

A Population-Based Analysis of Time to Surgery and Travel Distances for Brachial Plexus Surgery

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Purpose Despite the importance of timely evaluation for patients with brachial plexus injuries (BPIs), in clinical practice we have noted delays in referral. Because the published BPI experience is largely from individual centers, we used a population-based approach to evaluate the delivery of care for patients with BPI.

Methods We used statewide administrative databases from Florida (2007–2013), New York (2008–2012), and North Carolina (2009–2010) to create a cohort of patients who underwent surgery for BPI (exploration, repair, neurolysis, grafting, or nerve transfer). Emergency department and inpatient records were used to determine the time interval between the injury and surgical treatment. Distances between treating hospitals and between the patient's home ZIP code and the surgical hospital were recorded. A multivariable logistic regression model was used to determine predictors for time from injury to surgery exceeding 365 days.

Results Within the 222 patients in our cohort, median time from injury to surgery was 7.6 months and exceeded 365 days in 29% (64 of 222 patients) of cases. Treatment at a smaller hospital for the initial injury was significantly associated with surgery beyond 365 days after injury. Patient insurance type, travel distance for surgery, distance between the 2 treating hospitals, and changing hospitals between injury and surgery did not significantly influence time to surgery.

Conclusions Nearly one third of patients in Florida, New York, and North Carolina underwent BPI surgery more than 1 year after the injury. Patients initially treated at smaller hospitals are at risk for undergoing delayed BPI surgery.

Clinical relevance These findings can inform administrative and policy efforts to expedite timely referral of patients with BPI to experienced centers. (*J Hand Surg Am.* 2016;41(9):903–909. Copyright © 2016 by the American Society for Surgery of the Hand. All rights reserved.)

Key words Brachial plexus, travel, time to surgery, delay, nerve surgery.

 Additional Material
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ALTHOUGH THERE IS NO CURRENT CONSENSUS on the optimal timing of surgical intervention after brachial plexus injuries (BPIs), it is generally agreed that delay beyond 6 to 12 months compromises the feasibility and functional outcome of nerve reconstruction procedures.^{1–4} Given the more favorable improvements in strength, function, and pain relief noted with earlier treatment,⁵ delays in referral and treatment are suboptimal for both the patient and surgeon.

Whereas most patients with BPI receive definitive surgical treatment at academic tertiary care centers, details of referral patterns for patients with BPI in the United States have not been extensively studied. As with many subspecialized surgical procedures, it is possible that patients are traveling substantial distances to receive care for BPI. In consideration of previous studies that demonstrated an association between traveling to an academic referral center for subspecialty care and postoperative complications, expected benefits gained by traveling to receive specialized care must be balanced against the potential risks associated with doing so.⁶

To better understand potential reasons for delays in referral and to gain a better appreciation of the distances traveled by patients, we used a population-based approach to evaluate delivery of care for patients undergoing outpatient brachial plexus exploration, repair, decompression, or neurolysis. We asked the following research questions: (1) What is the time interval between traumatic injury and surgical treatment of BPI? and (2) Does patient travel distance influence timing of surgery for BPI?

MATERIALS AND METHODS

Data sources and cohort assembly

We used Healthcare Cost and Utilization Project statewide administrative databases from Florida (2005–2013), New York (2006–2012), and North Carolina (2007–2010). These states and specific time frames were selected based on the availability and completeness of data from the requisite data sets. For each of these states, we accessed the State Inpatient Databases (SIDs), State Ambulatory Surgery and Services Databases (SASDs), and State Emergency Department Databases (SEDDs). The SIDs contain records from hospital admissions (with procedures identified via International Classification of Diseases, Ninth revision, Clinical Modification [ICD-9-CM] codes only), the SASD contain records from outpatient surgery (with procedures identified via Current Procedural Terminology, Fourth edition [CPT-4] codes only), and the

SEDD contain billing records from emergency department encounters that do not result in hospital admission. We queried the SASD and SID using 3 approaches to identify patients undergoing surgery for BPI:

- SASD query using CPT-4 procedure codes to identify patients at least age 18 years who underwent surgical treatment of BPI coded as brachial plexus suture (CPT-4 64861) and brachial plexus neuroplasty (CPT-4 64713: exploration, neurolysis, or nerve decompression) as an ambulatory/outpatient surgery.
- SASD query for patients at least age 18 years who had an associated ICD-9-CM diagnosis code of brachial plexus injury (953.4) and who were undergoing a procedure with a CPT-4 code for neuroplasty, nerve repair, nerve grafting, or nerve transfer ([Appendix A](#); available on the *Journal's* Web site at www.jhandsurg.org).
- SID query for patients at least age 18 years who had an associated ICD-9-CM diagnosis code of brachial plexus injury (953.4) and who were undergoing a procedure with an ICD-9-CM procedure code for neurolysis, peripheral nerve decompression, peripheral nerve graft, nerve transplantation, nerve repair, or neuroplasty ([Appendix A](#); available on the *Journal's* Web site at www.jhandsurg.org). CPT-4 codes are not available in SID.

In each of these databases, a unique identifier for each patient allows linkage across the individual state's databases. Patients cannot be tracked across different states.

To allow evaluation of 2 years of preceding SID and SEDD data for hospitalizations or emergency department visits, we identified patients who underwent surgery from SASD and SID records. The date of surgery (defined by the procedure date corresponding to the relevant CPT-4 code) was included. Using a unique personal identifier, we searched the SID and SEDD for any hospitalizations or emergency department visits by the patient within 2 years preceding the identified BPI surgery. We used ICD-9-CM diagnosis codes and "E codes" (for external causes of injury) from a prior hospitalization or emergency department visit to identify corresponding injuries ([Appendix B](#); available on the *Journal's* Web site at www.jhandsurg.org). These diagnosis codes from the "injury" event were collated and reviewed by a fellowship-trained orthopedic hand surgeon (C.J.D.) to determine appropriateness for inclusion in the study cohort. The date of injury was recorded from the admission date of the "injury" event, using the E code as the injury date if both types of codes were present. We included in this study only patients for whom we were able to identify both surgery and injury

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