Foot Care for the Aging

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Age-related changes in the feet include alterations in the skin, which becomes dry, inelastic, and cool and often exhibits hyperkeratoses. Thickened and brittle toenails complicate pedicure. The contour of the foot widens with age and may have increased forefoot height in the presence of toe deformities. Sensory acuity diminishes, as does joint mobility, muscle-force production, and ability to withstand stress. The elderly person's gait is slower and less forceful, with shorter strides. Visual loss affects footwear donning and toenail trimming. Older individuals on a limited income are less likely to have appropriate shoes and hose. Preventive care begins with good hygiene and continues with selection of suitable hosiery and shoes. Conservative management of the podiatric conditions most often seen in geriatric patients (eg, metatarsalgia and hallux valgus) should be based on relating the pathomechanics of the disorder to the options available in shoe selection, modification, and insert design.

Key Words: *Foot deformities; Geriatrics; Orthotics/splints/casts, shoe modifications; Podiatry.*

Feet mirror the aging process happening throughout the body. Aging includes the sum total of changes that occur throughout life not attributable to accident or disease.[1] Although aging continues throughout the life span, certain changes become more prominent in the later years. Unlike other manifestations of growing older, however, foot changes can have profound consequences; severe foot disorder terminates the individual's mobility and, with it, independence. Maintaining foot function is thus a major responsibility with each elder and is also an important public health issue. The increasing life expectancy has changed the composition of our population by expanding the elderly segment. More than half of those individuals who have ever been older than 65 years of age are living now.[2]

The purpose of this article is to review 1) the effects of aging on the feet and 2) the physical and psychosocial concomitants of aging that influence foot health. Physical therapists are in an advantageous position to guide geriatric patients to appropriate care and clothing of the feet. Conservative management of foot disorders will be described to enhance the overall function and comfort of the elderly client.

AGE-RELATED CHANGES IN THE FEET

Careful assessment of the older person's feet usually reveals gross changes in appearance and alterations in sensitivity, joint motion, and muscle-force production, any of which can lead to dysfunction. Subtle changes in the foot's response to stress also affect performance.

Gross Changes

Examination of the mature person's feet logically begins with skin inspection. As skin ages, it tends to become dry, inelastic, and cool and may exhibit hyperkeratoses. Collagen and elastin fibers in the cell matrix become less soluble and less elastic, respectively.[1] Dryness results from lack of hydration and lubrication and diminishes elasticity as the skin becomes more fragile. Dryness also fosters formation of fissures that can allow bacterial invasion, which, in turn, can lead to infection.[3] Older skin does repair but at a slower rate than in younger individuals.[1] The already sparse subcutaneous tissue on the dorsum and sides of the foot thins further, reducing the ability to resist pressure (eg, as from a tightly laced shoe). Constricted circulation accounts for hair loss along the outer side of the leg and dorsal foot and skin coolness. Abnormal warmth, however, signals infected areas.

On the sole, hyperkeratotic areas are apt to form, making walking uncomfortable. Skin thickening is a response to keratin dysfunction and persistent shear stress. Plantar, medial, and lateral callosities are sometimes aggravated by pressure from narrow or high-heeled shoes.[4] The plantar fat pad atrophies, allowing painful calluses to form under the metatarsal heads and heel.[5] Callus also results from loss of soft tissue, changes associated with arthritis, foot malalignment, and irritation from ill-fitting footwear.[6]

Toenails thicken and become brittle, making pedicure more difficult and risky. Changes in the toenails can be accelerated by persistent trauma, such as that inflicted by abrasion from the anterior portion of a shoe that is too short or snug. The most extreme deformity, ram's horn nail, in which the toenail is thick, ridged, and curved, can result when pedicure is not performed for very long periods and may prevent the individual from wearing ordinary shoes.[3,4,7]

Foot contour tends to alter as a person grows older. Few adults remain at the same shoe size throughout maturity. Morphologic and physiological changes are caused by the static and dynamic loads carried for many years. The older foot is usually wider, often because of hallux valgus with bunion and splaying from lowering of the transverse arch.[4] Forefoot height increases with overlapping or underriding toes, hammertoes, and claw toes. *Hammertoes* are noted when the metatarsophalangeal joint is extended, the proximal inter-

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phalangeal joint is flexed, and the distal interphalangeal joint is extended. *Claw toe* refers to a similar malalignment, differing only with flexion of the distal joint.[8] Other alterations in shape are exaggerations of early patterns of weight-bearing associated with pes planus or pes cavus.[4] Further distortion results from years of walking on unyielding pavement with relatively stiff-soled shoes, which force the feet to absorb shock and create chronic microtrauma. Hard surfaces reduce the function of the intrinsic foot muscles, with eventual atrophy of the small toe muscles. Failure to compensate for stress may precipitate bony and soft tissue inflammation. Edema caused by circulatory disorder also disturbs foot shape. Obesity is another factor influencing foot contour. The overweight individual has broad feet with dorsal enlargement caused by fat deposition under the relatively thin skin. The plantar surfaces are apt to reveal excessive thickening in response to the greater load imposed on the feet by the heavy person.

