

Topical Becaplermin Improves Outcomes in Work Related Fingertip Injuries

Bruce M. Freedman, MD, Elisabeth H. Oplinger, MPT, and Irwin S. Freedman, MD

Background: Fingertip injuries are common and bear significant costs associated with treatment, lost work, and functional impairment. This study compared these factors in occupationally related fingertip injuries treated with becaplermin, a recombinant human platelet-derived growth factor, and those treated with surgical reconstruction.

Methods: This was a prospective controlled trial involving occupationally related fingertip injuries. Fifty men (ages 23–51) with full thickness, single fingertip injuries ≥ 1.5 cm² with or without phalangeal expo-

sure and distal to the distal interphalangeal (DIP) joint were evaluated. Group I (n = 25) underwent treatment with daily topical becaplermin. Group II (n = 25) underwent surgical reconstruction with a skin graft or local soft tissue flap. Time to wound healing, time to return to work, associated treatment costs, and calculated functional impairment were recorded.

Results: Patients in Group I returned to work in significantly less time than those in Group II—10 days versus 38 days respectively). The average calculated functional impairment in Group I was

10% versus 22% in Group II. Associated treatment costs in group A were $\$1580 \pm 145$ USD compared with $\$6750 \pm 785$ USD in Group II. All differences were statistically significant at $p < 0.05$

Conclusion: In this study, the functional and economic costs were significantly less when fingertip injuries were treated with topical becaplermin than when they were treated with surgical reconstruction. This information should allow emergency and acute care physicians to treat these injuries more efficaciously and conveniently.

J Trauma. 2005;59:965–968.

Fingertip injuries are common in the workplace and bear significant costs associated with treatment, lost work, and functional disability. Treatment decisions are based on the individual needs of the patient, the nature of the wound and the knowledge and experience of the attending clinician.¹ The main goals of fingertip reconstruction are to minimize pain, speed the healing process, and to reduce the duration of functional disability. Usually, treatments for these injuries include primary closure, skin grafting, local soft tissue flaps and healing by secondary intention.² Soft tissue defects that are < 1.0 cm² have been treated conservatively, with diligent wound care alone, while those defects that are > 1.0 cm² have generally been approached surgically.³

Surgical treatment, while an effective method of wound closure, is associated with substantial costs and notable scarring. In an effort to avoid these problems, some clinicians have chosen to treat larger fingertip injuries (> 1.0 cm²) conservatively, especially in children.⁴ However, it has been our experience that in adults, a high incidence of scar contracture, cold intolerance and inadequate pulp volume have resulted from the conservative care of larger fingertip injuries with exposed bone or tendon. This has often resulted in

dyesthesia, reduced function, and the need for additional therapy. Recent evidence has shown that becaplermin, recombinant human platelet-derived growth factor, promotes the rapid formation of granulation tissue with coverage of vital structures and adequate re-epithelialization.^{5,6} Furthermore, the use of becaplermin in acute wounds has been shown to enhance wound closure without wound contracture.⁷ These findings suggest that the addition of an exogenous growth factor, such as becaplermin, accelerates secondary intention healing, which in turn would reduce the problems seen with conservative treatment of larger fingertip wounds. This would result in a more rapid, reliable, way of treating larger fingertip injuries nonsurgically.

Emergency and acute care physicians are routinely confronted with fingertip injuries. The purpose of this study was to compare outcomes in occupationally related fingertip injuries treated with topical becaplermin and those treated with surgical reconstruction. With more information, physicians can make better decisions when treating these problems. This will benefit both patients and physicians from a clinical and socioeconomic standpoint.

MATERIALS AND METHODS

Study Design

A prospective controlled trial was undertaken to assess the functional and economic differences between patients with fingertip injuries who were treated either surgically or with a topical growth factor. Fifty men, ages 23–51, referred by their employers with occupationally-related fingertip injuries were evaluated in the office of a hand surgeon with a

Submitted for publication March 3, 2005.

Accepted for publication May 31, 2005.

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From the Plastic Surgery Associates of Northern Virginia LTD, McLean, Virginia.

Address for reprints: Bruce M. Freedman, MD, 8180 Greensboro Drive, Suite 1015, McLean, Virginia 22102, email: bfreedman58@aol.com.

DOI: 10.1097/01.ta.0000187801.53919.e7

suburban private practice. The injured workers met the following criteria: 1) full thickness, single fingertip injuries with a wound area $\geq 1.5 \text{ cm}^2$ with or without phalangeal exposure 2) distal to the DIP joint and 3) not involving the flexor tendon insertion. They were alternately assigned to two groups. Each patient consented for treatment of their fingertip injury in accordance with the study protocol. Group I ($n = 25$) underwent, when necessary, sharp debridement under digital block anesthesia to clean grossly contaminated wounds or to shorten exposed bone. No anesthesia was used in clean injuries. Topical application of becaplermin (Regranex, 0.01% gel, Johnson & Johnson Wound Management, Somerville, NJ) in conjunction with saline-moistened gauze was initiated daily and continued until wound closure was complete. Group II ($n = 25$) underwent surgical debridement, then reconstruction with a skin graft or local soft tissue flap as indicated. The frequency of each technique employed was recorded: primary closure (3), skin graft (8), Atasoy flap (8), thenar flap (4), and cross-finger flap (2). The procedures were performed on an outpatient basis under regional anesthesia. After surgery, appropriate wound care was administered. Flap division, when necessary, was performed under local anesthesia in the office. All patients received 72 hours of antibiotics for bacterial prophylaxis and were seen in the office on a weekly basis for wound assessment and functional evaluation.

