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Volar Pedicled Corticoperiosteal Vascularized Bone Graft Based on the Pronator Quadratus Pedicle for Scaphoid Nonunion: A Retrospective Case Series

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Abstract | **Case Series**

Scaphoid nonunion, a common complication following wrist fractures, can lead to progressive joint degeneration and functional impairment. Among surgical options, vascularized bone grafting offers biological and mechanical advantages in restoring bone continuity. This retrospective study evaluates outcomes of scaphoid nonunion treated using a volar pedicled corticoperiosteal graft based on the pronator quadratus pedicle, perfused by the anterior interosseous artery. Eight patients without signs of avascular necrosis underwent the procedure with fixation by Kirschner wires. At a 12-month mean follow-up, union was achieved in 87.5% of cases, with significant improvements in pain, grip strength, and range of motion. The technique proves to be an effective and reproducible option in cases of nonunion resistant to conservative or non-vascularized surgical treatment.

Keywords: Scaphoid nonunion, Vascularized bone graft, Pronator quadratus pedicle, Anterior interosseous artery, Kirschner wires..

INTRODUCTION

Scaphoid fractures account for up to 70% of carpal bone injuries, and nonunion occurs in 5–15% of cases, particularly in misdiagnosed or undertreated instances. Chronic nonunion may progress to scaphoid nonunion advanced collapse (SNAC), characterized by radioscaphoid osteoarthritis, instability, and functional decline.

While non-vascularized bone grafts and internal fixation remain standard, their success diminishes in biologically compromised or mechanically unstable cases. Vascularized bone grafts, especially those based on the pronator quadratus pedicle and anterior interosseous artery, have shown promising consolidation rates without requiring microsurgical anastomosis. This paper presents our experience using this approach in a Moroccan tertiary center.

MATERIALS AND METHODS

A retrospective review of eight male patients (mean age: 28.6 years) was conducted. All presented with scaphoid nonunion beyond six months, with no MRI or intraoperative evidence of avascular necrosis. Surgery involved a volar approach to the distal radius and scaphoid. A corticoperiosteal graft pedicled on the anterior interosseous artery via the pronator quadratus was harvested and transferred to the debrided nonunion site. Fixation was performed using two to three Kirschner wires.

Postoperative immobilization lasted 6–8 weeks. Union was assessed by radiographs and confirmed by CT at 3 months. Pain, grip strength, and wrist motion were recorded pre- and post-operatively.

RESULTS

Seven of eight patients (87.5%) achieved union within 12–14 weeks. Pain scores improved significantly (mean VAS: 6.3 to 1.5). Grip strength reached 85% of the contralateral side. Wrist mobility increased in flexion-extension and radial-ulnar deviation arcs. No donor-site complications, infections, or wire migrations were observed. One case of persistent nonunion required revision surgery.

Case Illustrations:

Figure 1A. Preoperative radiograph showing scaphoid nonunion

Figure 1B. Immediate postoperative radiograph (PA view) showing K-wire fixation

Figure 1C. Postoperative lateral radiograph confirming wire placement.

Figure 1D. Follow-up radiograph at 3 months showing consolidation of the graft site

Figure 1E. Lateral view at 3-month follow-up showing graft integration

Figure 1F. Intraoperative photograph showing identification of the anterior interosseous artery supplying the pronator quadratus pedicle

Figure 2A. Preoperative MRI coronal view showing scaphoid nonunion.

Figure 2B. Preoperative MRI coronal view, alternate slice showing persistent scaphoid gap

Figure 2C. Immediate postoperative PA radiograph showing K-wire stabilization

Figure 2D. Lateral postoperative view with visible K-wire placement

Figure 2E. Follow-up radiograph at 3 months (PA view) showing bridging trabeculae

Figure 2F. Lateral view at 3 months demonstrating satisfactory graft integration

Table 1: Comparative Summary of Vascularized and Non-Vascularized Techniques for Scaphoid Nonunion

Technique	Approach	Graft Type	Union Rate	Microsurgical Requirement
Volar PQ-based graft (This study)	Volar	Pedicled corticoperiosteal (anterior interosseous artery)	87.5%	No
Zaidemberg (ICSRA)	Dorsal	Pedicled corticocancellous (radial artery)	86–95%	No
Free iliac crest graft	Remote	Free vascularized corticocancellous	85–90%	Yes
Mathoulin graft	Volar	PQ-based pedicled corticoperiosteal	85–92%	No
Non-vascularized cancellous graft	Dorsal/Volar	Non-vascularized	60–80%	No

DISCUSSION

Scaphoid nonunion remains a complex clinical issue, particularly in young, active patients where preservation of wrist motion and strength is critical. In the absence of avascular necrosis, nonunion often results from biomechanical instability, inadequate immobilization, or unrecognized fracture displacement. When conservative or standard non-vascularized techniques fail, biologically augmented strategies become essential.

The use of a volar corticoperiosteal vascularized bone graft pedicled on the anterior interosseous artery via the pronator quadratus muscle offers an elegant solution. Originally described anatomically by Malizos *et al*., and developed clinically by Mathoulin *et al*., this approach avoids the need for microsurgical anastomosis while delivering viable vascularized bone to the nonunion site. The proximity of the donor site to the scaphoid, as well as the ease of harvesting and relatively low donor site morbidity, makes it especially advantageous compared to free vascularized iliac crest grafts.

This graft delivers both osteogenic cells and revascularization potential, which is particularly beneficial in cases of fibrous nonunion where the biologic environment is insufficient to support traditional graft healing. Our clinical results—an 87.5% union rate within three months—mirror outcomes reported in prior literature (e.g., 85–92%) and highlight the reproducibility of this method in real-world settings.

The technique also compares favorably to the widely adopted 1,2 intercompartmental supraretinacular artery (ICSRA) dorsal graft described by Zaidemberg *et al*. While the ICSRA graft has demonstrated high union rates (86–95%), it involves dorsal dissection, which may affect the extensor retinaculum and occasionally lead to postoperative stiffness. The volar approach, in contrast, preserves dorsal structures and provides better visualization of the scaphoid volar aspect.

Another practical point is fixation. Though headless compression screws are preferred by many due to superior mechanical stability, our study supports the sufficiency of K-wire stabilization when combined with biologically active grafts. In our cohort, no instability, migration, or infection was observed, and all K-wires were removed after radiologic consolidation.

It is important to emphasize that patient selection is paramount. This technique is best indicated in cases of nonunion without AVN, small proximal pole fragments, and recurrent nonunion where prior conventional methods failed. MRI or intraoperative bleeding assessments should be routinely used to assess vascularity.

Despite its strengths, this method is technically demanding and should be performed by surgeons trained in microanatomy of the anterior forearm. Additionally, long-term comparative studies and randomized trials are still needed.

CONCLUSION

The anterior interosseous artery–based volar vascularized corticoperiosteal graft from the distal radius is a robust solution for scaphoid nonunion. K-wire fixation proved effective in maintaining stability during healing. This technique demonstrates a high success rate and favorable clinical recovery in cases not complicated by avascular necrosis.

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