

Feet Microbial Infections

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Abstract

Microbial foot disorders are quite common around the globe. People who usually don't take care about their foot hygiene and overall health often suffer from serious foot ailments. Causes of these disorders may be poor cleanliness, diabetes miletus, improper foot ware and socks use. Among them, shoes and socks as remain moist due to sweat and dirt, are a potent source of microbial invasion which may be either of bacterial, fungal or viral origin, sometimes algal too. People of third world countries are more prone to such disorders because of lack of awareness. These issues can be controlled by introducing proper general mass awareness regarding foot care and hygiene and by spreading information regarding foot ulcers and wounds handling to medical staff and common people.

Keywords: Microbial foot disorders; improper foot ware; microbial invasion; foot hygiene; foot ulcers.

1. Introduction

Foot ailments commonly occur due to use of improper and unhygienic socks and shoes. Because people usually ignore basic principles of hygiene for feet just like hands [1]. Some may suffer due to such feet microbial infections as they are already diabetic or have some wounds or feet ulcers [2]. Some common feet infecting microorganisms are of bacterial origin like *Pseudomonas aeruginosa*, *Acinetobacter* sp. [3], fungal strains [1], often blue green algae [4] and may be some type of enteroviruses [5]. So hygienic care being the essential part of life is necessary to maintain good health and prolonged life.

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Due to the unhygienic condition in third world countries such as Pakistan, India, Afghanistan, Bangladesh and other Asian countries may result in many diseases including the foot diseases. Hygienic care is one of the most important part in our environment and without it, we cannot live healthy life. The serious health issue such as diabetes, eczema and onychomycosis [6] occur due to use of unhygienic and improper shoes and socks. Whereas the management of diabetic foot disease is primarily focused on avoiding damaging results of lower extremities and it should be sorted out through three main ways; identification of the “at risk” foot, treatment of severe foot disease and prevention of further disease problem [7]. Most leading cause of feet ailments is microbial infections, in this regard, the dermatophytes are the group of fungi which mainly affect and penetrate the keratinized tissue i.e. nails, hairs and skin of human beings and it also affects the animals. It commonly causes an infection known as dermatophytosis [8]. Similarly, a most common nail disorder is onychomycosis. In North America 7% to 14% people affected by this disease and in Pakistan up to 54% population is suffering from it [9, 10, 11, 6]. It is important mention here that severity of shoe and socks diseases increase with the passage of time and may result in foot loss [12]. If the infection is not treated accurately and diagnosed at earliest then it leads to high level of morbidity and mortality [13]. In this review, authors are trying to highlight hygiene-based issues like lack of general public awareness about such feet microbial ailments along with their causes, effects and possible control.

2. Causes & Effects

There are some factors for development of dermatophytic infections i.e. occlusive footwear, male sex, immune system suppression, concurrent dermatological conditions, and moist environment [14]. Potent causes are as follows:

2.1 Lack of hygiene

Use of mismanufactured or continuously moist like due to sweating and dirty footwear causes which leads to fungal infection [15, 16]. Such infections are more common in tropical countries. That’s why; ideal footwear for diabetic patients should have a unique style i.e. footwear should have wide toe box, soft soles, extra depth and laces for fitting and adjustment. But patient’s compliance about such a footwear is usually poor, particularly at home where they are more active than outside [17]. Similarly, tinea pedis does not affect the athletes but also to others but comparatively more men are reported than women for this foot ailment because still in major part of the world ladies are confined to home and gents are more exposed to external environment and show carelessness related to hygienic care. This infection begins from the space between the toes of feet then gradually spreads on the foot sole in a “moccasin” pattern [18] and may transform in to foot cancer. Sometimes, foot may cut off to prevent the whole leg from spread of infection. Exchange of footwear may cause microbial infections by sharing footwear or by contact to others [14].

2.2 Bacterial and cyanobacterial infections

Pitted keratolysis is an infection which is common among athletes and those individuals who use damp and fuzzi having footwear all time [19]. This skin disorder affects the stratum corneum of the plantar surface. It is caused

by the gram- positive bacteria that show coccoid and filamentous morphology [20]. In addition to this, the irritative dermatitis due to exposure to skin blue green algae in areas of seashores has been frequently reported which is a toxic allergy [21, 22, 4]. Broad spectrum toxicants are found, produced by toxic algae and common in tropical regions. The diagnosis and treatment of such dermal ailments of algal origin require the clinical history of contact and symptomatic and supportive treatment [4]. Similarly, various aquatic recreational points where algal blooms are present may cause dermatitis due to exposure of algal cyanotoxins to humans [23]. Moreover, a common moss Bryozoans may cause severe allergic contact dermatitis in fishermen, featuring dry, fissuring and exudative lesions of the hands, arms, legs and feet [24]. Addition to this, *Calothrix confervicola* has been found as potent human skin irritant and cause sewed dermatitis or swimmer's itch [25].

