the technique described below.

AVN of the navicular bone was secondary to distal capital or proximal corporeal fracture of the navicular. The lesions occurred in male manual workers, aged between 25 and 35 years, with total occupational disability for more than one year.

The seven patients (five male, two female) with lunate necrosis had symptomatic Kienböck's disease. In six of them, who were in their thirties, the condition had been progressing over two years. The last patient had been followed over a period of 40 years for a Kienböck disease which was fairly well tolerated for a long time, but ultimately became so painful that operative treatment appeared necessary although she was 70 years old and had hypertension and mild coronary heart disease.

All patients presented with complete loss of active wrist mobility, owing to pain on the slightest movement.

All patients were reviewed one year after the pisiform transfer. Eight could be reviewed at a long term. The results were evaluated by the junior author (C.K.), who was not yet on our team at the time of the surgical intervention. The clinical evaluation took into consideration the residual pain, the range of motion of the wrist and the grip strength measured with Jamar's dynamometer (model PC 5030 J1A).

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Surgical procedure

The operation was done under tourniquet control without exsanguinating the limb, to facilitate vessel identification. Haemostasis was done progressively. An 8-cm antero-medial zigzag incision was made extending from the forearm to the palm, just lateral to the flexor carpi ulnaris tendon and directed towards the fourth ray in order to avoid the palmar cutaneous nerves.

The vessels on the lateral border of the pisiform were cut and electrocauterised. The pisiform was freed from its muscular attachments (flexor carpi ulnaris) and from the pisohamate ligament, preserving the lateral distal insertions of flexor carpi ulnaris. The type of incision of the pisotriquetral capsule differed according to the bone necessitating the transfer. When the capsule was incised, the pisiform was only attached to the blood vessels on its medial border. The latter, in addition to the dorsal carpal branch of the ulnar artery and accompanying veins were contained in a cellulo-adipose bundle easily identifiable by traction on the pisiform. The dorsal carpal branch was divided and ligated at the level of the triquetrum near the origin of the deep palmar branch. This bundle was dissected from distal to proximal. Dissection is easier in relation to the flexor carpi ulnaris than to the dorsal branch of the ulnar nerve situated just behind the artery. The tourniquet could be deflated temporarily to differentiate vascular and nervous structures. The vessels were passed behind the flexor carpi ulnaris and were freed up to the ulnar artery. The pedicle obtained was at least 4 cm long. The pisiform and its pedicle were slipped behind the flexor carpi ulnaris and placed lateral to the ulnar neurovascular bundle. The flexor carpi ulnaris tendon remaining in continuity with the pisohamate ligament and the abductor digiti minimi forms a fibromuscular septum protecting the ulnar neurovascular pedicle. The flexor retinaculum was incised longitudinally on its medial side to open the carpal tunnel. The flexor tendons and the median nerve were retracted laterally and volarly

Navicular reconstructions

For transplantation into the navicular (fig 1, 3, 4), the major part of the pisotriquetral capsule should be harvested with the transplant when elevating the pisiform. Incision of the radiocarpal ligament gives access to the proximal pole compartment. The latter is collapsed and contains necrotic bone fragments that have lost their distal and most of their proximal attachments. Necrotic bone should be removed and a Kirschner wire placed

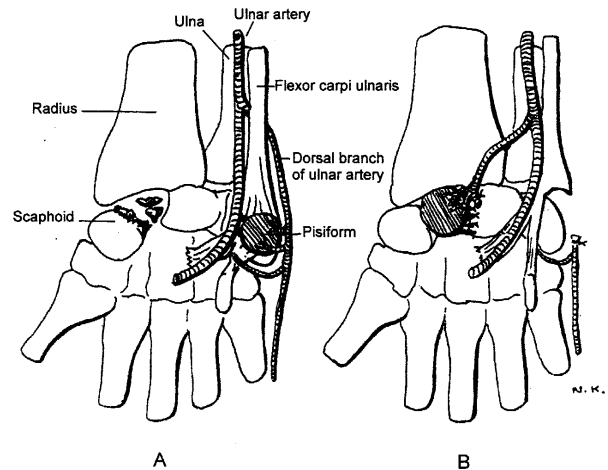


Fig. 1. — Scaphoid transplantation (diagram).

a : Proximal pole necrosis.

b : Replacement with the pisiform bone pedicled on the dorsal branch of the ulnar artery.

