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Scaphoid Nonunion Treated with Vascularized Pronator Quadratus Pedicled Bone Graft and Compression Headless Screw: A Case Report

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ABSTRACT

Introduction: The scaphoid is the most commonly fractured bone in the carpus and patients are often healthy young individuals. Non-union of scaphoid fractures are reported to occur in about 10% of cases.1 Management options include bone graft techniques, screws, Kirschner wires and salvage procedures, with choice of treatment dependent on both patient and disease characteristics. Surgery has a reported failure rate of 25%–45%.

Case Presentation: A 17 year old male came to the polyclinic with the main complaint of pain on the right wrist which was felt since 1 year ago after falling during sports. After the fall, the patient experiences minimal pain so that the patient does not go to the doctor and is only treated with ice packs and taking pain medications A month after the fall, the patient finally checked his right wrist to the doctor, but the X-ray results did not show any abnormalities in the patient's wrist. Then patient underwent physiotherapy for 5 months. A year after the trauma, patient went back to the doctor and found a fracture in the wrist that had not yet fused. Patient is a high school student with dominant right hand. The history of massage was denied by the patient. On physical examination, there was no swelling, redness and deformity of the wrist. There was tenderness in the volar wrist and there was no disturbance of sensation. The range of motion of the wrist is limited due to pain. Patient already done vascularized bone graft with Herbert screw

Discussion: The treatment of scaphoid nonunion is still a challenge for hand surgeons. Nonunion rate of scaphoid fractures varies between 5% and 15%.1 Due to tenuous retrograde blood supply of the scaphoid. The most prominent symptom of scaphoid nonunion is pain during wrist motion but if left untreated, it can cause osteoarthritis, decrease in grip strength and limitation in wrist range of motion. The aim of the treatment is to achieve union and restore normal carpal anatomy, stability and range of motion

Conclusion: In summary, this case further demonstrates that non-union scaphoid fracture can be treated with vascularized bone graft and screw fixation as a primary intervention, despite the long duration to surgical management. Therefore in this specific patient group there is evidence that reconstruction should be considered before salvage procedures such as proximal row carpectomy and wrist fusion.

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Introduction

Scaphoid Fractures are relatively common injuries. Differentiation between stable and unstable fractures is always not possible with conventional radiographs and should also be evaluated by computed tomographic scan. Also the scaphoid fractures have the highest prevalence of nonunion in the human body. Ahimnia et al, stated that thirty percent of wrist fractures were not prospectively diagnosed on radiography, suggesting that CT should be considered after a negative radiographic finding if clinically warranted.5 The location of a dorsal scaphoid avulsion fracture emphasizes the need for specific radiographic views or cross-sectional imaging for diagnosis. Scaphoid fracture can be treated by both nonoperatively and surgically. Traditionally, acute nondisplaced scaphoid fractures have been treated nonoperatively in a cast, and the expected union rate approaches 90%. Internal fixation of nondisplaced scaphoid fractures has increased in popularity, and a union rate of 100% has been reported. The growing trend is to recommend internal fixation for the majority of acute scaphoid fractures. In this study a non-union scaphoid fracture , there was difficulty in diagnosis of a scaphoid fracture in the early of injury, due the clinical sign and radiological view can't show the deformity. This is it is a challenge for the surgeon to make a diagnosis as early as possible to provide appropriate management.

Case Presentation

A 17 year old male came to the polyclinic with the main complaint of pain in the right wrist which was felt since 1 year ago after falling during sports. The patient said that a year ago (December 2019) the patient fell on the floor while resting on the palm of his right hand. After the fall, the patient experiences minimal pain so that the patient does not go to the doctor and is only treated with ice packs and taking pain medications. A month after the fall, the patient finally checked his right wrist to the doctor, but the Xray results did not show any abnormalities in the patient's wrist and it was recommended to return to control if the complaint persisted or worsened. The patient underwent physiotherapy for 5 months. The patient is a high school student with dominant right hand. The history of massage was denied by the patient. On physical examination, there was no swelling, redness and deformity of the wrist. There was tenderness in the volar wrist and there was no disturbance of sensation. The range of motion of the wrist is limited due to pain. Union fracture found after 1 year trauma due to clinically patient still feels no improvement with pain killer and physiotherapy, pain in the wrist area especially when it is used to carry out light-moderate activities using the right hand so the patient returns to control and radiologically found the current x-ray is found a non-union of proximal pole scaphoid fracture. Patient already done vascularized bone graft with Herbert screw fixation. For 1 year postoperative follow-up based on the DASH score there was a significant improvement compared to the preoperative DASH score where the patient was able to carry out mild-moderate activities without any significant interference on the wrist.

