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Traumatic finger amputation treatment preference among hand surgeons in the US and Japan

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Abstract

Purpose—Large geographic differences in utilization of a procedure draw into question its appropriate use. In Japan, replantation is commonly conducted for even very distal finger amputations. In the US, revision amputation is far more common. There has been no detailed investigation into the drivers of these differences.

Methods—We created a survey to assess surgeons' experience with replantation, estimates of physical and functional outcomes, attitudes toward amputees, and preferences in several injury scenarios. The survey was distributed to members of the Finger Replantation and Amputation Multicenter (FRAM) Study and to hand surgeons making podium presentations at the Central Japanese Society for Surgery of the Hand Annual Meeting.

Results—100% of both groups responded. There were no significant differences in experience with finger replantation. Japanese hand surgeons were significantly more likely to recommend replantation in all scenarios, despite 62% ranking function 6 months after replantation as “poor.” Japanese surgeons rated the appearance of a hand with an amputated finger significantly poorer than American surgeons. Japanese surgeons were also significantly more likely to report stigmatization against finger amputees.

Conclusion—There is no high level of evidence study comparing outcomes following replantation and revision amputation. The lack of evidence results in surgeons basing recommendations on personal preference. In this case, Japanese surgeons preferred replantation despite agreeing that functional outcomes were suboptimal. This may be because of Japanese cultural beliefs. Comparative effectiveness research, like that planned by the FRAM study, can help elucidate the appropriate utilization of finger replantation based on evidence.

Keywords

finger replantation; surgeon preference; cross-cultural difference

One of the most innovative Reconstructive Surgery procedures in the modern era is the replantation of digits through microsurgery techniques. Often these novel procedures are incorporated into practice before comparative effectiveness research has provided strong evidence based on rigorous outcomes studies to define indications and contraindications of their application. By the time such a trial can be planned, surgeons often have developed deeply seated preferences and no longer possess the equipoise necessary for an unbiased trial.¹ As a result, the indications for many procedures are loosely defined and decisions are based on patient and/or provider preference. The US federal government is now investing an unprecedented amount of money in biomedical research, not only for innovative new devices and surgical techniques, but to compare existing interventions. The Patient-Centered Outcomes Research Institute (PCORI) provides funding for comparative effectiveness research to identify and define the appropriateness of care. Inappropriate surgery, even if outcomes are good, is costly and imposes unnecessary risks on patients.²

Hand injuries pose a worldwide burden. Much of the world relies on manual labor such as farming and factory work for sustenance and income. In these cases, revision amputation, which allows for quicker return to work while largely maintaining function, is the preferred treatment. Despite more oversight by many countries in developing safety measure to protect workers, amputation of digits occurs frequently, even in highly developed countries such as the US and Japan. In these regions surgeons are engaged in intense microsurgical training and have access to advanced surgical technology and are able to replant amputated digits successfully. The use of this procedure is variable, however. In Japan and other parts of Asia, ever expanding indications for finger replantation mean the procedure is performed with increasing frequency.^{3, 4} In contrast, finger replantation is performed by a small fraction of hand surgeons at only 15% of American hospitals.^{5, 6} Of the hospitals that do offer replantation procedures, most perform fewer than 10 operations per year.^{5, 6} Consequently, only 14% of finger amputations injuries in the US are treated with replantation.⁵⁻⁷ Whereas in Japan, replantation is attempted in 29% of digit amputation cases⁸

There is little data comparing the results of finger replantation and revision amputation. Finger replantation can preserve digit length, nail, and sensate fingertip skin, but the procedure requires a long rehabilitation period and can result in functional deficits owing to persistent finger stiffness especially for injuries in Zone 2.^{3, 4, 9} If the finger is not replanted recovery following revision amputation is relatively short and function is largely retained.¹⁰ However, proximal amputations can cause functional deficits, and psychological problems may arise after amputations at any level. There is also little data regarding the appropriate indications for replantation. In the US, replantation is generally not indicated if there has been an extended ischemia time, for crush or avulsion injuries, for amputations distal to the PIP joint, or for single digit amputation.¹¹⁻¹³ In fact, replantation has been shown to be not a cost-effective treatment for a single digit amputation; replantation only becomes cost-effective when replanting 3-4 digits.¹⁴ In Japan, however, all types of digit amputations are

considered for replantation, even distal replantations, including those that have no bone loss.^{15–17} Japanese patients' satisfaction is generally attributed to maintaining digit length and salvaging the nail.^{18, 19}