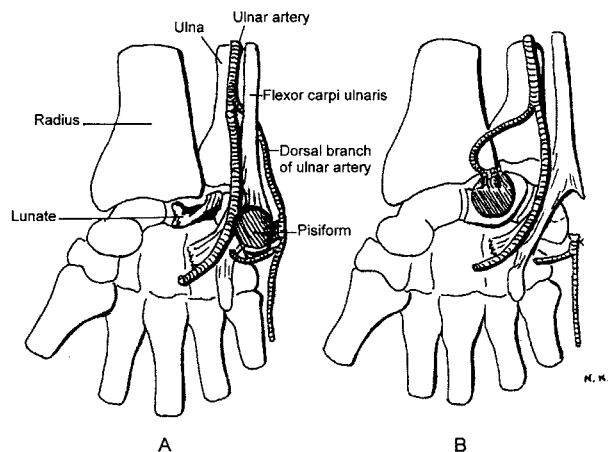


Fig. 2. — Lunate implantation (diagram).

a : Kienböck's disease stage III.

b : The pisiform is implanted inside the lunate.

percutaneously into the distal scaphoid up to the non-union site. In the cases we operated, the vascular pedicle was sufficiently long to bring the pisiform into the proximal pole compartment without tension. Traction was applied to the hand in order to open the compartment. The pisiform sometimes had to be introduced forcefully. It has approximately the shape of the necrotic proximal pole and replaces it. Its articular surface was brought against the lunate and its pedicle was placed in an anterior and distal position. The Kirschner wire was then introduced to fix the transplant. The accessible part of



Fig. 3. — Proximal pole necrosis, one year after scaphoid fracture (Schernberg type III). PA and lateral views.



Fig. 4. — Proximal pole replacement with the pisiform pedicled graft ; fixation with Kirschner wires. Intra-operative PA and lateral views.

the pisotriquetral capsule was sutured to the remnants of the scapholunate ligament. The tourniquet was released. The radiocarpal incision was closed. The skin was closed and plaster immobilisation applied.

Lunate reconstructions

For implantation into the lunate (fig 2, 6, 7), the pisiform was completely detached from the pisotriquetral capsule and its articular cartilage was abraded. The radiolunotriquetral ligament was incised to expose the lunate. Necrotic bone fragments were removed from the lunate to allow graft placement. If the cartilaginous shell of the



Fig. 5. — Proximal pole replacement with the pisiform pedicled graft, at 11 years' follow-up.



Fig. 6. — Kienböck's disease stage III : PA and lateral views.

lunate is not fractured, it should be respected even if strongly buckled, as the introduction of the graft will restore its concavity. If the cartilage is fractured, as we have noted in one case, its radiocarpal portion should be removed. Traction is applied to the wrist and a percutaneous scaphotrapezial K-wire is inserted. The pisiform is inserted into the lunate with care to orient the pedicle as anteriorly and distally as possible to prevent it from being crushed during forced palmar flexion of the wrist. The transplant is fixed with a lunotriquetral K-wire. After tourniquet release, the incision in the radiolunotriquetral ligament is closed taking care not to compress

the vascular pedicle. Skin is closed and plaster immobilisation is applied.

Kirschner wires are removed at two months and plaster immobilisation is continued for another month. Physiotherapy is undertaken progressively.

RESULTS

Short- and mid-term results

Scaphoid reconstruction failed in one patient owing to a technical error. The pisiform was placed too far anteriorly and did not articulate with the radius. Persisting pain (grade IV) necessitated wrist fusion; during this operation, we noted that the graft was vascularised and had united to the body of the scaphoid.

The other six patients resumed their preoperative occupational activities at six months. Pain had completely subsided. Two patients had persisting hyperaesthesia and dysesthaesia in the ulnar nerve distribution. One patient had hyperesthaesia over the scar. The range of motion of the fingers was normal. Wrist motion was slightly decreased. Palmar and dorsal inclination was diminished by 10 to 30° as compared to the contralateral side; the deficit was essentially in volar inclination in some cases and essentially in dorsal inclination in others. Adduction-abduction was similarly diminished with the deficit being greater in adduction. Graft incorporation was confirmed radiologically in all our patients.



Fig. 7. — Pisiform implanted inside the lunate, fixation with Kirschner wires. Intra-operative PA and lateral views.

In scaphoid proximal pole reconstructions, the trabecular pattern was reconstituted between the body and the pisiform transplant. The radiocarpal joint remained normal.

In lunate reconstructions, the pisiform introduced between the radius and capitate had arrested the process of carpal collapse. The lunate bone was reconstituted and had regained normal density. At one year wrist mobility and radiological images were unchanged. Neurological symptoms had resolved.