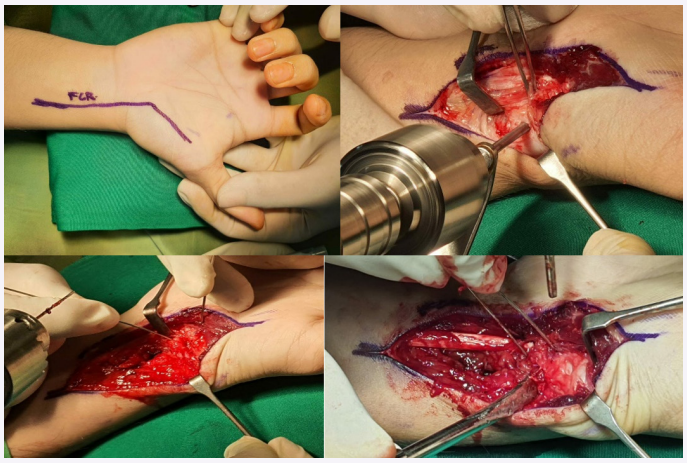

Figure 1. Clinical picture during operation

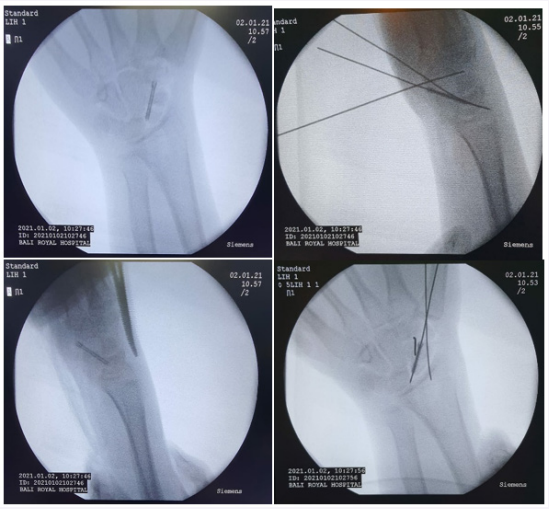

Figure 2. Radiograph after surgery

Discussion

Scaphoid fracture is a common fracture of hand, many scaphoid fractures are either dismissed by the patient or family as a sprain or may be missed on early evaluation and radiographs by the primary care provider. Adequate radiographs and thorough examination may be insufficient to diagnose an acute scaphoid fracture. Many of these missed scaphoid fractures present as nonunion months to years after injury. In this case at the present of trauma patient just treat it with ice compression and pain killer, after 1 month he went to doctor then fracture wasn't seen.

Most commonly, patients complain of vague wrist discomfort and loss of motion. On examination, there is often localized swelling on the dorsoradial aspect of the wrist. Tenderness is usually localized to the anatomic snuffbox, and pressure over the scaphoid tubercle or performance of a "scaphoid shift" test is generally painful. Based on this case, from physical examination patient felt persistent pain at right wrist region, particularly on anatomic snuffbox, therefore patient was advised to control routinely monthly to evaluate development of the wrist. The patient underwent physiotherapy for 5 months but there was no improvement in the pain he felt. From the literature the unusual vascularity of the scaphoid has been investigated as a primary cause of nonunion.[2] The proximal 70 to 80% of scaphoid vascularity is based on retrograde blood flow from radial artery branches entering through the narrow, oblique dorsal ridge. The distal portion of the blood supply comes from direct radial artery branches entering the volar tubercle. The volar and dorsal branches of the anterior interosseous artery anastomose with the radial artery branches to provide collateral blood flow. The proximal pole of the scaphoid is covered almost entirely with articular cartilage and few perforating vessels. Therefore, it is not surprising that, while only 30% of middle third fractures have been associated with avascular necrosis, nearly 100% of proximal pole fractures are rendered avascular as a result of poor retrograde blood flow.[2]

Treatment of scaphoid nonunion is still a challenge for hand surgeons. The nonunion rate of a scaphoid fracture varies between 5% and 15%. Due to a weak retrograde scaphoid blood supply. The most prominent symptom of scaphoid nonunion is pain during wrist movement but if left untreated it can lead to osteoarthritis, decreased grip strength and limited range of motion of the wrist. The goal of treatment is to achieve fusion and restore normal carpal anatomy, stability and range of motion.[3]

The gold standard treatment in patients with nonunion scaphoid fractures is the Matti-Russe Procedure eg. placing non-vascularized bone graft into scaphoid fracture site. Conventional bone grafting is the preferred method, but due to the limited osteogenic potential of the Non-Vascularized Bone Graft (NVBG), the results may be suboptimal, and fusion may not be achieved in the majority of patients. With a better understanding of distal radius blood supply and advances in microsurgical techniques, the use of Pedicled Vascularized Bone Grafts (VBGs) is increasingly being applied to nonunion of the scaphoid bone. Theoretically, VBG has the advantage of keeping osteocytes and osteoblasts alive. VBG can accelerate revascularization and fusion of the scaphoid nonunion.[4] Due to the preserved vascularization of these grafts, better bone remodeling, less osteopenia, faster incorporation and better maintenance of bone mass are expected compared to conventional non-vascular grafts.[6]