A focus on aesthetics over function in Japanese patients may be due to Confucian teachings that maintain that the body is a gift from one's parents and therefore must be safeguarded. Hence, if one begins life with a complete body, it is one's responsibility to see that it remains complete.²⁰ These values of body integrity may lead Japanese patients to favor replantation. Finger amputation can have an especially notorious connotation as well. A well-known Japanese gang, Yakuza, has a custom involving the self-amputation of the small finger.²¹ Someone with a traumatic defect to the small finger may find it difficult to avoid assumptions of gang involvement. The observed difference in utilization rate may be due to patient preference. But patients generally make decisions based on the advice and recommendations of their surgeons. Revision amputation may be more common in the US because American surgeons recommend it to their patients. Likewise, Japanese surgeons may preferentially recommend replantation. The aim of this project was to survey hand surgeons from the US and Japan about their experience with and attitudes about replantation. We hypothesized that Japanese surgeons will have more experience than American surgeons and that they will view the results of finger replantation more favorably than will American hand surgeons.

Methods

Study Sample

Plastic surgeons with expertise in replantation were recruited from members of the Finger Replantation and Amputation Multicenter (FRAM) Study for the American survey and hand surgeons who made podium presentations at the 32nd Annual meeting of the Central Japanese Society for Surgery of the Hand were recruited for the Japanese survey. The FRAM study is the largest multicenter study conducted by the Plastic Surgery Foundation to prospectively determine outcomes of revision amputation and replantation after traumatic finger amputation as well as patient, surgeon, and hospital-level predictors of outcomes. Each of the 15 study sites is the primary center for hand trauma in their region. Participating surgeons (approximately 2 per site) have extensive experience treating traumatic hand injuries including finger amputation. The Central Japan Society for Surgery of the Hand is one of the largest societies for hand surgeons and its annual meeting has been held since 1984. Members are hand or orthopaedic surgeons and microsurgeons and are leaders in their fields. Surgeons scheduled to make podium presentations were asked to complete the survey prior to the meeting. All members of both groups (100% participation) completed the survey. The survey was administered via 2 online survey creation websites (1 in English and 1 in Japanese).

Questionnaire

We created a survey (Appendix) based on a conceptual framework (Figure 1) that hypothesizes that treatment decisions are influenced by hand surgeons' experience with finger replantation, personal preferences, and attitudes toward finger amputees. Surgeons

were presented with 4 scenarios and asked what treatment they chose in each case. (Figure 2) Each scenario involved an otherwise healthy, nonsmoking 30-year-old man who has sustained a single finger amputation. A single index finger amputation was selected because it is the most controversial procedure with no clear indication whether to replant or to amputate. Scenarios covered distal versus proximal amputation and intact versus contaminated fragments. Surgeons were asked to estimate the function and appearance for the index finger PIP-level amputation injury scenario 6 months after successful replantation or revision amputation as well as the time off work expected after each treatment. We also asked questions to assess possible stigmatization experienced by finger amputees. Stigma-related questions were adapted from two Neuro-QOL short forms (Ability to Participate in Social Roles and Activities and Stigma) and the Amputee Body-Image Scale (ABIS).^{22–25} These surveys were created and validated to be self-administered by patients to report their personal experiences; we modified select items so that the questions would be in reference to other people. For example, the ABIS question, “Because I am an amputee, I feel anxious about my appearance on a daily basis” was altered to “People with a single finger amputation feel anxious about their appearance on a daily basis.”

Standard “translation, back-translation” methodology was used to ensure both the English and Japanese surveys were querying the same topics.²⁶ The survey was created in English by both an American and Japanese native to ensure cultural sensitivity. The survey was then translated to Japanese and another native Japanese speaker translated the Japanese version back into English. The resulting two English surveys were compared by a fourth, native English-speaking, party to determine that the questions in each survey were the same or had the same meaning. After satisfactory translation the English survey was pilot-tested by surgical residents at the US hospital. Changes were made for readability, relevance of questions, and technical issues as necessary.

