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Onychocryptosis: A review of epidemiology, risk factors, classification, complications and effective therapeutic strategies

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Abstract:

Ingrown toenails, clinically known as onychocryptosis, represent a prevalent nail pathology. The clinical manifestation involves symptoms typical for a foreign body reaction and in severe cases, tissue hypertrophy with complications may occur. Key risk factors include improper nail care, trauma, obesity, tight footwear, poor foot hygiene, and genetic predisposition. The condition predominantly affects individuals between the first and the third decades of life and older adults, with a predilection for the great toe, especially the lateral skin fold. The Heifetz and Scholz classifications delineate the stages of ingrown toenails based on severity. Therapeutic approaches range from conservative procedures, such as taping, dental floss, gutter treatment, cotton nail cast, braces and super elastic wire to surgical interventions like partial or total nail avulsion, matricectomy and advanced techniques like the Vandebos procedure or the Winograd procedure. Although

many studies have analysed available treatment methods, there is no consensus among specialists regarding the best therapeutic strategy. Complications include paronychia, infection, and scarring. A comprehensive therapeutic approach should consider clinical severity, patient preferences, and both conservative and surgical interventions, emphasizing the importance of larger randomized clinical trials to establish definitive guidelines.

Aim of this study:

The current literature on epidemiology, risk factors, classification, complications and current therapeutic procedures in ingrown toenail was reviewed. In order to update knowledge about this disease entity.

Material and methods:

A systematic review of the scientific and medical literature from the PubMed and Google Scholar databases was carried out.

Key words: ingrown toenail; onychocryptosis; matricectomy.

Introduction

Ingrown toenail is the most common nail pathology that patients report to a primary care physician or specialist [1]. Also known as onychocryptosis, it affects approximately 5% of the general population, though it is believed that the percentage may be significantly higher due to many individuals ignoring early symptoms and not visiting specialist care [2]. Current literature mentions two main theories regarding the development of onychocryptosis. The first attributes the problem to an abnormal toenail that grows into the surrounding skin fold. Another theory identifies the pathology's source in abundant periungual skin [3]. Regardless of the pathogenesis, the course of the process is the same, manifesting as a classic cascade of inflammatory reactions with pain, swelling, and redness. Severe cases may involve infection, ulceration of damaged tissues, and take on the form of chronic inflammation with hypertrophy of surrounding tissues [2,4]. Therapeutic management depends on the stage of advancement, including both conservative and surgical treatments [1].

Epidemiology

In recent years, there has been an observed increase in cases of ingrown toenails among the population, likely stemming from increased societal health awareness

and the promotion of healthy behaviors [1]. Although an ingrown toenail can occur at any age, this pathology is more commonly observed in the population between the ages of 10 and 30, as well as in older individuals [3,5]. In approximately 80% of cases involving the foot, the ingrown toenail affects the big toe, and in over half of the patients, the damage involves the lateral skin fold [6]. Among adolescents and young adults, a higher susceptibility has been noticed in males compared to females, with a ratio of nearly 2:1 [1]. Diabetics face a significantly higher risk of onychocryptosis, reaching up to 32%. Additionally, patients with circulatory and sensory disorders experience a more severe inflammatory process [7].

Risk factors

Risk factors for the development of ingrown toenails include: improper nail trimming, nail trauma, obesity [5], as well as wearing excessively tight footwear, poor foot hygiene, and genetic factors [8]. In young age, there is an increased risk associated with greater foot sweating during adolescence and active sports participation. This process causes the nail plate to become softer and more vulnerable to damage. [1,8]. Conversely, in older individuals, poor hygiene practices, toenail thickening with age, and decreased visual acuity (leading to improper nail trimming) contribute to an elevated risk of this condition [3,8]. Additionally, cases of ingrown toenails have been described following the use of isotretinoin [9,10].

Classification

Depending on the stage of the condition, ingrown toenails can be categorized into three stages, using the **Heifetz classification**.

Stage I (mild) is characterized by swelling, redness, and mild pain.

Stage II (moderate) manifests as increased pain, inflammatory state with a non-healing wound, the presence of granulation tissue, and seropurulent exudate.

Stage III (severe) is characterized by chronic inflammation with granulation tissue formation and hardening of the lateral epidermal fold [11,12].

