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Comparison of Two Treatments for Finger Tip Amputation:
A Retrospective Cohort Study

by

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A thesis submitted in partial fulfillment
of the requirements for the degree of
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ABSTRACT

Purpose: To compare the costs and length of disability for conservative treatment versus skin grafting of distal finger and thumb tip amputations.

Methods: Thirty-five zone I finger or thumb tip amputations in thirty-five workers in the Southeastern United States were included in this study. Twenty-four were treated with conservative treatment (bandaging to protect the wound). Eleven were treated with skin grafting. The total cost of medical care, total cost including wage replacement, and the length of disability were compared between the two groups. Impairment at the end of treatment was considered.

Results: Even when the cost of wage replacement was taken into account, the total cost for skin graft treatment for these injuries is significantly higher. The length of disability was not statistically different between the two treatment groups. There was not a significant difference in impairment reported at the end of treatment.

Conclusion: This study did not demonstrate any economic or medical advantage for treating zone I finger or thumb tip amputations with skin grafts. The size of the defect in the skin graft group was significantly larger, though, and the results obtained in this comparison may not allow us to draw valid conclusions about the comparison of these two treatments.

Introduction

Specific Aim: The specific aim of this study was to compare two treatments for distal finger or thumb tip amputations in a population of workers from the Southeastern United States. The first method of treatment was conservative management, usually bandaging the digit to keep it clean and covered. The second method of treatment was a simple full or split thickness skin graft to cover the open area. These two treatments were compared in terms of several outcomes: total cost, medical cost, wage replacement cost, length of disability, and impairment at the end of treatment.

Research Question: Is skin grafting a more cost effective treatment for distal fingertip amputations than conservative treatment in a population of workers in the Southeastern United States?

Null Hypothesis #1: The time to heal for a fingertip amputation is the same whether treated by skin grafting or treated conservatively.

Null Hypothesis #2: The total cost of medical treatment and lost wages for an injured worker with a fingertip amputation is the same whether treated by skin grafting or treated conservatively.

Background and significance

Fingertip amputations are a common injury, with an incidence each year of approximately 15,000 occupational amputations[1] and 25,000 non-occupational amputations. The occupational amputations most commonly occur when using machinery. The non-occupational amputations have a bimodal distribution: peak incidence occur among young children who get their fingers caught in doors and among older adults, between 55 and 64, who use power tools.

Although mortality from distal fingertip amputations is quite rare, the morbidity they cause is significant. All activities requiring the use of the injured hand are limited. The wound has to be kept clean and dry limiting hand washing and other activities. The bulk of the bandage limits the use of the hand for skilled tasks and impairs many activities necessary for daily living. Laborers cannot work or are quite limited in what they can do. Infection is a serious concern.

Because this injury impacts one's ability to function both at home and at work, the time to heal is important, not only for comfort but also for productivity. The real cost of this injury is not just the cost of treatment, but also the cost of disability due to limited use of the hands. In order to look at both the time to heal and the total cost of the injury, this study will evaluate a population of workers. Both the medical costs and wage-replacement costs will be evaluated.

Despite the fact that a fingertip amputations are a common injury with significant morbidity, there is no consensus as to the best treatment[2]. Review articles on this topic

are generally expert opinions[3-5]. The majority of articles that have been published are case series, detailing a specific technique for treatment and the results which the author(s) have had with that technique[6-13].

There has been at least one study which compared two treatments. Hattori, et al, published a retrospective comparison of outcomes in patients who had their distal fingers replanted versus those who had the bone shortened and the wound closed primarily. He concluded that successful replantation resulted in better functional outcome, improved appearance, and higher patient satisfaction. The cost of treatment and the length of disability were substantially greater, though, in the replantation group.[14]

No other studies were found that systematically compared the results from different treatments. This current study compares two treatments for smaller amputations where replantation is not generally considered an option.

The techniques to repair fingertip amputations fall into four general categories. The most conservative method is to bandage the wound, usually with an occlusive dressing until granulation tissue fills in the defect to replace the lost skin. This is called healing by secondary intention and is considered conservative treatment because it involves the least intervention. This treatment is simple to provide, does not require any technical expertise, and is inexpensive. Very good results have been reported by some researchers[6]. Its disadvantage is that healing can take a long time and the finger can be painful, even after it has completely healed.

