



Partial matricectomy with cryotherapy in treatment of ingrown toenails

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Objective: The aim of this study was to investigate the effectiveness of cryotherapy applied for the purpose of matricectomy following partial nail removal in treatment of ingrown nails.

Methods: Between 2010 and 2013, 76 ingrown toenails of 62 patients were included in this prospective study. Following partial toenail removal, matricectomy with cryotherapy was performed. The lateral nail matrix was frozen for 45 seconds with open spray and spot-freezing technique using liquid nitrogen. Patients were followed up for a mean of 17.6 months (range: 12–44 months).

Results: Wound recovery had occurred by 3-week follow-up. Recurrence in the form of spicule growth in 2 ingrown nails was detected on 6-month follow-up. Matricectomy application with cryotherapy was successful in the remaining 74 ingrown nails.

Conclusion: Destruction of the nail matrix with cryotherapy following partial toenail removal for ingrown nails was found to be an effective treatment with a low recurrence rate.

Keywords: Cryotherapy; ingrown nail; matricectomy.

Level of Evidence: Level IV, Therapeutic Study.

Ingrown nail is a toenail problem which is usually seen in adolescents and young adults and affects daily activities and social life negatively. Although the cause of ingrown nails remains controversial, it is almost certain that trauma is the primary factor. Unfitting footwear is the most common cause. A second factor is incorrect cutting of the toenails. Hyperhidrosis may aggravate the condition.^[1,2] Ingrown nails are classified in 3 stages based on presence of pain, drainage, infection and granulation tissue: inflammatory stage (stage 1), abscess stage (stage 2), and granulation stage (stage 3).^[3] Although success may be achieved with conservative treatments during the inflammatory stage of ingrown nails, there is a consensus that

the nail matrix needs to be permanently destroyed with surgical or chemical methods during end period of the abscess stage and granulation stage.^[4–12]

Partial matrix excision^[5,13–15] and wedge excision^[10,11,16–19] are the most preferred methods in surgical ablation of the nail matrix. Relatively high rates of recurrence have been reported following these surgical excisions.

In dermatology, liquid nitrogen is used widely in the treatment of some benign skin lesions in order to destroy live tissues due to its local freezing characteristic.^[20] Following partial nail removal in patients with ingrown

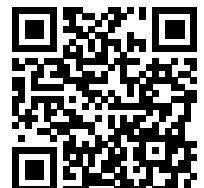
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toenails, destruction of the germinative cells of the nail matrix with cryotherapy using liquid nitrogen was performed, the efficacy of which was then evaluated.

Patients and methods

In our prospective study, matricectomy with cryotherapy following partial nail removal was performed on 87 ingrown nails of 73 consecutive patients who presented to our orthopedics outpatient clinic between February 2010 and December 2013 due to ingrown nail of the big toe. Eleven patients who were followed up for a period of less than 1 year or were lost to follow-up were excluded from the final study results. Treatment outcomes of the remaining 62 patients with 76 ingrown nails were evaluated. Seven ingrown nails were at stage 2, and 69 ingrown nails were at stage 3. Prior to study, approval from the local ethics committee was obtained, and informed consent forms were obtained from each patient. Patients with diabetes, peripheral vascular diseases, collagen tissue diseases, allergies to local anesthetic drugs, patients intolerant to cold, and patients who had been using systemic steroids were excluded. No fungal infections were detected clinically in any patient. Thirty-nine patients were male, and 23 patients were female. Average age was 24.3 years (range: 16–39 years), and average follow-up period was 17.6 months (range: 12–44 months).

Surgical applications were performed by the same surgeon in the outpatient operating room. The toe was washed with povidone-iodine and covered sterilely. Digital nerve block anesthesia was applied with 2% adrenaline-free lidocaine (Jetokain Simplex Ampul 2 ml, Ad-eka, Istanbul, Turkey). The lateral side of a sterile surgical glove was cut in strips 1 cm in width. A strip was wrapped in a circular fashion from the distal of the big toe to its proximal and rolled around itself a few times at the proximal. The big toe was exposed by cutting the strip from the distal and keeping it intact at the proximal. Thusly, tourniquet application was performed and hemostasis achieved. On the ingrown side of the nail plate, a 6- to 7-mm vertical skin incision was performed on the proximal nail fold in order to remove the one-quarter lateral part of the nail plate. The cutting edge of the surgical blade was reversed, as to face the foot dorsal. The ingrown part of the nail plate on the lateral was excised by cutting from the distal of the nail, avoiding damage to the nail bed (Figure 1a). Granulation tissue was cleaned with a curette. Skin over the nail matrix was pulled sideways. The lateral part of the matrix was totally exposed. A 90° angled fine-tip was used for open-spray cryotherapy (CRY-AC, Brymill Co., Ellington, CT, USA), and the matrix was sprayed from a 5- to 10-mm distance with spot-freezing technique,

forming an icing area. Spraying was continued uninterrupted for 45 sec after ice formation (Figure 1b). Destruction of the matrix site lying beneath the one-quarter lateral portion of the nail plate, excised independent from the plate width, was performed with cryotherapy. Following defrosting, the skin was closed with a single suture (Figure 1c). The wound was covered with sterile dressing, and the tourniquet was removed.

