

## Treatment of Avascular Necrosis of the Capitate with Vascularized Graft (Case Report)

### Abstract

Avascular necrosis (AVN) of the capitate is extremely rare and leads to chronic wrist pain. Currently, there is no standard treatment protocol for AVN of this wrist bone. Due to the rarity of these cases, limited experience exists regarding treatment methods. This report presents a 30-year-old male patient with AVN of the capitate. The patient was treated with a vascularized bone graft. After one year of follow-up, the symptoms have resolved, and there has been no progression of capitate necrosis.

**Keywords:** Avascular necrosis of bone, Carpal bones, Vascular grafting.

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### Introduction

Avascular necrosis (AVN) of the carpal bones, with the exception of the lunate, is extremely rare. AVN of the capitate was first reported by Jonsson in 1942<sup>(1)</sup>. There is limited information regarding the etiology and clinical course of AVN of the capitate compared to the lunate<sup>(1)</sup>. While extensive studies exist on Kienböck's disease (AVN of the lunate), few reports on AVN of the capitate suggest no significant correlation between severe trauma and its onset. Most cases reported involve young, active individuals with no history of trauma<sup>(1,2)</sup>. There is no standard treatment for AVN of the capitate and other carpal bones. However, in the early stages of the disease, conservative treatments are generally attempted. These include changes in the work environment, the use of non-steroidal anti-inflammatory drugs (NSAIDs), local corticosteroid injections, and wrist immobilization with a splint<sup>(3)</sup>.

This report presents a case of AVN of the capitate treated with a vascularized bone graft, and it also reviews the treatments reported in other cases.

### Case Description

A 30-year-old male patient presented with chronic left wrist pain for the past six months. Pain was more pronounced during wrist dorsiflexion. The patient had no history of systemic disease or specific medication use. His occupation involved road construction, and he worked with drilling machines. Radiographic findings showed slight sclerosis in the distal capitate, but there were no signs of osteoarthritis, fragmentation, or collapse. The lengths of the carpal bones were normal, and no evidence of instability was observed (Figure 1). Further evaluation with MRI revealed involvement of the entire capitate. On the T1-weighted images without contrast, the capitate appeared as a low-density area (Figure 2).

The laboratory tests showed the following results:

- Blood cell count:  $8.8 \times 10^4/\text{mm}^3$
- Rheumatoid factor (RF): Negative
- Uric acid: 3.9 mg/dL
- Erythrocyte sedimentation rate (ESR): 10 mm/h
- C-reactive protein (CRP): 4.5 mg/dL

The patient was initially treated with conservative methods, including a wrist splint and non-steroidal anti-inflammatory drugs (NSAIDs) over a six-month period. Despite these measures, the patient continued to experience pain. A single corticosteroid injection in the dorsal region provided relief for two months, but the pain returned with increased intensity after this period.

Due to the persistence of symptoms, a surgical intervention was planned. The procedure was performed through a dorsal approach along the third

metacarpal with a longitudinal incision in the space between the fourth and fifth compartments. A vascularized bone graft was placed in the extracompartmental space.

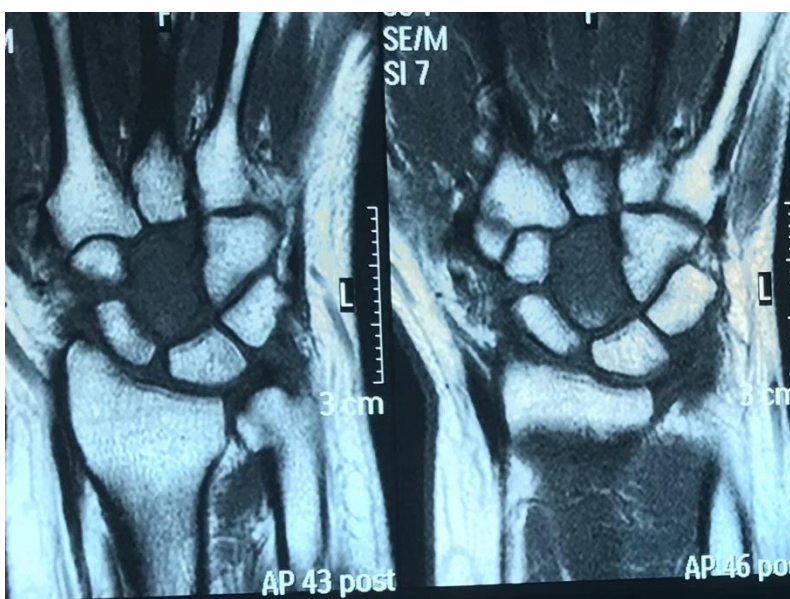
The fifth extracompartmental artery and its accompanying vein were identified. The artery is typically located at the floor of the compartment, adhering to the wall between the fourth and fifth compartments. A radial-based flap was raised from the extensor retinaculum, spanning the third to fifth compartments. A graft measuring 1 × 0.5 cm was prepared and placed vertically into the prepared