A second technique which can be used is primary closure, where any remaining skin is sutured together over the defect. The skin on the fingertip cannot stretch much,

though, so the distal bone must often be cut back to accomplish this, leaving the finger shorter than before. Neither patients nor surgeons are usually satisfied with this result.

A third technique is to cover the defect with a partial or full-thickness skin graft. The tissue for the graft can be taken from the hand, the forearm, or other donor sites on the body[8]. This tissue is sutured in place with interrupted sutures and further secured by a bolster dressing.

The fourth group of techniques is to use some type of flap-graft or advancement graft[7, 10-13, 15]. These techniques are more complicated, often requiring two operations instead of just one. They are most often reserved for amputations which involve most of the distal phalanx, not just the fingertip. Microsurgical reattachment is not generally a consideration unless the digit has been amputated at the distal interphalangeal joint (DIP) or proximal to it. This current study only evaluated amputations of the tip of the finger or thumb including the pulp, with no bone injury greater than a distal tuft fracture.

There is consensus in the literature reviewed that primary closure is rarely the best treatment. Patients treated with this technique take longer to heal and are left with deformities of the finger. Flap grafts, advancement grafts, and replantation are generally reserved for more severe injuries than this study addresses. None of these treatments were considered in this study.

The two remaining repair techniques, conservative treatment and simple skin grafts, were compared in this study to determine which one heals faster and which one costs less. This study was unique in that the cost of wage replacement was included in the total cost of the injury.

Study Design

This study addressed the questions posed in the hypotheses using a retrospective cohort of workers from the Southeastern United States who sustained finger or thumb tip amputations between January 1, 2004 and December 31, 2006. They were identified using the database of a large Workers' Compensation insurance company. Information about the cases was abstracted from the claim records maintained by the insurance company. Cases which meet the inclusion criteria were divided into two cohorts based on the treatment they received: skin graft or conservative treatment.

One outcome which was evaluated was total cost of medical treatment and lost wages. A second outcome which was evaluated was length of disability. Other issues which were considered included any remaining impairment at the end of treatment such as numbness or hypersensitivity affecting the use of the hand.

Because this study utilized records which were already in existence and did not involve recording any information which could identify the specific patients or be linked back to their personal information, an application for 'Exempt' status was filed with the University of South Florida Institutional Review Board, and was approved.

Study Population

The study population included all workers from 18 to 65 years old with an isolated, zone one (distal to the base of the nail bed) traumatic amputation of the finger or thumb tip whose insurance benefits were managed by Heritage Summit Healthcare in the Southeastern United States. The date when these injuries occurred was between January 1, 2004 and December 31, 2006. The records for this population are accessible in the electronic data base of the insurance company.

The target population for this study is workers from 18 to 65 years old in the United States who are treated for this type of injury. The results are applicable to workers around the world depending on the circumstances surrounding their injury and treatment. The results may be applicable to the non-occupational injuries of this type which occur in adults. The application of these results to the treatment of small children who sustain this type of injury would be limited because performing simple skin grafts on their fingers would be more difficult without sedation. Children may also heal better with conservative treatment than their adult counterparts.

Cases were identified through a computer search of diagnostic codes for 885.0, traumatic amputation of the thumb without complication; 886.0, traumatic amputation of the finger without complication; and 883.0, open wound of the finger or thumb. Inclusion criteria included treatment by one of the two methods being compared.

Exclusion criteria will include 1) other major traumatic injuries; 2) any bone involvement proximal to the tuft of the distal phalanx; and 3) a skin defect greater than

three square centimeters. A practical exclusion criterion which occurred in the course of the study was lack of medical records about treatment. This was rare as providers of care are not paid unless the insurance company receives the medical record. In these cases, no apparent treatment was provided and no lost wages were paid.

Retention of subjects was not an issue. Because workers' compensation insurance covers all benefits for a specific injury, all treatment was managed by the insurance company even if the worker changed jobs or moved. Some records were missing, though. In some cases, the adjustor had commented that the treating physician had released the patient to light duty, full duty, or put them at MMI on a specific date. No medical record from that date was scanned into the file, though. In these cases, the adjustor's memo was considered to be accurate.