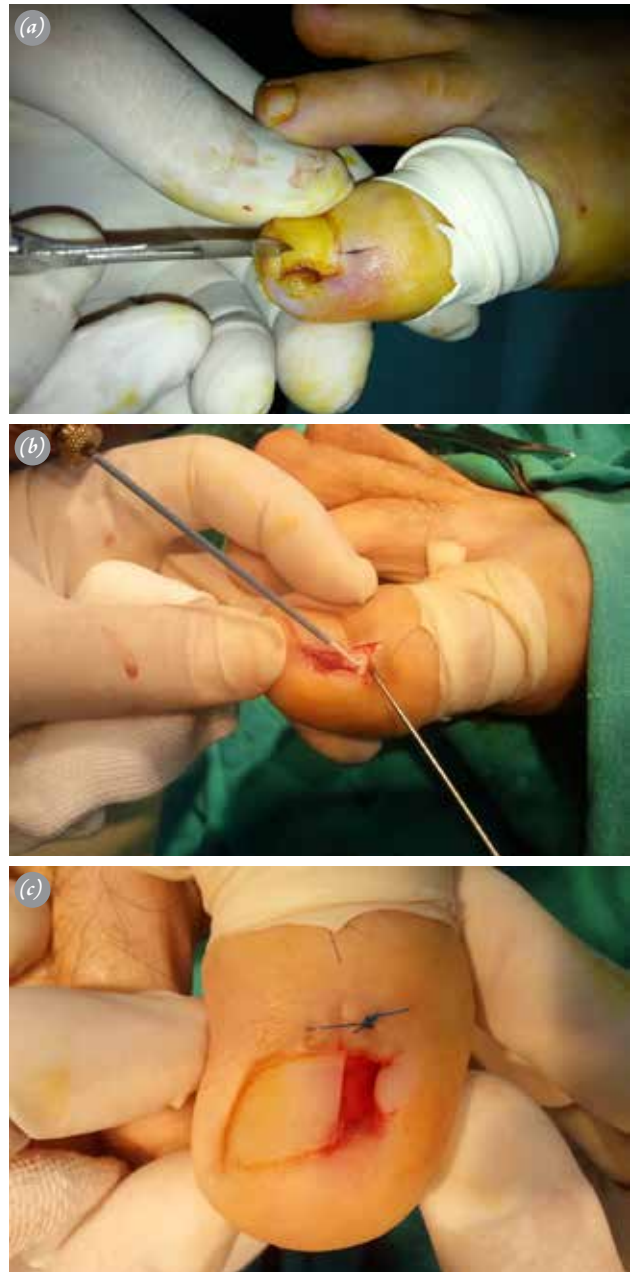


Fig. 1. (a) The surgical blade was reversed and one-quarter of the lateral nail plate was excised. (b) The lateral nail matrix being sprayed with liquid nitrogen from a cryotherapy device with a 90° angled tip. (c) Appearance of the big toe following closure of the skin. [Color figures can be viewed in the online issue, which is available at www.aott.org.tr]

Patients were advised to take acetaminophen when they had pain. Systemic antibiotics were not administered to any patient. Wounds of the patients were followed up at the second, fifth, and eleventh days postoperatively, at which point they were removed. Patients were asked to return for follow-up at the third and sixth weeks postoperatively, as well as the third and sixth months, after which they were to return at 6-month intervals. Presence of pain, infection and drainage was investigated at the 6-week follow-up. Recovery time was accepted when improvement of edema in the toe, loss of inflammatory changes, and epithelization in the partial matrixectomy region were observed and patients were able to wear their usual shoes. A repeating ingrown nail, painful nail edge dystrophies, or development of spicule in the region which partial matrixectomy with cryotherapy was applied was considered as recurrence. Patients' satisfaction with the general appearance of their nails was investigated at the 12-month follow-up.

Results

The majority of the patients reported mild pain after surgery. No patients developed postoperative infection. Intensive serous liquid accumulation on the matrix region, where cryotherapy had been performed, was observed at the 2- and 5-day follow-ups in all patients, and the surrounding area was macerated. At the 11-day follow-up, there was no serous drainage over the matrix region where cryotherapy was performed. At the 3-week follow-up, epithelialization was observed, and all patients wore their normal shoes and returned to their normal daily activities. In 74 ingrown nails which were followed up for 12 months or more, the patients did not have any complaints and were completely satisfied with the appearance of their nails (Figures 2a-e). Two patients had new nail growth in the matrixectomy area at 3-month follow-up. These 2 ingrown nails (2.6%) were considered as recurrence and spicule, and formation was observed at 6-month follow-up.



