



New, Effective and Minimally Invasive Technique for the Treatment of Ingrown Toenails: Our Application Experiences

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Abstract

Ingrown nail is a serious medical problem and the correct approach for its treatment is still controversial in the existing literature. In this study, we presented the results of our application experiences on our new developed technique for the treatment of ingrown toenails. The study is a prospective clinical quasi experimental study for treatment. This study included 147 patients who applied to SBU Sultan 2. Abdülhamid Han Training and Research Hospital, General Surgery Clinic with the complaint of ingrown toenails. The duration of the study covers October 2018 to March 2022 and the 6-month follow-up period for each patient. All the patients were treated with this minimally invasive technique. In this technique, a piece cut in the form of a half-groove, 3–4 cm long, obtained from the tube part of the intravenous drip set plastic, is placed between the dermis and the nail in a sandwich model and fixed to the nail with the suture technique. According to the results of the study, overall recurrence rate was low at 9.5% (14 patients). The follow-up results by the end of six months demonstrated that the technique is very effective for the treatment of ingrown toenails that 94.5% of the patients had no complaints. Our application experiences with our new minimally invasive technique for treating ingrown toenails, presented in this study, have shown that this technique is quite effective. The main advantages of the technique are the preservation of the anatomy and function of the nail, high patient satisfaction, less pain, rapid recovery, low recurrence rate, and ensuring patients a quick return to their daily activities or work life.

Keywords Ingrown toenail · Onychocryptosis · Minimally invasive technique

Introduction

Ingrown toenails, also referred to as onychocryptosis or unguis incarnates, is a common and frequent painful nail condition encountered in clinical practice [1]. Ingrown toenails are characterized by the growth of nail plate into the periungual dermis and often results in foreign body, infectious and inflammatory processes that may become cyclical and chronic [2]. The disease most frequently occurs in hallux nails but it can occur at any toe [3]. It may be observed at any age but mostly observed

at teenagers and young adults. Ingrown toenails cause considerable pain being the main symptom, also disability and discomfort in the foot if left untreated and it affects daily activities and quality of life [4]. Ingrown toenail is an important medical problem that cannot be overlooked and selecting the right treatment approach still remains controversial in daily practice. It can be treated with numerous conservative and surgical techniques [5]. In this presented study, our experience is presented that we gained from 147 patients who were treated with our newly developed technique which is a quick, effective, practical to perform, minimally invasive method for the treatment of ingrown toenails. Low pain, rapid recovery after treatment, good functional and aesthetic results, and rapid return to daily activities and work are the advantages of this technique. A high recovery rate was achieved with this technique in the first week, first month, and six-month follow-up results.

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Patients and Method

The presented study includes the treatment of total 147 patients (40 women, 107 men, 11 to 79 years age; mean 24.9) with ingrown toenails who applied to Sultan 2. Abdülhamid Han Training and Research Hospital, General Surgery Clinic, İstanbul with 6 months follow-up for each of the patients. Patients with complaints of swelling, erythema, and exudate along with pain in the first phalanx of the foot were included in the study. Children younger than 10 years old and patients older than 80 years old, patients having diabetic foot, neuropathy, and active fungal disease were excluded from the study. In the clinical experimental study for such a treatment, it was predicted that there should be minimum 100 patients according to the power analysis evaluations; therefore the sample size was determined to be over 100 patients. The duration of the study covers October 2018 to March 2022 and the 6-month follow-up period for each patient. All patients were treated by the same method as described below which was approved by the Ethics Committee of İstanbul Health Sciences University Hamidiye Clinical Research Ethics Committee. Some of the patients were referred to our outpatient clinic by dermatology after ineffective medical treatment and interventions.

Our method applied to the patients, instead of nail avulsion which is a commonly applied surgical method, is a minimally invasive technique (Senol's procedure) [6]. Before the procedure, a povidone-iodine foot bath was performed. No systemic antibiotics or NSAID were prescribed. The toe and its surroundings were disinfected with povidone-iodine solution. Before the procedure, standard digital block was applied with 1% lidocaine without epinephrine. A digital tourniquet was applied to stop the bleeding during the procedure. The ingrown side nail edge was slightly lifted until the nail matrix. In our technique, a piece cut in the form of a 3 cm long half-groove obtained from the tubing part of the intravenous drip set plastic was used. The half-groove shaped piece was placed between the dermis and the nail with sandwich model. It was fixed to the nail with the suture technique with the help of polypropylene suture. It was not changed or removed, and the procedure was completed. Then the tourniquet was opened and the area was dressed with povidone-iodine ointment and gauze. One day after the procedure, the patients removed the dressing and returned to their normal activities. Daily cleaning with soap and pressurized water were recommended to the patients. After the procedure, the nail fully grew on the soft tissue thanks to this barrier in a period of about 3–4 months and the treatment was finalized. The patients were called for follow-up at the end of first week, first month and six months. This presented study is