In order to minimize the problem of missing information in the charts, standard information which is consistently recorded in workers' compensation cases has been identified for comparison in this study. This was supplemented with information abstracted from the records of treatment.

Data Collection Methods

The database maintained by the insurance company includes all payments made for medical treatment, wage replacement, and legal services. All medical records for treatment of the covered injury are scanned into the database. In addition, information from the employer, the health care provider, and the worker is documented by the adjustor according to workers' compensation requirements. The payment information and the adjustor information is generally quite complete. The medical records may vary in both completeness and legibility according to provider.

As described above, cases were identified by a systematic search of the database by diagnostic codes, 8830, 885.0, and 886.0. Identifying those cases which were treated with skin grafting was aided by a second search of the database for procedure codes related to skin grafts on the hands, 14040, 15000, 15120, and 15050. The charts were further evaluated according to the inclusion and exclusion criteria as defined under the study population section.

The charts were reviewed for information on the nature of the injury. This included the size of the defect, any bony involvement, the mechanism of injury and the level of the amputation. The size of the defect was very difficult to determine from the available records. Actual measurements were almost never recorded. The size of the defect was estimated based on the anatomical description of the injury, radiology reports, and drawings in the medical records.

The type of treatment was clearly designated in the medical records. Those who were instructed to bandage the wound without any other intervention were included in the conservative treatment group. The follow up notes on this group were less frequent and less detailed than those for the graft group. A note in the chart from the adjustor that the injured worker was working full duty without any problems was accepted as evidence of full healing. Those who had a skin graft had both a detailed procedure note in their record and subsequent notes commenting on the success or failure of the graft.

Patient characteristics were recorded included age, sex, smoking history, and medical history. These have been shown to be related to graft survival and may also affect recovery with conservative treatment[16]. The mechanism of injury was also recorded. A finger tip amputated cleanly by a knife will heal much better than one that is torn off or avulsed. The most damaging type of injury is a crush injury.[16]

The dates when the injured worker was allowed to return to light duty and full duty were recorded. Maximum Medical Improvement (MMI) is a workers' compensation term designating that further treatment will result in no further improvement. This may reflect complete healing from an injury, or there may be a residual impairment from the injury. The date the injured worker was said to be at MMI was recorded.

At MMI, any residual impairment is rated according to state guidelines based on the Guidelines to the Evaluation of Permanent Impairment published by the American Medical Association. This permanent impairment at the time of MMI was recorded when available. It was recorded as zero, if not otherwise recorded. This assumption of an impairment of zero is consistent with what the worker would have been paid for their impairment.

All costs related to the claim were recorded. No detailed bills were reviewed. The total amount paid for wage replacement, medical treatment, and legal services was recorded for each claim.

The time it took for the worker to return to their job without any restrictions was used to approximate the time to heal in this study. The ability to work, with or without restrictions, was addressed in all the records reviewed. The worker's injury should be healed when the doctor releases them to work without any restrictions and they are able to do so.

The second outcome which was evaluated was total cost. The medical costs and wage replacement costs are both documented in the workers' comp file. The average weekly wage (AWW) of each worker will be recorded. The total wage replacement paid to each worker will be recorded. Total medical will be recorded. Before these costs can be compared, an adjustment may have to be made if the AWW differs between the two cohorts.

Results

The query using 883.0 for open wound of the finger or thumb, generated a list of several thousand claims. The combined query for 885.0, traumatic amputation of the thumb, and 886.0, traumatic amputation of the finger generated a list of 101 claims. On review, thirty-five of these met the inclusion and exclusion criteria. Twenty-four were treated conservatively; eleven had skin grafts. The mean age of these two groups was 33 years. The average size of the wound was smaller in the conservative treatment group by 0.5 cm². This approached statistical significance with an Exact Test value on Wilcoxon Sum Rank testing of 0.08.