Analysis

Demographic and experiential differences were compared with Wilcoxon-Mann-Whitney test or Fisher’s exact test, as appropriate, using country as the independent variable. Country-related differences in treatment preference were also analyzed with Fisher’s exact test. Kruskal Wallis test (a non-parametric version of ANOVA), using country as the independent variable, was used to explore relationships between country and preference, estimates of recovery, and attitudes toward amputees.

Estimate of function, sensation, and appearance after recovery, time off work, and attitudes toward amputees were recorded on 5-point Likert scales with 1 being the worst result and 5 being the best result. Surgeons’ preferences for each of the four scenarios (shown in Figure 2) were recorded as 1 for attempted replantation and 2 for revision amputation (surgeons who responded “other” were discarded from this portion of the analysis). The four responses were summed to create an ordinal variable indicating how inclined a surgeon was to attempt replantation. The variable ranged from 4 (very likely to attempt replantation) to 8 (not at all likely to attempt replantation). For example, a surgeon who selected “attempt replantation” for Cases 1 and 2 and selected “revision amputation” for Cases 3 and 4 would have a score of 6 (1+1+2+2=6). This score was used as the outcome variable in a multivariable regression

model to determine which, if any, recovery factors and/or attitudes predicted treatment preference. Finally, Spearman correlation and Wilcoxon-Mann-Whitney test was used to test the effect of age and gender, respectively, on replantation preferences.

Results

100% of surgeons contacted to complete the survey responded; a total of 66 surveys were completed. American and Japanese hand surgeons were similar in terms of age and gender. (Table 1) Surgeons in the American sample were significantly more likely to be trained in plastic surgery (78% vs 12%; $p<0.0001$), whereas those in the Japanese sample were more often trained in orthopaedic surgery (22% vs 88%; $p<0.0001$). This reflects the practice patterns in the respective countries, in which plastic surgery hand surgeons in the US have intense exposure to microsurgery and orthopaedic hand surgeons in Japan have more exposure to hand surgery. American surgeons in this study were also much more likely to work in teaching hospitals (94% vs 32%; $p<0.0001$). Both groups contained surgeons of differing levels of experience with finger replantation. (Table 2) American surgeons were significantly more likely than Japanese surgeons to report that they were “very confident” or “confident” in their ability to safely and effectively perform a finger replantation (88% vs 47%; $p<0.0001$); we inferred the difference may be owing to the Japanese trait of modesty rather than actual differences in surgical skill.

Japanese surgeons were significantly more likely than their American counterparts to opt to attempt replantation in all scenarios at a ratio of more than 2:1. (Table 3) Japanese surgeons were also more likely to strongly agree or agree with the statement “finger replantation should always be attempted (21% vs 13%; $p=0.003$). The inclination toward replantation existed despite there being no significant difference in agreement with the statement “all patients prefer replantation” (16% vs 21%; $p=0.58$). Furthermore, American and Japanese surgeons agreed that function and sensation of the replanted digit would be only good or fair 6 months after surgery (Table 4). American surgeons anticipated a significantly longer time off work following replantation than Japanese surgeons ($p=0.0009$). The surgeons agreed that hand function would be better 6 months after revision amputation than after replantation and that patients would be back to work sooner. Japanese surgeons rated stump sensation significantly worse than did American surgeons ($p=0.0004$). The most disagreement was seen regarding hand appearance after revision amputation; 62% of Japanese surgeons estimated appearance as “poor” whereas only 13% of American surgeons gave a “poor” rating ($p<0.0001$). Finally, Japanese surgeons believed that single finger amputees are more stigmatized than did American surgeons. (Table 5) Japanese surgeon were significantly more likely to strongly agree or agree that single finger amputees are disabled (6% vs 12%; $p<0.0001$), are less employable (6% vs 21%; $p=0.0003$), and may be avoided by others (6% vs 12%; $p=0.03$). American surgeons were more likely to strongly agree or agree that amputees are concerned about functional ability (24% vs 45%; $p=0.03$).

