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Scientific/Clinical Article

Acetic acid iontophoresis for recalcitrant scarring in post-operative hand patients

Agnes Dardas BS[a,b], Gordon H. Bae BA[a,b,c], Arthur Yule BA[b,c], Judith Wright BS[b], Noreen Straughn BS[b], Charles S. Day MD, MBA[a,b,*]

[a] Harvard Medical School, Boston, MA, USA
[b] Beth Israel Deaconess Medical Center, Department of Orthopaedic Surgery, Boston, MA, USA
[c] Harvard College, Cambridge, MA, USA

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ABSTRACT

Study design: Retrospective cohort comparison.
Introduction: Using acetic acid iontophoresis (AAI) as a treatment modality significantly improved the functionality of hand in patients with recalcitrant scarring.
Methods: Open trigger finger release patients followed up exclusively at a hand clinic between 2009 and 2011 were analyzed. Group I recovered optimal total active range of motion (TAM) after 14 standard of care (SOC) therapy sessions but Group II (10 digits) could only reach optimal recovery after 7 additional AAI sessions.
Results: After SOC therapy, Group I's TAM recovery plateaued at 245 and Group II's at 219 ($p < 0.01$). After undergoing AAI, the TAM of Group II increased from 219 to 239 ($p < 0.01$).
Discussion: Clinical studies suggest that AAI can modify collagen structure in scars. AAI could be a novel non-surgical treatment for restoring functionality to areas affected by difficult, recalcitrant scars.
Conclusion: AAI significantly improved the TAM of hand surgical patients who could not recover optimally with SOC therapy alone.
Level of evidence: Level 3.

Introduction

Functional outcome after hand surgery is largely dependent upon final range of motion, pinch, and grip strength of affected digits and hand.[1,2] Elevated and thickened noncompliant scar formation following surgery can result in pain and contractures, which limit function and cause reduced self-image and social impairment.[3] Although healthy scar tissues normally form after surgery during the wound healing process as type I collagen is secreted by fibroblasts in the affected area, too much collagen I secretion can lead to unwanted hypertrophic scarring.[4,5] After trigger finger release surgery, 3% of patients develop pain, 2% stiffness, and 2% scar tenderness.[6] Currently, a number of therapeutic techniques are used by hand therapists to help manage postoperative scarring, such as pressure therapy, silicone sheeting, corticosteroid injection, ultrasound, orthotic intervention, and topical cream application.[7] However, few therapies have shown to be particularly effective in clinical studies or practice.[7]

Before its use in clinical practice, 0.5 M acetic acid was used to isolate collagen from human tissue by remodeling collagen.[8,9] Since the late 1990s, acetic acid injection has been employed in a clinical setting to treat small hepatocellular carcinoma.[10] Although other agents such as ethanol could also cause necrosis of the carcinomas, acetic acid was shown to penetrate through collagen septae and thus require less frequent treatment and has shown better results.[10] The only other clinical use is acetic acid iontophoresis (AAI), a non-invasive method to deliver acetic acid transdermally through the use of low electric currents.[11] AAI is used to treat calcifying tendonitis of the shoulder, plantar fasciitis, and heel pain, reducing pain and increasing the range of motion of the affected joint.[12–14] In these clinical applications, the molecular mechanism behind acetic acid's ability role in treating diseases is not completely understood. However, it has been deemed safe for use in patients.

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* Corresponding author. Beth Israel Deaconess Medical Center, Department of Orthopaedic Surgery, 330 Brookline Avenue, ST 10, Boston, MA 02215, USA. Tel.: +1 617 667 3940; fax: +1 617 667 2155.
E-mail address: cday1@bidmc.harvard.edu (C.S. Day).

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Purpose of the study

Despite its apparent effectiveness in remodeling collagen, there have been no studies done on the effects of AAI on scar tissue. As acetic acid has shown to remodel type 1 collagen, it is hypothesized that AAI can be used to weaken scar tissue and increase scar pliability. If delivered in a controlled and targeted manner, acetic acid could be a useful postoperative scar treatment modality. The purpose of this study is to determine the effect of AAI on improving the function of the hand in open trigger finger release patients with recalcitrant scarring. These patients' functional recovery prematurely plateaued after undergoing traditional hand therapy modalities. The effects of AAI on the increase in the total active range of motion of the patients in this patient population were measured.

Methods

After obtaining the approval of Beth Israel Deaconess Medical Center institutional ethics review board, we retrospectively reviewed the medical records of all adult patients who underwent open trigger finger releases by the senior author, a hand surgeon at the main campus of an academic medical center from 2009 to 2011. The rights of the human subjects were protected throughout this study.