Table 1: Characteristics of Study Subjects

Gender	Age	Race	Smoking History	Alcohol	Medical History	Injured Digit	Injury Size cm³	Mechanism
Male	25	White	Yes	Social	No	Lthumb	25	Sharp Cut
Male	24	Unknown	Unknown	Unknown	No	Lthumb	50	Sharp Cut
Female	32	White	Unknown	None	No	Rthumb	50	Sharp Cut
Male	33	Other	Unknown	None	Yes	Lthumb	50	Sharp Cut
Male	25	Unknown	Yes	Social	Yes	Lthumb	100	Unknown
Male	32	Unknown	Yes	None	Unknown	Rindex	100	Avulsed
Male	25	Unknown	Yes	Daily	No	Lthumb	100	Sharp Cut
Male	40	Unknown	Yes	None	Yes	Rmiddle	100	Sharp Cut
Male	37	Unknown	Unknown	Unknown	Unknown	Lthumb	100	Sharp Cut
Male	26	Hispanic	Unknown	None	No	Lthumb	100	Rough Cut
Male	35	White	Yes	Unknown	No	Lmiddle	100	Sharp Cut
Male	43	Unknown	Yes	Unknown	No	Lthumb	100	Sharp Cut
Male	43	White	No	Social	Yes	Lthumb	100	Crushed
Male	23	Hispanic	Yes	Social	No	Rthumb	150	Sharp Cut
Male	20	White	No	None	No	Lindex	150	Rough Cut
Male	23	Unknown	No	None	No	Lthumb	150	Sharp Cut
Male	31	White	No	Social	No	Rmiddle	150	Crushed

Gender	Age	Race	Smoking History	Alcohol	Medical History	Injured Digit	Injury Size cm3	Mechanism
Male	23	White	No	Social	No	Lthumb	150	Rough Cut
Male	49	Unknown	No	Social	Yes	Lthumb	200	Sharp Cut
Male	32	Unknown	No	None	Yes	Lthumb	200	Rough Cut
Male	43	Hispanic	No	None	No	Rthumb	200	Crushed
Male	19	White	Unknown	None	No	Lthumb	200	Sharp Cut
Male	54	Other	Yes	None	Yes	Lthumb	200	Rough Cut
Male	50	White	No	None	Yes	Lindex	200	Avulsed
Male	18	Hispanic	Unknown	Unknown	No	Rthumb	100	Sharp Cut
Male	18	Unknown	Unknown	Unknown	Unknown	Rthumb	150	Sharp Cut
Male	20	Hispanic	No	None	No	Lthumb	150	Sharp Cut
Male	31	Hispanic	No	None	No	Lthumb	150	Crushed
Male	37	Unknown	Unknown	Unknown	3	Lindex	200	Crushed
Female	45	Unknown	Unknown	Unknown	Unknown	Lthumb	200	Sharp Cut
Male	52	Unknown	Yes	Social	No	Lthumb	200	Rough Cut
Male	41	Unknown	No	None	No	Lthumb	200	Rough Cut
Male	27	Unknown	Unknown	None	Unknown	Lthumb	200	Rough Cut
Male	51	White	Yes	Daily	Yes	Lthumb	200	Rough Cut
Male	25	White	Yes	Daily	No	Lthumb	250	Avulsed

Thirty-three of the injured workers were male. The digit injured most often was the left thumb. It accounted for more than 65% of the injuries.

Table 2: Frequency of Injury by Digit

Injured Digit		
	Frequency	Percent
L index	3	8.57
L middle	1	2.86
L thumb	23	65.71
R index	1	2.86
R middle	2	5.71
R thumb	5	14.29

One of the outcomes which was compared was the cost of treatment. The mean costs for medical treatment were computed for each group and compared. The medical costs in the skin graft group were much higher, averaging \$4316 compared to \$1590 for the conservative treatment group. The Wilcoxon Two Sample Test showed this difference to be statistically significant with an Exact Test value of 0.0026.

A second aspect to the cost of treatment is the amount of time a person is unable to work. Because this was reimbursed for these workers' compensation claims, this cost was added to the medical cost to get the total cost of treatment and lost wages. When these were compared, the costs in the skin graft group were still higher, averaging \$5,498 compared to \$2,403 for the conservative treatment group. This difference was also statistically significant with and Exact Test value of 0.00019.

Table 3: Comparison of Cost and Lost time by Treatment Type

		Total Cost	Total Med	Weeks Lost
Treatment	N	MEAN	MEAN	MEAN
Conservative	24	\$2,403	\$1,590	2.9 weeks
Skin Graft	11	\$5,498	\$4,316	3.1 weeks

The mean average wage was greater in the skin graft group, so weeks lost from work was compared instead of wages. The difference in the time lost from work between these two groups has no practical significance, therefore statistical significance was not calculated.

