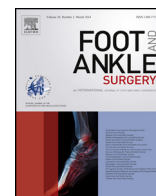




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Review

Does autogenous bone graft work? A logistic regression analysis of data from 159 papers in the foot and ankle literature

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ABSTRACT

Background: While autogenous cancellous iliac crest bone graft is the gold standard for foot and ankle surgery, it lacks Level I evidence. Although one third of all graft cases performed in the United States today rely on allograft, some surgeons believe no graft is necessary. We hypothesized that a systematic review of the foot and ankle literature would reveal that (1) autogenous bone graft during foot and ankle arthrodesis would demonstrate healing rates that were superior to the use of either using allograft or no bone graft at all, and (2) these differences would be even more dramatic in patients having risk factors that impair bone healing. To our knowledge, neither of these assessments to date has ever been performed with this body of literature. The goal of this study was to review the use and union rates of bone graft during foot and ankle arthrodesis and determine if autogenous bone graft was superior.

Methods: A literature search was performed to include articles between 1959 and 2012 using autograft, allograft, and/or no bone graft for foot and/or ankle arthrodesis. Case reports involving fewer than four patients, investigations failing to incorporate outcome data, those involving orthobiologic augmentation, and those including vascularized graft, xenograft, or pediatric patients were excluded. Recorded search results included patient demographics, comorbidities, pre-operative diagnosis, surgical procedure, bone graft type and indication, union rate, method of fixation, patient satisfaction, all outcome scores, definition of healing/success, and any listed complications including revision. Final data were stratified based upon the type of graft material.

Results: This search generated 953 related articles, of which 159 studies (5327 patients) met inclusion criteria. The majority (153/159) were retrospective case series. Systematic review demonstrated a trend toward higher union rates for cancellous autograft (OR 1.39, $p = 0.11$), structural autograft (OR 1.52, $p = 0.09$), and cancellous allograft (OR 1.31, $p = 0.52$) relative to no graft material, but none reached statistical significance. Compared to no graft, structural allograft trended toward worse performance (OR 0.62, $p = 0.17$). The overall probability of union was 93.7% for cancellous autograft, 94.2% for structural autograft, 93.3% for cancellous allograft, 91.4% for no graft, and 86.9% for structural allograft. When only comparing the 19 papers that included a no graft arm (91.9% union rate), data revealed the highest union using cancellous autograft (95.1%, OR 1.73, $p = 0.09$) and structural autograft (96.3%, OR 2.33, $p = 0.06$) while only 76% for structural allograft. No significant statistical association existed between union rates and other recorded variables.

Conclusion: Systematic analysis of bone graft use in foot and ankle fusions favors the use of autograft and cancellous allograft for optimized healing rates, although no differences were statistically significant. If

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we assume that graft material been chosen for more complex procedures having lower anticipated union rates, then these data lend further support to the use of autograft and cancellous allograft.

Level of Evidence: Level IV.

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Contents

1. Introduction	151
2. Methods	151
3. Results	152
4. Discussion	154
5. Conclusions	156
References	157

1. Introduction

Despite a transforming evolution of bone graft substitutes and orthobiologic technologies over the past few decades, autogenous cancellous bone graft is still universally regarded as today's gold standard for augmenting healing during arthrodesis and non-union surgery. It is the only naturally occurring material purported to possess osteoconductive, osteoinductive, and osteogenic properties. While this prevailing theory has been reasonably evidenced in a rat model, human evidence has not conclusively confirmed that inductive proteins and cytokines are truly active in cancellous autograft [1,2]. Perhaps more remarkable is that no prospective randomized controlled trial has been performed to provide a direct comparison between the outcome of arthrodesis surgery with and without autogenous bone graft (ABG)—despite this model remaining the most well-accepted method for establishing clinical effectiveness of most medical treatments. In fact, ABG earns only a Grade-C recommendation in some recent studies [3], which corresponds to supportive data derived from either Level-IV and V evidence—or from conflicting evidence [4]. One can therefore make a reasonable argument today that ABG has perhaps been long heralded as our historical gold standard based largely on unchallenged theoretical rationale, as postulated by Professor Thomas Kuhn in the 1960s [5]. Amidst this scientific paradox, the use of bone graft in orthopedic surgery has given rise to a multi-billion dollar industry—and the fact remains that nonunion rates still approach upwards of 10% in foot and ankle surgery [6].