A more detailed five-stage **classification by Scholz** is also applied:

In the first stage, there is slight discomfort with no signs of inflammation.

The second stage is marked by the onset of inflammation, pain, and swelling.

The third stage includes the presence of purulent exudate and intense pain.

The fourth stage exhibits symptoms similar to the third stage, but granulation tissue is additionally observed.

For stages 1 to 4, the labels 'a' and 'b' are used, where 'a' indicates symptoms on one side, and 'b' on both sides.

The final, fifth stage signifies the postoperative state, where 5a indicates the possibility of continued ingrowth, and 5b is associated with the presence of an additional nail [11,13].

Treatment

There are various approaches to treating ingrown toenails, both conservative and surgical. Indications for treating ingrown toenails include severe pain or infection, nail plate deformities, and recurrent inflammation of the nail fold. Conservative treatment is recommended for patients with mild symptoms of ingrown toenails [14]. In cases of moderate or severe onychocryptosis, surgical intervention should be prioritized. Despite numerous studies, there is no consensus among specialists regarding the best surgical method [15].

Conservative Treatment

Proper hygiene habits.

Appropriate nail cutting straight across, avoiding tight footwear around the toe area, and early treatment of predisposing conditions such as nail fungus and excessive sweating are fundamental recommendations for every patient, regardless of the cause of the ingrown toenail [3].

Taping.

This is a method that, when applied chronically and appropriately, allows for satisfactory results in cases of mild-stage disease. Most patients can apply it themselves at home after proper training [16]. The aim of this method is to lift the skin fold away from the nail plate using flexible tape. There are several different

techniques of ingrown toenail taping, and they are continually being refined [17]. Traditional taping involves placing one end of the tape on the skin fold of the ingrown toenail, then wrapping the tape around the toe to pull the damaged skin away from the nail plate. Elastoplast is often used in this method [18]. The use of traditional taping was associated with more frequent visits to specialists, dermatological problems, and perceived discomfort. For many, it was inconvenient and led to discontinuation of further treatment. The modified taping method presented in one study involves the use of a wider (25mm) and shorter (3-4 cm) tape than in the traditional method. One end of the tape should be attached along the upper edge of the lateral fold of the damaged side, then guide the skin fold away from the nail plate, creating a gap. Attach the remaining part of the tape along the side of the big toe. It is important to attach the other end of the tape to the toe pad without stretching it. The advantage of this modification was the absence of circulation disorders caused by elastic tape and a reduction in pain symptoms for all patients [17]. Another taping method, particularly used in cases of distal onychocryptosis, is anchor taping. In contrast to the methods mentioned above, this technique requires the use of two pieces of tape, each 5cm in length [19]. One end of the tape is placed in the hyponychium area, then the tape is led along the plantar side of the toe, proximally and diagonally towards the base of the toe. The second piece of tape is placed in a similar way, but led on the opposite side of the toe. This type of method is often used as an adjunctive treatment when applying other therapeutic methods [19,20].

Dental Floss.

This method is applied in the early stage of an ingrown toenail. It involves placing dental floss diagonally under the nail plate in the affected area, damaging the skin fold. The aim is to isolate the skin fold from the nail, which is the source of the problem. This procedure is performed daily by the patient until a sufficient space is created between the nail and the nail fold [21].

Gutter Treatment.

Gutter splints are used in the treatment of acute and chronic stages of ingrown toenails, especially those accompanied by granulation tissue formation. The key

requirement for applying this method is the appropriate size and shape of the toenail [22]. This method involves placing a cut tube, from top to bottom, on the edge of the ingrown toenail and covering them with acrylic foundation. The positioned tube is shaped using scissors. The tube is removed when granulation tissue disappears or when the toenail reaches the tip of the toe. The duration of this method is approximately 3 months [22,23].

Cotton Nail Cast.

Another method of conservative treatment involves placing a cotton nail cast between the nail plate and the damaged nail fold. The applied dressing is adhered with cyanoacrylate adhesive. This method demonstrated relief of pain in all patients within 3 days of application. The dressing is removed after 2 months [24].

Braces and Super Elastic Wire (SE-wire).