Because the skin graft group had a larger wound on average, the comparison was repeated using only wounds larger than one square centimeter from both treatment groups. This left 11 in the conservative treatment group and 10 in the skin graft treatment group. This did not significantly change the results.

Table 4: Comparison by Treatment Type Matched For Injury Size

		Total Cost	Total Medical Cost	Weeks Lost	Days Before Light Duty	Days Before Full Duty	Days To MMI
Treatment	N	MEAN	MEAN	MEAN	MEAN	MEAN	MEAN
Conservative	11	\$3,082.18	\$2,399.95	2.3	12	31	46
Skin Graft	10	\$5,947.92	\$4,663.56	3.2	19	42	88

A final outcome to be compared was the impairment, if any, at the end of treatment. This impairment reflects any loss of sensation or use of the injured digit. The conservative treatment group had an average PIR of 0.5 compared to an average of 1.2

for the skin graft group. Statistically, this is almost significant with a two-sided Exact Test value of 0.08. What the difference really reflects, though, is that one person in each group received a PIR of 11%. There were more than twice as many subjects in the conservative group, therefore, the average PIR was lower.

Discussion

The first major potential bias in this study is the intent-to-treat. This bias poses a difficult problem for retrospective studies of different treatments for a condition. The treatment is not randomly assigned. There may be a very significant difference between the injuries in the two cohorts which influenced the treating physician to choose one treatment over the other. In this study, conservative treatment may have been chosen more often when the injury was less severe and the wound was smaller. This would skew the results in favor of conservative treatment. If skin grafting is a better treatment, this would bias the study results so that the benefit of skin grafting is not apparent, a type II error.

This intent-to-treat bias can be overcome when there are centers where one treatment is preferentially provided. This situation exists in Florida where many of these cases occurred. One Occupational Medicine provider with six clinics, skin grafting of minor fingertip amputations is routinely provided instead of conservative treatment. The intent when this study was designed was that many of those cases would be included in the data, overcoming the intent-to-treat bias elsewhere. The current study design did not allow for identification of the providers or preferentially pulling data by provider. This unique situation in Florida does allow for an excellent treatment comparison to be done. This may be attempted again in a future study.

A second bias in this study is a selection bias of sorts. The study subjects are identified by a diagnostic code for traumatic amputation. The amputations which we

attempted to compare in this study are relatively minor and may have been given a different diagnostic code such as 883.0, open wound of the finger, which includes burns, lacerations, and several very common injuries. The injuries which are treated with a skin-graft are more likely to be coded correctly as amputations or discovered when the database is searched for the skin graft procedure codes. An attempt was made to search code 883, but this produced a list of claims too large to review within the confines of this study.

The quality of information in the medical records was problematic in this study. The information recorded about the skin graft group was much more complete than that recorded for the conservative group. The skin graft group required a higher level of technical expertise and the notes reflected this. Cases were identified for which the information in the chart was so incomplete that they could not be used in the study. If these cases differed substantially from cases for which the information was complete, that would affect the validity of the study results.

This study looked at fingertip amputations in workers. When this injury occurs outside the workplace, its highest incidence is in young children and older adults. The results of this study would be reasonably applicable to older adults. The healthy-worker effect would probably not be significant when considering workers as compared to older adults who are active enough to be out in their garages using power tools. The results of this study may not be applicable to young children. A skin graft which heals very well in an adult might do poorly in a child who cannot keep from disturbing the bandage or it may do better because their tissue is younger and healthier. Young children may also

regenerate their skin better than older adults when allowed to heal conservatively. For these reasons, the results of this study would not necessarily apply to young children.

Conclusions

This study showed that finger and thumb tip amputations which are treated by skin grafting have higher medical costs and higher total costs including the wage replacement costs than amputations treated conservatively. No benefit from an earlier return to work was apparent between the two groups. The study may not have compared equivalent injuries. Those injuries which were treated with a skin graft were probably more severe. Any future study which looks at this issue must make sure that the injury severity in the treatment groups is comparable, so that the comparison of treatments is accurate.

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