Joint deterioration necessitating fusion in the foot and ankle occurs as a result of a number of maladies, including degenerative joint disease (DJD), posterior tibial tendon insufficiency, trauma, congenital deformity, inflammatory or crystalline arthropathy, Charcot neuropathy, diabetes, avascular necrosis, tumor, and many other causes. Bone graft is often incorporated during reconstructive procedures for these various pathologies in an attempt to improve healing rates during arthrodesis, osteotomy, and non-union surgery. According to available literature, interventions commonly involving bone graft application include tibiotalar (TT), subtalar (ST), tibiotalarcalcaneal (TTC), triple, tibiotalarcalcaneal (TC), talonavicular (TN), calcaneocuboid (CC), naviculocuneiform (NC), and tarsometatarsal (TMT) arthrodesis, calcaneal osteotomy (CO), and various nonunion repairs.

Clearly, any surgeon's decision to use or not use a particular type of graft material (cancellous versus structural, local versus distant, auto versus allo) is predicated on both patient factors and surgeon preference. Compared to other forms of bone graft, cancellous autograft has a higher surface area and greater cellular potential, thereby earning its reputation for a capacity to induce more new bone formation than structural (cortical or

corticocancellous) autograft [7]. Structural autograft is often required when significant bone loss or deformity is present, as a means of restoring length, height, and/or alignment. It should be noted that another confounding material distinction between graft forms is that local autograft is defined as being obtained through the same surgical incision whereas distant autograft is harvested through a separate incision, regardless of anatomic region. To our knowledge, there exist no studies that have directly compared the use of local versus distant autograft with respect to healing potential. In recent years, the increasingly well-documented disadvantages of autograft—namely donor site morbidity, pain, increased surgical time, and limited supply—have led to the more frequent use of allograft as well as a growing appetite for synthetic orthobiologic alternatives (“bone graft substitutes”).

Hundreds of studies exist in the foot and ankle literature that have investigated union rates after reconstructive surgery with or without bone graft augmentation. Few have been designed to specifically and directly compare the utility of our various forms of graft supplementation—and to date no meta-analysis or systematic review has been reported to summarize this information for the foot and ankle surgeons who must make these decisions every day [8,9]. We therefore decided to pursue this analysis and hypothesized that enhancing a surgical site with ABG would be superior to both an absence of bone graft as well as the alternative use of allograft after foot and ankle arthrodesis. In addition, we anticipated that utilizing ABG would prove even more dramatically successful in high risk patients having co-morbid factors known to impede bone healing, such as tobacco use, diabetes, and revision surgery. Other defined goals of this study were to characterize any relationship between preoperative diagnosis and arthrodesis union rate, define any propensity of different joints to fuse, determine the complication rates for different types of graft, and identify any influence of various co-morbidities on union rates after foot and ankle fusion surgery.

2. Methods

An extensive literature search from 1959 to 2012 was performed using PubMed, Cochrane, Medline, and EMBASE. Additional examination involving all references from these studies was also conducted to identify any investigations not originally discovered.¹

¹ Search parameters: “(foot OR ankle OR calcaneus OR calcaneal OR talus OR talar OR subtalar OR tarsal OR ankle OR tibiotalar OR tibiotalarcalcaneal OR calcaneocuboid OR triple OR talonavicular OR Chopart OR naviculocuneiform OR midtarsal OR mid-tarsal OR tarsometatarsal OR Lisfranc OR metatarsophalangeal OR interphalangeal) AND (fusion OR arthrodesis OR non-union OR nonunion OR salvage OR revision) AND (autograft OR graft OR allograft OR autogenous OR autologous).”

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