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Risk Factors and Prevention of Onychocryptosis in Adult Population. Review of the Literature

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Abstract

Onychocryptosis, or ingrown toenail, is a common and painful condition which affects young people. Controversy still exists regarding its etiopathogenesis and treatment options, which include conservative and surgical techniques. In this article, we will briefly discuss the etiopathogenesis, clinical features and different prevention options for ingrown toenail. A documentary study was developed based on the format described in the PRISMA system. The databases Pubmed/Medline, Google Scholar, OVID and EBSCO were used for research, using the keywords: onychocryptosis, prevention, etiopathogenesis (in English and Spanish). In this analysis, we have exposed the classic risk factors and those less frequently found in the literature.The importance of this is because by identifying and understanding the risk factors associated with onychocryptosis, it is possible to adopt preventive measures to reduce the likelihood of developing this condition. We have pointed out some important factors to consider, the presence of which may increase the risk of suffering from onychocryptosis, hematopoietic stem cell transplantation, previous nail surgery, matrixectomy, hallux interphalangeal angle, onychogryphosis, subungual hyperkeratosis and nail consistency. Simple non-surgical palliative measures include correction of improper footwear, treatment of hyperhidrosis and onychomycosis, soaking of the affectedtoe followed by application of a medium to high potency topical steroid, and placement of cotton tufts or dental floss under the lateral edge of the ingrown nail.

Keywords: Onychocryptosis • Risk Factors • Prevention

Introduction

Onychocryptosis, commonly known as ingrown toenail, is a prevalent condition characterized by the incurvation of the nail margin towards the peripheral tissue, predominantly affecting the hallux and presenting a peak incidence in the second and fifth decades of life. In severe situations, it can cause significant pain and alterations. Risk factors include trauma, weight fluctuations, inadequate nail cutting techniques and hyperhidrosis [1]. Several therapeutic modalities, surgical and non-surgical, are available, and the choice

of treatment depends on the general health status of the patient, the severity of the condition and concomitant symptoms. This comprehensive review addresses the prevalence, risk factors, underlying pathogenic mechanisms, evaluation and classification of ingrown toenails, along with the different therapeutic options. Despite the need for more clinical trials comparing different therapies, current recommendations suggest a conservative approach in the first instance, followed by surgical intervention in case of symptomatic persistence. This review intends to expose the risk factors, beyond those already recognized for the development of onychocryptosis, in the adult population.

Methodology

The purpose of this study was to analyze the characteristics of onychocryptosis (ingrown toenail disease) and its main riskfactors from an epidemiological perspective of primary prevention. To fulfill this objective, a documentary work was developed based on the format described in the PRISMA system for systematic reviews and meta-analyses. The databases Pubmed/Medline, Google Scholar, OVID and EBSCO were used to search the following keywords: onychocryptosis, prevention, etiopathogenesis (in English and Spanish). Original articles were selected, prioritizing their relevance, original studies, and the GRADE system was used for quality analysis.

Results

Ten results were obtained from the intentional research conducted with the keywords onychocryptosis, prevention, and risk factors, and only 7 of them met the selection criteria, all of them qualified as high level of evidence according to GRADE (Figure. 1). The information was divided into subtopics for better understanding.

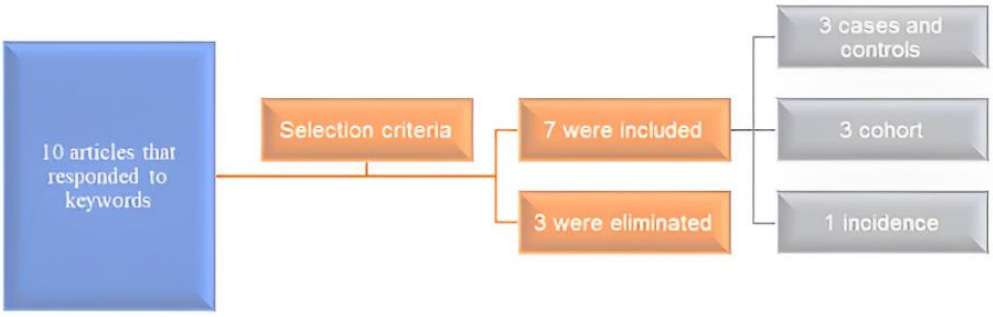

Figure 1. Article Selection.

