

The Effectiveness of Matrix Cauterization With Bichloroacetic Acid in the Treatment of Ingrown Toenails

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BACKGROUND Chemical matricectomy is performed mainly by 2 agents, phenol and sodium hydroxide. Chemical matricectomy with phenol has a low recurrence rate and good cosmetic results, but it produces extensive tissue destruction and can result in drainage and a delayed healing time. These adverse effects have brought forward the use of chemical agents such as sodium hydroxide and trichloroacetic acid for matricectomy.

OBJECTIVE This prospective study aimed mainly to evaluate the efficacy of partial nail avulsion and selective chemical cauterization of the matrix using 90% bichloroacetic acid (BCA) in the treatment of the ingrown nails.

MATERIALS AND METHODS A total of 30 patients with 58 ingrown toenail edges were included in this study. All of the patients underwent chemical matricectomy with 90% BCA after partial nail avulsion. Adverse effects such as postoperative pain and drainage were minimal in most of the patients.

RESULTS One patient who underwent matricectomy had recurrence in a single nail edge (1.8%) at the 12th month of the follow-up. No recurrence was observed in 29 patients during mean follow-up period. This was considered to be statistically significant ($p < .001$).

CONCLUSION This is the first study to use BCA for the treatment of ingrown toenail. Partial nail avulsion followed by BCA matricectomy is a safe, simple, and effective method with low rates of postoperative morbidity and high rates of success. Therefore, partial nail avulsion and BCA matricectomy can be used as an alternative treatment method for the treatment of ingrown toenails.

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Ingrown toenail is an often painful clinical condition which usually affects big toenails. It is a common condition of young adults. Ingrown toenails are 3 times more common in men than in women. The 2 most important causes of ingrown toenails are wearing tight shoes and toenails that are not trimmed properly.^{1,2} Other causes include trauma, an imbalance between the nail plate and the nail bed, hyperhidrosis, abnormal walking habits, arthritis, circulatory insufficiency, obesity, onychomycosis treatment, and subungual neoplasms.^{1,2}

Ingrown toenails are characterized by 3 stages of evaluation. Stage 1 ingrown toenails are characterized

by erythema, slight edema, and pain with pressure to the lateral nail fold. Stage 2 is marked by increased symptoms of Stage 1 as well as drainage and infection. Stage 3 ingrown toenails display magnified symptoms of Stage 1 accompanied by lateral wall thickening and granulation tissue. Conservative treatment methods are used in Stage 1 ingrown toenail. Surgical treatment methods should be used in recurrent Stage 1 ingrown toenails, and in Stage 2 and Stage 3 cases.³⁻⁵ Non-selective surgical management, such as nail avulsion, wedge resection, total nail bed ablation, and soft tissue resection are usually associated with high rates of recurrence and morbidity.^{3,6,7} Partial nail avulsion and chemical matricectomy is the most successful

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management method used for the treatment of ingrown toenails in recent years.^{2,3,7,8} Phenol is the most commonly used agent for chemical matricectomy. Chemical matricectomy with phenol has a low recurrence rate and good cosmetic results, but it produces extensive tissue destruction and can result in drainage and a delayed healing time. These adverse effects have brought forward the use of chemical agents such as sodium hydroxide and trichloroacetic acid (TCA) for matricectomy.^{3,7,8} BCA is typically used at full strength (100%) in its natural liquid state and has a broad range of indications, including xanthelasma, sebaceous hyperplasia, verrucae, hard and soft corns, seborrheic keratoses, ingrown nails, cysts, chemical peeling, and benign erosions of the cervix.⁹ BCA causes coagulative necrosis of cells through extensive protein denaturation and resultant structural cell death.^{8,9} The authors believe that BCA can be used in place of phenol in chemical matricectomy. The objective of this study was to evaluate the effectiveness and safety of chemical matricectomy with BCA in the treatment of ingrown toenails.

Materials and Methods

Patients

A total of 30 patients with 58 ingrown toenail edges were included in this study. All of the patients underwent chemical matricectomy with 90% BCA after partial nail avulsion. Clinical characteristics of the patients are presented in Table 1.

TABLE 1. Clinical Characteristics of the Patients

Number of patients	30
Ingrown nail edges	58
Gender, n (%)	
Male	12 (40)
Female	18 (60)
Age	36.08 ± 12.43
Duration of follow-up	10.58 ± 5.13
Stage, n (%)	
Stage 1	11 (18.9)
Stage 2	40 (68.9)
Stage 3	7 (12.06)
Affected nail edge, n (%)	
Lateral	14 (20.6)
Medial	44 (79.4)

Appropriate systemic and topical antibiotics were administered to patients who were diagnosed with infection before surgical procedure. The authors diagnosed an infection in their patients, if they developed severe redness and swelling, drainage, pus, and malodor. Ten of them (7 of Stage 2 and 3 of Stage 3 disease) received systemic antibiotics. They used amoxicillin/clavulanik acid (875/125 mg, twice in a day) and also they haven't seen any serious side effect. Before the procedure, the patients were evaluated for the presence of peripheral vascular disease, uncontrolled diabetes mellitus, hemorrhagic diathesis, hypersensitivity (irritant or allergic contact dermatitis) to chemical solutions and serious systemic diseases.