Multiple regression indicated that beliefs that finger amputees would be stigmatized ($p=0.008$) or treated unkindly ($p=0.04$) and beliefs that finger amputees are less attractive ($p=0.02$), disabled ($p=0.05$), and unable to care for themselves ($p=0.05$) were predictors of preference for replantation regardless of country. Professionally, surgeons who had more

experience with replantation ($p=0.03$) and had performed replantation more recently ($p=0.04$) preferred replantation. No significant relationship was noted between age and replantation preference. When examined by country, the lack of relationship persisted for American surgeons. However, there was a significant inverse relationship between Japanese surgeons age and preference with younger surgeons being more likely to attempt replantation ($\rho=-0.52$, $p=0.02$). Finally, there were no significant differences in replantation preference between male and female surgeons both as a whole and on the country level.

Discussion

Our hypotheses that Japanese surgeons would have more experience with replantation than American surgeons and that they would view the results of finger replantation more favorably than American hand surgeons were rejected. Japanese hand surgeons had no more experience than American hand surgeons nor had they performed finger replantation more recently, although those were the 2 professional factors driving preference for replantation regardless of country (in Japan age was an additional factor). Furthermore, Japanese surgeons did not view replantation more favorably. They agreed with American surgeons that function and sensation would be only good to fair 6 months after replantation. Japanese surgeons, however, did view amputation more unfavorably than American surgeons. Japanese surgeons rated hand appearance after amputation lower and reported that finger amputees would be stigmatized and avoided by some people. This is consistent Japanese beliefs regarding body integrity and finger amputation's association with gang activity in that country, values that were not expressed by American surgeons. American surgeons believed that single finger amputees were more concerned about their functional capabilities. However, there was no difference between groups in estimated hand function 6 months after amputation. This may indicate how well surgeons know their unique patient populations. American surgeons estimate acceptable function 6 months after amputation but they anticipate that American patients will nonetheless be concerned. Japanese surgeons also estimate acceptable function and anticipate that Japanese patients will focus their concerns elsewhere, perhaps on appearance.

The decision to attempt replantation must be made in a relatively short period of time. Patients, naturally, do not have the extensive experience treating finger amputation injuries that surgeons have and often rely on surgeon recommendation to guide their decision. But as our study shows, those recommendations may be more preference than evidence-based. There is little published comparative-effectiveness data that would assist providers and patients in making an evidence-based decision regarding finger amputation treatment. The FRAM study group aims to fill the existing evidence gap, first by undertaking the Finger Replantation AND Amputation CHallenges in assessing Impairment, Satisfaction, and Effectiveness (FRANCHISE) study. This project will retrospectively assess patients treated for traumatic finger amputations with either replantation or revision amputation. The data collected during the FRANCHISE study will inform priorities in the selection of outcomes measures for the prospective FRAM study. Ethical issues prevent FRAM from being a randomized trial. Treatment decisions will be made in the standard way, which includes the influence of patient and surgeon preferences. We do not view this as a problem, however.

Patient and surgeon preferences do exist and will continue to play a role in treatment decision-making. Randomized trials can demonstrate efficacy, but effectiveness may be reduced when treatment preferences come into play in the routine clinical environment. Acknowledgment of preferences allows for their incorporation into realistic clinical practice guidelines and appropriate use criteria.^{27, 28} For instance, if FRAM finds that the outcomes of replantation are not significantly worse and that replantation is not significantly more risky it may be appropriate to replant a digit based solely on patient preference.^{27, 28}

Sample size is a limitation of this project. Surgeon response rate to surveys is often very low. In anticipation of this, we surveyed discrete groups in both countries to ensure 100% participation. As can be seen in the demographic factors and experience, both groups represent a wide range of age, practice duration, and microsurgical experience. However, there were some areas where our survey sample may differ from the hand surgery populations who perform replantation. For instance, in our survey, 94% of American hand surgeons worked at teaching hospitals and 88% of Japanese hand surgeons were orthopaedic surgeons. Future surveys should endeavor to correct these, and any other, areas of possible bias. In the interest of reducing respondent burden we opted to present only 4 finger amputation injury scenarios for surgeons to consider. We selected injuries for which indications are not universally agreed upon. Multiple digit amputations, very proximal amputations, and amputations at any level in children are generally treated with attempted replantation.^{11, 13} Surveying surgeons about these scenarios would likely result in a consensus to replant. The presentation of scenarios involving distal amputation to a single digit in an adult is less certain and allowed surgeons demonstrate preference.

