EDITOR'S CHOICE

The Detrimental Effect of Decentralization in Digital Replantation in the United States: 15 Years of Evidence From the National Inpatient Sample

Joshua W. Hustedt, MD, MHS,* Daniel D. Bohl, MD, MPH,† Lloyd Champagne, MD*‡

Purpose Recent reports suggest a decrease in success rates in digital replantation in the United States. We hypothesize that this decrease may be associated with decentralization of replants away from high-volume hospitals.

Methods All amputation injuries and digital replants captured by the National Inpatient Sample during 1998 to 2012 were identified. Procedures were characterized as occurring at high-volume hospitals (> 20 replants/y), and as being performed by high-volume surgeons (> 5 replants/y). A successful procedure was defined as one in which a replantation occurred without a subsequent revision amputation. Hospital and surgeon volume were tested for association with the year and the success of the procedure.

Results The authors identified 101,693 amputation injuries resulting in 15,822 replants. The overall success of replants dropped from 74.5% during 2004 to 2006 to 65.7% during 2010 to 2012. The percentage of replants being performed at high-volume hospitals decreased from 15.5% during 2004 to 2006 to 8.9% during 2007 to 2009. Similarly, the percentage of replants being performed by high-volume surgeons decreased from 14.4% during 1998 to 2000 to 2.6% during 2007 to 2009. Replants performed by high-volume surgeons operating at high-volume hospitals had higher success rates than low-volume surgeons operating at low-volume hospitals (92.0% vs 72.1%). In addition, high-volume surgeons operating at high-volume hospitals attempted replantation at greater rates than low-volume surgeons operating at low-volume hospitals (21.5% vs 11.0%). Overall, an amputation injury presenting to a high-volume surgeon at a high-volume center had a 2.5 times greater likelihood of obtaining a successful replantation than an amputation injury presenting to a low-volume surgeon at a low-volume hospital.

Conclusions These data suggest that decreased success rates of digital replantation in the United States are correlated with the decentralization of digital replantation away from high-volume hospitals.

Clinical relevance The establishment of regional centers for replant referral may greatly increase the success of digital replantation in the United States. *(J Hand Surg Am. 2016;41(5):593–601.*

Key words Hand surgery, amputation traumatic, replantation, orthopedics.

*From the *Department of Orthopedics, University of Arizona College of Medicine-Phoenix, Phoenix, AZ; the †Department of Orthopedics, Rush University Medical Center, Chicago, IL; and the ‡Arizona Center for Hand Surgery, Phoenix, AZ.*

Received for publication November 13, 2015; accepted in revised form February 17, 2016.

No benefits in any form have been received or will be received related directly or indirectly to the subject of this article.

Corresponding author: Joshua W. Hustedt, MD, MHS, Department of Orthopedics, University of Arizona College of Medicine-Phoenix, 320 N. 10th St., Suite A, Phoenix, AZ 85006; e-mail: Joshua.hustedt@bannerhealth.com.

0363-5023/16/4105-0001$36.00/0
http://dx.doi.org/10.1016/j.jhsa.2016.02.011

Since the first successful thumb replant was described in 1965, the rate of successful revascularization of digital amputations has increased in the developed world.[1–3] Recent meta-analyses of digital replantation results worldwide reported successful revascularization rates in the 80% to 90% range, depending on indications.[4,5] Yet, despite the growing interest and success of digital replantation, there have been slow declines in the rate of successful revascularization in the United States.[6–8] A recent, large, retrospective review from 2 major U.S. level-1 trauma centers highlighted this decline, showing a success rate of only 57% in 135 digits.[9]

Furthermore, over time, fewer U.S. hand surgeons have reported experience with digital replantation.[10] A recent survey of the American Society for Surgery of the Hand members reported that only 56% of surgeons perform replants. Of those who do perform replants, the majority performed fewer than 5 replants per year. Although the reasons for this decline are likely multifactorial, reports have suggested a declining number of amputations, declining reimbursement for higher complexity cases, and increased selectivity for attempted replantation as possible causes for the decreased performance of this procedure.[1,7,8,10,11]

From evidence in the literature and experience in our own clinical practice, we speculate that the declining rates in digital replantation are due to decentralization of replants away from high-volume hospitals and high-volume surgeons. Therefore, the goal of our study was to examine the rate of successful revascularization in digital replantation in the United States and its association with surgeon and hospital volume over time.

METHODS

Study population selection

We conducted a retrospective cohort study of the National Inpatient Sample (NIS), a stratified survey of all U.S. hospitals conducted by the federal Healthcare Cost and Utilization Project. Hospitals in the sample are randomly selected to achieve a 20% sample of all U.S. hospitals. Numbers in this study are national estimates utilizing sampling weights based off the 20% national sample. All amputation injuries from 1998 to 2012 were identified with International Classification of Diseases, ninth edition (ICD-9) codes 885.0 to 886.1. Successful replantations were defined as those that underwent replantation (84.21, 84.22) without subsequent revision amputation (84.01, 84.02). All other amputation injuries were assumed to have been treated with initial completion amputation or similar debridement procedures.

A total of 105,003 patients were identified as having experienced a traumatic digital amputation. Owing to the limitations of ICD-9 coding in the database, only patients experiencing traumatic hand injuries who had 1 code for amputation injury were included in the study. These amputation patients were chosen as the study population because there was no way to determine the success or failure of individual digits in patients with multiple amputation codes with global ICD-9 coding in the database. Therefore, 3,310 patients were excluded owing to the presence of more than 1 code for a finger or thumb amputation injury. To ensure that these excluded patients did not represent a unique study population, the number of cases performed by high-volume providers was compared between those with single versus multiple amputation injuries, because it is possible that patients with multiple amputation injuries would be more likely to be transferred to a high-volume center. However, there was little difference between the percentage of patients with single versus multiple amputation injuries treated at high-volume hospitals (12.4% single injury vs 13.9% multiple injury) and a small difference by high-volume surgeons (9.3% single injury vs 13.3% multiple injury).

In addition, this study was designed to identify revascularization procedures following amputation injury. It may be that many other revascularizations take place in trauma practice; however, this study was designed to identify only revascularizations after amputation injuries because this has been shown to be a valid population to study in large databases.[6–8,12–14] Overall, 101,693 patients with single-digit, complete amputation injuries were identified for inclusion in the study sample. The study was granted exempt status by our institution's investigation review board owing to the deidentified nature of the data.

Study variables

High-volume hospitals were defined as those with greater than 20 cases per year and high-volume surgeons as those with greater than 5 cases per year. These cutoffs were chosen to remain consistent with previous work in the medical literature.[10,13,14] Under these definitions, "high-volume" surgeons and hospitals were those providers that ranked in the top 10% of overall national case volumes.

Study variables—including age, gender, finger or thumb injury, and year group—were extracted from the database and utilized in multivariable modeling. Study years were grouped into 3-year groups to minimize variability in sampling error from year to year. All patients were assigned an Elixhauser Comorbidity Index score, with the use of comorbidity software,