PART 4

It is All About the Foot:
Hair Skin and Nails -
Completing the Package

BY DEAN MASON, MA, OST C. PED., CO
In this fourth installment of our educational refresher series re-acquainting you with the basic and advanced anatomy, and physiology of the foot, we will focus the next part of this series on ‘outside’ of the feet.

The integument, aka the skin, is the body’s largest organ. It covers the entire body and has differing properties depending on what body part or location you refer to. Skin around the eyes has different properties than skin on the plantar surface of the feet. It is all skin, but it’s not all the same.

Anatomy of the Skin

Cutaneous skin refers to the upper layer; anything below is referred to as subcutaneous. Skin is a richly innervated and perfused organ. It houses hair follicles, sweat and oil glands, all atop a layer of arteries, veins, skin ligaments and fat. For its ‘thin’ thickness, there is a lot going on within it.

Skin has three basic structures: the epidermis, the dermis, and subcutaneous tissues. The epidermis (above the dermis) is the structure most visible. Consisting of the stratum corneum (the uppermost layer), stratum lucidum, stratum granulosum and the stratum basale. "Stratum" means layer. The stratum corneum consists of dead cells also known as the "horny" layer. Next is the lucidum, the translucent layer below the corneum. The lucidum (for light) is found in the thick skin on the plantar surface and palmar surface. It contains no hair follicles. A very thin layer is found in the remaining skin. The stratum granulosum is the granular layer and assists in propagation of tissue. The spinosum is the layer between the granular and base layer containing prickle cells, a cell with delicate radiating processes connecting with similar cells. The basale is the base cell layer of the epidermis.

The dermis, the central structural layer, holds the hair follicles and matrix, capillaries, sweat glands and the oil glands. These structures exit on the epidermal layer.

Subcutaneous tissue contains the arteries, veins, and nerves of the skin. Plantar skin is completely different from the rest of the integument. The stratus lucidium is very thick on the plantar surface, and plantar fat is a totally different structure from other subcutaneous fat. Skin is very resilient and elastic in its normal state. It must reside in a state of homeostasis in order to provide protection from the outside world. Excessive moisture in the skin leaves it vulnerable to the entrance of bacteria. Macerated skin exaggerates the skin cells, making them more porous and thus susceptible to bacterial invasion. In a compromised foot such as a diabetic, this allows infection to set up shop in areas not protected by adequate perfusion of blood.

Excessive heat has a deleterious effect on skin. Heat can be increased by outside temperature, shoe gear that does not allow for air flow, and friction between the skin and the shoe.

Skin disorders can be classified under five categories: mechanical stress, infection, disorders of the sweat glands, deficiency states, and dermatology issues. In this article, we will explore some of the basic disorders. More pathologies will be covered in an upcoming series of articles.

Stress Disorders

Pedorthists treat many conditions that create lesions on the plantar surface. For some, these lesions are a painful nuisance, and for others, it could lead to loss of the lower limb. There are four mechanical stresses that result in hyperkeratotic
conditions. Hyperkeratosis is the result of over stimulation of the stratum corneum resulting in hypertrophy. These lesions are corns (on the dorsum) calluses and helomata (callus with a core pressing into the dermis) on the plantar surface.

Compression is the result of two convergent stresses acting in opposite directions (ex: calcaneus reacting with the skin underneath it). Tensile or torsion stress is the result of stretching of tissues. Tensile stress is applied during ambulation as the plantar ligaments and fascia stretch during weight bearing. Shearing stress occurs when forces in different planes act in opposite directions. Shear causes heat and along with friction, can break down the plantar skin. Torsion stress is shear combined with rotation.

Pedorthics uses various modalities to offload these stresses and thus bring the foot into as normal a condition as possible. Corns occur on the digits, in the DIP and PIP areas, and are often associated with hammertoes. Corns can also occur on digits that constantly rub against the shoe upper (as in dress pump styles). Calluses occur on the plantar surface and are caused by bone rubbing against skin. As a rule of thumb, cavus feet callus on met heads 1 and 5, planus and lower arched feet on 2-3-4. The medial aspect of the hallux and the lateral aspect of the fifth digit are also common areas for callusing. Thickened skin on the posterior aspect of the heel is hyperkeratosis and its principal cause is the medio-lateral shifting of the heel in the shoe. Once we relieve the pressure, the lesion tends to disappear. Paring of calluses offers relief, but complete relief involves removing the source of stress.

Complications of hyperkeratotic lesions are infection, ulceration, perforating ulceration, fibrosis, synovial sacs, dermal protrusions, furrowing and fissures. Here is a brief look at these complications.