Our study has demonstrated that Japanese surgeons prefer to attempt replantation in nearly all scenarios, even while acknowledging that replantation does little to improve function over revision amputation. This is likely influenced by beliefs about hand appearance after finger amputation and perceptions that single finger amputees may be stigmatized. In fact, when replantation is not possible complicated reconstruction and even phalangeal lengthening are used for aesthetic benefit.^{29–32} American surgeons are inclined to perform revision amputation in nearly all survey scenarios, likely because there is little stigma attached to finger amputation in the US. Our study has inadvertently uncovered a major hurdle to apply the results of comparative effectiveness in everyday practice. In cases where there is no clearly superior treatment current practice has been driven by provider, and in some cases, patient preference. Projects such as the FRAM study can determine which patients and injuries benefit most from replantation but it remains to be seen if clinical practice guidelines or appropriate use criteria born from the study will be able to overcome cultural influence.

Supplementary Material

Refer to Web version on PubMed Central for supplementary material.

Acknowledgments

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Figure 1.
Conceptual model of influences on surgeon treatment recommendation

Please consider the following cases. In this scenario please indicate how you would treat the patient if they presented to your practice.

Case 1: You are asked to consult on the case of a 30-year-old man with an **index** finger amputation at the **PIP** joint level due to a saw injury. The amputated fragment is **intact**. He is otherwise healthy and does not smoke.

☐ Attempt replantation
☐ Revise amputation
☐ Other. Please specify: _____

Case 2: You are asked to consult on the case of a 30-year-old man with an **index** finger amputation at the **DIP** joint level due to a saw injury. The amputated fragment is **intact**. He is otherwise healthy and does not smoke.

☐ Attempt replantation
☐ Revise amputation
☐ Other. Please specify: _____

Case 3: You are asked to consult on the case of a 30-year-old man with a **little** finger amputation at the **DIP** joint level due to a saw injury. The amputated fragment is **intact**. He is otherwise healthy and does not smoke.

☐ Attempt replantation
☐ Revise amputation
☐ Other. Please specify: _____

Case 4: You are asked to consult on the case of a 30-year-old man with an **index** finger amputation at the **DIP** joint level due to a saw injury. The amputated fragment is **severely contaminated**. He is otherwise healthy and does not smoke.

☐ Attempt replantation
☐ Revise amputation
☐ Other. Please specify: _____

Figure 2.
Four scenarios presented in survey

Table 1

Cohort demographic and professional factors

	United States		Japan		p-value
	n	%	n	%	
	32		34		
Age					
mean	46.2		42.8		0.15
range	29–64		29–69		
Gender					0.10
male	27	84%	33	97%	
female	5	16%	1	3%	
Specialty training					<0.0001
Plastic Surgery	25	78%	4	12%	
Orthopaedic Surgery	7	22%	30	88%	
When did you complete hand fellowship training?					0.86
<1 year ago	1	3%	2	6%	
1–5 years ago	8	25%	9	27%	
6–10 years ago	8	25%	9	27%	
11–20 years ago	6	19%	8	24%	
>20 years ago	9	28%	6	18%	
Where do you perform hand surgery? (select all that apply)					
private hospital	6	19%	13	38%	0.12
public hospital	8	25%	13	38%	0.30
teaching hospital	30	94%	11	32%	<0.0001
private practice	3	9%	1	3%	0.35

