

A Population-Based Study of Replantation After Traumatic Thumb Amputation, 2007–2012

Elham Mahmoudi, PhD, MS,* Helen E. Huettelman, BS,* Kevin C. Chung, MD, MS†

Purpose The recommended surgical treatment after thumb amputation is replantation. In the United States, fewer than 40% of thumb amputation injuries are replanted, and little is known about factors associated with the probability of replantation. We aimed to investigate recent trends and examine patient and hospital characteristics that are associated with increased probability of attempted thumb replantation. We hypothesized that higher-volume teaching hospitals and level-I trauma centers attempted more replantations.

Methods We used 2007–2012 data from the National Trauma Data Bank. Our final sample included 2,206 traumatic thumb amputation patients treated in 1 of 365 centers during the study period. First, we used a 2-level hierarchical logistic model to estimate the odds of replantation. In addition, we used a treatment effect estimation method, with the inverse propensity score weighting to examine the difference in thumb replantation if the only variation among patients was their presumptive payer.

Results There was a higher probability of attempted replantation at teaching hospitals than nonteaching hospitals (odds ratio [OR], 1.40). Patients were less likely to undergo replantation at a level II (OR, 0.53) or a level III (OR, 0.33) trauma center. The uninsured were less likely to undergo replantation (OR, 0.61) than those with private insurance.

Conclusions Having insurance coverage and being treated in a high-volume, teaching, level-I trauma hospital increased the odds of replantation after traumatic thumb amputation. Regionalization may lead to a higher number of indicated cases of replantation actually being attempted. (*J Hand Surg Am.* 2017;42(1):25–33. Copyright © 2017 by the American Society for Surgery of the Hand. All rights reserved.)

Type of study/level of evidence Therapeutic II.

Key words Amputation, insurance, replantation, thumb, trauma.

 Additional Material
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From the *Section of Plastic Surgery; and the †Department of Surgery, Section of Plastic Surgery, University of Michigan Medical School, Ann Arbor, MI.

Received for publication April 4, 2016; accepted in revised form October 12, 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: Elham Mahmoudi, PhD, MS, University of Michigan, North Campus Research Complex, 2800 Plymouth Rd., Building 16, Room G024W, Ann Arbor, MI 48202; e-mail: Mahmoudi@med.umich.edu.

0363-5023/17/4201-0006\$36.00/0
<http://dx.doi.org/10.1016/j.jhsa.2016.10.016>

OVER 45,000 PATIENTS SUFFER TRAUMATIC digit amputations in the United States annually.^{1,2} These injuries disproportionately occur among young, blue-collar, male workers.² Since the first successful thumb replantation by Tamai and Komatsu in 1965,³ advances in the field of microsurgery and replantation have been substantial. Over time, the indication for replantation has expanded and microsurgical techniques have been refined to achieve better aesthetic and functional outcomes.^{4,5} With a favorable survival rate of 74% to 92% and health benefits such as motion and sensory return, if

clinically possible, replantation of an amputated thumb is recommended.^{6–8}

About half of the function of the hand is contributed by the thumb.⁹ Replantation of the thumb after traumatic amputation is a cost-effective procedure,⁴ with the majority of patients being able to return to their previous occupation and their daily living activities.¹⁰ For example, Sears and colleagues⁴ found that, despite an increased cost, a thumb replantation procedure was more effective and resulted in greater quality-adjusted life years than revision amputation. Despite documented functional and long-term economic benefits of thumb replantation,^{4,10} the procedure remains uncommon in the United States compared with other developed countries.^{11–16} For example, in 2001, 2004, and 2007 combined, only 27% of thumb amputations were replanted in the United States.¹⁷ A 2007 survey of the American Society for Surgery of the Hand members indicates that only 56% of hand surgeons perform replantation.⁵ Evidence indicates microsurgical expertise remains a scarce resource,^{17–20} and patients may undergo several transfers of care prior to definitive treatment.^{21,22} Replantation is most commonly performed in large, public teaching hospitals, and previous studies have demonstrated that the distribution of surgeons skilled in microsurgical techniques is not uniform.²³ The Committee on Trauma from the American College of Surgeons (ACS) is leading the national effort to regionalize complex hand trauma care in the United States to address the variation of care in acute microvascular repair of hand injuries, which include timely replantation of thumb and finger amputations. Regardless of evidence showing the substantial benefit and relatively high survival rate, little is known regarding the factors that contribute to variation in attempted replantation of an amputated thumb.

Using the 2007–2012 National Trauma Data Bank (NTDB),²⁴ the largest trauma registry in the United States, we examined the probability of attempted replantation among 2,206 traumatic thumb amputation patients who attended 1 of 365 hospitals during the study period. We examined variations in treatment procedure adjusting for relevant patient and hospital characteristics. The 3 specific aims of this study were (1) to examine the most recent trends in prevalence of thumb replantation versus revision amputation, (2) to examine patient and hospital characteristics that were associated with replantation attempts, and (3) to specifically examine the association between insurance and replantation as a recommended treatment for thumb amputation. We predicted that attempted replantation rates would

decrease throughout our study period. In addition, we hypothesized that high-volume teaching or level-I trauma hospitals had higher odds of replantation. Finally, we hypothesized that individuals without insurance coverage or with Medicaid had a lower probability of undergoing replantation.

MATERIALS AND METHODS

Data source

The NTDB²⁵ is managed by the ACS.²⁶ Major changes were made to this database in 2007. With 2012 being the last year available, we used the 2007–2012 NTDB for our analyses. The dataset includes information on patient, injury, and emergency department characteristics. We used the International Classification of Diseases, Ninth Revision, codes to define injury diagnosis (volumes 1 and 2) and the undertaken procedure(s) (volume 3).²⁷ We used diagnostic codes 885.0, 885.1 to classify traumatic thumb amputation. Procedure codes 84.02 and 84.21 were used to define revision amputation and thumb replantation, respectively.

Cohort selection

We included all traumatic thumb amputation patients who underwent revision amputation or attempted replantation after a thumb amputation. Between 2007 and 2012, there were 2,690 reported cases of traumatic thumb amputation. Our study cohort included patients 64 years old or younger because treatment of older patients might have been influenced by other confounding issues, contraindicating attempted replantation. Status as a trauma center (level I, II, III, or other) is designated by state officials and is verified by the ACS. Centers classified as “other” report their data to the NTDB; however, they are not officially a trauma center or assigned a trauma level according to their resources.

Our final sample, after excluding patients who were 65 years and older and patients with missing values, included 2,206 traumatic thumb amputation cases treated at 1 of 365 centers over the study period. A schematic flow diagram of our study population is presented in [Appendix A](#) (available on the *Journal's* Web site at www.jhandsurg.org).

Explanatory and outcome variables

We included the following relevant, available explanatory variables in our regression models.²⁷ The main outcome of interest in this study was the rate of undergoing replantation versus revision amputation after experiencing traumatic thumb amputation. At the patient level, our predictor variables included

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