

## Evaluation of Foot Deformities in Patients With Ingrown Nails

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**Key words:** ingrown toenail, onychocryptosis, hallux valgus angles, pes planus angles, x-ray

**Citation:** Sarı N, Saylam Kurtipek G, Ünal M, Öztürk M, Sarı İF. Evaluation of Foot Deformities in Patients with Ingrown Nails. *Dermatol Pract Concept*. 2024;14(1):e2024049. DOI: <https://doi.org/10.5826/dpc.1401a49>

**Accepted:** August 8, 2023; **Published:** January 2024

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**Funding:** None.

**Competing Interests:** None.

**Authorship:** All authors have contributed significantly to this publication.

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### ABSTRACT

**Introduction:** Ingrown nail is a condition caused by the perforation of the periungual soft tissues on nail folds by the sides of nail plaque, causing inflammation and severe pain. Recently, the role of foot anatomical disorders in ingrown nail development has been emphasized.

**Objectives:** The main objective of this study aimed to determine whether foot deformities played significant roles in ingrown nail development with objective radiological parameters.

**Methods:** The study included 64 patients diagnosed with clinical ingrown nail and 71 patients as controls without any ingrown nail history. In both groups, we evaluated the bilateral foot radiographs of patients with ingrown nails for hallux valgus angle (HVA), interphalangeal angle (IPA), and intermetatarsal angle (IMA) associated with hallux valgus, and the calcaneal pitch angle (CPA), talohorizontal angle (THA), and talometatarsal angle (TMA) related to pes planus.

**Results:** No significant difference was found in terms of hallux valgus radiological measurements of HVA, IPA and IMA as well as pes planus radiological measurements of CPA and TMA values, when compared to controls. THA was statistically significantly higher in the control group ( $P = 0.025$ ). There was a moderate strength positive relationship between ingrown nail stage and measured TMA for pes planus diagnosis ( $\rho = 0.326$ ;  $P = 0.04$ ), yet there are no significant correlations between ingrown nail stage and other angles.

**Conclusions:** Therefore, we do not recommend foot anatomy correction in the prevention and treatment of ingrown nails, unless there is an accompanying foot deformity; however, pes planus is a foot deformity that can accompany patients with severely ingrown nails.

## Introduction

An ingrown nail is a pathological condition affecting an individual daily life by causing pain, inflammation, and functional activity limitation [1]. An ingrown nail is defined as the periungual skin perforation by the opposite nail plate [2]. Most commonly, stinging initiates at the distal end of one or both lateral nail grooves [3]. Ingrown nails commonly occur in adolescents and young adults; however, their incidence is higher in men [1,4]. Ingrown nails possibly occur owing to improperly trimmed nails, abnormal shape of nails, hypertrophy of the lateral nail folds, congenital or acquired nail disorders, nail infections, factors enhancing external pressure such as wearing tight shoes, genetic predisposition, obesity, trauma, subungual tumors, excessive sweating, and medications [5,6]. Recently, the role of foot anatomical disorders in ingrown nail development has been emphasized. With the distal phalanx deviation to the lateral side, the external pressure owing to the lateral nail edge also increases, possibly playing a role in the development of ingrown nails [7]. The commonly occurring deformities are hallux valgus, defined as the lateral deviation of the big toe, and pes planus characterized by the collapse of the medial longitudinal arch. However, only a limited number of previous studies have investigated the relationships between these deformities and ingrown nails with conflicting results.

## Objectives

The present study evaluated the bilateral foot radiographs of patients with ingrown nails for hallux valgus angle (HVA), interphalangeal angle (IPA), and intermetatarsal angle (IMA) associated with hallux valgus, and the calcaneal pitch angle (CPA), talohorizontal angle (THA), and talometatarsal angle (TMA) related to pes planus, and the presence of foot deformities by measuring these angles. Moreover, the study investigated the relationship between the severity of ingrown nails and angles measured.

## Methods

### Patients and Controls

This prospective and controlled study included a total of 64 patients with ingrown nails aged between 18–77 years who reported to our clinic, between December 2018 and June 2019. A total of 76 feet with ingrown nails were evaluated. The exclusion criteria were as follows: patients who were younger than 18 years; those who were pregnant and lactating; those with subungual exocytosis; those with significant clinical deformities in the forefoot, midfoot and hindfoot; and those with a history of past osteoarticular surgery and severe traumas. The control group comprised 71 individuals

who were in the same age range and who admitted to our hospital with diagnosed lower extremity trauma. The X-rays in the Radiology Picture Archiving and Communication System (PACS) of those who did not have diagnosis with ingrown nails and foot complaints in the patient's file, and who did not have a new or old fracture, congenital foot deformity in imaging were included. The approval for the study was obtained from the Non-Invasive Clinical Research Ethics Committee.