a prospective clinical quasi experimental study for treatment. Placing half-groove shaped piece of intravenous drip set between dermis and the nail with sandwich model, and fixing it with suture technique provided the nail to grow normally without any pain. We described the results of this technique which was applied to 147 patients. The results showed a high achievement rate. Recurrence developed in 14 (9.5%) (9 men, 5 women) of 147 patients. In terms of side of the toenail, recurrences were 5 on the right foot, 8 on the left foot, and 1 bilateral. In terms of localization, recurrence developed in 8 patients with lateral ingrown toenails, in 4 with medial ingrown toenails, and in 2 with bilateral ingrown toenails.

Statistical Analysis

Mean, standard deviation, median and range values were used as descriptors of the variables. Non-parametric tests were used. Pearson Chi-Square test was used to compare group differences. The differences were statistically evaluated within the 95% confidence interval, and those with a *p* value less than 0.05 were considered statistically significant. The distribution normality of the age of the patients was examined with the Kolmogorov Smirnov test. The relationship between age and recurrence was examined with the Mann–Whitney U test. Statistical analysis was performed using SPSS (Statistical Package for Social Sciences) version 25.0 software (SPSS Inc., Chicago, USA).

Results

This study included 147 patients (107 men (72.8%)/40 women (27.2%)) with the complaint of ingrown toenails. The mean age of the patients was 24.9 (range 11–79), and median age was 21. According to the Mozena classification, 54 ingrown toenails (36.8%) were determined to be stage 1, 59 (40.1%) stage 2, and 34 (23.1%) stage 3. The location of the disease was 59 right (40.1%), 77 left (52.4%), and 11 bilateral (7.5%). Pain, alone or alongside other complaints, was the symptom seen in all patients. 21 patients (14.2%) applied with only pain complaints, while pain and erythema were observed in 33 patients (22.4%), pain and exudate in 8 patients (5.4%), pain and swelling in 15 patients (10.2%), pain, erythema and exudate in 2 patients (1.3%), pain, erythema and swelling in 28 patients (19%), pain, swelling, exudate in 6 patients, and 34 patients (23.1%) had pain, swelling, erythema and exudate (Table 1). No complications developed during the procedure. The implementation time of the procedure took less than 20 minutes in all patients. No pain or infection was observed in the patients while holding the plastic between the dermis and the nail.

Table 1 Demographic data of our patients with ingrown toenails

Demographic and Post-procedure Data	Results
Total, <i>n</i> (%)	147
Men, <i>n</i> (%)	107 (72.8%)
Women, <i>n</i> (%)	40 (27.2%)
Age, median (range) (years)	21 (11–79)
Affected side (toe) (<i>n</i> , %)	
Right	59 (40.1%)
Left	77 (52.4%)
Bilateral	11 (7.5%)
Localization (<i>n</i> , %)	
Lateral	93 (63.3%)
Medial	29 (19.7%)
Bilateral	25 (17%)
Stage (<i>n</i> , %)	
Stage 1	54 (36.8%)
Stage 2	59 (40.1%)
Stage 3	34 (23.1%)
Complaints (<i>n</i> , %)	
Pain	21 (14.2%)
Pain, erythema	33 (22.4%)
Pain, exudate	8 (5.4%)
Pain, swelling	15 (10.2%)
Pain, erythema, exudate	2 (1.3%)
Pain, erythema, swelling	28 (19%)
Pain, exudate, swelling	6 (4%)
Pain, erythema, exudate, swelling	34 (23.1%)
Post-procedure period (<i>n</i> , %)	
Follow-up results 1 st week, complaint	3 (2%)
Follow-up results 1 st month, complaint	9 (6.1%)
Follow-up results 6 th month, complaint	8 (5.4%)
Recurrences, <i>n</i> (%)	14 (9.5%)

The short-term results of the treatment were remarkable. No post-procedure infection was detected in the patients and no post-procedural pain was observed. The patients were able to put on shoes and continue their activities the next day. In the follow-up period, the sutures were not removed, the plastic material was not removed, and the plastic was expected to fall off on its own as the nail grew. The fixed plastic fell off on its own with the expected time in 129 patients (88.7%) as the nail fully grew within 3–4 months. The technique was reapplied for 14 patients (9.5%) whose plastic fell off earlier than expected. The remaining 4 patients did not state any complaints although the plastic fell early, and reoperation was not applied to them. In the first week follow-up, 3 patients (2%) had complaints. Two patients had pain. In the other patient, swelling was observed in the dorsum of the foot; antibiotics were given, elevation was applied, and patient's complaints regressed within two days. The pre

and post-procedure images of some of the treated ingrown toenails are shown in Fig. 1.