2.3 Fungal Allergy & irritation

Shoe infection may be a form of allergy or due to some irritant contact dermatitis [26]. Reported data suggests that skin lesions are often formed due to allergic shoe dermatitis and on exposure of dermal allergens through shoes [26-30]. Moreover, these cases are frequently reported in warm areas where overall humidity level and sweating rate are higher [26-28]. Similarly, in a heated climate, due to humidity and inner shoe friction, sweating, pressure and other chemical reactions which occur inside shoes may cause serious feet infections [26, 28]. In the recent research, it is noted that leather, rubber and adhesives are the major and most common source of shoe allergens [31, 26, 32, 27, 33]. Basically, the use of improper chemicals and components cause shoe dermatitis [31, 34]. Different types of shoes in relation to climatic conditions and traditmons may cause diverse dermal problems [31, 26, 32, 27]. Similarly, footwear dermatitis is a form of contact dermatitis which is spread by shoes and reported data indicates that children are its major sufferers [35]. Moreover, experimental investigations high light that shoe dyes and leather may act as allergens i.e. tanning agents are present in hypoallergenic shoes leather.

2.4 Viral infections

Hand, foot, and mouth diseases are common types of childhood illness caused by enteroviruses. Increasingly, the disease has a substantial burden throughout east and southeast Asia [5]. Moreover, diverse viral skin biopsies have also been reported on exposed body parts so far [36].

2.5 Spoiling wounds and diabetic foot ulcers

Among microbial feet infections, diabetic foot ulcers are one of the serious complications of diabetes progression [6].The three major causes that contributes in this disease are peripheral neuropathy, peripheral arterial disease and immunosuppression which may be of microbial origin [37-40]. Some patients of diabetes often develop a type of neuropathy which is responsible for the decreased cutaneous sensitivity. Neuropathy basically occurs due to the poor nutrition to the nerve endings and as outcome, deficient inflammatory reaction due to blockage of influx cause infection [41]. The change in sensitivity causes a severe affect that leads to calluses and deformations in feet. These calluses precede the onset of ulcers which are then infected by several microorganisms [41]. The infections spread rapidly, in case of poor dermal defense capability. In the diabetic

foot, several biochemical abnormalities can induce and accelerate vascular and neuropathological changes in patients. One of the most important disease is hyperglycemia. It damages the endothelium of blood vessels and stops the production and activation of nitric oxide synthase; it is a crucial element in the mechanism of arterial vasodilation. There are many other crucial elements in the genesis of endothelial dysfunction and cell damage i.e. Dyslipidemia insulin resistance and oxidative stress [42].

2.6 Eczema & other immunological disorders

Several inflammatory and autoimmune disorders that primarily affect the skin like psoriasis, atopic dermatitis, scleroderma, dermatomyositis, cutaneous lupus erythematosus, and generalized vitiligo have been reported so far. The way, shoes cause inflammation like eczema on feet due to improper footwear. This eczema may appear as bilateral or symmetrical, reciprocal to the depiction of shoe such as uppers and sides, soles, heels and sandal straps and no fungal infection are of diverse types of dermal ailments [31, 34, 43-44]. The study of sufferers of from foot eczema and leather allergy show that filaggrin mutation is also a major factor which causes the foot eczema. There are different forms of eczema i.e., Atopic, Non-atopic. Both are treated in same way so far [45, 11, 46]. The variations in clinical phenotype of eczema has multiple reasons and although the pathophysiology is not completely understood yet. It is known that there is an immune system-based disturbance in skin tissues which leads to its damage due to environmental triggers and defective functioning of skin as barrier [45]. Common treatments of various types of eczema are moisturizer, thematic steroid, topical inhibitors and UV therapy [45, 47].

