Complex Hand and Wrist Reconstruction using Free Vascularized Bone Grafts

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INTRODUCTION: Free transfer of vascularized bone grafts (VBG) can be used to promote union in bone defects of the hand and wrist.[1–3] We review reported patient-centered outcomes after microvascular VBG to the upper extremity following nonunion after previous operative repair.

MATERIALS AND METHODS: A systematic review of free VBG in hand and wrist reconstruction was performed querying MEDLINE and PubMed databases using predefined criteria. Patient characteristics, perioperative details, and patient-reported and functional outcomes were critically evaluated. Subgroup analysis was performed using the t-test, α=0.05.

RESULTS: Sixteen studies met inclusion criteria, constituting 189 patients (age 29.5±10.9 years old, 89.4%±24.8% male, and follow-up of 57.5±28.0 months (Table 1). The rate of union after free VBG to the distal upper extremity was 89.9%±13.4% with union occurring at 13.9±2.1 weeks postoperatively. The union rate after free VBG as a primary procedure was 89.9%±15.0%, while free VBG for operative revision reported 90.3%±28.7% rate of union (p=0.9). Four studies reported smoking status with 29.5%±21.4% prevalence. After free VBG, smokers demonstrated 72.7%±26% rate of union compared to 100% of non-smokers (p<0.01). There was no difference in bony union in fractures of the waist (95%±19.2%) compared to proximal pole fractures (93%±7.8%) of the scaphoid when treated with free VBG. There was no difference in union rates based on time from injury to free VBG (p=0.1), or use of K-wire or screw fixation (p=0.9).

Compared with the contralateral wrist, patients postoperatively demonstrated 69.4%±12.1% of flexion, 73.8%±6.5% of extension, 72.2%±11.9% of radial deviation, 73.0%±11.2% of ulnar deviation, and 82.1%±15.1% of grip strength. Patient satisfaction was 91.3%±12.9%, DASH score 18.4±10.5, and MMWS 79.3±6.4. By 4.7±2.4 months, 91.6%±5.5% of patients returned to work. Major complications, including flap loss and reoperation occurred in 7.4% of cases, and 61.4% of patients reported minor complications at the donor or recipient site, including pain, paresthesia, or deformity.

CONCLUSION: The use of free VBG to the hand and wrist facilitated bone union in patients with nonunion following previous repair. Smokers demonstrated significantly worse outcomes compared to nonsmokers. High functional recovery scores, levels of satisfaction and rates of return to work were reported. The rate of major complications was low, justifying the use of free VBG in patients at risk or with history of nonunion after surgery.

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FIGURE LEGEND:
Table 1. Systematic Review of Microvacular Vascularized Bone Grafts for Distal Upper Extremity Reconstruction. DASH – Disabilities of the Arm, Shoulder and Hand Score, MMWS – Mayo Modified Wrist Score, DIJ – Distal Interphalangeal Joint

Article	Study Design	n	Total Union (%)	Smoker union (%)	Revision Surgery union (%)	Contralateral Flexion (%)	Contralateral Extension (%)	Contralateral Grip Strength (%)	Return to Work (%)	Satisfaction	Functional Score
Burger, et al 2013.	Retrospective Cohort - scaphoid nonunion	16	93.7%	85.7%	93.8%						
Doi K, et al 2000.	Case Series - scaphoid nonunion	10	100%		100%	86.0%	81.9%	82.5%	100%		MMWS 84
Gabl M, et al 1999.	Case Series - scaphoid nonunion	15	80%		0%	65.7%	75.4%	88.5%			
Jones DJ, et al 2008.	Retrospective Review - scaphoid nonunion	12	100%	100%	100%			86%			
Jones DB Jr, et al 2010.	Retrospective Review - scaphoid nonunion	12	100%	100%	100%			86%		100%	
Fernandez DL, et al 1995.[1]	Retrospective Review – scaphoid nonunion	11	90.9%		100%	81.9%	81.7%	87.8%	90.9%	81.8%	MMWS 75
Harpf C, et al 2001.	Retrospective Review - scaphoid nonunion	60	91.7%		92.3%						
Arora R, et al 2010.[2]	Retrospective Review - scaphoid nonunion	21	76.2%	44.4%	76.2%	56.30%	67.20	81%	85.7%		DASH 20
Gabl M, et al 2002.[3]	Case Series - Kienbock's Disease	18	88.9%			71%	71.00%	81%			
Gordon L, et al 1985.	Case Series - shotgun trauma	2	50%					40%	100%		
Sammer DM, et al 2009.	Case Report - metacarpal reconstruction	1	100%								
Giessler GA, et al 2011.	Case Report - thumb crush injury	1	100%		100%				100%		
Lin, 2005.	Case - distal upper extremity trauma	7	85.7%					63.3%			
Del Pinal F, et al 2012.	Case Report - ulnar head avascular necrosis	1	100%		100%			81%	100%		DASH 2
Hachisuka H, et al 2007.	Case Report- trauma and osteoarthritis	1	100%		100%				100%		DASH 1.67
Grant I, et al 2005.	Case Report - DIJ osteoarthritis	1	100%		100%				100%		
Total		189	89.9%	72.7%	90.3%	69.4%	73.8%	82.1%	91.6%	91.3%	DASH 18.4, MMWS 79.3
p-value				<0.01	0.94						