In the first month follow-up, 9 patients (6.1%) had complaints. According to the results of the sixth month follow-up, 8 patients (5.4%) had complaints. Ingrown toenail treatments of the remaining patients were successful, complete recovery was achieved. Nail growth of the patients was not affected and nail dystrophy did not occur. There were no scars observed in the patients. Overall cosmetic results were considered excellent. In our study, the recurrence rate (14 patients) was found to be 9.5%.

Recurrence developed in 5 of 40 women patients and in 9 of 107 men patients (64.3% and 35.7% respectively), men and women recurrence differences were analyzed Fisher's exact test and no significant difference was found between them ($p=0.529$). The distribution normality of the age of the patients was examined with the Kolmogorov Smirnov test and it was observed that they were not normally distributed. The relationship between age and recurrence was examined with the Mann–Whitney U test and no significant relationship was found between them ($p=0.214$). In terms of the affected side of the toenail, the development of recurrence occurred in 5 of 59 patients with ingrown toenails on the right foot, in 8 of 77 patients with ingrown toenails on the left foot, and in 1 of 11 patients with bilateral ingrown toenails (5.7%, 57.2%, and 7.1% respectively). According to Pearson Chi-Square test results, no significant relationship was found between recurrence and the involved side of the toenail ($p=0.930$). Recurrence developed in 8 of 93 patients with lateral ingrown toenails, in 4 of 29 patients with medial ingrown toenails, and in 2 of 25 patients with bilateral ingrown toenails (57.1%, 28.6%, and 14.3% respectively). The relationship between ingrown nail localization (lateral, medial, and bilateral) and recurrence was investigated by Pearson Chi-Square test and no significant relationship was found ($p=0.680$) (Table 2).

Discussion

Ingrown nail is a common clinical condition usually seen in hallux and young adults. It can be seen at any age, but mostly occurs in early adulthood. An ingrown toenail causes discomfort and pain and limits the patient's daily activities. It is caused by the lateral edge of the nail growing or pressing on the lateral nail fold [4, 5]. The incidence of ingrown nails peaks in adolescents and young adults, and there is a clear men predominance (men/women ratio of approximately 2 to 1). Ingrown toenails can occur on one or both sides of the nail. The involvement of the lateral toe is twice of the medial side [3, 7]. Ingrown toenail is often observed in people with voluminous nail folds. Various causes have been suggested for the disease, including anatomical abnormalities, incorrectly trimmed nails, improperly fitting or narrow shoes,

Fig. 1 The images of the ingrown toenails before and after the procedure; left: pre-treatment, middle and right: post-treatment



Table 2 Demographics and recurrence rates of ingrown toenails patients

Demographics and ingrown toenail location	Total patients (n = 147)	Recurrence (n = 14, 9.5%)	p*
Men/women	107 (72.8%)/40(27.2%)	9 (64.3%)/5 (35.7%)	0.529
Age, median (range) (years)	21 (11–79)	17.5 (12–66)	0.214
Side (toe)			
Right	59 (40.1%)	5 (35.7%)	0.930
Left	77(52.4%)	8(57.2%)	
Bilateral	11 (7.5%)	1(7.1%)	
Localization			
Lateral	93 (63.3%)	8 (57.1%)	0.680
Medial	29 (19.7%)	4 (28.6%)	
Bilateral(lateral + medial)	25 (17%)	2 (14.3%)	

*Fisher's exact test, Mann–Whitney U test, Chi-Square test, p < 0.05 statistically significant

poor foot hygiene, repetitive traumas, obesity, working in a job requiring standing for long periods of time, and genetic predisposition [8, 9].

The soft tissue in the nail sulcus is not normally in contact with the nail edges. The balance between the lateral nail sulcus and the nail body is disturbed by factors that cause ingrown nails. The lateral nail edge grows or pushes into the lateral nail fold. This initially causes pain and if the process continues, foreign body reactions, bacterial infections, drainage and abscess formations occur. In the final stage, hypertrophy and pyogenic granuloma develop at the lateral nail edge. Consequently, severe pain, difficulty in walking, and interruption of work and social life begin [10].