Onychocryptosis, also known as ingrown toenail or ingrown nail, is a highly prevalent and frequently painful nail pathology. Its main characteristic lies in the invasion of the periungual dermis by the adjacent nail plate [2]. The incidence in the general population is estimated between 2.5% and 5%, and its occurrence is more frequent in individuals with diabetes (13%-32%). Among diabetics and those with circulatory disorders and neuropathies that lead to decreased sensitivity, more severe cases of this condition may occur [3].

Onychocryptosis is characterized by invasion of the periungual dermis by the contiguous nail plate, triggering a cascade of foreign body, inflammatory, infectious and repair processes, which can sometimes become chronic and cyclical. In severe situations, this condition can be disabling and have a negative impact on daily life. Simple measures such as the use of drains and proper trimming technique can be employed to relieve symptoms and halt the progression of the pathology [3].

There are several proposed theories on the pathogenesis of onychocryptosis. However, controversy still exists whether the nail plate is the underlying cause or if hypertrophic nail fold tissue is the true culprit. Mechanisms contributing to the development of this condition include: epidermal breakdown in the lateral nail fold due to continued pressure exerted by the titive trauma, widening of the base of the distal phalanx leading to narrowing and elevation of the distal part of the nail plate, as well as inflammation of the periungual tissue inducing an inflammatory reaction, fibrosis and encrustation of the lateral part of the nail plate [3].

Classically, predisposing factors have been identified with clear differences between younger and older adults (Table 1). In addition to this, different authors have reported other risk factors or factors that increase the risk of recurrence (Table 2), which are detailed below.

Table 1. Predisposing factors for onychocryptosis (3)

Young Individuals	**Older adults**
Ill-fitting shoes and tight socks	Thick nails
Hyperhidrosis and increased athletic activity	Poor nail care
Trauma	Wider and thicker nail folds
Incorrect cutting of toenails, i.e., too short or rounding of the nail	Increased curvature of the nail plate (claw nails)
Obesity	Diabetes
	Obesity
	Thyroid, heart and kidney disease

Table 2. Risk factors related to the presence of onychocryptosis.

Author	**Risk factor identified**	**Design and main result**
Ezekian 2017 (4)	Hematopoietic stem cell transplantation	RR 1.82 (IC95% 1.12-2.97) Cohort
Erdogan 2014 (5)	Cirugía ungueal previa	Incidence 21.4%. Case series
Montesi S 2019 (6)	Chemical Matricectomy with phenol Cardiovascular disease	RR 1.1 (IC95% 0.5 – 2.3) RR 5.1 (IC95% 0.6 – 7) Cohort
Kim J 2022 (8)	Hallux interphalangeal angle	Calcaneal inclination p= 0.21 differences between groups. Cases and controls
Vural S 2018 (9)	Diabetic vasculopathy Onychogryphosis Subungual hyperkeratosis	Prevalence 16%. OR 9 (IC95% 2-34)

		OR 4 (IC95% 1.9 - 9) Cases and controls
Romero-Pérez 2017 (7)	Diabetic vasculopathy Onychogryphosis Subungual hyperkeratosis	Increased number of infections in SM OR 7.2 (IC95% 2.4-21) Cases and controls
Pico AM 2017 (10)	Nail consistency	Prevalence of 74.1%; p = 0.002

Hematopoietic Stem Cell Transplantation

In the study by Ezekian et al. analyses of patients undergoing surgery for onychocryptosis were performed and an institutional database of hematopoietic stem cell transplantation (HSCT) was examined to investigate the possible association between onychocryptosis and HSCT [4]. In this study, 17 children were identified who had undergone surgery for onychocryptosis, of whom 8 (47.1%) had previously received a hematopoietic stem cell transplant. The children who underwent HSCT were reported to have an aggressive form of onychocryptosis, with 50.0% bilateral involvement of the big toe and nail margin, and a recurrence rate of 37.5%. When analyzing a cohort of 1069 children who had received HSCT, 91 (8.5%) of them were identified as having onychocryptosis. Male sex, non-black race, acute graft-versus-host disease, and older age at the time of transplantation were independently associated with the presence of onychocryptosis. In conclusion, Ezekian et al. determined that HSCT is strongly associated with the occurrence of onychocryptosis requiring surgical intervention. Children with a history of HSCT may also have more aggressive toenail disease, with higher rates of surgical intervention, onychocryptosis on both sides, recurrence and need for reoperation.