The study recorded the demographic data, including age, sex, occupation, presence of comorbid systemic diseases, heights, weights, and body mass index (BMI) of the individuals in both the patient and control groups. The study evaluated the duration of the stinging complaint of those in the patient group, whether there was a previous history of ingrown nails, the foot with the ingrown nail, the ingrown nail edge, or nail trimming patterns. The classification modified by Mozena was used to assess the severity of ingrown nails [8].

### Radiographic Analysis and the Technique

The aforementioned angles in hallux valgus and pes planus were measured by a radiologist who was blinded to the group the individuals belonged to, and the data were recorded. Individuals in both the patient and control groups, the HVA, IPA, and IMA were measured in the anteroposterior foot radiographs (Figure 1). Moreover, the CPA, THA, and TMA were measured on the lateral foot radiographs where the weight was placed on the ground (Figure 2). The angle measurement



**Figure 1.** The measurement of angles for hallux valgus. (A) Intermetatarsal angle (IMA). (B) Hallux valgus angle (HVA). (C) Interphalangeal angle (IPA).

was conducted based on the techniques mentioned in the reference literature. The angle between the longitudinal axis of the proximal phalanx and first metatarsal for HVA, that between the longitudinal axis of the proximal and distal phalanx for IPA, and those between the longitudinal axis of the first and second metatarsal for IMA were also measured. In hallux valgus, values of 15° for HVA, 10° for IPA, and 9° and above for IMA were considered pathological [9]. The lateral foot radiographs were used to evaluate the radiological angles for pes planus with the individual standing and both knees in full extension. The angle between the horizontal line passing through the floor and a plantar axis extending between the posterior and anterior tuberosities of the calcaneus was measured for CPA; the angle between the mid-talar line and ground surface where the foot was placed was measured for THA; and the angle between the midtarsal line and line connecting the navicular bone and first metatarsal shaft



**Figure 2.** The measurement of angles for pes planus. (A) Calcaneal pitch angle (CPA). (B) Talohorizontal angle (THA). (C) Talometatarsal angle (TMA).

was measured for TMA. Values of 15° and below, 30°, and 4° and above were considered pathological in terms of pes planus for CPA, THA, and TMA, respectively [10].

### Statistical Analysis

The data obtained were transferred to the computer and analyzed in the IBM SPSS (version 21.0) package program. The descriptive statistics were presented as mean  $\pm$  standard deviation and percentages. The Kolmogorow-Smirnov test was used to examine the conformity of the variables to the normal distribution. The variables with normal distribution between two independent groups were determined using the independent samples t-test. The statistical significance between two independent groups for the variables that did not fit the normal distribution was assessed using the Mann-Whitney U-test. Pearson Chi-Square and Fisher Exact tests were used to evaluate the categorical variables. The stage of the ingrown nail was correlated with the angles that were used to evaluate pes planus and hallux valgus using Spearman correlation test. A P value less than 0.05 was considered statistically significant.

### Results

Table 1 shows the age, sex, BMI, occupation, and comorbidity data. The mean age was 32 (18–77) and 34 (18–75) years in the ingrown nail and control groups, respectively. A total of 180 feet were evaluated; 76 were symptomatic feet of 64 patients with ingrown nails and 104 feet of 71 individuals with a foot radiograph in the control group. No statistically significant differences were detected between the groups in terms of sex, age, and BMI values. The mean duration of

**Table 1.** Demographic data and comorbid diseases.

	Patient group (N = 64)	Study group (N = 71)	P value
Age, year $\pm$ SD	32.41 $\pm$ 15.99	34.96 $\pm$ 12.94	0.127
Sex, N (%)			
Female	27 (42.2)	35 (49.3)	0.408
Male	37 (57.8)	36 (50.7)	
BMI, kg/cm <sup>2</sup> $\pm$ SD	26.18 $\pm$ 4.65	27.80 $\pm$ 5.13	0.057
Occupation, N (%)			
Student	29 (45.3)	18 (25.3)	0.083
Desk job	7 (10.9)	11 (15.5)	
Housewife	11 (17.2)	21 (29.6)	
Job without sitting	17 (26.6)	21 (29.6)	
DM, N (%)	6 (9.4)	5 (7.0)	0.621
HT, N (%)	4 (6.2)	8 (11.3)	0.306
Additional dermatologic diseases, N (%)	5 (7.8)	1 (1.4)	0.101
Cardiac diseases, N (%)	1 (1.6)	4 (5.6)	0.369

BMI = body mass index; DM = diabetes mellitus; HT = hypertension; SD = standard deviation.

ingrown nails was 15 months in the patient group. Ingrown nails were higher in women on the lateral side of the thumb than that in men at significant levels in 73.7% of the patients ( $P = 0.004$ ). Considering the stages, stage 1 ingrown nail was the most common (Table 2).