Outcome Measures

Time to return to work and healing time were documented in all patients. The decision to return patients to the workforce was made by an independent physician who was blinded to treatment allocation. Patients were returned to work in a modified duty capacity before being released to full duty without restriction. Healing time was defined as complete re-epithelialization in Group I and graft/flap stability in Group II. Physiotherapy was initiated at the treating clinician's discretion when it appeared necessary to facilitate rehabilitation. Associated treatment costs for facility fees, physician fees, physiotherapy and medications were recorded and tabulated in US Dollars (USD). After the patients had reached maximum medical improvement, functional impairment ratings were determined by an independent physician using the American Medical Association Guidelines to the Evaluation of Permanent Impairment, 5th Edition.⁸ Cold intolerance, grip strength, and total active motion (TAM) in the affected digits were measured to calculate functional impairment.

Primary Data Analysis

The Pearson's χ^2 test was used to compare treatment Groups I and II with respect to age, initial wound area, and distribution of fingertip injuries. Statistical analyses comparing time to return to work, calculated functional impairment, and associated treatment costs were conducted with an unpaired Student's t test for continuous data. Statistical significance was set a priori at $p < 0.05$.

RESULTS

Table 1 summarizes demographic and other comparable data for all patients in the study. There was no statistical difference between Group I and Group II with respect to age, initial wound area, or distribution of fingertip injuries. The χ^2 testing verified that the patients had been effectively randomized such that subject characteristics did not influence outcome variables. This justified the use of the unpaired Student's t test since the homogeneity of variance was met and the subject variables found to be similar.

Group I patients were able to return to work in 10 ± 3 days compared with Group II patients who were able to return to the workforce in 38 ± 9 days ($p < 0.05$). Healing time in Group I occurred in 25 ± 3 days versus 35 ± 7 days in Group II ($p < 0.05$). The functional parameters that were determined after the patients had reached maximum medical improvement indicated TAM of $220 \pm 15^\circ$ in Group I compared with TAM of $180 \pm 30^\circ$ in Group II ($p < 0.05$). Likewise, the calculated functional impairment in Group I averaged $10 \pm 4\%$ and in Group II $22 \pm 6\%$ ($p < 0.05$). Cold intolerance in Group I was 20% compared with 44% in Group II ($p < 0.05$). 20% of patients in Group I required a short course of physiotherapy while 56% of patients in Group II underwent physiotherapy ($p < 0.05$). Finally, total treatment costs in both groups were compared. In patients treated with becaplermin, associated medical costs averaged $\$1580 \pm 145$ USD per patient while patients treated surgically accrued average treatment costs of $\$6750 \pm 785$ USD ($p < 0.05$). All clinical findings are summarized in Table 2.

Fingertips treated with becaplermin had adequate soft tissue coverage with soft, supple pulp and good tendon gliding. The becaplermin treated fingertips had satisfactory esthetic results (see example in Figure 1). Surgically-treated

Table 1 Demographic Data

	Group I	Group II
Patient Age (Years)	29 ± 5	31 ± 6
Wound Area (cm^2)	2.2 ± 0.5	2.4 ± 0.6
Distribution of Fingertip Injuries (%)		
Thumb	20	16
Index	32	32
Long	36	32
Ring	8	12
Little	4	8

Table 2 Results

	Group I		Group II
Return to work (Days)	10 ± 3	$p < 0.05$	38 ± 9
Wound stabilization (Days)	25 ± 3	$p < 0.05$	35 ± 7
Functional impairment (% of Finger)	10 ± 4	$p < 0.05$	22 ± 6
Patients undergoing physio-therapy (%)	20	$p < 0.05$	56
Treatment cost (US Dollars)	$1,580 \pm 145$	$p < 0.05$	$6,750 \pm 785$

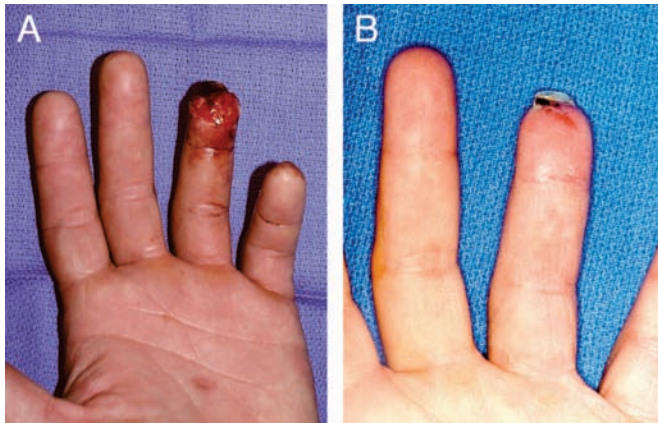


Fig 1. Full thickness ring fingertip injury (A) before, and (B) after treatment with topical becaplermin.

fingertips were slightly shorter when advancement flaps were used. Skin-grafted fingertips were often unsightly, especially in pigmented skin phototypes. A fingertip treated with full thickness skin graft can be seen in Figure 2.