All patients who were followed up in a specific outside hand therapy facility were included in the study. These patients were divided up into two groups. Group 1 consisted of patients who had optimal postsurgical recovery of their total active range of motion (TAM) in their fingers after receiving standard of care (SOC) occupational therapy (OT) at this site. SOC OT included range of motion treatment, tendon gliding, edema control, dressing changes, night extension orthotic intervention, scar management, hot pack therapy, and stretching exercises. Patients underwent SOC therapy after the wound has closed, which was on average about 12 days after their surgery (range 6–27 days, one 56 day outlier). Group 2 consisted of patients whose TAM recovery prematurely plateaued during SOC OT and underwent AAI treatment at this hand therapy facility with a current of 2.5–4 mA and a dosage of 40–50 mA/min along with SOC (Fig. 1). Patients were started at 40 mA/min and if no side effects occurred, the dosage was increased to 50 mA/min. Once the patient has seemed to tolerate the higher milliampere, the rest of the sessions were performed at the higher level. Patients were given AAI treatment two times each week for an average of 4 weeks. Group 2 also included patients who had initially failed SOC OT at other sites as determined by the treating hand therapists and were subsequently referred to this hand therapy clinic by the treating surgeon. Any patients who were pregnant, had cancer in the last five years, and/or exhibited intolerance to iontophoresis were excluded from the study. Intolerance to iontophoresis was defined by pain, skin irritation, and reaction to the electrodes.

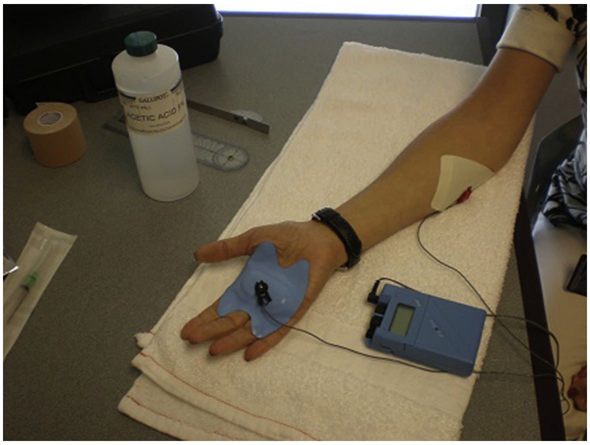

Fig. 1. Set up of acetic acid iontophoresis. Iontophoresis is a non-invasive method to deliver charged substances into the skin. In AAI, 5% glacial acetic acid is placed onto a dermal patch connected to a power source. Subsequently, an electric current pushes the ionized acetic acid into the skin for an average of about 20 min.

We collected data on available demographics, such as age and sex, and noted any pertinent available clinical details regarding treatment, including the digit affected (digitus I, II, III, IV, and V), start of OT post surgery and number of OT sessions, where SOC and AAI sessions were recorded separately, initial pain level, TAM in the treated finger. We also analyzed for multiple trigger finger surgery vs. single trigger finger surgery with respect to SOC and AAI OTs.

We assessed the effectiveness of the treatment modalities for post-surgical scarring of the hand using TAM as our primary outcome before and after AAI. TAM was defined as the difference between the sum of the affected digit's flexion at the distal interphalangeal (DIP), proximal interphalangeal (PIP), and metacarpal (MP) joints and the sum of the same digit's extension at those same joints. For group 1, TAM was assessed by abstracting information from notes corresponding to two time points: (1) the initial visit to the OT's clinic, and (2) the last recorded ROM values at the OT's clinic, marking the final progress made by SOC management. For group 2, TAM was assessed by three time points: (1) the initial visit, (2) the visit marking the final progress of SOC-only management, and (3) the last recorded ROM after use of AAI. The initial pain level at rest and with activity was measured using a visual analogue scale (VAS) from 0 to 10 prior to starting the postoperative therapy.

Univariate comparisons were performed between the 10 AAI-treated digits and the 13 SOC-treated digits to assess for differences in outcome (TAM) as well as differences in baseline covariates, including age, gender, affected digit, days post-op when starting OT management, and the number of OT sessions. Continuous variables were compared using Student's *t*-test and categorical variables were compared using the Fisher exact test. All statistical analyses were performed with StataSE 11. All statistical tests were two-tailed. We considered $p < 0.05$ to be statistically significant.

Results

We identified 23 digits in 17 patients having undergone an open trigger finger release and followed up exclusively at the outside hand therapy facility between 2009 and 2011. Due to the incidence of multiple fingers within a single patient being operated on at different times during these two years, we performed our analysis from the perspective of the digit (case) instead of the patient.

Of the 23 cases, 13 responded well to SOC and 10 did not ($TAM_{respondent} = 245$ (205–265) and $TAM_{non\text{-}respondent} = 219$ (195–250), respectively; $p < 0.01$ (Fig. 2)). When comparing these two groups, there were no statistically significant differences in gender (respondent = 77% female and non-respondent = 70% female, $p = 0.62$). There was a statistically significant difference in age between the two groups, the average respondent case being older than the average non-respondent case (respondent = 65 ± 5 and non-respondent = 58 ± 8; $p = 0.02$). There was no statistical difference between which affected finger was operated on and final treatment. However, although 75% of the patients who underwent single digit trigger finger release had an optimal TAM recovery with SOC OT alone, only 40% of patients who underwent multi-digit trigger finger release operations did so (Table 1).

All 23 fingers were treated with SOC OT management, beginning their first OT session at a median of 6–7 days post-operatively and continuing for a median of 14–15 sessions (range of 5–31 sessions). The patients on average finished SOC OT 64 days post-operatively