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Original Research Article

Outcome of vascularised muscle pedicle bone graft for scaphoid non-union

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ABSTRACT

Background: The objective of the study was to assess the outcome of vascularised muscle pedicle bone graft for scaphoid non-union.
Methods: 14 men and 6 women aged 18-45 (mean 25) years with non-union of scaphoid involving proximal pole (n=4), waist (n=14), distal pole (n=2) were randomized to undergo vascularised muscle pedicle bone graft with Herbert screw fixation. The mean duration of non-union was 10 months (range 4-14 months).
Results: The mean follow up duration was 24 months. 17 of 20 achieved union. 12 of 20 achieved correction of both scapholunate and radiolunate angle. 5 of 20 did not achieve full correction of sacpholunate and radiolunate angle. 3 of 20 did not achieve union. 2 of these 3 were associated with proximal pole absorption. There was no hardware failure or any iatrogenic fracture during pedicle dissection.
Conclusions: The use of vascularised bone graft has proved to be an effective method for treating scaphoid non-union, especially non-union with an avascular proximal pole and those that have failed to heal after previous procedure.

Keywords: Scaphoid non-union, Muscle pedicle graft, Avascular proximal pole

INTRODUCTION

5 to 10% of scaphoid fractures treated non-operatively may not achieve union and progress to carpal collapse and eventually to radiocarpal osteoarthritis.[1-3] Surgical fixations for scaphoid nonunion have success rates of 70 to 90%.[4,5] The use of Russe inlay bone grafting or iliac crest bone grafting with screw fixation results in a success rate of 90%.[6] Non-union is more common in proximal pole fractures, because of compromised vascularity and conventional bone grafting may fail when it is completely avascular and there is evidence of necrotic bone and no bleeding.[4,5,7,8] Vascularised bone grafting may introduce a source of angiogenic and osteogenic factors to the non-union site.[6,7] Vascularised pedicled bone grafts have been used in non-union of the anterior aspect of the wrist and forearm, the pronator quadratus and the scaphoid.[9-11] Other salvage procedures include radial styloidectomy with partial scaphoid excision and/or posterior and anterior interosseous neurectomy. More complex procedures include limited intercarpal fusion, proximal row carpectomy, scaphoid excision and 4-corner fusion, and total wrist fusion.[12]

METHODS

Between 2015 to 2017, 20 cases of non-union scaphoid were randomized to undergo vascularised muscle pedicle bone graft with Herbert screw fixation.

Informed consent of each patient was obtained. The study was approved by the local ethics committee of nalanda medical college and hospital.

The mean duration of non-union was 10 months (4-14 months). The mean range of motion was decreased. The most affected movements were radial deviation and dorsiflexion.

Anteroposterior, lateral and 30 degree ulnar deviation radiograph were taken. Scapholunate, radiolunate and intrascaphoid angles were measured.

Technique of operation

Volar zigzag incision were made over the scaphoid tuberosity and the distal radius to expose the site of nonunion. The radioscaphocapitate ligament complex were divided, but retained for later repair to the muscle pedicle. The sclerotic bone ends were freshend with a power burr to form an oval cavity 10 to 20 mm long and parallel to the axis of the scaphoid. The pronator quadratus was identified, and a block of bone graft 15 to 20 mm long at its distal insertion on the distal radius close to the abductor pollicis longus tendon were outlined, the margin of the graft were outlined with Kirschner wire holes to facilitate separation with a fine osteotome. Care was taken not to detach the pronator quadratus from the harvested bone graft, the muscle was dissected toward the ulna to secure a pedicle 20 mm thick (Figure 2). If the muscle was too tight to allow easy transfer of the pedicled bone, the ulnar origin of the pronator quadratus was released subperiosteally from the ulna through an additional incision over the distal ulna.The proximal and distal scaphoid segments were aligned carefully as a traction force is applied to the thumb. This maneuver corrects any intercalated segment instability and allows the grafted bone to be inserted snugly into the cavity in the scaphoid. The proximal and distal scaphoid segments and the graft were fixed with a Herbert's screw introduced at the scaphoid tuberosity avoiding crossing the radiocarpal joint with Herbert screw (Figure 3). Skin was closed, and a long-arm thumb spica cast applied.

