

## Impact of Patient Age and Graft Material on Fusion Success Following Hindfoot and Ankle Arthrodesis

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### INTRODUCTION

Nonunion rates for hindfoot and ankle arthrodesis have remained stubbornly high, with some reported rates nearing 30% for primary triple arthrodesis patients.[1] A recent survey of 100 international foot and ankle surgeons revealed that smoking, lack of fusion site stability, poor vascularity, and diabetes are perceived by surgeons to be risk factors most closely associated with nonunion.[2] Patient age greater than 60 years was perceived as a less significant risk factor.

While surgeons in the described survey perceived age to be of lesser concern, it is important to explore because bone healing is highly dependent on mesenchymal stem cells (MSCs) and their ability to differentiate into osteoblasts. Recent research has shown that MSCs collected from older patients have decreased osteogenic potential [3, 4] and migration capacity [4-6]. This suggests that autograft, one of the most common grafting materials used in arthrodesis procedures, may not be as effective in older patients.

### AIM

The objective of this study was to determine if autograft has the same effectiveness in both younger and older hindfoot and ankle arthrodesis patients. The hypotheses were:

1. autograft would result in lower odds of fusion success in older subjects
2. an autograft alternative, recombinant human platelet-derived growth factor combined with beta tricalcium phosphate (rhPDGF-BB/β-TCP), would have similar odds of fusion success in both younger and older subjects
1. rhPDGF-BB/β-TCP would result in higher odds of fusion than autograft when used in older subjects.

### METHODS

Data was analyzed from a previously conducted randomized controlled trial comparing fusion status at 24 weeks for hindfoot and ankle arthrodesis subjects requiring supplemental graft material treated with either autograft or rhPDGF-BB/β-TCP.[7]

The odds of fusion success at 24 weeks were compared using odds ratios for joints in subjects younger or older than the following age thresholds: 55, 60, 65, 70, and 75 years. The odds of fusion success in joints from subjects in the two groups older than each age threshold were then compared. Fusion success was defined as evidence of 50% osseous bridging on computed tomography (CT) as determined by a blinded, independent radiologist.

#### Statistical Considerations

Demographics and clinical factors were compared via the Fisher's exact test for categorical variables and two-sample t-test for continuous variables. CT fusion rates were compared based on parametric test of two proportions.

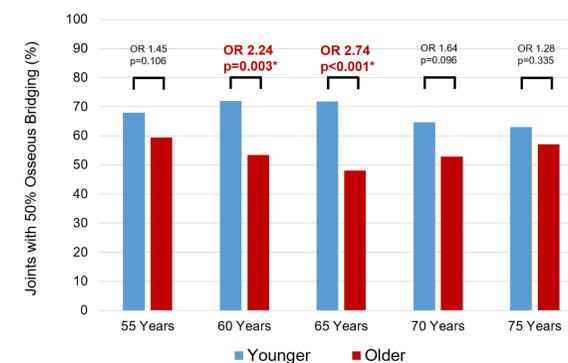
### RESULTS

There were a total of 397 subjects (597 joints) included in the analysis. Demographics were similar between the two groups (Table 1).

**Table 1. Demographics for each study group**

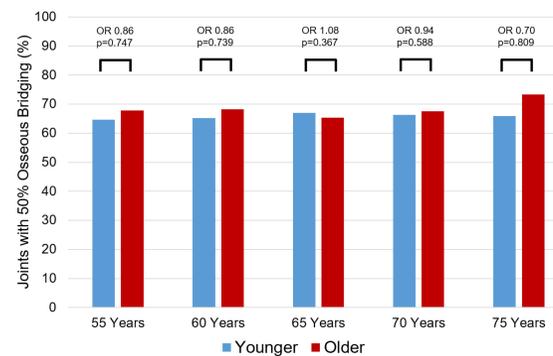
	Autograft	rhPDGF-BB/β-TCP	P-value*
<b>N Subjects</b>	137	260	
<b>Gender (M/F)</b>	79/58	125/135	0.073
<b>Mean Age (range)</b>	57.3 years (20-82)	55.8 years (20-86)	0.332
<b>Mean BMI (range)</b>	30.6 (19-45)	31.3 (20-44)	0.246
<b>Risk Factors</b>			
<b>Smoking History</b>	32 (23.4%)	64 (24.6%)	0.807
<b>Obesity (BMI ≥ 30 kg/m<sup>2</sup>)</b>	57 (41.6%)	124 (47.7%)	0.289
<b>Previous revision surgery</b>	32 (23.4%)	60 (23.1%)	1.00
<b>Diabetes History</b>	18 (13.1%)	26 (10.0%)	0.401
<b>Arthrodesis Location</b>			
<b>Ankle</b>	52 (38.0%)	100 (38.5%)	0.915
<b>Subtalar</b>	38 (27.7%)	66 (25.4%)	
<b>Calcaneocuboid</b>	0 (0.0%)	3 (1.2%)	
<b>Talonavicular</b>	9 (6.6%)	14 (5.4%)	
<b>Double Arthrodesis</b>	10 (7.3%)	20 (7.7%)	
<b>Triple Arthrodesis</b>	28 (20.4%)	57 (21.9%)	

For each age threshold, joints in younger subjects in the autograft group had higher odds of fusion than those in older subjects. For the 60 and 65 year age thresholds, joints in younger subjects had over **2 times** the odds of fusion success as those in older subjects (Figure 1).



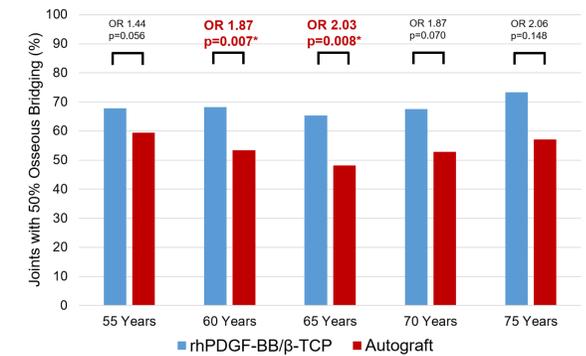
**Figure 1. Percentage of joints in autograft group achieving 50% osseous bridging on CT scans at 24 weeks**

For each age threshold, the odds of fusion success was similar in joints from either younger or older subjects in the rhPDGF-BB/β-TCP group (Figure 2).



**Figure 2. Percentage of joints in rhPDGF-BB/β-TCP group achieving 50% osseous bridging on CT scans at 24 weeks**

When joints from subjects older than each threshold were compared between the two groups, those in the rhPDGF-BB/β-TCP group were approximately twice as likely to have fusion success (Figure 3).



**Figure 3. Percentage of joints in subjects older than each age threshold for both groups achieving 50% osseous bridging on CT scans at 24 weeks**

### CONCLUSIONS

- Age is an identifiable risk factor for nonunion following hindfoot or ankle arthrodesis.
- Joints in patients over the age of 60 years have statistically higher odds of nonunion when treated with autograft alone.
- The use of an osteoinductive autograft alternative, rhPDGF-BB/β-TCP, may help mitigate the negative, age-related variability seen in autograft.

### LIMITATIONS

- The study supplying data was not designed specifically for the performed ad-hoc analyses.
- The use of CT imaging and selected fusion success criteria are high barriers and make comparison with other published success rates difficult due to the typical use of radiographs.

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