DISCUSSION

Since hand and fingertip injuries account for 3-4% of all emergency room visits, primary recognition of these injured structures usually falls under the responsibility of an acute primary care or emergency room physician.⁹ Specifically, fingertip injuries can be painful, disabling, and economically detrimental due to lost work. Treatment options fall into two categories: delayed healing by secondary intention and surgical reconstruction. Reports in the medical literature describing fingertip injuries have generally been case series, reviews, or comparison of treatment modalities without control for wound size or patient age.^{2-4,10-15} The investigators have practiced in various health care systems and represented several medical specialties. These factors have contributed to conflicting data regarding loss of working days and residual

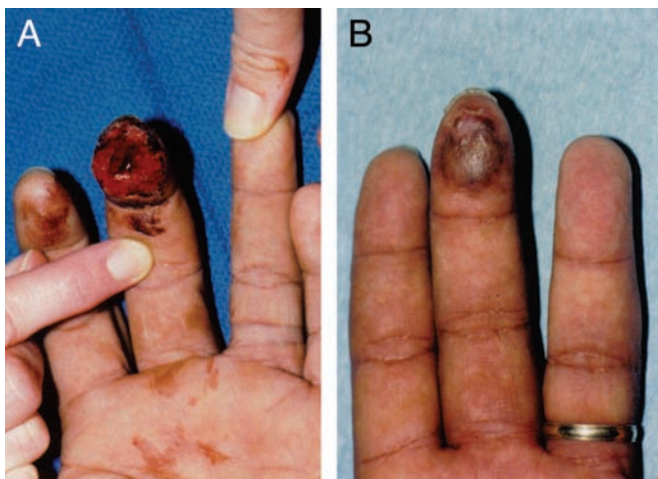


Fig 2. Full thickness long finger injury (A) before, and (B) after application of full thickness skin graft.

impairment following fingertip injuries. The problems associated with each approach have been well described and include cold intolerance, scarring, loss of sensation and stiffness.¹¹ Likewise various treatments have offered different relative advantages. Secondary intention healing often results in less cold intolerance, while adequate tip coverage is generally observed after surgical care. To date, it has been difficult to determine under which circumstances conservative care or surgical reconstruction is preferable in the treatment of most fingertip injuries.

Over the past ten years, methods to modify and enhance the natural healing process have been actively investigated. Topically applied growth factors have been shown to accelerate epithelialization kinetics and are critically influential in the healing process.¹⁶ Specifically, platelet-derived growth factor has been shown to be a strong fibroblast mitogen and a potent angiogenic factor.¹⁷ These activities result in fibroblast proliferation and the rapid deposition of the cellular and extracellular matrix that comprises a healthy granulation tissue bed. Becaplermin, recombinant human platelet-derived growth factor, has been shown to improve wound closure in non-healing diabetic lower extremity ulcers.^{18,19} It has also improved healing time and tensile strength in human and murine models in the acute wound.^{7,20} For these reasons, we believed that becaplermin could be successfully used in the treatment of fingertip injuries where an adequate soft tissue bed and a supple epidermis play an important role in functional outcome. We hypothesized that becaplermin application might decrease the cold intolerance and inadequate pulp volume seen following normal secondary intention healing, due to increased angiogenesis and lack of wound contracture. It also appeared reasonable that becaplermin application would accentuate some of the benefits of non-surgical treatment, namely earlier small joint mobilization and decreased donor site morbidity.

In summary, the use of becaplermin in work-related, single fingertip injuries resulted in better range of motion, less cold intolerance and less functional impairment when compared with surgical reconstruction. Furthermore, in the becaplermin-treated group physiotherapy was not required as frequently, a benefit attributable to earlier mobilization. This may have given patients more confidence in returning to the workforce, as evidenced by an earlier return to work in the becaplermin-treated group. These factors contributed to significantly fewer associated medical costs, and a decreased economic burden on injured workers, employers, and the Worker's Compensation system. We conclude that the use of topical becaplermin in the treatment of single, occupationally-related fingertip injuries is effective and compares favorably to surgical reconstruction from both a functional and socioeconomic perspective. These data should empower acute primary care and emergency medicine physicians to actively manage many fingertip injuries. Consequently, reparative treatment can be initiated immediately without the need to access specialty care. This will prove beneficial in

areas where surgical specialists are not readily available and will simplify the overall treatment course for these injuries. Although this was a limited study, the results highlight the positive effects of exogenous growth factors in acute wound management. Further research on growth factors could prove to be medically beneficial and uncover additional potential contributions.

ACKNOWLEDGMENTS

The authors would like to acknowledge Margaret Schatteles for her role in statistical analysis and technical assistance in the preparation of this manuscript.

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