Previous Nail Surgery

Erdogan et al. conducted a follow-up of 88 patients with a total of 123 ingrown toenails, which were successfully treated using orthopedic devices. The research team monitored those patients every 2 months for the first 6 months and every 3 months thereafter. The main objective was to evaluate the recurrence of the condition. In this study, the recurrence rate was found to be 21%, and more than one third of the patients experienced recurrences after bracing treatment. However, it was determined that recurrence appeared to be independent of all risk factors, except when a previous operation had been performed in the same area. Erdogan reports that, as a first step, one can try to stop the swelling of the skin irritated by the nail by gently pulling upward, which helps to relieve edema and prevent further trauma. In cases where these measures are ineffective, surgical intervention may be considered as a second treatment step [5].

Ethanol Matricectomy

Chemical Phenol Matricectomy (CMP) is a well-established treatment option for onychocryptosis. However, the optimal duration of phenol application required to achieve adequate destruction of the nail matrix is still unknown. Optimal ablation is crucial to achieve low recurrence rates. In order to evaluate the recurrence rate in patients treated with CMP, Montesi S. et al. followed up a cohort of 622 consecutive patients treated with a 4-minute CMP application [6]. The risk of recurrence in all patients treated with 4-minute CMP was found up to 1.1% (n = 622; 95% CI = 0.5%-2.3%). In a subgroup of patients with cardiovascular disease (n = 39), the risk of recurrence was 5.1% (95% CI = 0.61-7.3). In addition, it was observed that younger age was associated with higher odds of recurrence (p = 0.036). This observational study suggests that a 4-minute continuous application of phenol seems to be adequate time for the treatment of onychocryptosis by CMP. In the same context, Romero Pérez D. et al. designed a study to evaluate

the success rate, postoperative comfort, postoperative complications and patient satisfaction with two different procedures: Surgical Matricectomy (SM) versus Phenol Chemical Matricectomy (CMP). Although Surgical Matricectomy was associated with a lower recurrence rate, CMP was found to provide better postoperative outcomes in terms of patient comfort and satisfaction [7].

Alignment of the Foot

In order to investigate the relationship between foot alignment and the development and presentation of ingrown toenail, Kim J. et al. conducted an evaluation of radiographs for various parameters: hallux interphalangeal angle (HIA), hallux valgus angle (HVA), talonavicular coverage angle (TNCa), talo-first metatarsal angle (Meary's) and calcaneal pitch angle (CP), as well as medial sesamoid position, in a cohort of 103 young, healthy patients (mean age 20.5 years) with ingrown toenail. A control group of 63 patients was included for comparisons in terms of radiographic parameters. A subgroup analysis was also performed for those patients with lateral (n = 65) or medial (n = 38) nail fold involvement. The results of the study indicated that a lower medial longitudinal arch may act as a predisposing factor in the development of ingrown toenails. Lateral nail fold involvement was associated with lateral deviation of the distal phalanx. In this context, a lower calcaneal inclination angle was the only predisposing factor identified in the development of ingrown toenails, suggesting a possible association with flatfoot deformity. In subgroup analysis, increased HIA was associated with lateral nail fold involvement, suggesting that lateral deviation of the distal phalanx may be a predisposing factor in the development of ingrown toenails. To conclude, the results of this study suggest a possible association between foot malalignment and the occurrence and presentation of ingrown toenail. These findings may be relevant to the prevention, treatment, recurrence, and counseling of young, healthy patients with ingrown toenails [8].

