Original Article

Pitted Keratolysis: An International Study in Five Occupational Groups

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ABSTRACT

Objective: The aim of the study was to evaluate the incidence of Pitted Keratolysis (PK) in two groups from two different countries, to estimate the importance of hyperhidrosis, warm and occlusion in inducing PK.
Design: Prospective study
Setting: Department of Dermatology, 6th Military Support Unit, Ustka, Poland
Subjects: One thousand nine hundred and eleven people were examined and the control group consisted of 229 people, randomly selected. Those surveyed were divided into five groups.
Intervention: None
Main outcome measures: A two-center, clinical survey was done in order to estimate variable parameters in patients diagnosed with PK, including age, gender, work status, associated skin problems, presence of hyperhidrosis, use of occlusive shoes, recurrences, complaints and impact on work and social life.
Results: PK was diagnosed in a total of 152 (7.95%) people, and two (0.87%) in the control group. Out of these, 19 (90.48%) patients had hyperhydrosis, 7 (63.63%) were homeless, 13 (30.23%) were farmers, 10 (7.04%) were athletes, and 103 (6.08%) were soldiers. In 82.89% (126) persons, presence of lesions was related to wearing shoes that were not breezy enough.
Conclusion: The presence of PK is connected with the chronic effect of sweat, occlusion, or increased humidity. A large role in the etiology of diseases is played by injuries, micro trauma and inadequate hygiene of feet.

KEY WORDS: corynobacterium, pitted keratolysis, soldier, skin diseases, stratum corneum

INTRODUCTION

Pitted keratolysis (PK) is a bacterial infection of the skin first described in 1910 by Castelani as *Keratoma plantare sulcatum*. In his opinion, the disease was specific to people living in tropical and subtropical areas.

In 1965, Zaias changed the name of the disease to Pitted Keratolysis, as it is well accepted today.

Corynebacterium triad is a clinical entity that includes PK, *trichmycosis axillaris* (trichobacteriosis) and *erythrasma,* caused by the same pathogen Corynebacterium spp[1]. *Kryptococcus sedentarius*, *dermatophilus congolensis* and *streptomices* have also been reported to induce the disease[2].

Corynebacterium spp are Gram-positive bacteria that invade and proliferate within plantar stratum corneum of feet favored by over warming, humidity, occlusion, overstressed feet and poor hygiene[3,4]. Corynebacterium spp produce keratolyic enzymes which damage stratum corneum, especially in the presence of hyperhidrosis. It is considered that hyperhidrosis is present in 95% of all cases of PK[5].

PK affects people of all ages, being mostly described in adult males, more often in soldiers[3,5], homeless[6], athletes[4], farmers[7], and silk workers[6]. The lesions are typically located on the soles of the feet[8] and only one foot or both feet may be affected.

Unpleasant smell of rancid apples is frequently described by the patients diagnosed with PK[8]. Pain sometimes occurs, burning while walking, and desquamation of the skin are common complaints of patients[6].

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Keratolytic enzymes produced by Corynebaterum spp destroy the stratum corneum of the epidermis, explaining the presence of characteristic, more or less visible, shallow or deep crater-shaped sores. Two histological types of PK are admitted: superficial type with discrete depressions and deep variant with larger depression[9]. The depressions' depth varies between 0.5 – 1.0 mm and may achieve the depth of 2 mm[10].

Wood lamp examination, although it is of great help in erythrasma and trichomycosis, is not a useful diagnostic tool in PK[11].

Different treatment modalities have been tried in PK: topical antibiotics (erythromycin 2%, clindamycin 1%), antiseptics (chlorhexidine, isopropyl alcohol 40-60%), sometimes accompanied by botulinum toxin injections for hyperhidrosis[4,5,12].