Bolded values indicate statistical significance

Table 2

Surgeon experience with finger replantation

	United States		Japan		p-value
	n	%	n	%	
How much of your practice is hand surgery?					1.0
<25%	2	6%	2	6%	
25% – 49%	4	13%	5	15%	
50% – 74%	9	28%	9	27%	
75%+	17	53%	18	53%	
How many finger replantation surgeries have you done in your entire career?					0.74
0	1	3%	3	9%	
1 – 20	18	56%	11	32%	
20 – 50	8	25%	7	21%	
>50	14	44%	13	38%	
How long has it been since you personally have performed a finger replantation?					0.19
<3 months	16	50%	18	53%	
3 – 6 month	8	25%	4	12%	
7 – 12 months	1	3%	4	12%	
>12 months	7	22%	5	15%	
I do not perform finger replantation	0		3	9%	
How confident are you in your ability to safely and effectively perform finger replantation?					<0.0001
Very confident	21	66%	3	9%	
Confident	7	23%	13	38%	
Somewhat confident	2	6%	12	35%	
Not confident	2	6%	3	9%	
I do not perform finger replantation	0		3	9%	

Bolded values indicate statistical significance.

Table 3

Treatment preference by country

Patient: A 30-year-old man who has never smoked and is otherwise healthy injured by a saw

scenario	% opting to attempt replantation		p-value
	United States	Japan	
amputation at the PIP joint of the index finger; fragment is intact *	31%	88%	<0.0001
amputation at the DIP joint of the index finger; fragment is intact **	38%	97%	<0.0001
amputation at the DIP joint of the small finger; fragment is intact ***	25%	97%	<0.0001
amputation at the DIP joint of the index finger; fragment is severely contaminated ****	9%	41%	<0.0001

* 9% of US surgeons and 12% of Japanese surgeons selected “other” (ray amputation, let the patient decide, decision based on schedule)

** 3% of both groups selected “other” (let the patient decide, decision based on schedule)

*** 3% of Japanese surgeons selected “other” (let the patient decide)

**** 21% of Japanese surgeons selected “other” (flap reconstruction, let the patient decide)

Table 4

Recovery estimates 6 months after injury

	Replantation (%)			Revision Amputation (%)		
	US	Japan	p-value	US	Japan	p-value
hand function			0.76			0.06
excellent	0%	0%		19%	15%	
very good	16%	18%		53%	32%	
good	38%	41%		23%	29%	
fair	38%	29%		13%	21%	
poor	9%	12%		0%	3%	
finger/stump sensation			0.16			0.0004
excellent	3%	0%		13%	6%	
very good	9%	3%		41%	15%	
good	31%	27%		38%	47%	
fair	44%	56%		6%	27%	
poor	13%	15%		3%	6%	
hand appearance			0.93			<0.0001
excellent	13%	21%		0%	0%	
very good	53%	41%		16%	0%	
good	25%	32%		38%	9%	
fair	9%	6%		34%	29%	
poor	0%	0%		13%	62%	
Estimated time off work						
0 – 2 months	0%	3%	0.0009	81%	88%	0.42
3 – 4 months	22%	47%		16%	12%	
5 – 6 months	44%	35%		3%	0%	
7 – 12 months	28%	14%		0%	0%	
>12 months	6%	0%		0%	0%	

Bolded values indicate statistical significance.

Table 5

Attitudes about amputees and stigmatization

People with single finger amputations are...	US	Japan	p-value
disabled			<0.0001
strongly agree/agree	6%	12%	
neither agree nor disagree	3%	32%	
disagree/strongly disagree	91%	56%	
less employable than other people			0.0003
strongly agree/agree	6%	21%	
neither agree nor disagree	6%	44%	
disagree/strongly disagree	88%	35%	
avoided by some people			0.03
strongly agree/agree	6%	12%	
neither agree nor disagree	16%	32%	
disagree/strongly disagree	78%	56%	
less attractive than other people			0.26
strongly agree/agree	0%	0%	
neither agree nor disagree	19%	3%	
disagree/strongly disagree	81%	97%	
treated unkindly by some people			0.14
strongly agree/agree	9%	27%	
neither agree nor disagree	28%	27%	
disagree/strongly disagree	63%	47%	
concerned about their functional capabilities			0.03
strongly agree/agree	47%	23%	
neither agree nor disagree	31%	38%	
disagree/strongly disagree	22%	38%	

Bolded values indicate statistical significance