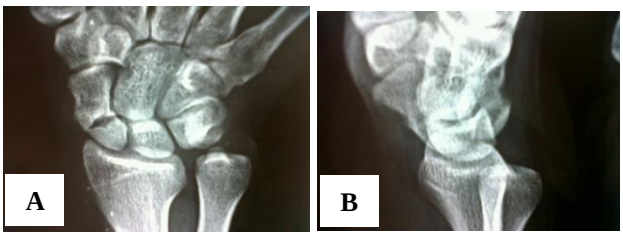

Figure 1 (A and B): Pre-op X-ray.

Postoperative care

The long-arm thumb spica cast is worn for 1 month, followed by the wearing of a short-arm thumb spica cast for another month. At 2 months, union is evaluated with radiographs and, in case of doubt, tomograms. The wrist is braced in a functional position for another 1 to 2 months, and then active exercises are begun.

Figure 2: Intra-op clinical photograph showing Schaphoid being initially stabilized with guide wire and pronator quadratus muscle pedicle harvested.

Figure 3: Post-op X-ray showing fixation with Herberts screw.

RESULTS

Out of 20 cases of non union scaphoid, 14 men and 6 women aged 18-45 (mean 25 years) with non-union of the scaphoid involving proximal pole (n=4), waist (n=14), distal pole (n=2),The mean follow up duration was 24 months. 17 of 20 achieved union (Figure 4). 12 of 17 (union) achieved correction of both scapholunate and radiolunate angle. 5 of 17 (union) did not achieve full correction of scapholunate and radiolunate angle. 3 of 20 did not achieve union. 2 of 3 (non-union) were associated with proximal pole absorption (Table 1).

The average range of movement of the wrist improved after operation. Taken as a percentage of a normal range, dorsiflexion increased from 67% to 79%, palmar flexion increased from 72% to 76%, radial deviation from 47% to 73% and ulnar deviation from 67% to 80%.The mean grip strength increased by 35% (Figure 5).

Table 1: Fixation outcome of vascularised muscle pedicle bone graft for scaphoid non union.

S. no.	Age	Duration of non union in months	Site of fracture	Dorsiflexion in degrees pre-op/post-op	Palmar flexion in degrees pre-op/post-op	Radial deviation in degrees pre-op/post-op	Ulnar deviation in degrees pre op/post-op	Union status
1	32	7	Waist	52/ 62	50/53	8/13	23/27	United with anatomical restoration
2	20	13	Waist	48/57	58/61	11/15	24/29	United without anatomical restoration
3	22	6	Waist	55/64	52/56	9/14	22/27	United with anatomical restoration
4	30	14	Distal pole	45/55	56/58	10/14	25/29	United without anatomical restoration
5	23	5	Waist	49/57	51/55	8/13	21/26	United with anatomical restoration
6	22	15	Proximal pole	51/62	57/59	11/15	26/30	United with anatomical restoration
7	20	4	Waist	47/56	53/56	10/13	24/27	United with anatomical restoration
8	34	16	Waist	53/63	55/58	9/15	23/29	United without anatomical restoration
9	30	9	Waist	46/57	55/57	11/15	26/30	United with anatomical restoration
10	22	11	Distal pole	54/62	53/57	8/13	21/26	United with anatomical restoration
11	24	8	Waist	53/61	51/55	10/14	20/24	United with anatomical restoration
12	21	12	Waist	47/58	57/59	9/14	27/32	United without anatomical restoration
13	20	10	Waist	44/53	49/52	7/11	24/30	United with anatomical restoration
14	33	10	Waist	56/66	59/62	12/17	23/26	United without anatomical restoration
15	28	13	Proximal pole	50/59	48/52	9/12	27/31	Not united with proximal pole absorption
16	23	7	Waist	50/60	60/62	10/15	20/25	United with anatomical restoration
17	25	4	Waist	45/54	54/56	12/15	19/25	United with anatomical restoration
18	28	16	Waist	55/65	54/58	10/16	28/31	Not united
19	19	5	Waist	42/52	49/52	7/13	25/29	United with anatomical restoration

S. no.	Age	Duration of non union in months	Site of fracture	Dorsiflexion in degrees pre-op/post-op	Palmar flexion in degrees pre-op/post-op	Radial deviation in degrees pre-op/post op	Ulnar deviation in degrees pre-op/post-op	Union status
20	24	15	Proximal pole	58/67	59/62	9/14	22/27	Not united with proximal pole absorption
Mean ROM pre-op/post-op				50/59.5	54/57	9.5/14	23.5/28	
Mean increase in ROM in %				12	4	26	13	

Figure 4: 6 months follow up showing union.