Fig. 2. (a) Preoperative view of the bilateral ingrown nail. (b) Postoperative day 5 view of the same patient's toes. Edema and serous fluid deposition can be seen. (c) Postoperative month 12 view of the same patient's toes. (d) Infected granulation tissue covering the nail lateral. View of the nail before surgery. (e) View of the same toe at 18-month follow-up. [Color figures can be viewed in the online issue, which is available at www.aott.org.tr]

Discussion

Nail plate, which causes ingrown nails, develops from the nail matrix due to a process called onychokeratinization. The matrix consists of 2 cell layers. The lower layer is the basal compartment, which contains germinative cells. The plate which grows here and extends to the distal adheres tightly to the nail bed beneath.^[21] Unfitting footwear and improper cutting of the nail destructs the lateral nail fold. With continuous toe movements, nail spicules are formed. The lateral nail fold is punctured with spicules, which move like foreign objects by burying themselves in the lateral nail fold.^[22] Mild erythema, edema, sensitivity, and pain along the lateral nail bed can be observed in early stages. This stage is called the inflammatory stage, in which success can be achieved with conservative treatments. With increasing erythema, edema, sensitivity, and pain, infection manifests itself. Protuberance develops on the lateral nail fold and nail plate, and with drainage development, the abscess stage follows. Granulation tissue covers the lateral nail fold, preventing drainage. In this stage, the granulation stage, the epithelium begins to spread over the granulation tissue.^[1,22]

Successful results can be obtained with conservative treatment during the inflammatory stage and at the beginning of the abscess stage of ingrown nails. Treatment can be applied with appropriate foot care and correct nail cutting, systemic antibiotic use, and by lifting the lateral nail edge with cotton, acrylic balls, or nail splints.^[1,22,23]

Insisting on conservative treatment for a long period tires both the patient and the doctor. In the abscess and granulation stages, where conservative treatment is not sufficient, partial or total removal of the nail without destroying the nail matrix, placing a polyethylene tube in the lateral nail groove, and destroying the granulation tissue with electrocautery or cryotherapy are other alternatives.^[22,24,25] However, as recurrence rates are high in surgeries performed without destroying the nail matrix, permanent destruction of the partial nail matrix with surgical or chemical methods primarily using phenol—10% sodium hydroxide and trichloroacetic acid have been used in a small number of studies—have become recognized modes of treatments.^[4,5,7,9–16,26–29] CO₂ laser and radiofrequency methods have also been used, albeit rarely.^[30–32]

In surgical treatment of ingrown nails, wound recovery period is defined as the time until drainage ends and inflammatory changes disappear. Despite a lack of detailed recovery information in most studies, time to return to normal physical activities is considered as the recovery period. The time frame for this period has

been reported as 2–4 weeks in various studies.^[26,33–36] Use of oral systemic antibiotics has not been found effective in wound recovery.^[37] Infection post-surgery was not observed in any patient in the present study. Wound healing was completed by postoperative week 3 in all patients, all of whom returned to their daily activities.

The main purpose of surgical treatment of ingrown nails is to ensure minimization of recurrence rates and produce cosmetically acceptable results. Regrowth in the nail edge, painful nail edge dystrophies, and presence of spicules are considered recurrence. Recurrences were usually seen between the third and twelfth postoperative months.^[27–29,33]

Recurrence rates of 32%–83% were reported following total removal of the nail plate or removal of the lateral part without destroying the nail matrix. Similarly, high recurrence rates were reported in total excision of the nail bed. Total or partial nail extraction is only recommended when abscess covers the whole nail.^[1,27,38]

Recurrence rates were reported as 0%–21% in surgical excision or electrocautery ablation of the matrix on the side of the ingrown nail.^[10–19,35,39] Another commonly used method is chemical partial ablation of the matrix using phenol. Recurrence rates were reported as 2.7%–24% following phenolization.^[5,7,10,15,16,27] Despite its effectiveness in treatment of ingrown nails, use of phenol also presents certain disadvantages. Phenol is a toxic substance that can easily be absorbed through skin. It should be neutralized with saline solution or glycol-alcohol following its application. Diffuse damage might be seen in the surrounding tissue. Additionally, it may lead to delayed drainage and healing. Use of phenol is not recommended in pregnant patients.^[40]

In a study which compared partial matrix excision and segmental phenolization for ingrown nails, 34 ingrown nails were treated with partial matrix excision following partial nail extraction, and 7 recurrences were reported. Seven recurrences were also reported in 29 ingrown nails which were treated with phenolization following partial nail extraction. In comparison of the 2 techniques, it was seen that partial matrix excision caused less postoperative morbidity and faster healing, and prolonged wound drainage was observed following phenolization. Recurrence rates were very high in both methods, though the preferred method was matrix excision, to avoid using phenol.^[5] Another study emphasized that the application area for phenol should be limited in treatment of ingrown nails.^[37]