In this study surgical treatment was used in recurrent Stage 1 ingrown toenails, and in Stage 2 and Stage 3 cases. In this study, all Stage 1 cases have lateral involvement and these cases have also medial Stage 2 or Stage 3 involvement in the same toe.

Surgical Technique

Digital anesthesia with epinephrine-free 1% lidocaine was performed after cleaning the site of operation with povidone-iodine solution. A tourniquet was applied to the proximal of the big toe. By using septum elevators, the ingrown nail was freed from the nail bed from the edge and distal to proximal, then the nail was cut longitudinally with 3 to 4 mm width from the ingrown portion, and extracted. Ninety percent BCA was applied with a cotton tipped applicator to the matrix of extracted part and rubbed into the nail bed. BCA application was performed 2 times 2 minutes each, for a total of 4 minutes. The site of operation was flushed with isotonic saline solution to neutralize the effect of BCA. The tourniquet was removed, an ointment containing antibiotic was applied, and a gauze bandage was wrapped around the nail.

Postoperative Care

All patients were followed-up for 1 week post-operation with 2-day intervals and weekly follow-ups were continued until complete healing of the wound. Postoperative complications, including pain, drainage, and infection were evaluated during postoperative follow-ups. After complete wound healing

the patients were scheduled for follow-up visits every 3 months. During follow-up period, recurrence rate and cosmetic results were evaluated to determine the effectiveness of surgical treatment. Recurrence was defined as evidence of ingrowth of the nail edge or spicule formation. For statistical analyses of the results from the study, NCSS (Number Cruncher Statistical System) 2007&PASS 2008 Statistical Software (Utah) was used. Student's *t*-test was used for comparisons of quantitative data, in addition to descriptive statistical methods. Chi-square test and Fisher's exact χ^2 test were used for comparisons of qualitative data. Statistical significance was defined as $p < .05$.

Results

The mean age of the patients was 36.08 ± 12.43 (2–69). Of the 30 patients, 12 (40%) were male and 18 (60%) female. Ten patients (33.3%) had a single ingrown toenail, whereas 20 patients (66.6%) had 2 or more ingrown toenails. The mean follow-up duration of patients was 10.58 ± 5.13 months (5–26 months). Of the 58 ingrown toenails, 40 (68.9%) were defined as Stage 2, 11 (18.9%) as Stage 1, and 7 (12.06%) as Stage 3.

Adverse effects such as postoperative pain and drainage were minimal in most of the patients. Although 10 of the patients (33.3%) had mild pain, 10 (33.3%) moderate pain; 10 patients (33.3%) experienced no pain. Postoperative drainage improved within 10 days in 29 of the patients (96.6%) and within 15 days in 1 of the patients (3.3%). None of the patients had postoperative infection.

One patient who underwent matricectomy had recurrence in a single nail edge (3.3%) at the 12th month of the follow-up. No recurrence was observed in 29 patients during mean follow-up period. This was considered to be statistically significant ($p < .001$). None of the patients complained about cosmetic results. Figures 1 and 2 show pretreatment and 6 months posttreatment photographs of a patient with an ingrown toenail.

Discussion

There is no consensus on the choice of treatment for ingrown toenails. Partial or total nail avulsion is



Figure 1. Pre-treatment image of a patient with an ingrown toenail.

commonly used as a conventional treatment modality, however, these procedures have resulted in higher rates of recurrence (42%–83%) because destruction of the germinal matrix has not been achieved.^{3,10,11} The recurrence rates in wedge resections range from 3% to 33%.^{3,12,13} Excision of the proximolateral matrix segment has a 4% recurrence rate.¹⁴ The latter 2 procedures are difficult surgical techniques with postoperative complications including prolonged healing time, considerable pain, and frequent infections.⁵ The Zadik's procedure has recurrence rates ranging from 14% to 28%, and postoperative pain and time off from work or school, along with poor cosmetic results, are the disadvantages.^{10,15,16} Selective matricectomy must minimize damage to the surrounding normal skin and soft tissue to shorten the healing time and obtain a satisfactory cosmetic result. There are 2 major methods in selective matricectomy: mechanical and chemical methods. Surgical matricectomy has a low recurrence rate, but technical difficulties, the length of time required, postoperative pain, and prolonged drainage limit the use of this technique. Several



Figure 2. Six months post-treatment image of the same patients.