SUBJECTS AND METHODS

In the study period of five months, 1911 people were examined – males and females aged 18 – 86 (average 52 years old), pursuing a variety of professions and originating from different social groups. The control group consisted of 229 people, randomly selected – males and females aged 19 – 77 (average 48 years old). Those surveyed were divided into five groups:

1. soldiers – 1694 people, males aged 18 – 27 (average 22.5 years old);
2. farmers – 43 people, men aged 44 – 86 (average 65 years old);
3. athletes – 142 people, males and females aged 19 – 34 (average 26.5 years old), among whom were basketball players (24 people), volleyball players (32 people), football players (56 people), light athletics competitors (22 people) and martial arts competitors (8 people);
4. Homeless people – 11 individuals, males aged 41 – 53 (average 47 years old);
5. Patients with hyperhidrosis – 21 people, males aged 19 – 33 (average 26 years old).

Eligibility criteria for participants were people from different social groups and carrying out certain professions.

In addition, those examined were interviewed about their history of foot injuries, chronic diseases and treated skin diseases on the feet (all those with diagnosed hyperhidrosis were included in group 5).

The limitation of this study was the presence of other foot diseases including dermatomycosis. In doubt, mycological examination was performed with KOH on clinical lesions.

The study was conducted in two Departments of Dermatology, the 6th Military Support Unit in Poland and in the Apollonia University Iasi in Romania.

Exclusion criteria included: The study excluded people with physical disabilities and children.

Inclusion criteria required: All able-bodied people above the age of 18 years were included in the study groups. Soldiers of the Polish Army, farmers and homeless from Poland and Romania, professional athletes from Poland and Romania, and patients with hyperhidrosis for at least one year.

This study was approved by the 6th Military Support Unit in Poland and by Apollonia University Iasi in Romania.

Ethics

This study was performed on human subjects; thus, all patients were aware of the presence of the study.

RESULTS

Pitted keratolysis was diagnosed in 7.95% of the cases (152 of those examined) and in 0.87% of cases in the control group (2 individuals).

The vast majority of those diagnosed with PK (90.48%, equaling 19 people) were individuals suffering with hyperhidrosis. The order of the remaining cases was as follows: the homeless constituting 63.63% of cases (7 people), farmers with the percentage of 30.23% (13 individuals), athletes – 7.04% (10 people) and soldiers – 6.08% (103 people) (Table 1).

In 82.89% cases, the lesions had to do with wearing shoes that were not breezy enough. Almost 85% of lesions were located on the sole of the foot, in the forefoot area or on a heel, and only 2.63% lesions affected the whole foot. The subjective symptoms those questioned complained about were: unpleasant smell (86.84%), hyperhidrosis of feet (78.29%) and pain while walking (19.74%).

Additional features and factors favoring the formation of PK as well as subjective experience (subjective symptoms) are presented in Table 1.

In addition, among the respondents, there were 161 cases reporting tinea pedis (8.42% of those examined), including as many as 8.50% soldiers (144 individuals), four cases reported type II diabetes (0.21% of respondents) and four cases of varicose veins in lower legs and vasomotor disorders (0.21% of respondents).

After obtaining all data, five groups were identified:

1. Soldiers – 1694 people, men, aged 18 - 27 (average 22.5);
2. Farmers – 43 people, men aged 44 – 86 (average 65);
3. Athletes – 142 people, males and females, aged 19 – 34 (average 26.5), 24 basketball players, 32 volleyball players, 56 football players, 22 light athletics competitors and 8 martial arts competitors;
4. Homeless people – 11 individuals, all men aged 41 – 53 (average 47);

Table 1: The features and factors favoring the formation of Pitted Keratolysis as well as subjective experience (subjective symptoms)

Groups	Features					
	Occlusion and / or protective footwear % (n)	Pain when walking % (n)	Unpleasant odor % (n)	Sweating % (n)	Location	
					Forefoot or heel	Whole foot
Soldiers	100 (103)	20.39 (21)	100 (103)	95.15 (98)	100 (103)	-
Homeless	100 (7)	85.71 (6)	100 (7)	100 (7)	71.42 (5)	28.57 (2)
Athletes	40 (4)	10 (1)	90 (9)	50 (5)	100 (10)	-
Farmers	92.31 (12)	15.38 (2)	100 (13)	69.23 (9)	84.62 (11)	15.38 (2)
Summary	82.89 (126)	19.74 (30)	86.84 (132)	78.29 (119)	84.87 (129)	2.63 (4)

5. Persons with hyperhidrosis – 21 people, men, aged 19 – 33 (average 26).

DISCUSSION

Healthy feet are an important factor in maintaining physical condition mainly in military training (basic training). Foot injuries, acute or chronic diseases could be criteria of elimination of soldiers from training[5,13].

