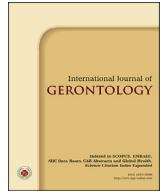


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Original Article

Plantar Hyperkeratotic Patterns in Older Patients

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SUMMARY

Background: Plantar hyperkeratotic lesions are very common among the older population. Very little has been documented on the frequency or distribution of such lesions. The aim of this study is to analyse the location of plantar hyperkeratoses in a group of the older population, defining the patterns of the most significant manifestations thereof and analysing the correlation between them and different contributing factors.

Methods: It is a descriptive correlational study conducted on 850 participants who attended the Bellvitge Podiatry Hospital in Barcelona province, Spain, in 2015. Hallux valgus, lesser toe deformities and hyperkeratoses were documented on a topographical map of the foot. The existence of plantar hyperkeratoses was correlated with different variables from the medical record of each participant.

Results: Of the 850 participants, 529 (62%) presented with hyperkeratotic lesions. In all, 87 hyperkeratotic patterns were documented, the most common of which were the medial side of the first metatarsophalangeal joint (MTPJ) (8.7%), the medial side of the first MTPJ plus the medial side of the first interphalangeal joint (IPJ) (8.5%) and the medial side of the first IPJ (7.7%). In addition, the hyperkeratoses were associated with hallux valgus ($p < 0.01$) and with lesser deformities of the second ($p < 0.04$), third ($p < 0.04$) and fourth ($p < 0.05$) toes.

Conclusions: The most common hyperkeratotic patterns were found on the first radius, corresponding to 36% of total lesions. In addition, hyperkeratotic lesions appear to be associated with the presence of hallux valgus and with lesser deformities of the second, third and fourth toes.

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1. Introduction

Hyperkeratosis is defined as a thickening of the stratum corneum of the epidermis caused by hypertrophy or hyperplasia of its cells.¹ This increase fundamentally affects the keratinocytes or corneocytes, which are the most numerous cells of the outermost layer of the epidermis.² In addition, their production may lead to the onset of various cutaneous alterations, which can have a significant impact on the patient's quality of life.³

Plantar hyperkeratotic lesions are one of the most prevalent foot problems among the older population, affecting 30–65% of people aged over 65 years.^{4,5} Incidence is greater among this group because, with age, the skin undergoes several changes that cause alterations in the functions of the integumentary system. These

changes entail a thinning of the stratum corneum, a decline in sebaceous gland secretion, a reduction in the skin's fat and water content, a loss of subcutaneous adipose tissue and of connective tissue, and a decline in the quantity of collagen,⁶ thus contributing to the formation of hyperkeratoses. In addition, dryness of the skin may contribute to the formation of fissures, which is directly related to the proliferation of fungal and bacterial infections.⁷

Various authors have conducted studies on plantar hyperkeratoses, but only five of those studies have documented the prevalence and distribution thereof^{7–11} (Table 1). Just one of those studies focused exclusively on the distribution of hyperkeratoses of the forefoot,⁸ whereas the others performed an analysis of the metatarsal heads.

Although the number of existing studies is small, knowledge of the topographical location of plantar hyperkeratoses is fundamental when it comes to creating footwear, orthotics and ergonomic supports to prevent and minimise their onset, thereby reducing the high cost of treating them on the one hand, and improving the patient's quality of life on the other.

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Table 1
Prevalence and distribution of plantar hyperkeratotic lesions. MTPJ: Metatarsophalangeal joint. IPJ: Interphalangeal joint.

	n	Characteristics	Mean age (years)	Most common lesions			Country	Year
Spink et al ⁸	181	Older people	77.2 ± 4.9	1st MTPJ (12%)	1st MTPJ + IPJ (12%)	1st MTPJ (12%)	Australia	2009
Menz et al ⁹	151	Older people	77.6 ± 6.9	1st MTPJ (53%)	2nd MTPJ (44%)	1st IPJ (43%)	Australia	2007
Springett et al ¹⁰	328	Caucasians, non-smokers	Not given	2nd MTPJ (35.9%)	1st MTPJ (26.9%)	5th MTPJ (13.4%)	UK	2003
Grouios et al ¹¹	91	Male runners	29.6	2nd MTPJ (31.9%)	1st MTPJ (23.2%)	5th MTPJ (12.6%)	Greece	2005
Merriman et al ⁷	145		Not given	2nd, 3rd, 4th MTPJ (14%)	2nd MTPJ (10%)	1st, 5th MTPJ (8%)	UK	1983

The aim of this study is, therefore, to analyse the location of plantar hyperkeratoses in a group of the older population, defining the patterns of the most significant manifestations thereof and analysing the correlation between them and different contributing factors.