Diabetic Vasculopathy

Vural S. et al. conducted an evaluation of nail properties, the prevalence of ingrown nails in patients with type 2 diabetes mellitus (DM), the risk factors involved in the development of ingrown nails, and the impact of diabetic polyneuropathy and vasculopathy on the development and outcome of ingrown nails. The study involved 300 patients with type 2 DM who attended a DM outpatient clinic for routine examinations. The general characteristics and changes in the feet of the study population were analyzed. Diabetic polyneuropathy and diabetic vasculopathy were evaluated by biothesiometer, monofilament testing and arterial Doppler ultrasonography. The frequency of ingrown toenails was 13.6%. Through multivariate analysis with logistic regression, several variables were identified as predictors of ingrown toenails in this population. These variables included body mass index (odds ratio [OR] 1.077; 95% confidence interval [CI] 1.007 to 1.15; p = 0.03), previous trauma (OR 2.828; 95% CI 1.017 to 7.867; p = 0.042), weak dorsal pedicle pulse (OR 2. 72; 95% CI: 1. 17 to 6.30; p = 0.02), nail trimming type (OR 2.3; 95% CI: 1.06 to 4.98; p = 0.35), onychogryphosis (OR 9.036; 95% CI: 2.34 to 34.87; p = 0.001) and subungual hyperkeratosis (OR 4.3; 95% CI: 1.99 to 9.3; p = 0.001). The incidence of onychomycosis was significantly higher in patients with ingrown toenails (p = 0.032) than in those without this condition. In addition, it was observed that the nail curvature index was higher in patients with ingrown toenails than in the group with normal nails. On arterial Doppler ultrasound, peripheral arterial disease was found in 19 patients (46.9%) with ingrown toenails. The prevalence of ingrown toenails was higher in patients with DM compared to the healthy population [9].

Nail shape and consistency

Pico AM et al. investigated the possible influence of factors such as nail shape and consistency, sex, and sports activity on the development of common nail disorders in a young population. The study involved examination of the nail plates of 140 young people (66 females and 74 males). Of these participants, 72 were runners who underwent training exceeding 10 hours per week and competed regularly, while 68 did not regularly engage in any sporting activity. The shape, consistency and alterations of the nails

were analyzed, considering the sex of the participants and their sporting activity. It was observed that hard nail consistency was more prevalent in runners (74.4%) compared to those who did not practice sports (25.6%). On the other hand, soft nail consistency was more prevalent in sedentary participants (70%) than in runners (30%). A relationship between sex and onychocryptosis was also found, as females had a higher prevalence of this nail disorder (57.8%, $p = 0.016$). However, young male runners exhibited the highest and significant percentage of onychocryptosis (74.1%; $p = 0.002$). In conclusion, Pico and his team suggest that sports activity in young male runners, whose nails have a hard consistency, seems to be directly related to the high incidence of onychocryptosis in this population [10].

Discussion and Conclusion

In this study, the classic and less frequent risk factors associated with onychocryptosis have been presented, which is relevant for the identification and understanding of these factors and to allow the implementation of preventive measures to reduce the probability of developing this condition. It has been mentioned that ingrown toenails represent approximately 20% of foot problems in primary care [11], with the big toe being the most affected. In addition, ingrown toenails occur more frequently in young men, and nail care habits and footwear are often contributing factors. Important factors that may increase the risk of onychocryptosis have been identified, such as hematopoietic stem cell transplantation, previous nail surgery, matrixectomy, hallux interphalangeal angle, onychogryphosis, subungual hyperkeratosis, and nail consistency. There is no consensus on the best therapeutic approach, but treatments for ingrown toenails can be non-surgical or surgical. Non-surgical treatments are generally applied from moderate to mild cases, while surgical treatments are reserved for moderate and severe cases. Palliative nonsurgical measures include correction of improper footwear, treatment of hyperhidrosis and onychomycosis, soaking the affected toe with the application of a medium- to high-potency topical steroid, and placing cotton or dental floss tufts under the lateral edge of the ingrown nail [12]. Application of a gutter splint to the edge of the ingrown nail to separate it from the lateral fold provides immediate pain relief. In addition, placement of a cotton-cyanoacrylate plaster, bandaging of the lateral nail fold, or orthonyxia may provide mild to moderate relief of the ingrown nail.

As for surgical approaches, they seek to eliminate the interaction between the nail plate and nail fold to avoid local trauma and inflammatory reaction. These approaches are most effective in preventing recurrence. Partial avulsion of the lateral edge of the nail plate is the most common surgical approach. In addition, matricectomy, performed by surgical, chemical or electrosurgical means, can further prevent recurrence.

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