In a study performed by Brzezinski *et al* who followed 3714 soldiers for one year, the results confirmed the presence of foot infections (including PK) in 3.39% persons reported to all skin diseases diagnosed in the same population group[3].

Another survey released on 1694 people by Brzezinski *et al*, soldiers who were checked for skin diseases over a period of two years reported the presence of infections localized on the feet in 2.47% cases[5].

PK is a common disease that occurs in people with chronic venous insufficiency of the inferior limbs, peripheral vasomotor disorders and obesity. The role of circulatory system as a predisposing factor for PK was brought into discussion for the first time by Esterman and Pilotto when examining traumatic lesions in Australian soldiers[14].

Another research conducted by Abdel-Fattah *et al* on soldiers of the Saudi Arabian army concluded that abnormal foot construction (flat feet) was not a major risk factor for excluding a soldier from military exercises[15].

During the last decades, many reports have been published emphasizing the relation between excessive foot sweating and PK. According to Shah *et al*, hyperhidrosis, the presence of tinea unguim, the existence of microtraumas in soldiers and athletics play a major role in the etiology of PK[16].

Fifty-three patients (mean 24.9 years) were observed by Blaise *et al* for a period of two years; over two thirds (68%) of those examined reported hyperhidrosis of the feet, whereas unpleasant smell and foot pain were reported by 66% and 47% of the patients respectively[17]; and occlusive footwear was confirmed by 96.2% of examined persons.

In comparison, a Belgian study in present reports pain only by 19.74% of the Polish patients, 85.71% of them being homeless.

Danpiere also notified the incidence of PK in 30 soldiers partaking in a mission in the rainforests of Guyana[18].

Frequent occurrences of PK were confirmed in Nigerian and German soldiers[15,19].

Scrutiny of skin diseases in farmers from Southern India, done by Shenoi *et al* concluded the presence of PK in 43.4% of people who were examined[20]

Kanthraj *et al* noted the presence of skin diseases in 68% of silk workers, out of whom 38% suffered from PK[21].

In a study realized by Pasricha and Baru, PK was found in 51.8% cases of skin disorders among silk workers in Assam, in a proportion of 37.5% in Kamata and presented also in cashew nut workers in Karnataka[22].

Stratigos *et al* performed a survey on 142 homeless living in Boston-USA searching for skin diseases over a three month-period; the results confirmed the occurrence of PK in 20.4% of cases and tinea pedis in 38% of persons [6]

Limitations

There are some limitations in this study. Foremost, it is a retrospective study which compares data over a span of one year. This study included in-patients treated from two different clinical centers and two states. The following year the number of soldiers could rise twice. The soldiers were studied in the first month of military training and number of symptoms could increase in the coming months.

CONCLUSIONS

Healthy skin of feet plays an important role in maintaining proper physical condition. It is important to wear proper footwear and to take good care of the feet, as well as to maintain good level of hygiene.

Plantar Pitted keratolysis is the disease of "wet feet". The occurrence of PK is related to a chronic influence of sweat, occlusion and increased humidity that are in favor of bacterial infection by Coryneacterium spp. A prominent role in the etiology of the disease is played by injuries, microtraumas and inadequate hygiene. Symptoms of the disease were accompanied by an unpleasant smell, hyperhidrosis and foot pain.

The real incidence of PK is not known, although many reports exist concerning high-risk groups: persons prone to prolonged use of occlusive footwear.

Present study highlights the high incidence of PK on a large predisposed population and raises the hypothesis that PK might be more common in large populations.

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