authors have reported the use of carbon dioxide (CO₂) laser for performing selective matricectomy.^{6,17–19} The CO₂ laser achieves more selective destruction of the nail matrix than chemical matricectomy, but has disadvantages such as technical difficulty, in addition to requiring prolonged healing time and achieving a poor cosmetic outcome.^{17,19}

The ideal surgical method for the treatment of ingrown toenails should be doable under local anesthesia, technically easy to perform, should heal quickly with minimal postoperative morbidity, and high success rate. Chemical matricectomy is one of the ideal methods that meet all these criteria and produce excellent results. Chemical matricectomy after partial nail avulsion is known to be a successful and safe surgical therapeutic option for the treatment of ingrowing nails.^{3,7} Chemical matricectomy, which was first introduced in 1945 by Boll, is a widely used method since then.²⁰ The objective of treatment is to chemically destroy the lateral matrix horn to prevent the lateral nail plate grow into the lateral nail fold in

the future. Generally phenol and sodium hydroxide are used in chemical matricectomy.^{3,7,20} Phenol is an effective protein denaturant. Phenol cauterizes by producing a coagulation necrosis in the matrix and surrounding soft tissues. It has antibacterial and local anesthetic effects that offer additional advantage for its use.² Phenol matricectomy has been the choice of treatment for many investigators with high success rates (91%–100%) for years.^{2,20} However, the disadvantages of performing this procedure include unpredictable tissue damage due to chemical burn caused by phenol, excessive drainage, persistent infection, and extended healing times.^{8,20} After phenol application abdominal pains, dizziness, hemoglobinuria, cyanosis, and occasionally severe systemic reactions such as cardiac arrhythmia may occur in addition to local side effects.^{8,21} However, some authors still believe that segmental phenolization is also as safe as partial matrix excision in the treatment of even teenage ingrown toenails and patients return to their daily activities in less time with this treatment modality. The success of ingrown nail treatment by selective matrix horn cautery depends on the complete chemonecrosis achieved with the cauterant, which is not critical as long as the matrix is necrotized.^{21,22}

In recent years, matricectomy with sodium hydroxide has been found to be as effective as phenol matricectomy, with shorter healing periods and a lower risk of local or systemic toxicity.^{3,7,8,20} Sodium hydroxide causes fewer alkali burns and liquefaction necrosis, resulting in less postoperative drainage and faster healing, however, prolonged application of a strong alkali can cause excessive damage due to slowly progressing liquefaction necrosis.²³ TCA is one of the most commonly used agents for chemical peel. It is used for superficial or medium depth chemical peeling. TCA is a caustic chemical agent that causes coagulation necrosis, like phenol. It produces epidermal and dermal necrosis and then neutralizes by itself without serious systemic toxicity. In a recent study, Kim and colleagues⁸ performed chemical matricectomy with 100% trichloroacetic acid in 25 patients with ingrowing toenail edges, and reported that the success rate was 95%. They reported that side effects such as postoperative pain, drainage, and infection were mild,

that postoperative drainage generally decreased within 1 week and did not last more than 2 weeks.^{8,24} Recently, the authors observed the effectiveness of matrix cauterization with TCA in the treatment of ingrown toenails.²⁵ Sometimes skin complications from TCA have been reported previously.^{26,27}

BCA is typically used at full strength (100%) in its natural liquid state and has a broad range of indications, including xanthelasma, sebaceous hyperplasia, verrucae, hard and soft corns, seborrheic keratoses, ingrown nails, cysts, chemical peeling and benign erosions of the cervix.⁹ BCA causes coagulative necrosis of cells through extensive protein denaturation and resultant structural cell death. BCA often does not leave behind any side-effects on skin. This is the first study to use BCA for the treatment of ingrown toenail. In this study, side effects such as postoperative pain and drainage were at a minimal level in the majority of the patients. None of the patients had postoperative infection. Bostanci and colleagues, during mean patient follow-up period of 14 months, found success rates of 95.1% with sodium hydroxide matricectomy and 95.8% with phenol matricectomy. They reported that recurrences occurred within 10 months after treatment.²⁰ In this study, the success rate of treatment was found to be 96.6%. One patient who underwent matricectomy had recurrence at the 12th month of the follow-up. In this study, 90% BCA matricectomy shows treatment success comparable with those of phenol, TCA and sodium hydroxide matricectomy.

Partial nail avulsion followed by BCA matricectomy is a safe, simple, and effective method with low rates of postoperative morbidity and high rates of success. Therefore, partial nail avulsion and BCA matricectomy can be used as an alternative treatment method for the treatment of ingrowing toenails. Bichloroacetic acid is a viable alternative to other modalities in the management of unguis incarnatus. Advantages include simplicity, cost-effectiveness, speed, safety, and efficacy.

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