Allograft Bone

What Is the Role of Platelet-Derived Growth Factor in Hindfoot and Ankle Fusions

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KEYWORDS

• Platelet-derived growth factor • PDGF • Ankle • Hindfoot • Fusion • Bone graft • Allograft

KEY POINTS

- Nonunion is a common complication associated with arthrodesis procedures of the ankle and foot frustrating both patients and surgeons.
- Allograft biologics, such as platelet-derived growth factor (PDGF), are a viable alternative to autogenous bone grafting with reports indicating equivocal outcomes.
- PDGF avoids the obvious morbidity associated with harvesting autogenous bone graft.
- Crushed β-tricalcium phosphate granules are an effective means of delivering PDGF into a fusion site.
- Patients with known risk factors for nonunion should be considered candidates for adjunct biologics such as PDGF.

INTRODUCTION

Biologics have been widely used in ankle and hindfoot arthrodesis for the past several decades. Historically, foot and ankle surgeons have faced significant challenges with regards to achieving a successful arthrodesis. Nonunions also leads to poor patient outcomes, chronic disability, and increased health care expenditure. Literature reports up to a 40% nonunion rate for ankle arthrodesis, 16% for subtalar joint (STJ) arthrodesis, and 17% to 30% for tarsometatarsal joint arthrodesis.[1–4] More recently, a study by Arner and Santrock[5] reports nonunion rates of approximately 10% in ankle and hindfoot fusions. They note a significant increase in nonunion rate associated with smoking, avascular necrosis, and surgical error. Delayed union also remains problematic, especially among patients with known

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risk factors. Fortunately, documented rates of tobacco use are declining in the United States; however, diabetes and other clinical risk factors are still prevalent.

Patients with Increased Risk of Nonunion

1. Smokers
2. Diabetics
3. Posttraumatic arthritis
4. Revision surgery
5. Renal impairment

Optimizing arthrodesis rates have brought increased emphasis on mechanical stabilization. Arthroscopic techniques along with new locking plate constructs are attempts to facilitate improved arthrodesis outcomes. However, modern techniques demand biologic augmentation in some patients for increasing surgical success. There are 4 key points in determining the indications for biologics in foot and ankle surgery[6]:

1. What are the specific indications?
2. Where do biologics belong?
3. Which biologics belong?
4. How is this pertinent to my practice?

Once the appropriate patient has been identified for surgery and a biologic is considered, an autograft or allograft is selected. When determining the type of biologic, one should also consider the 3 bone graft properties:

1. Osteoinductive
   a. Direct mesenchymal stem cells (MSCs) to differentiate into osteoblasts
2. Osteoconductive
   a. Provide a scaffold/latticework for new bone formation
3. Osteogenic
   a. Synthesize new bone from within the graft

Although autograft continues to remain the "gold standard," it does carry obvious risks and is not without additional costs. Polly and colleagues[7] demonstrated a significant cost analysis for harvesting iliac crest bone graft (ICBG) during lumbar fusion. The investigators noted the average overall cost of harvesting ICBG to be $2365. Several studies have demonstrated chronic donor site pain and morbidity in harvesting ICBG.[8,9] Schwartz and colleagues[8] noted persistent pain at the donor site to be as high as 25% up to 2 years after surgery. A meta-analysis published by Noshchenko and colleagues[10] found chronic pain of the ICBG site of 49%, nonunion at 24 months at 15%, a 20% rate of major acute complications, and a 7% risk of wound complications. Baumhauer and colleagues[11] in 2013 reviewed 142 patients with bone graft harvest from 5 donor sites: iliac crest, proximal tibia, distal tibia, calcaneus, and other. They concluded that chronic pain was noted in 13% to 20% of bone graft donor sites (proximal tibia < distal tibia < calcaneus).[11,12]

The use of bone marrow aspirate (BMA) added to bone allograft has been an alternative to autologous bone graft harvest.[13] The concept here is to supplement the osteoconductive properties of the demineralized bone matrix with osteoprogenitor cells from the BMA. BMA is typically easy to harvest from multiple sites and carries less morbidity than autologous bone graft harvest. Daigre and colleagues[14] noted there was no significant chronic pain from the BMA harvest in the distal tibia and iliac