The rate of integration with NVBG application decreased to 40-67% in the presence of proximal polar avascular necrosis (AVN). Two retrospective studies found better cure rates and faster recovery in proximal polar AVN treated with VBG compared to NVBG. Ribak et al achieved bone fusion in 89.1% of AVN patients treated with VBG, while this figure was 72.5% in the NVBG group. The difference was found to be statistically significant (p = 0.024) .[7] Caporrino et al achieved similar rates of bone fusion in both groups but fusion 12 days earlier in the VBG group (p = 0.002).8 In a meta-analysis by Merrell et al., Where In 36 studies included, the fusion rate in the presence of a proximal pole of AVN was found to be 88% after VBG, while it was found to be 47% in patients treated with NVBG (p <0.0005) .9 A vascular graft of the volar radius based on the pronator quadratus also determined. Kawai and Yamamoto were the first to report their results with this type of graft in 1988. They reported 100% integration in eight patients. 10 Noaman et al also used pedicled pronator quadratus grafts and they found a fusion rate of 95% in their 45 patients.1 Lee et al. Applied these grafts with a headless compression screw if there was any deformity or instability of the dorsal segment. They achieve a 100% incorporation rate and good functional yield.40 In this patient, the choice of therapy is Vascularized Pronator Quadratus Pedicled Bone Graft and Compression Headless Screw because Pronator quadratus pedicled grafts carry relatively less risk with vascular manipulation because they are based on a rich anastomosis between the anterior, radial and ulnar interosseous artery branches. Important to note in the management of a scaphoid fracture is to maintain the function of the new vascularization that is taken from the graft so that it is hoped that the non-united scaphoid bone can re-fuse so that the patient is able to perform normal Range of Motion.[4]

Under general or regional anesthesia, the patient is placed in a supine position on the operating table. The operation is assisted by the installation of a tourniquet on the upper arm. An incision in the volar part of the wrist is made over the scaphoid tuberosity and distal radius to expose the nonunion site of the scaphoid. The radioscaphoid ligament complex is divided by a zigzag incision for subsequent repair without compromising wrist vascularity. The scaphoid was examined, and a nonunion was identified. A 1.2 mm K wire was inserted in each scaphoid fragment to facilitate manipulation and reduction using the "joystick" technique. To avoid interference with the screw path, the distal wire is placed more ulnar and the proximal wire is more radial to the central axis of the projected bone.5 Using joystick K-wires, the scaphoid alignment is corrected and the length and rotational alignment is restored by manipulating the distal scaphoid fragment into extension and supination. The surface of the nonunion is exposed, and the inserted fibrous tissue is cut using a rongeur. The sclerotic edge of the nonunion was cut using an oscillating saw of 5 mm in increments of 2 mm until healthy cancelous bone was found.

In the distal radius, the pronator quadratus is identified and a bone graft block measuring approximately 15 to 20 mm is dis- plotted at the distal insertion, near the abductor pollicis longus tendon. Prior to bone block removal, an L-shaped incision was made in the radial side of the pronator quadratus muscle along with the muscle insertion margin without detachment of the abductor pollicis longus and brachioradialis tendons.6 A hole is made along the edge of the graft with K-wire to facilitate separation with the smooth osteotome, allowing the graft to be pulled from the cortex without damaging it. Care is given not to remove the pronator quadratus from the bone graft taken, and to dissect the muscle towards the ulna to secure a pedicle about 20 mm in length. The anterior interosseous vessels do not require identification. If the muscle is too tight to facilitate transfer of the vascularized bone, the ulnar side of the quadratus pronator is dissected subperiostally from the ulna. The proximal and distal scaphoid segments and the graft are then repaired temporarily with a wire attached to the scaphoid tuberosity. Compressed with a 3.0 mm headless screw. A guide wire is then inserted from the volar section. X-rays are used to ensure that the screw is placed along the longitudinal axis of the scaphoid and across the bone graft into the proximal fragment. A screw that is at least 4 mm shorter than indicated by the depth

measurement is used to limit the risk of screw protrusion to the radiocarpal or scafotrapezial joint.[1]

A compression headless screw is installed, and the quality of the fracture reduction as well as the screw position is determined under fluoroscopy guidance. Finally, the temporary fixing K-wire was removed. The radioscaphocapitate ligament complex is repaired, and the skin is closed. Thumb spica splint was applied for 2 weeks for tight immobilization. Two weeks after surgery, the thumb splint is removed and the patient is trained to perform active wrist and thumb movements in a tolerable manner. Six weeks postoperatively, the patient increased wrist mobilization without weight on the operated hand.

Conclusion

Management of patients with scaphoid fracture nonunion can be performed using bone graft using either a Non-Vascularized Bone Graft (NVBG) or by using a Vascularized Bone Graft (VBG). Using VBG provides better union rate results than using NVBG. The selection of the right bone graft to use is still debatable. The use of VBG with a pronator quadratus pedicled bone graft has been shown to provide better results due to differences in arterial perfusion, venous outflow, pedicle position and length.

DECLARATIONS

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Patient consent: Written informed consent was obtained from the patient for publication of this case report and accompanying images. A copy of the written consent is available for review by the Editor-in-Chief of this journal on request.

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