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Case Report

Avascular necrosis with non-union of the scaphoid managed with a dorsal pedicled vascularised bone graft of the distal radius: a case report

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ABSTRACT

Avascular necrosis (AVN) of the scaphoid is common following proximal pole fractures due to an arduous retrograde arterial vascular supply and it is a challenge to the hand surgeon. The treatment for scaphoid non-union with avascular necrosis is vascularized or non-vascularized bone grafts. Non vascularised bone grafts (NVBGs) can be categorized as autograft or allograft and cancellous or cortical bone grafts. Vascularised bone grafts promote biological healing and revascularizes ischaemic bone and they are free or pedicled grafts. Pedicled vascularised bone grafts maintain the vascular supply of the donor bone graft and this leads to better bone remodelling, less osteopenia, faster incorporation and better maintenance of bone mass compared to the non-vascularised graft with good clinical and radiological outcomes. In this paper, we have treated avascular necrosis of scaphoid with a pedicled vascularised bone graft based on the 1, 2 intercompartmental supraretinacular artery (1, 2-ICSRA) that resulted in a favourable outcome.

Keywords: Avascular necrosis, Non-union, Scaphoid, Vascularised bone graft

INTRODUCTION

The incidence of non-union of scaphoid fractures varies between 5% and 15% but in proximal pole fractures, it can go upto 30% due to the precarious retrograde blood supply.[1,2] The most distressing symptom of scaphoid nonunion is pain during wrist motion and if unattended can lead to osteoarthritis, scaphoid nonunion advanced collapse (SNAC) and progressive arthritis of the wrist.[3] The goal of the surgery is to achieve union and restore normal carpal anatomy, stability and range of motion. The treatment options are conventional bone grafting, with or without internal fixation, and pedicled or free vascularized bone grafting. Conventional bone grafting is the most preferred method but because of the limited osteogenic potential the results are poor. The use of pedicled vascularized bone grafts (VBGs) has been gaining popularity as it has the advantage of preserving the living osteocytes and osteoblasts showing better biologic and mechanical properties and can therefore speed up revascularization and healing of the scaphoid non-union.[4-6] Thus, VBGs is now recommended as a primary procedure for scaphoid non-unions with avascular necrosis than NVBGs in proximal pole scaphoid fractures.[7]

CASE REPORT

41 year old male presented to us with a history of fall from a 2 wheeler three months ago and sustained injury to the right wrist. He complained of pain and difficulty in extending his wrist. There was no history of any co-morbid illnesses. On examination, his right wrist appeared normal.

There was pain on pressure on the scaphoid and pain increased on wrist extension. The scaphoid shift test and the Watson's test were positive. A clinical diagnosis of an old scaphoid fracture was made. This was confirmed with X-ray and an magnetic resonance imaging (MRI) which showed fracture line at the waist of the scaphoid with increased opacity of the proximal pole suggestive of avascular necrosis (Figure 1a and b). We planned for exploration of the scaphoid and placement of a VBG. Under axillary block and tourniquet control, a dorsoradial curvilinear incision was made. The scaphoid was exposed and the fracture was identified. The callus was removed and wedge created. Distal segment found to be vascular. The wedge was plugged with 1, 2 intercompartmental supraretinacular artery based vascularised bone graft of the distal radius (Figure 2). A 0.8 mm K-wire was used to stabilise the bone graft to the scaphoid (Figure 3). Haemostasis was secured and the incision was closed in layers. Dressing was done and plaster of Paris (POP) slab was applied. Post-operative period was uneventful with sutures removed on the 10th post-operative day and K-wire removed at 6 weeks. He was started on physiotherapy and after 6 months of follow-up, he was pain-free with full range of wrist extension.

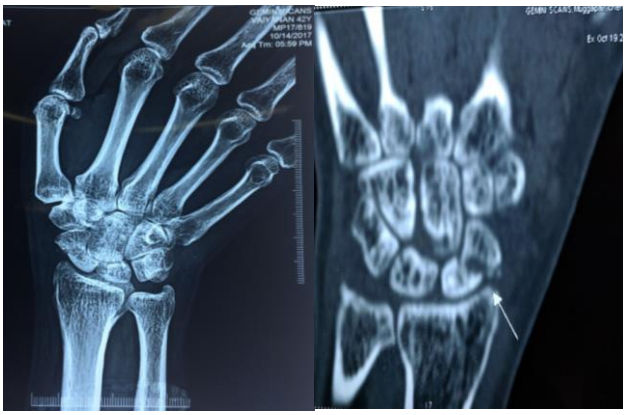

Figure 1: (a) X-ray and (b) MRI showing the non-union of scaphoid at waist and avascular necrosis of proximal pole.

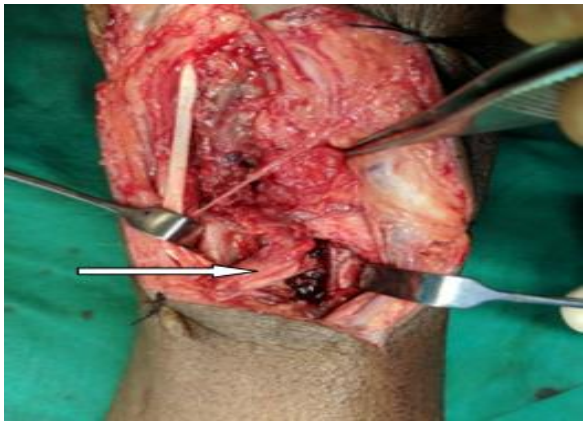

Figure 2: Dorsal radial bone graft harvested along with 1, 2 ICSRA (white arrow).