Chemical partial matricectomy with 10% sodium hydroxide or trichloroacetic acid was performed in some

studies in an attempt to avoid the toxic effects of phenol. Recurrence rates reported in these studies are similar to those of phenol applications and were found as 2.4% and 5%, respectively.^[28,29]

Partial matricectomy with CO₂ laser was performed in 19 ingrown nails, and spicule occurrence was observed in 1 case (5.5%).^[31] The use of CO₂ laser in partial matricectomy application on 344 previously unsuccessfully treated ingrown nails resulted in delayed healing of up to 6 weeks, 5 recurrences, 14 spicules, and 8 infected nail folds.^[30] As presence of spicules should also be considered recurrence, the real recurrence rate was 19 cases (5.5%). Of note, this system is technically challenging and expensive.

Cryotherapy is a local freezing application performed on live tissues with liquid nitrogen. Liquid nitrogen has the lowest boiling point among current freezing agents (-196 °C) and is widely used in treatment of certain benign skin lesions. It is a fast and cost-effective treatment and is applied by spraying or with a probe on skin lesions. Different cells and tissues have different sensitivities to cold. In descending order, the cells most sensitive to cold are melanocytes, basal cells, and keratinocytes. It is reported that in order to treat skin lesions with a diameter of 5–25 mm, the cryotherapy device must be used at a distance of 10 mm from the skin lesion for 60–90 sec, and with this application -50 °C will be reached at a depth of approximately 3 mm. It was reported that this temperature is sufficient to kill the skin cells and shrinkage which develops in the application site in 10–14 days. Following cryotherapy, temporary edema, drainage, and maceration may be seen, and color changes in the application site and minimal scarring are common consequences. Cosmetic outcomes are in general favorable.^[20]

Liquid nitrogen creates completely reversible functional changes in peripheral nerves. Because of this, it was reported that lesions can be treated without pain. Liquid nitrogen destroys pyogenic granuloma with its anti-infective and necrosis-developing characteristics.^[24] Due to the anti-infective effect of liquid nitrogen, antibiotics were not used in any patients in the present study.

Sonnex and Dawber^[24] treated 44 infected ingrown nails with granulation tissue via cryotherapy. The authors reported recurrence in 11 patients after nail avulsion, and 8 patients previously underwent unsuccessful lateral nail and matrix excision. The authors applied cryotherapy for 30 sec from a distance of 10 mm to the infected granulation tissue and reported that the lesions healed in 4–5 days and many patients were able to discontinue dressing the wound in 1–2 weeks. Total treatment success rate was reported as 63.6% in 13–18

month follow-up. The authors stated that this success rates could be increased by decreasing the nail bed volume or extending the freezing time. The reported rate of success is low. However, the authors did not perform matricectomy with cryotherapy, choosing to instead directly spray liquid nitrogen onto the infected granulation tissue.

In his critical work published in 1991, Masters^[41] discussed the work of Sonnex and Dawber and stated that his study was similar to theirs. As 15 out of the 20 patients experienced recurrences, he abstained from recommending cryotherapy, citing its inefficacy and unnecessary. Cryotherapy was not performed with matricectomy in this study either; only spraying of liquid nitrogen on granulation tissue was performed.

The effectiveness of electrocautery and cryotherapy in matricectomy in the treatment of ingrown nails was evaluated in a recent study, and it was reported that the 24 patients who were given cryotherapy and followed for 3–12 months did not develop any recurrence.^[39] This study is the only one which cited the use of cryotherapy with partial matricectomy that we could retrieve in the literature; however, application of cryotherapy was not discussed in detail.

In the present study, partial matricectomy with cryotherapy was performed for ingrown nails. Our application is not the excision of the nail matrix and nail fold (Winograd procedure),^[10,13] nor does it bear resemblance to any other previous techniques.^[5,12,17,26,28–30,32] Our follow-up period was a minimum of 12 months. This period is sufficient to observe recurrence. The 60 patients with 74 ingrown nails had no recurrence and were satisfied with the appearance of their nails in general. At the 6-month follow-up of 2 nails, recurrence was observed in the form of spicule growth in the nails.

The limitations of our study were the lack of a comparison group and relatively high rate of inadequate follow-up of patients.

In conclusion, destruction of the nail matrix with cryotherapy following partial nail removal is considered an effective and safe method for ingrown nail treatment. Serous drainage seen postoperatively should be dressed frequently. Our procedure is a minimally invasive surgical approach with low recurrence rates, which should be supported further by more comprehensive studies.

Conflicts of Interest: No conflicts declared.

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