Mid-term results

Eight patients were reviewed at five years' follow-up. They had no more pain (grade I), they reported no particular problem and were satisfied with the result. Four male patients had respectively 10, 12 and 13 years' follow-up after transplantation for AVN of the proximal pole of the navicular (fig 5). Two male patients had 10 and 14 years' follow-up and two female patients had 8 and 10 years' follow-up after pisiform implantation into the lunate bone for Kienböck's disease (fig 8). No clinical or radiological changes had occurred since the review at one year. One of them had developed minimal signs of osteoarthritis since the first examination but this did not progress. CT scan demonstrated preservation of the radiocarpal joint. The range of motion of the wrist and the grip strength



Fig. 8. — Pisiform implanted inside the lunate, at 10 years' follow-up. PA and lateral views.

Table I. — Detailed assessment of the long-term results :

Age : age of the patients at the first consultation.
 Sex : M : male F : female
 Follow-up : duration of follow-up after the graft.
 Force : grip force evaluated with Jamar's dynamometer.
 GS : grafted side
 HS : healthy side

Case	Sex	Profession	Age (years)	Follow-up (years)	Wrist inclination				Grip force
					dorsal	volar	lateral	medial	(Kg/force)
					GS/HS	GS/HS	GS/HS	GS/HS	GS/HS
<u>Necrosis of the proximal pole of the navicular bone :</u>									
1	M	worker	32	10	70/80	61/63	9/14	29/34	55/60
2	M	electrician	29	10	30/55	66/70	8/10	30/32	58/64
3	M	plumber	35	12	60/65	72/80	16/19	15/17	56/62
4	M	deliveryman	41	13	45/75	58/66	16/20	42/46	60/65
<u>- Stage III Kienböck's disease :</u>									
5	F	housekeeper	70	8	55/60	40/50	10/15	30/35	24/30
6	F	waitress	32	10	75/80	80/85	20/20	32/38	32/35
7	M	trader	38	10	70/80	30/56	15/20	36/42	54/58
8	M	banker	33	14	30/60	62/75	15/15	44/50	44/50

showed 10 to 20% loss as compared to the contralateral side. The details of those evaluations are summarised in table I.

DISCUSSION

Replacement of the lunate bone with the pisiform was first performed by Beck in 1971, using the ulnar artery as a pedicle (1). Saffar took up the idea in 1982, replacing the lunate with the pisiform with its vascular supply and attached to the flexor carpi ulnaris (3). Simultaneously, the senior author (JNK) proposed in 1982 that the pisiform transfer be based on the dorsal branch of the ulnar artery (2) ; in an anatomic study of 50 wrists with the arteries injected with coloured latex, he noted that the dorsal branch of the ulnar artery has a fairly large diameter and constantly sends branches to the medial side of the pisiform.

According to us, the use of a pisiform-bone vascularised graft has specific and limited indications, first of all the presence of established bone necrosis, but its use poses several problems.

The first problem is the vitality and the osseous solidity of the graft.

The choice of this pedicle is of utmost importance. Beck (1) obtained good results using the ulnar artery but it may be considered unjustified to sacrifice a main artery. Direct vascularisation through the tendon of the flexor carpi ulnaris or retrograde vascularisation through the abductor digiti minimi seems quite weak as noted with the injection of anatomical specimens by the senior author. The dorsal branch of the ulnar vessels offers sufficient flow and length to warrant the success of pisiform grafts (2).

Owing to the strength of its cortex, which should be respected, the pisiform appears strong enough to resist collapse under the considerable stresses exerted in the radiocarpal and midcarpal joints. It retains its vitality hence its strength owing to its pedicle. The latter should also bring a vascular aid to necrotic local tissue where it is transplanted.

Next there are the problems related to the shape of the bone graft. The pisiform corresponds well to the shape of the proximal pole of the navicular, but it is too small to replace the lunate.

In stage III Kienböck's disease we have abandoned simple replacement of the lunate with the pisiform, as the latter is small and difficult to fix to

the adjacent bones. Instead, implanting the pisiform inside the lunate helps to restore its normal volume and preserves the deep ligaments attaching it to the radius, the scaphoid and the triquetrum. On the other hand, it cannot maintain its height and the scaphoid has to adapt, through some degree of horizontal subsidence. The proximal row gains in width what it has lost in height so that there is no capsular looseness.

At last, there remains the problem of the coverage of the articular surfaces of the transplanted or implanted bones. In case the cartilage has been preserved, can it unite to its new osseous support ? In case it is lost, is it replaced by fibrous tissue or does the bone surface remain denuded ? The favourable clinical evolution and the absence of radiological changes suggest that this process is quite different from that seen in arthritic articular changes. Arthroscopy could be of value to assess the condi-

tion of the articular surface, but it is difficult to propose arthroscopy to a patient who considers himself healed.

Although not all functional results obtained are perfect, they appear to be long-lasting and they are superior to those achieved with limited intracarpal fusions or proximal row carpectomies.

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