cavity of the same size. No fixation device was required, and the graft remained stable. The joint capsule was then repaired, and a volar splint was placed in a neutral position.

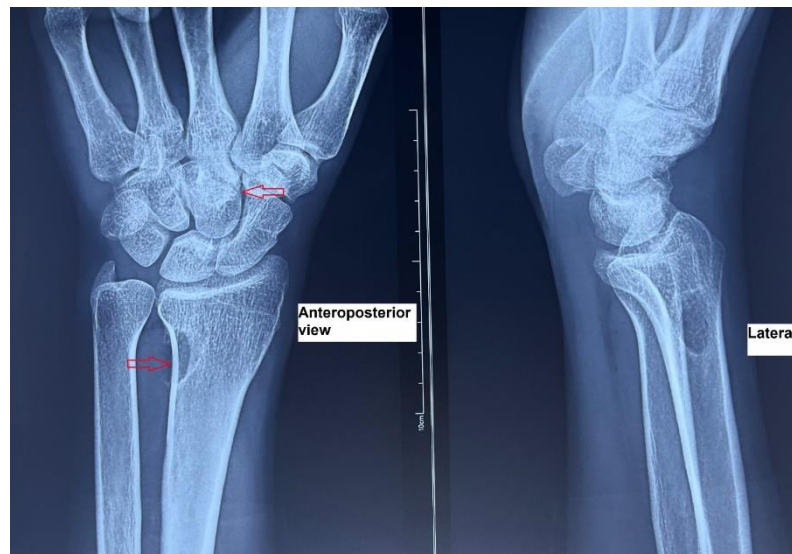
Two weeks after surgery, the sutures were removed, and wrist immobilization continued with a splint for one month. After one month, the patient began physical therapy. At the one-year follow-up, the patient reported complete resolution of pain and symptoms (Figure 3). The range of motion in the wrist joint was normal, and the patient was pain-free.



**Figure 1: In the plain radiograph, there is a decrease in density across the entire head of the bone without any evidence of collapse or sclerosis**



**Figure 2: The T1 non-contrast image shows low signal density throughout the capitate bone**



**Figure 3: Radiograph taken one year after follow-up shows the site of the graft removal from compartments 4 and 5 of the extensors. Bone density in the capitate bone has returned to normal**

## Discussion

Avascular necrosis (AVN) of the capitate bone occurs due to impaired blood supply. Various etiologies have been associated with AVN, including trauma (such as wrist fractures and dislocations), surgery, diabetes, tumors, radiation, injections into the wrist bones, and alcoholism<sup>(4)</sup>. In most cases, it is caused by direct trauma to the wrist, particularly when a simultaneous fracture of the capitate and scaphoid occurs, leading to a condition known as naviculocapitate syndrome<sup>(5)</sup>. Reports of AVN of the capitate often lack any prior trauma history. Cases have been observed in individuals such as technical workers, gymnasts, and carpenters. Additionally, AVN can occur in instances of repeated trauma to the capitate bone due to disruption of its blood supply<sup>(4,5)</sup>.

The blood supply to the hand occurs via two primary routes. The extrinsic blood flow is provided through the ulnar and radial arteries, whose common branches form the palmar branches, which supply the capitate bone. The secondary blood flow comes from the interosseous artery associated with the anterior interosseous artery<sup>(3,6)</sup>. Both routes feed the capitate bone from the palmar aspect. Therefore, any stress or pressure on the palmar side can disrupt blood flow. Additionally, the extrinsic blood flow is related to the capsule and ligamentous structures of the wrist, including the flexor pollicis longus and the flexor retinaculum<sup>(4,5)</sup>. Damage to these structures, particularly if located in the palmar region, can impede blood flow to the capitate bone<sup>(5)</sup>. According