2. Material and methods

Firstly, the sample size was calculated on the basis of total population aged over 65 years ($n = 53,181$ inhabitants) registered as resident in the city of Barcelona, Spain. To that end, data published by the Spanish National Statistics Institute (INI, as abbreviated in Spanish) on 31 December 2014 were taken into consideration. For a confidence interval of 95% and a confidence level of 3.5, a sample size of 773 people was obtained. A further 10% of subjects were added to this size to prevent any accidental sample losses. In total, 850 participants were ultimately analysed. All of the participants took part voluntarily in the study. The sample characteristics are shown in Table 2. All of the participants were recruited by the Chiropody Service of the University of Barcelona's Podiatry Hospital, Spain. The inclusion criteria for taking part in the study were that participants had to be older than 65 years and have attended the Hospital's Chiropody Service in 2015. Participants were excluded from the study if they had undergone any type of surgery on a lower limb in the past 18 months; were suffering from Parkinson's disease, neurological disorders or plantar verrucas; were unable to fill in questionnaires; had undergone lamination of the hyperkeratoses in the past six weeks (performed by a podiatrist or by themselves); had had any pathologies that cause hyperkeratosis (tinea pedis, eczema or psoriasis); were unable to walk without help or were amputees. None of the participants received any payment in cash or in kind for taking part in the study, and all the participants signed an informed consent form. Local Ethical Committee approval was received from University of Barcelona and written consent was obtained from all participants.

Before commencing the study and after signing an informed consent form, the participants were each given a questionnaire that they had to complete, stating their gender and age, and whether or not they suffered from diabetes mellitus type 2 and/or were smokers. The grade of hallux valgus was assessed using the Manchester scale.¹² Based on standardised photographs of the foot, this instrument defines four grades of hallux valgus: none, mild, moderate and severe. A high correlation was found between the Manchester scale and the hallux valgus angle measurement using

Table 2
Characteristics of the study sample. SD: Standard deviation. CI: Confidence interval.

n = (850)	Mean (SD)	CI 95%
Age	76.2 (6.18)	75.66–76.74
Height	1.57 (0.18)	1.42–1.72
Weight	67.7 (11.83)	66.67–68.73
Body mass index	27.36 (5.07)	26.92–27.8
Shoe size	38.86 (4.23)	38.43–39.17

conventional radiology (Spearman's $\rho = 0.73$, $P < 0.01$).¹³ Deformities of the toe and hyperkeratoses were documented on a topographical map of the foot. Lesser toe deformities were definite as alterations in normal anatomy that create an imbalance between the intrinsic and extrinsic muscles, include mallet toe, hammer toe, claw toe, curly toe, and crossover toe.¹⁴ The margin between normal skin and hyperkeratotic skin was clinically assessed on the basis of the location of the transition zone between normal pink skin and the yellowish hyperkeratotic plaque. The diameter of the lesions was measured using a ruler (millimetre precision), and the repeatability of this measurement proved to be high ($p < 0.01$).¹⁰

2.1. Statistical analysis

Creative Research Systems software (Petaluma, United States of America) was used to calculate the sample size. A descriptive analysis of the results was then performed, presenting the mean and standard deviation as centralisation and dispersion statistics, respectively. After that, associations and comparisons between the participants with and without hyperkeratotic lesions were determined using chi-square coefficients and odds ratios (for the dichotomous variables). Differences were considered statistically significant when they reached values of $p \leq 0.05$. All the data were analysed using SPSS (version 20.0).

3. Results

Of the 850 participants recruited into the study, 569 were women (67%) and 281 were men (33%). The mean age was 75.96 ± 4.8 years (mean \pm standard deviation), 286 participants presented hallux valgus (34%) and 172 had lesser toe deformities (20%). Eighty-seven participants stated that they suffered from diabetes mellitus type 2 (10%), 53 were smokers (6%) and 135 presented with obesity (BMI > 30) (16%). In addition, 529 participants (62%) suffered from at least one hyperkeratotic lesion. All of the participants completed the study (Table 3).

3.1. Hyperkeratotic patterns

Of the 1700 feet analysed, 985 (58%) presented with hyperkeratotic lesions. In all, 87 different hyperkeratotic patterns were recorded, of which 10 of the most common patterns (representing 49% of total lesions) were selected for this study (Fig. 1).

3.2. Diameter

Regarding the diameter of the hyperkeratoses, 43.4% were between 0.1 and 1 cm, 31.8% between 1.1 and 2 cm, 20% between 2.1 and 3 cm and 4.8% between 2.1 and 3 cm.

3.3. Correlations of the hyperkeratoses

From the different variables analysed, hallux valgus was associated with the presence of plantar hyperkeratoses ($X^2 = 27.13$,

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