A graphic record of plantar changes can be obtained with periodic use of a simple inked-footprint mat.[6] The footprint should be compared with the contour and size of the individual's shoe before and after introduction of any changes in footwear (see article by Rodgers in this issue for additional measurement techniques). Changes in foot shape noted by direct observation of the feet and confirmed by the footprints may present clinical problems if the patient fails to obtain shoes to fit the current size of the feet. Forcing wide feet with enlarged dorsal aspects and deformed toes into short, narrow, high-heeled, thin-soled shoes can make walking painful. Alteration of ankle, knee, hip, and low back posture in response to foot pain may hasten fatigue. Tight shoes can abrade the skin, and lack of plantar cushioning in the shoe increases the tendency to form thick callosities.

Sensory acuity diminishes with age. The elderly individual may not be aware of undue pressure from an ill-fitting shoe or wrinkled hose or the presence of a foreign object in the shoe. If the patient has proprioceptive loss (eg, the loss associated with diabetes), gait may be disturbed. Reduced temperature sensitivity may lull the elder into keeping the feet close to a hot water bottle or radiator, thereby incurring burns. Protecting the feet from undesirable pressures and temperature changes becomes a critical therapeutic goal.

Ranges of joint motion, particularly subtalar eversion and metatarsophalangeal flexion, diminish with the passing years. Although symptomatic osteoarthritis is less common in the foot joints than in other joints, with the exception of the first metatarsophalangeal joint,[3,5] any restriction of ankle or subtalar motion accentuates stress on the forefoot joints. Arthritis may develop after intra-articular fractures and contribute to foot dysfunction.

Muscle-force production lessens as the aging individual loses both the number and size of muscle fibers. Fiber-type differentiation also decreases. Transmission of impulses across the myoneural junction becomes less rapid. Weakness develops as an increasing proportion of skeletal muscle is replaced by fibrous tissue. The primary cause of muscle-force production loss, nevertheless, is change in life style and decreased use of the neuromuscular system.[10]

Circulatory Changes

In addition to the alterations in foot appearance and function that are readily apparent, other changes are associated with aging, particularly in the circulatory system. Peripheral vessel resistance increases in response to narrowing of the vascular lumen and arteriosclerosis.[1] Consequently, a slight skin lesion on the foot can accelerate to serious proportions.[5] Less oxygen is conveyed by the blood because less air is inspired, and basal metabolism lowers. Stress response thus loses efficiency, in part because of reduced cardiac reserve and depressed endocrine performance.[1] Osteoporosis from decreased blood calcium from the hormonal changes may predispose the feet to fracture from relatively trivial incidents.

AGE-RELATED CHANGES ELSEWHERE IN THE BODY THAT AFFECT THE FEET

In addition to the local changes in the feet, other physical and psychosocial features of the later years have direct bearing on foot health.

Physical Alterations

Diminished visual acuity interferes with self-inspection of the feet, hose, and shoes and trimming of the toenails. Appropriate eyeglasses thus can improve foot function. Lessened manual dexterity affects an individual's ability to perform pedicure, don hose and shoes, and manipulate shoe closures. Reduced flexibility of the back, hips, and knees also interferes with shoe donning and fastening and foot hygiene. Obesity compounds the flexibility problem.

An individual's gait changes with the passage of time. Older people select slower walking cadences, taking fewer steps per minute with reduced force on the heel during early stance. Stride is shorter, and more time is spent in the stance phase, thereby reducing loads on the lower limb.[3] Lower cadence may be a protective maneuver used by elderly individuals who fear falling, especially among those with visual and proprioceptive impairment.

Psychosocial and Economic Factors

Elderly people are often beset by psychosocial and economic difficulties that preclude the use of suitable footwear. Typically, their family and friendship circle shrinks. Resultant loneliness may cause the elder to perceive no particular need to wear proper hose and shoes, especially if the individual lives alone without sufficient social support. Among men over age 65 years, one in seven lives by himself; one third of similarly aged women reside alone.[11] Loneliness breeds lack of purpose, with the common result that disinterest in dressing carefully and suitably develops in response to the dwindling self-image.

Emotional problems are aggravated by loss of income level, which can curtail the purchase of adequate shoes and their repair. Current estimates are that 15% of individuals over 65 years of age are below the poverty level, with many more elders near destitution.[11] Meager income also impedes obtaining transportation to medical services, including pedicure.

PREVENTIVE FOOT CARE

Prudent care and clothing are essential to enable the aging person to continue a self-sufficient life style.

Foot Care

Careful bathing is fundamental to foot health. Because temperature perception may be faulty, the older individual should be instructed to test bath water with the hands before stepping into what may be a scalding or chilling surprise. The elder who fears losing balance in a slippery tub or shower will benefit from a secure bath or shower seat. Some frail persons require assistance from a family member or home attendant. Obese individuals have difficulty lowering themselves into and rising from a tub. Footbaths, thus, may be more convenient and safer. Particular care should be directed at washing between the toes, especially if the digits overlap. Feet should be dried gently but thoroughly. Bathing in the evening is preferable to allow maximum time for drying and thereby avoid the potential irritation caused by placing damp feet in hose. Use of a skin lubricant allays the adverse effects of skin dryness.