Table 3 shows the measured values of HVA, IPA, IMA, CPA, THA, and TMA of the patient and control groups. According to HVA and IPA values, hallux valgus was detected

in 60.05% and 84.2% of patients, respectively. According to THA and TMA values, pes planus was detected in 23.7% and 59.2% of the patients, respectively. THA was found to be statistically significantly higher in the control group ( $P = 0.025$ ). When it was examined whether there was pes planus according to THA, pes planus was found in 23.7% of the patients in the group with ingrown nails. However, no significant differences were detected between

**Table 2. Clinical features of patient group.**

	Patient group (N = 64)			P value
	Female (N = 27)	Male (N = 37)	Total (N = 64)	
Duration, month±SD	14.48±25.33	16.92±30.15	15.89±28.03	0.951
Side, N (%)				0.853
Right	10 (37.0)	16 (43.3)	26 (40.6)	
Left	12 (44.5)	14 (37.8)	26 (40.6)	
Bilateral	5 (18.5)	7 (18.9)	12 (18.8)	
Nail trimming shape, N (%)				0.224
Straight	7 (25.9)	15 (40.5)	22 (34.4)	
Improper	20 (74.1)	22 (59.5)	42 (65.6)	
History of ingrown nail, N (%)				0.331
Recurrent	24 (88.9)	29 (78.4)	53 (82.8)	
First	3 (11.1)	8 (21.6)	11 (17.2)	
	Ingrown toenails foot assessment (N = 76)			P value
	Female (N = 32)	Male (N = 44)	Total	
Ingrowing edge, N (%)				0.004
Lateral	29 (90.6)	27 (61.4)	56 (73.7)	
Medial	3 (9.4)	17 (38.6)	20 (26.3)	
Stage, N (%)				0.628
Stage 1	18 (56.2)	21 (47.7)	39 (51.3)	
Stage 2a	3 (9.4)	9 (20.5)	12 (15.8)	
Stage 2b	4 (12.5)	5 (11.4)	9 (11.8)	
Stage 3	7 (21.9)	9 (20.4)	16 (21.1)	

SD = standard deviation.

**Table 3. Radiographic parameters of pes planus and hallux valgus in the study and control group.**

	Study group Mean±SD (N = 76)	Control group Mean±SD (N = 104)	P value
Pes Planus Evaluation			
Calcaneal pitch angle	20.22±5.79	20.00±7.01	0.823
Talohorizontal angle	26.70±4.87	28.43±5.17	0.025
Talometatarsal angle	6.68±4.64	7.79±5.44	0.161
Hallux Valgus Evaluation			
Hallux valgus angle	16.36±7.54	18.05±6.51	0.110
Intermetatarsal angle	9.94±2.66	9.24±2.65	0.084
Interphalangeal angle	15.09±5.45	15.27±5.44	0.697

SD = standard deviation.

**Table 4. Spearman correlation between the stage of ingrown nail and the evaluation angles of pes planus and hallux valgus (N = 76).**

	Pes Planus			Hallux Valgus		
	CPA	THA	TMA	HVA	IMA	IPA
Ingrown nail staging	-0.019	0.179	0.326**	-0.089	0.069	-0.086

CPA = Calcaneal pitch angle; HVA, Hallux valgus angle; IMA = Intermetatarsal angle; IPA = Interphalangeal angle; THA = Talohorizontal angle; TMA = Talometatarsal angle.

\*\* P <0.01

the hallux valgus-related HVA, IMA, and IPA, and the pes planus-related CPA, and TMA measurements of the individuals in the patient and control groups (Table 4).

A moderately strong and positive relationship was detected between TMA and stage when the relationship between the stage of an ingrown nail and angles in which pes planus and hallux valgus were evaluated was considered ( $\rho = 0.326$ ;  $P = 0.04$ ), and no significant relationship was detected between other aspects and the stage of ingrown nails.

## Conclusions

Ingrown nail, a painful condition, is a health concern affecting daily life and is frequently detected in dermatology clinics [11]. Several factors cause ingrown nails. Knowing the etiological factors prevents recurrences that may develop owing to the treatments applied.