to the theories presented, repeated small traumas and continuous pressure on the palmar side of the hand can disrupt the blood supply to the capitate. The head of the capitate bone lacks lateral blood supply<sup>(4)</sup>, making it more susceptible to AVN. All of the aforementioned blood supply patterns are linked to the proximal segment, forming a blood supply "bridge." Currently, there is no standardized treatment for avascular necrosis of the wrist bones. Due to the limited number of patients, there is little experience regarding the treatment approach. There is very little knowledge in this field, and the primary goal of treatment is to prevent morphological changes to the bone and its collapse. Additionally, maintaining the longitudinal alignment of the carpal bones can reduce the risk of degenerative changes<sup>(7)</sup>. In the early stages, conservative treatment is often recommended, which includes the use of non-steroidal anti-inflammatory drugs (NSAIDs), corticosteroid injections, and wrist immobilization with splints<sup>(3)</sup>. However, these treatments may not be effective for some patients, leading to the indication for surgical interventions. In recent years, vascularized bone grafts have gained attention<sup>(3)</sup>. This surgical intervention is recommended when collapse of the carpal bone has not occurred. However, there is no available information regarding the long-term outcomes of these treatments. In patients with collapse and degenerative changes in the carpal bone, wrist arthrodesis or arthroplasty may be performed<sup>(3)</sup>. The treatment methods for AVN of the capitate bone are summarized in Table 1.

**Table 1: Reports on the treatment of avascular necrosis of the capitate bone**

Treatment Type and Patient Follow-up	Number of Patients and Year of Publication	Authors
Free vascularized bone graft from the medial femoral condyle using microsurgery; 9-month follow-up; complete recovery	1 male, 23 years old - 2023	Shtarbanov et al. <sup>(7)</sup>
Vascularized bone graft from compartments 3 and 4 of the extensors; 5-year follow-up; complete recovery	5 patients, aged 30–37 years - 2019	Athlani et al. <sup>(8)</sup>
Vascularized bone graft from the base of the second metacarpal; 14-month follow-up; complete recovery	1 female, 45 years old - 2019	Usami et al. <sup>(9)</sup>
Hemiressection of the capitate and fusion to lunate with tendon interposition (Mid-Carpal Joint Sparing Procedure); 1-year follow-up; partial improvement in pain intensity but poor function	1 male, 21 years old - 2020	Ansari et al. <sup>(10)</sup>
Vascularized bone graft from compartments 4 and 5 of the extensors; 12-month follow-up; complete recovery	2 females, 29 and 32 years old - 2022	Quintero et al. <sup>(11)</sup>
Scaphocapitolunate arthrodesis in 5 patients and 4-corner fusion in 1 patient; 9-year follow-up; partial improvement in pain intensity	6 patients, aged 20–30 years - 2013	Peters et al. <sup>(12)</sup>
Vascularized bone graft from the distal radius, compartments 4 and 5 of the extensors; 1-year follow-up; complete recovery	1 male, 15 years old - 2009	Hattori et al. <sup>(13)</sup>
Free vascularized bone graft from the medial femoral condyle as corticocancellous bone; 18-month follow-up; complete recovery	1 female, 16 years old after trauma - 2017	Kazmers et al. <sup>(14)</sup>

Vascularized bone grafts, whether local or free, have been associated with successful outcomes in the early stages of the disease. Given the higher prevalence in younger, more active individuals, the choice of treatment becomes crucial. The number of patients with avascular necrosis of the capitate bone is very small, and there is limited therapeutic experience in this area. In cases where arthritis changes are present in the carpal bones, the recommended treatment is intercarpal arthrodesis, which has been effective in controlling pain intensity in patients<sup>(11-14)</sup>.

The use of non-vascularized bone grafts has not yielded favorable results. However, vascularized grafts from the intercarpal 2 and 3 superretinacular compartments, as well as from the 4 and 5 extensor compartments, have shown promising clinical outcomes according to reports. What is important is that a vascularized graft, by enhancing blood supply, can play a critical role in improving avascular necrosis of the capitate bone.

## Conclusion

In conclusion, THA is frequently performed in SCD patients due to the high prevalence of femoral head osteonecrosis. Research has shown that individuals with SCD face an elevated risk of postoperative medical and surgical complications compared to non-

SCD patients. As a result, comprehensive care is essential, necessitating thorough preoperative evaluation and coordinated communication among the surgical, anesthetic, hematologic, hospitalist, infectious disease, and cardiology teams to optimize outcomes for this high-risk patient population.

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