Figure 3: K-wire used to fix the VBG.

DISCUSSION

Roy-Camille was the first to use of VBGs by transferring the scaphoid tubercle with a pedicle from the abductor pollicis brevis muscle.[8] Zaidemberg et al initially report the use of a distal radius VBG based on 1, 2 intercompartmental supraretinacular artery with good results achieving union in all of their patients.[6] Sheetz in 1995 introduced the vascular structures of the distal radius in detail.[9] The blood supply of VBGs provides excellent healing of scaphoid non-union and are now used as a primary procedure in the treatment of scaphoid non-union.[7] VBGs are contraindicated in the presence of radiocarpal joint degeneration.[10] The two main methods described for VBG transfer from distal radius to scaphoid are dorsal or volar grafts. Dorsal pedicled distal radius VBGs are used for proximal scaphoid non-unions, while volar grafts are preferred for non-unions in the waist region of the scaphoid and in non-unions with humpback deformity. Dorsal pedicled VBGs of the distal radius are the most commonly performed due to their proximity to the scaphoid and are preferred in displaced proximal pole fractures, avascular necrosis of proximal fragment, chronic non-unions and non-unions which have failed to heal by NVBGs.[10,11] They are not used in cases with humpback deformity as it is hard to correct the deformity with dorsal approach.[12] Dorsal VBGs are based on four pedicles which are the 1, 2 and 2, 3 intercompartmental supraretinacular artery located between 1, 2 and 2, 3 extensor compartments and 4+5 extensor compartmental arteries arising from the dorsal branch of the anterior interosseous artery. Sheetz et al in their anatomical study et al of 41 cadavers, 1, 2 and 2, 3 intercompartmental supraretinacular artery, and 4+5 extensor compartmental arteries were present in 94%, 100%, 100%, 100% of the cadavers respectively.[9] The advantages of dorsal grafts are their anatomic reliability of dorsal vascular network, vascular anastomosis not required, dissection and placement done through the same incision and relatively simple technique compared to volar grafts.[2] Majority of the studies have claimed excellent outcomes with union rates nearing 100% at average of 6–12 weeks, a few studies have also reported low union rates of about 27%.[11-14] Steinmann et al achieved 100% union in their 14 patients including four with proximal pole AVN

at an average of 11 weeks.[11] Waitayawinyu et al achieved union in 93% of proximal pole AVN in their series, with better outcomes in grip strength, function and scaphoid height–length ratio.[14] Straw et al had poor results with 1, 2 intercompartmental supraretinacular artery pedicled VBG reporting 27% union rate by using K-wires and this was due to the inadequate stabilization as proposed by Payatakes and Sotereanos.[13,15] Chang et al in his large series, had a union rate of 71% and this was due to humpback deformity or carpal instability which constitutes a contraindication for a dorsal VBG procedure.[12] Dorsal rectangular graft usage in patients with humpback deformity leads to persistence of the deformity with malunion or non-union and hence larger volar VBGs are more appropriate for these group of patients. Average pedicle length of the 1, 2 intercompartmental supraretinacular artery was found to be 22.5 mm (range: 15–31 mm) by Waitayawinyu et al.[16]

Despite its adequate length and short arc of rotation, styloidectomy may be required to avoid kinking and tension in the pedicle.[17] 2, 3 intercompartmental supraretinacular artery pedicled VBGs also have promising results but are infrequently done.[18,19] Tan et al reported a large series with 52 patients with 92.3% union rate at an average of 14.5 weeks using the 2, 3 intercompartmental supraretinacular artery as its adequate length without tension and wider rotation arc provided easier access to the volar carpus, thus making it a valuable and viable option in the treatment of scaphoid non-unions.[2] The large pedicle length of the 4+5 extensor compartmental artery pedicled VBG makes it a great option for the treatment of proximal scaphoid non-union. The 5th extensor compartmental artery is the largest among the dorsal arteries that can be used as a pedicle but it is used mostly with the 4th extensor compartmental artery if a long pedicle is needed as it does not provide a nutrient artery to the graft.[9] To simplify the pedicle dissection and prevent vessel kinking, Sotereanos et al described a dorsal VBG from the distal radius based on the joint capsule.[20] He reported an 80% union rate with increased grip strength and range of motion.[20] The simple dissection and graft harvesting is the main advantage of this technique and the location of this graft provides easy access to both lunate and the proximal pole of the scaphoid.[15]

CONCLUSION

Primary treatment by vascularized graft showed good consolidation, recovery of motion and pain relief compared to secondary treatment or by non-vascularized graft. Vascularized graft from the dorsal radius based on the 1, 2 intercompartmental supraretinacular artery is thus a good option for primary treatment of scaphoid avascular necrosis and non-union.

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