The lateral nail fold of the big toe is the most frequently affected area in ingrown nails. It has been suggested that ingrown toenails develop due to the compression of the lateral nail fold between the two fingers, causing inflammation, infection and granulation tissue [12,13]. In our study, 73.7% of all patients had lateral stinging, which supports these data in the literature. Ingrown nail on the lateral margin was observed more frequently in both women and men, and it was found to be statistically significant in women compared to men (90.6% versus 61.4%). Since women prefer high-heeled pointed-toed shoes more, the pressure on the big toe increases, and the pressure applied towards the lateral edge of the nail increases due to the narrowing of the toe box located at the tip of the pointed shoe [14]. We attribute the statistically more significant stinging on the lateral margin in women to this.

The role of foot anatomical disorders in the development of ingrown nails has been emphasized in recent years. The present study also aimed to determine whether foot deformities played significant roles in ingrown nail development with objective radiological parameters. Some researchers reported that the presence of hallux valgus plays a role in ingrown nail development. The lateral deviation of the distal phalanx increases the internal pressure, causing ingrown nail

development at the lateral nail margin, as suggested by Darwish et al. HVA and IPA values measured in the ingrown nail feet were higher at significant levels when compared to the contralateral feet of the patient group and normal controls. Therefore, based on these results, abnormal HVA and IPA were concluded as possible risk factors in the pathogenesis of ingrown nails [7]. In the study conducted by Fernández et al, the presence of pathological IPA was interpreted as one of the possible underlying causes of ingrown nails [15]. In a population-based study conducted by Cho et al, hallux valgus was found as the most common acquired malalignment in patients with ingrown nails [13]. Abnormal IMA and HVA angles were reported as important in the etiology of ingrown nails by Rota et al [16]. In contrast, Köse et al detected no statistically significant differences between the ingrown nails and control group in terms of hallux valgus-related angles. Their study results were supported by the view that not every individual with hallux valgus has ingrown nails [17]. In the present study, no significant differences were found in HVA, IPA, and IMA between those with ingrown nails and the control group.

Pes planus is another common deformity in society, which is 8–24-fold more common in adolescents with hallux valgus [18]. To the best of our knowledge, no study has investigated the relationship between midfoot deformities and ingrown nails. Therefore, this study aimed to evaluate the relationship between ingrown nails and the presence of pes planus. In the population-based study conducted by Cho et al, pes planus was found to be a risk factor in the development of ingrown nails, based on the International Classification of Disease codes. They also elucidated the relationship between pes planus and ingrown nails by the weight-bearing feature of the medial side of the big toe owing to the collapsed arch of the foot with increasing pressure [13]. In our study, we found that THA was statistically significantly higher in the control group ( $P = 0.025$ ). According to THA, pes planus was found in 23.7% of the patients in the ingrown toenail group and 36.5% in the control group, and this difference was not statistically significant ( $P = 0.066$ ). However, no statistically significant differences were detected in the present study between the ingrown nails and the control group in terms of CPA, and TMA.

Studies evaluating the correlation of ingrown nail staging with angles for hallux valgus and pes planus are still very limited. The TMA was measured to detect the presence of pes planus, and the ingrown nail stage was detected to have a moderately strong and positive relationship.

Hallux valgus was detected in 60.05% and 84.2% of patients with ingrown nails, respectively, according to HVA and IFA. While, pes planus was detected in 23.7% and 59.2% of patients, respectively, according to THA and TMA. Although individuals had pathological hallux valgus and pes planus in the patient group according to the reference values, no significant differences were detected compared to the control group. It was linked with the frequent occurrence of foot deformities. One of the study limitations was that radiographic angle measurements were not performed on the contralateral foot of the patient group. In addition, the control group was randomly selected from the PACS data archive. In particular, patients may apply to the orthopedic outpatient clinic with the complaint of chronic foot pain, and hallux valgus and pes planus can be detected in these patients. To rule this out, although we included the foot x-rays (without new or old fracture and malformation) of patients with lower extremity trauma in the control group, some of the x-rays in the control group were belonged to Orthopedics outpatient clinic. Although we tried to minimize this limitation, hallux valgus and pes planus deformities may have been found to be high in the control group, due to x-rays of the orthopedic outpatient clinic.

An increased risk for the presence of pes planus and hallux valgus deformities was not detected in patients with ingrown nails when compared to the normal population. Therefore, we do not recommend foot anatomy correction in the prevention and treatment of ingrown nails, unless there is an accompanying foot deformity; however, pes planus is a foot deformity that can accompany patients with severely ingrown nails.

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