3. Preventive measures

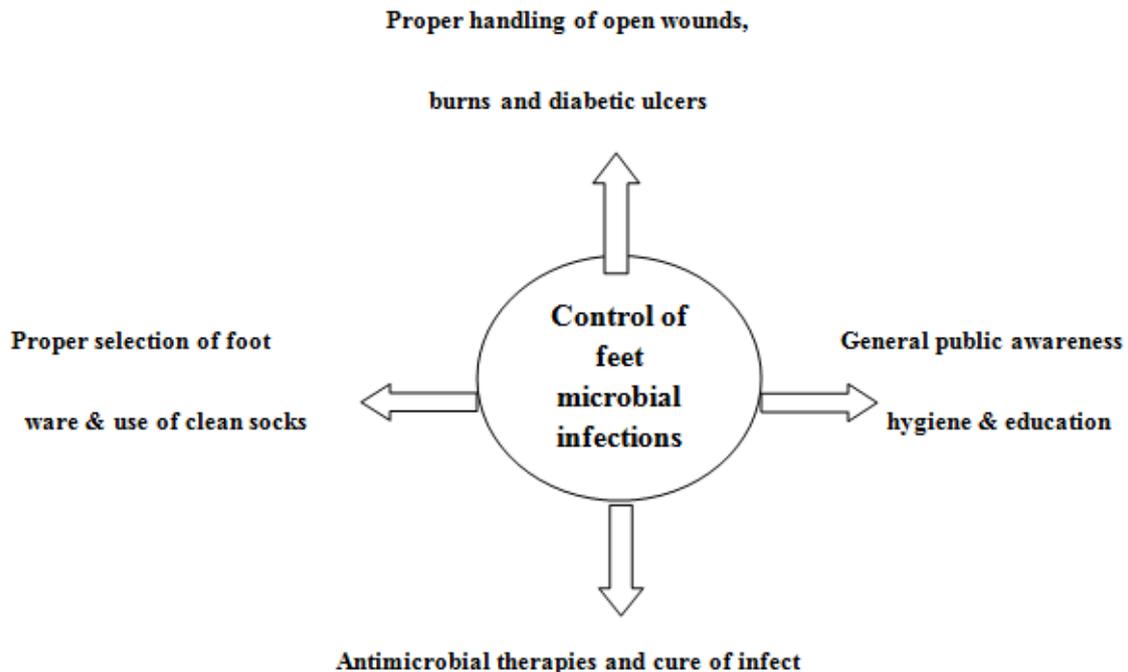


Figure 1: Control of feet microbial infections

Following efforts should be adopted for prevention and control of various feet microbial infections (Fig.1).

3.1 General public awareness

Preventive measures of disease e.g., Tinea pedis infection include assurance of hygiene, skin should be dry and avoid sharing of socks and foot wears with infected individuals [48]. By adopting such precautions and by giving a complete awareness to public people about not only diabetic but overall foot care, 49% to 85% of all kinds of diabetic foot problems can be avoided [49-51]. Moreover, prevention and management of localized trauma or infection and pre-existing vascular damage, improvement regarding poor glycemic control, improved awareness and self-practice of foot care are also helpful to minimize the foot ailments [52-53].

3.2 Effective remedies

Some natural ingredients have effective and strong vasodilatory and thrombolytic effects; therefore, it mainly takes part in removing the obstruction of small subcutaneous vessels [54-63]. Some of them can even enhance angiogenesis [64, 59]. They also prevent damage of mitochondrial material of the endothelial cells by many other factors i.e. oxidative stress, subsequent cell death after oxygen glucose deprivation and avoiding damage [65]. In nature, there are some natural ingredients that protect the neurons from oxidative stress and decrease the ischemic damage by multiple mechanism like inhibiting apoptosis [54, 66-77]. Thus, natural ingredients also can decrease local glycemic levels and have a useful antioxidant effects and as result anti-inflammatory properties [70]. In the last, some natural ingredients have an antibacterial effect over some bacteria i.e. *Staphylococcus aureus*, *Escherichia coli*, *Pseudomonas aeruginosa* and other bacteria, taking part towards the prevention of severe type of diabetic foot infection. They also play important role against fungus. With the technology the product remains effective after fifty washes.

3.3 Cure of diabetic ulcers

There are many methods to control the diseases for diabetic patients:

The most important methods are to control the blood glucose and modifiable cardiovascular risk factors such as diet, exercise, body weight and cessation of smoking. Foot and footwear should be hygienic based. Education is the major point to control the disease for diabetic patients. Education in a structured, organized and repetitive manner may prevent foot problem [17]. International Working Group on the Diabetic Foot acknowledges to the diabetic patient to control and improve their foot care and hygienic conditions [78]. Wash the feet daily with water and dry them carefully, especially between the toes. Use oils or cream for dry skin but not between the toes. Cut the nails properly, do not remove skin by chemical agents or plaster, always wear socks with shoes and check the shoes before wearing them. Do not walk bare footed all time. After injury or scratches consult with doctor immediately [79]. In the whole world nearly 415 million people suffered with diabetes. Out of 415M 75% people live in low- and middle-income countries. National Institute for Health and Care Excellence gives guideline on diabetic foot. They referred three tiers system for foot care and prevention: primary health care for preventive services and appropriate referral of diabetic foot; foot protection services at community level for management and care of foot problem; and foot care services at tertiary level to handle complex foot problems

and diseases. In third world or middle-income countries, doctors are not well trained in a diabetic foot care. Multidisciplinary foot care services are available at a few high-level centers and we should train the primary doctor about the diabetic foot care. All the hospitals should have to develop the tertiary diabetic foot care centers. These centers would provide foot protection, nail care and surgeries in which wound will heal with the passage of time. Modern foot services should be provided at all tertiary level hospitals with all facilities.

4. Conclusion

Feet microbial infections should not be ignored which are globally overlooked so far due to lack of hygienic awareness. That's why; a person who use frequently leather footwear either with socks or without socks is more prone to attack of dermatophytic fungi. Similarly, prevalence of tinea pedis is more in males than females and epidemiology of other microbial feet infections is also significant. Moreover, diabetic foot ulcers are associated to an increased risk of death, it frequently leads to removal of lower limb. The ways of management that can ensure successful and rapid healing of diabetic foot ulcer include education, blood sugar control and surgery.

5. Author's contributions

The authors organized concerned data of Pakistan of last ten years and used to write the manuscript. All the authors revised and approved the final manuscript.

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