Orthonyxia involves applying a brace made of metal or plastic to a properly prepared toenail, i.e., after removing the damaging element of the nail. The brace is applied to reduce pressure on the delicate tissues and correct the deformation of the nail bed [25]. It consists of a central part resembling the letter omega and hooks on both sides. After placing the hooks under both edges of the nail, the brace is tensioned and then secured to the nail plate using adhesive [23]. Proper adjustment of the brace tension allows for correcting the direction of nail growth [26].

The procedure using SE-wire is recommended when the free edge of the damaged nail is more than 2mm wide, and the angle of inclination of the nail plate does not exceed 90 degrees. This method involves creating two holes with needles in the free distal edge of the nail. Then, carefully guide the needle through one hole towards the other. The SE-wire is inserted until the angle of the nail plate bend reaches 60 degrees. Subsequently, the resulting holes are filled with an adhesive agent. Due to the elastic properties of the used needle, correction of the deformed nail plate is possible. The SE-wire in this position is maintained for up to 3 months [27].

Surgical Treatment

The aim of surgical intervention is to correct the improper interaction between the nail plate and the nail fold [16]. Surgical intervention for ingrown toenails is recommended when conservative treatments prove ineffective or when the condition becomes highly painful or recurrent, and the patient expresses a desire for a more definitive solution [28].

Among the techniques used in surgical treatment, we distinguish:

Partial nail avulsion or total nail avulsion. The first method involves removing only

the portion of the nail that is the source of the problem, while the second involves the complete removal of the nail plate. Partial nail avulsion is often preferred for its better cosmetic results and less invasiveness [29]. Relative contraindications to nail avulsion include diabetes mellitus, disorders of hemostasis, connective tissue diseases, acute inflammatory conditions of the nail unit and paronychia [30,31]. Both methods can be further enhanced by matricectomy to permanently destroy the matrix and inhibit nail growth. Partial nail avulsion combined with matricectomy is the most common surgical treatment method for onychocryptosis [32].

The combination of partial nail avulsion with phenolization proves to be more effective in preventing symptomatic reappearance compared to surgical removal without phenolization (4% of patients out of 25 vs. 38% of patients out of 21) [25]. However, there is a slightly increased risk of postoperative infection [33].

Matricectomy can be performed surgically, chemically, with a laser, electrosurgically [33], or using radiofrequency [34]. Surgical excision involves making a deep incision in the nail bed using a surgical instrument. The most commonly used substance for chemical matricectomy is 88% phenol, due to its ease of use and low recurrence rate [5]. The procedure consists of 1-3 cycles, with the substance applied for a period ranging from half a minute to a maximum of 4 minutes. After each cycle, neutralization is performed using alcohol or saline lavages [5]. Phenol has three main advantages- it has a necrotic effect, preventing the regrowth of the nail plate, it also acts as a disinfectant, reducing the risk of

postoperative infection, and it has an anesthetic effect, significantly reducing postoperative pain [28].

Alternative substances used in chemical matricectomy are 100% trichloroacetic acid (TCA) and 10% sodium hydroxide (NaOH). In a comparative meta-analysis, both TCA (OR 0.03; 95% CI 0.00–0.26) and phenol (OR 0.18; 95% CI 0.05–0.49) demonstrated significantly reduced recurrence rates compared to placebo treatments. However, there were no significant variations in recurrence rates between NaOH and placebo (OR 0.22; 95% CI 0.04–1.18). While TCA exhibited a tendency toward lower recurrence rates compared to phenol, the difference between them was not statistically significant (OR 0.17; 95% CI 0.02–1.00) [35]. The most compelling evidence indicates that either partial nail avulsion followed by phenolization or direct surgical excision of the nail matrix are equally successful in treating ingrown toenails [36].

In one study involving 117 patients, it was demonstrated that the recurrence rate for partial nail avulsion with phenolization (13.8%) was significantly lower compared to partial nail avulsion with surgical excision (38.9%), with a follow-up period of 1 year postoperatively. Additionally, some patients were locally treated with the antibiotic gentamicin after the procedure. The endpoint for assessing the development of infection was 7 days, but it was found that the infection rate was not associated with the use of antibiotics [30].