Infection is a common side effect as the feet are in a warm, moist environment, perfect for bacterial growth. Add to this a compromised vascular system and immune system, and that spells trouble. Cellulitis and staph infections are the most common.

Ulceration arises from the loss of contiguous skin cells due to necrosis (cell death). Principle causes are continuous trauma (most frequently compression), loss or degeneration of plantar fatty tissue, poor peripheral circulation and neuropathy from any cause. Patients often complain that their doctor gave them an ulcer as it often is hidden beneath a callus. They need to be reminded that the ulcer was there and the callus was merely covering it. Ulcers must be healed from the inside out, thus the need for frequent debridement of the site.

Perforating ulcers are a deep ulcerations that can penetrate into the deeper structures, even to the bone. The danger is osteomyelitis. These lesions tend to undermine the tissues around it and are difficult to manage. Complete removal of stress factors is key to healing this type. These often call for surgical intervention.

Fibrosis is an increase of fibrous tissues in the dermal and subdermal tissues on the plantar surface. It is usually caused by long standing mechanical stress. Repeated low grade inflammation coupled with repetitive stress create the environment for this lesion.

Synovial sacs filled with synovial fluid are created in the tissues by persistent shearing stress. Just as synovial sacs protect joints, these form to protect the tissue from shearing stress. Treatment includes removing the source of the stress, draining the incomplete bursa, astringent medication and even surgical removal.

Dermal protrusions are small herniations of the dermis beyond its normal position. Regular operating or exfoliation can demure the epidermal layer, allowing the dermis to protrude, just as an abdominal hernia protrudes through the abdominal wall. The excessive compression stress must be relieved before topical medications are used.

Furrowing occurs in a plantar callus when it becomes pinched into a deep trough. Adjacent met heads in a splayed foot constricted by a tight shoe is one cause. The margins of the furrow are highly vascular. Mechanical stress is the cause of this condition.

Fissures are splits in the epidermis caused by elasticity of skin. Interdigital fissures occur with hyperhydration and maceration of the skin, where fissures commonly found in the calcaneal area are caused by anhydrous conditions. Heel fissures must be reduced with debridement and the area controlled by relieving the weight causing the compression.

Outside Protection

Hair on the body is primarily used for the protection of skin (as on the head) and cooling. The skin of the foot and leg are loaded with hair follicles, sweat glands and oil glands. When in homeostasis, these all work together to provide a healthy environment.

As we treat elderly and vascularly compromised patients, changes with this area cause problems. A side effect of neuropathy is the
loss of hair, the decreased production of sweat and oils that keep the skin intact. Dry skin in diabetic patients is very common, and the moisture has to be artificially replaced. Dry skin causes cracks and fissures, thus increasing the likelihood that bacteria can cause infection. It is a vicious cycle to say the least.

The nails are hard plates of densely packed keratinized cells that protect the dorsal aspect of the toes. They are a descendent of the claws used for digging and fighting, and now are used for protection and to assist in scratching and picking up small objects.

The matrix is the living part of the nail. As it grows, it pushes out the highly keratinized and dead hard tissue that we know as nails. The cuticle is the thin band of skin that surrounds the proximal end of the nail.

The lunula, a half-moon shaped area of the living nail is seen on the dorsal surface. The onychodermal band is just proximal to the free edge (the part that we trim off). The proximal nail fold begins the actual visible nail. From this fold grows the superficial nail plate. Below this is the matrix, the growing part of the nail.

Healthy nails require good perfusion in order to grow properly. Dystrophic nails are generally caused by a problem with vascularization, infection or trauma. Poor perfusion cause nails to grow erratically. Fungal infections are very common with nails. There are now a class of oral anti-fungals that are good at resolving these infections. They are not for everyone.

Trauma is another cause of nail problems. Crushing injuries, dropping heavy objects on the nail, and poor trimming skills cause many complications. Recall that one of the leading causes for lower limb amputations in diabetics is from infections caused by poor nail trimming.

The skin, hair and nails are indicative of the general health of the individual. These systems will appear normal in healthy persons, and deteriorate in persons with systemic or traumatic injury. When examining patients, it is very important to note the condition of the integument and all diversions from normal. A black spot under a nail may not indicate trauma, but it can indicate cancer.

Any aberrations should be documented and the patient referred to their physician for follow-up. The combination of little things can help a doctor better manage their patient. We often see things that the doctors don’t, and we have our duty bound to bring these things to their attention.