The treatment of the ingrown toenails is selected based on the severity and stage of the disease. Initially, slight pain, erythema and edema are seen in patients with ingrown nails, in addition to these, inflammatory granuloma tissue formation is observed with exudate and infection, and epithelialized granulation tissue and abscess formation are observed in advanced cases. Depending on the patient's personal care, it is possible to see transitions between the stages of the disease. According to the classification in the study of Mozena, the first stage is called the inflammatory stage and is characterized by the presence of lateral mild pain, edema and erythema. The second stage is the abscess stage in which an increase in pain, erythema, edema, and hyperesthesia are observed, and the nail plate exceeds the nail bed by less than 3 mm. In the second phase of this stage, together with these symptoms, the nail plate exceeds the nail bed by more than 3 mm. In the third stage, granulation tissue and hypertrophy development in the nail becomes chronic. Untreated at this stage, onychocryptosis can progress further and cause significant chronic deformities. Severe chronic deformities of the toenail and distal hypertrophy are observed in the fourth stage [11].

Although many methods have been described in the literature for the treatment of this common disease, from conservative approaches to radical surgical techniques, no consensus has been reached for the best treatment approach and this issue is still controversial in the literature. Treatment methods include taping, packing, groove treatment, nail wire, chemical matrixectomies or cauterization of the matrix, total or partial nail extraction [12]. Nevertheless, these treatment methods have disadvantages such as side effects such as infection and excessive bleeding, unnecessary extensive surgery, the need for chemicals that are not always available. The application of conservative methods is recommended in patients with mild to moderate ingrown nails. Taping technique, gutter treatment, cotton wick placement, dental floss technique, use of acrylic artificial nails, as well as antibiotic use and foot hygiene measures can be counted among these conservative treatments [13]. Surgical techniques should only be done by the physicians. Surgical treatments include various techniques applied to the nail bed, nail plate and surrounding soft tissues. Wedge excision, partial or total nail avulsion, lateral nail reduction

and removal, nail bed excision, total ablation of the nail bed, segmental horn cauterization, surgical segmental matrix excision, chemical matrixectomy, toe tip amputation, rotational flap technique of the nail fold are the surgical treatment methods [11, 14]. The recurrence rate in surgical approaches has been reported to be in the range of 1.7% and 27%. Modified Emmert's procedure consisting of an elliptical longitudinal wedge-shaped excision of the lateral nail fold, ingrown nail, nail matrix and granulation tissue, has been reported to be associated with a recurrence rate of 5% to 20% [15]. Chemical matrixectomy with phenol is an interesting alternative, especially for dermatologists as it has a recurrence rate of 5% [16]. However, postoperative infections and complications are reported more frequently, and it also results in extensive tissue destruction that can cause delay in healing. In addition, phenol is reported to be potentially carcinogenic and therefore not available in every clinic [17, 18]. Almost the same therapeutic results have been achieved as with laser matrixectomy [19]. Nevertheless, the main disadvantage of matrixectomy, regardless of its type, is the risk of a narrower nail and sometimes poor cosmetic results with nail dystrophy or spicule formation [11]. In a recent study, radiofrequency and carbon dioxide laser ablation of the nail matrix are considered as preliminary and expensive approaches [20]. In some studies on surgical methods, series such as wedge resection, total or partial extractions have been reported, but most surgical techniques cause excessive and frequent treatment and do not guarantee recurrence, so minimally invasive surgery is recommended in recent publications [21]. The minimally invasive technique presented in this study provides the following advantages compared to matrixectomy. The anatomy of the toe and the function of the nail were preserved. The patients could be able to return their daily activities after the following day when the technique was applied to nail. Rapid recovery was achieved after the treatment, and good aesthetic results were observed.

Conclusion

The application experiences with the new minimally invasive technique (Senol's procedure) applied for the treatment of ingrown toenail presented in the study revealed that it is a very effective method with high patient satisfaction, low pain, rapid recovery, low recurrence rate and rapid return of patients to their daily activities or work life. It was observed that the technique is successful in ingrown nails in different stages ranging from the first to the third stage and that occur simultaneously on both feet and on both sides of a toe. The aesthetic results were also remarkable. The most important advantage of this procedure is that the anatomy and function of the nail is preserved and the patients return to their daily activities or work the next day without pain and uninterrupted.

Declarations

Ethics Approval Ethics Committee approval no. 21/99 was obtained from the SBU Hamidiye Clinical Research Ethics Committee with the decision dated 01/12/2021 for the presented study.

Conflict of Interest The authors declare that they have no conflict of interest.

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