Radiofrequency, electrocautery, and carbon dioxide laser are all viable approaches for removing an ingrown toenail. These techniques offer benefits such as minimized bleeding, decreased postoperative pain, and prompt sterilization of infected tissue. The CO₂ laser has the advantage of causing limited damage to surrounding tissues. One disadvantage is the extended wound healing period, requiring care for up to 6 weeks [37].

The Winograd procedure is a surgical method involving wedge resection of the nail fold skin with the removal of the problematic portion of the nail plate and partial destruction of the nail matrix [38]. The satisfactory treatment outcomes with this method make it popular among specialists [28]. Several modifications of this method have been described in the literature. The recurrence rate after treatment with the original Winograd method in one study was 7.9% [38]. For

various modifications of this method described in the literature, the recurrence rate ranged from 10.2% to 17.7% [39,40,41]. The healing process of the postoperative wound can extend up to 6 weeks and is associated with an increased risk of infection [16].

The Vandebos procedure stands out among other methods as it involves only the radical excision of nail fold skin. The nail and other elements of the nail unit remain untouched. This surgical approach provides a highly satisfying cosmetic result for the patient, with a low recurrence rate after the procedure [42]. There is no need for antibiotics, and the postoperative wound heals within 4-6 weeks through secondary intention. This method should not be used in older individuals whose nails are often thickened, discolored, and have an abnormal shape. In the case of fungal nail infections and nail plate deformities, the Vandebos method is not recommended [43]. Among rare complications, current studies suggest the possibility of loss of cutaneous innervation [4] and ischemic perfusion-reperfusion injury [44].

One study attempted to compare the treatment outcomes of the Vandebos method vs the Winograd method and found that patients treated with the Vandebos method achieved a low recurrence rate (0 recurrence cases, N=75, $p < 0.001$ vs 10 recurrence cases, N=70, $p < 0.001$), greater satisfaction with treatment results (74 patients (98%), N=75, $p < 0.001$ vs 56 patients (80%), N=70, $p < 0.001$), and satisfactory visual outcomes (74 satisfied patients (98%), N=75, $p = 0.003$ vs 60 satisfied patients (85%), N=70, $p = 0.003$). However, the recovery time (18.0 ± 2.1 , N=75, $p < 0.001$ vs 11.8 ± 2.6 days, N=70, $p < 0.001$) and the subjective pain assessment on the VAS scale during the first week after surgery (VAS= 7.2 ± 1.0 , N=75, $p < 0.001$ vs VAS= 3.9 ± 0.7 , N=70, $p < 0.001$) significantly favored the Winograd method [45]. Ultimately, the choice of the appropriate surgical technique should be selected on the individual requirements of the patient. A more detailed assessment of differences in both treatment methods requires larger randomized studies [45].

Complications

Complications of an ingrown toenail may include paronychia, infection, or scarring of the nail folds [1]. Infections are most commonly caused by *Staphylococcus*,

Pseudomonas, or Candida [3]. Paronychia is an inflammatory condition of the tissues along the nail. The most common cause of paronychia is an ingrown toenail. Common risk factors for both paronychia and ingrown toenails include trimming nails too short, wearing shoes that are too small, and excessive sweating [46]. The most dangerous systemic complication is sepsis [8].

Conclusions

Onychocryptosis is a frequent condition in the general population and is becoming an increasingly common reason for patients to visit a specialist. The accompanying symptoms can be bothersome and impact the quality of daily functioning. A proper therapeutic approach should consider both the patient's clinical condition and their preferences regarding treatment methods. Regardless of the clinical stage, appropriate hygiene practices and the treatment of predisposing conditions should form the basis of the treatment process, both conservative and surgical. Patients with mild symptoms can explore various conservative methods such as tapes, dental floss, cotton nail cast, gutter splint, braces or SE-wire. Surgical treatment is recommended for patients with moderate to severe symptoms of an ingrown toenail. A thorough comparison of the effectiveness, side effects, complications, and recurrence rates of different therapeutic procedures poses a challenge for contemporary researchers and larger randomized clinical trials are necessary.

Disclosure:

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Data Availability Statement

As a review paper, our work does not present new data or analyses. Therefore, there are no specific datasets or data availability to report. The information and findings presented in this review are based on previously published studies, which can be accessed through their respective sources as cited in the reference section.

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Conflict of Interest Statement

The authors declare that there are no significant conflicts of interest associated with this research work.

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