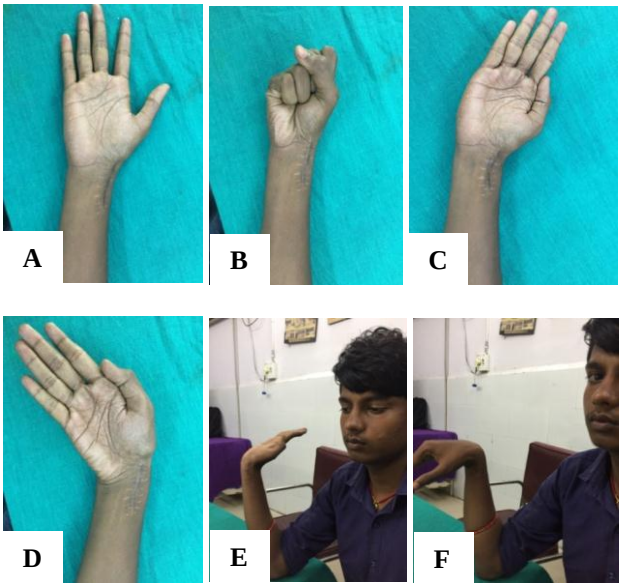

Figure 5 (A-E): Functional outcome 6 months after surgery.

DISCUSSION

The indication for vascularised bone grafting (VBG) is a proximal pole non-union and when there is AVN of the proximal pole. The absence of punctate bleeding points from the proximal pole during surgery and demonstration of AVN on MRI are the indicators of AVN.

In an early study of Herbert screw fixation, all 13 non-union cases failed to achieve union without bone grafting accurate placement of the Herbert screw using a free-hand technique is challenging; flexing the wrist and using the axis of the thumb as a guide may prevent malposition of the implant.[13] However, fluoroscopic confirmation of placement of the guide-wire is not possible, because the wrist is flexed. When Herbert-screw fixation is combined with bone grafting, 25 of 26 patients with scaphoid non-union achieved union.[14] Nonetheless, the follow-up period was short, and the definition of union was trabeculation over the fracture line on 2 of 4 radiographs.[14]

In a study of 33 scaphoid non-union treated with Herbert screws, bone grafting or both, after a mean follow-up period of 14 months, the mean palmar flexion, dorsiflexion, radial deviation, and ulnar deviation were 8º, 61º, 20º, and 35º, respectively, and the grip strength was equal to that of the uninjured hand. [15]

The Russe inlay bone grafting procedure is a reliable treatment for symptomatic non-union of the scaphoid.[16] The volar approach minimizes damage to the blood supply and facilitates correction of any flexion deformity. Union rates have been reported to be 20/22, 16 21/26 (in 7 to 18 years), 147/151 (in one to 10 years), and 38/44 (in 12 to 163 months).[17-19]

Vascularised bone grafts can preserve the normal anatomy of the carpus, which maximises anatomic motion and decreases the risk of degenerative change and collapse. The grafts can be obtained through one incision, and thus morbidity is minimal. The volar carpal artery originates from the radial artery at the level of radial styloid and runs along the volar aspect of the radius following the distal edge of the pronator quadratus and then forms a T-shaped anastomosis. Location of this branch is consistent and visible during dissection.

CONCLUSION

A combination of bone graft and fixation with Herbert screw consistently gives better result than alone. Addition of vascularised muscle pedicle bone graft adds to the benefits of vascularity to deal with such a vexed situation. Overall there is significant union rate of 85%, and significant increase in range of movement and grip strength.

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Conflict of interest: None declared
Ethical approval: The study was approved by the institutional ethics committee

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