SCIENTIFIC ARTICLE

Early Outcomes of Vein Grafting for Reconstruction of Brachial Arterial Injuries in Children

Kristin Alves, MD,* Hillard Spencer, MD,† Carol E. Barnewolt, MD,‡
Peter M. Waters, MD,§ Donald S. Bae, MD§

Purpose We postulated that, with microsurgical technique, vascular reconstruction with interpositional vein grafts in the pediatric population is safe and results in sustained vascular patency and excellent midterm outcomes.

Methods Twenty children with brachial artery injuries were treated with interpositional vein grafting at a tertiary pediatric hospital from 1995 to 2013. Medical records were evaluated for demographic, clinical, and radiographic data. Ten patients were available for longer-term follow-up. Pain at rest, pain with exercise, and temperature intolerance were assessed with visual analog scale (VAS) (range, 0–5). Functional outcomes were assessed using the Pediatric Outcomes Data Collection Instrument (PODCI) and Disabilities of the Arm, Shoulder, and Hand (DASH) questionnaires. Graft patency and flow were characterized via duplex sonography. Peak flow velocity and resistive index (RI) were compared with the contralateral extremity. Median patient age at the time of injury was 7.75 years (range, 4.6–11.5 years) and median follow-up was 1.75 years (range, 0.3–6.3 years).

Results All patients had perfused hands with palpable radial pulses at follow-up. There were no clinically meaningful differences in motion, sensibility, or strength between affected and unaffected limbs. Mean VAS scores for pain at rest, pain with exercise, and temperature intolerance were 0.4, 0.4, and 0.6, respectively. Mean global PODCI and DASH scores were 98.0 and 5.1, respectively. Nine of 10 patients had patent arteries with normal flow patterns. In the patient with graft occlusion, there was collateralization around the elbow with normal reconstitution of the distal vessels. Mean peak flow velocity proximal and distal to the graft were 77.7 cm/s and 66.5 cm/s, respectively. Mean RI of the graft were 0.84 and 0.77, respectively.

Conclusions Brachial artery reconstruction using interpositional vein graft and microsurgical technique is safe and effective and results in excellent functional outcomes in children. *(J Hand Surg Am. 2017;■(■):1.e1-e7. Copyright © 2017 by the American Society for Surgery of the Hand. All rights reserved.)*

Type of study/level of evidence Therapeutic V.

Key words Vein graft, arterial injury, pediatric.

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*From the *Harvard Combined Orthopaedic Surgery Program; the ‡Department of Radiology; the §Department of Orthopaedic Surgery, Boston Children's Hospital, Boston, MA; and the †Pediatric Orthopaedics, Anaheim, CA.*

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Corresponding author: Donald S. Bae, MD, Department of Orthopaedic Surgery, Boston Children's Hospital, 300 Longwood Ave., Hunnewell 2, Boston, MA 02115; e-mail: Donald.Bae@childrens.harvard.edu.

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Although rare, arterial injuries of the extremities may be devastating in children, with the potential for ischemic contractures, multiple surgical interventions, distal loss of limb, and lifelong disability.[1] Although vein graft survival in adult extremities has been well documented, it is unknown if similar results may be extrapolated to the pediatric population.[2–5] Children may demonstrate differences in graft survival and functional outcomes in comparison with their adult counterparts.[6] In trauma cases associated with vascular insufficiency, reperfusion of the limb has been advocated whenever technically possible.[6,7] In the acute period, restoration of flow with vein grafting is highly successful in the pediatric population.[7,8]

The longer-term results of vascular reconstruction in children, however, are poorly characterized. Specifically, it is unclear if vein grafts remain patent or simply allow time for collateralization of flow. The timing of vascular reconstruction and its effect on longer-term outcomes are also unknown. Whereas graft failure can theoretically occur by processes such as stenosis, intimal hyperplasia, thrombosis, aneurysm, or pseudoaneurysm formation, the incidence of these failure modes in children is not known.[9–11] Graft patency may affect patient function in terms of cold and heat tolerance, sensibility including dysesthesias, healing of muscular or skeletal injuries, and ultimate preservation of flow to the extremity. An understanding of the results of extremity salvage in vascular trauma is essential to surgical decision making, patient and family counseling, resource management, and optimization of functional outcomes. The purpose of this investigation was to analyze vein graft patency rates and functional outcomes in children who sustained brachial artery injuries treated with interpositional vein grafts.

METHODS

The primary objective of this study was to characterize vein graft patency and collateralization after brachial artery reconstruction, as measured by duplex sonography. The secondary objective of this study was to assess upper limb function after arterial reconstruction, based upon physical examination and patient's self-reported function, using the Disabilities of the Arm, Shoulder, and Hand (DASH) outcomes measure and the Pediatric Outcomes Data Collection Instrument (PODCI).[12,13]

With institutional review board approval, we reviewed medical records to identify children who had undergone vascular reconstruction for traumatic arterial injuries in the extremities from 1995 to 2013 at a tertiary-care children's hospital. Inclusion criteria included age at presentation of younger than 15 years, a diagnosis of a traumatic arterial injury in the upper extremity with surgically confirmed brachial artery injury, and surgical treatment consisting of interposition vein grafting. Using these criteria, 20 patients were identified as having sustained a brachial artery injury with repair involving the use of vein grafting.

Demographic and clinical data were obtained from the medical record for analysis of preoperative and postoperative predictors of outcomes. Data included age, mechanism of injury, time from injury to revascularization, length of interposition graft, associated neurological or musculoskeletal injury, medical comorbidities, simultaneous traumatic brain injury, and complications associated with injury or surgery. Complications included wound infection, early graft failure, donor site morbidity, revision of vascular reconstruction, development of contractures, extended hospital stay, sepsis, and limb loss.

Surgical indications included direct laceration of the brachial artery, a pulseless ischemic extremity after supracondylar fracture reduction, and/or pulseless upper extremity with absent or weak Doppler signal, especially when associated with median nerve injury.[14] Each patient underwent end-to-end anastomosis of reversed vein grafts using microvascular technique. After surgery, patients were admitted to the hospital for a minimum of 5 days in a warm room ($>78°$F) with serial neurovascular monitoring. Patients received perioperative antibiotics as well as intravenous anticoagulation (Dextran 40 at 5−10 mL/kg/d continuous infusion) for 5 days, followed by 2 weeks of aspirin (81 mg/d). On hospital discharge, patients with supracondylar humerus fractures were immobilized in a long-arm bivalved cast in approximately 70° to 80° degrees of elbow flexion.

Patients were contacted for clinical follow-up and noninvasive vascular examination using duplex sonography. Physical examination of the patient focused on active and passive range of motion of the involved limb compared with the contralateral extremity; neurological function in all peripheral nerve distributions, including gross motor strength and muscle bulk and tone, fine motor tasks and coordination, sensory perception to temperature, light touch, pinprick, static 2-point discrimination, when feasible; surgical site examination for scar formation, dystrophic skin changes, neuromas, pulsatile mass at the graft site; and vascular examination for distal pulses, transcutaneous oxygen saturation, and capillary refill.

Subjective assessment of pain, exertional symptoms, and temperature sensitivity was obtained by asking the