Pedicure is troublesome for elders whose vision is poor or whose dexterity is faulty. Arthritis and obesity hinder reaching the toes. Utmost care must be exercised to have the toenails cut straight across so that ingrowth and puncturing the skin are prevented. As with bathing, pedicure may require assistance. The elderly person should obtain professional assistance to manage corns and calluses. Home surgery can traumatize toes, especially if circulation is precarious.

Superficial circulation may be enhanced by gentle massage, ideally with skin lotion. The physical therapist can teach the reasonably agile patient to inspect the feet, especially the interdigital spaces, during massage and to be alert to blisters and lacerations that could develop serious complications. A mirror aids in examining the sole. A tepid whirlpool bath fosters superficial circulation, as does active foot exercise, which also prevents the fibrotic changes that contribute to stiffness and walking difficulty.

Footwear

Socks or stockings form the interface between the foot and the shoe and thus aid in foot function. The clinician should caution the geriatric patient 1) never to wear shoes without hose, to avoid subjecting the feet to irritation from the stitching and dyes in the shoe lining, and 2) to keep the feet in the cleanest environment possible. Unbleached white cotton socks are particularly satisfactory because they are hypoallergenic, absorb perspiration, and leave no doubt regarding cleanliness.

Hosiery should fit smoothly, neither constricting the foot nor wrinkling. Socks woven of stretchable fabric can force the toes to overlap or flex. When holes develop in socks, they should be discarded, because mended areas impose extra pressure on fragile skin. Pantyhose, knee-high hose, and girdles, if worn, should not be tight. Circular garters are contraindicated for individuals with vascular insufficiency. Patients with some vascular disorders may be comfortable wearing woolen socks over cotton ones; the inner layer absorbs perspiration, while the outer one provides warmth and absorbs shock during walking. If extra hose are worn, shoes must be large enough to accommodate the added thickness. Elderly women who experience difficulty donning stockings may achieve success with the aid of commercially available donning appliances.

Shoes are the most important part of the elderly individual's attire; no other article of clothing must fit so precisely and perform the critical function of transferring body weight to the unyielding floor and pavement while protecting the wearer from the environment. Shoes also must be cosmetically acceptable to the patient. Faulty shoes deprive the elder of mobility. Finlay determined that many residents in a geriatric hospital unit had either no footwear or footwear that was unsuitable or potentially dangerous; falls were more frequent among residents with poorly fitting slippers than among those with properly fitting footwear.[7] Slipper-clad geriatric patients attempting gait training is a sorry sight. Among the many responsibilities of physical therapists is establishing a model of safe care; thus, therapists should insist that patients receiving ambulation instruction have adequate footwear so that the practice will more likely continue after discharge.

New shoes must be comfortable, not causing prolonged reddening of the skin or other signs of irritation. The elderly person, however, should embark on a program of gradually increasing wearing time to guard against any incipient foot abrasion. Regular change of shoes and foot inspection are particularly important for elders with sensory diminution.

Most people can be fitted with mass-produced shoes, now available in a great variety of sizes and designs, that obviate the expense and delay associated with custom-made shoes. Therapists should consider several key features of the shoe to provide the utmost comfort and function for the wearer. First is the foot-shaped form over which the shoe is made, known as the *last*. The last determines the length, width, and volume of the shoe and its contour. By tracing the periphery of the patient's weight-bearing foot, the therapist can match the tracing to the sole of the current shoe to determine whether length and width are adequate. Both feet should be measured, inasmuch as a size discrepancy may exist. In such an instance, a pair of shoes should be selected so that the larger foot is comfortably fitted. The shoe for the smaller foot can then be modified to reduce its interior volume. A valuable option is the extra-depth shoe manufactured over a last that has greater vertical dimension than found in an ordinary shoe. The extra-depth shoe accommodates an insert and provides more room for claw toes, hammertoes, and overlapping toes. Individuals with severe hallux valgus may need shoes made over a bunion last to provide needed room.

The second element of the shoe is the upper portion that covers the dorsum of the foot. This upper section should be made of fabric or soft leather. Leather, however, is inappropriate for incontinent patients and may be too heavy for frail persons. The distal part of the upper should provide enough space for any toe deformities. Shoe closures should be manageable by the wearer. The Blucher type features a separation between the distal margins of the lace stays to offer a wide inlet, making the shoe easier to don and doff and more adjustable than alternate models. The individual who cannot tie laces because of arthritis, hand weakness, or visual loss may be well served by a VELCRO® brand touch fastener* flap or buckle arrangement that can be adjusted with gross movement of the hand, opposite foot, or cane. The posterior section of the upper should have a firm reinforcing counter to stabilize the rear foot. Slippers and slip-on shoes are apt to cause the wearer's heel to withdraw from the shoe; they also increase toe flexion during the swing phase of gait to retain the slipper on the foot.[7]

The sole is the third critical part of the shoe. Ordinarily, the sole should be of nonskid material. Resilient soles, such as those found in sneakers, provide good traction and cushion impact. The latter function is important for arthritic feet and feet with metatarsalgia. Patients with parkinsonism, however,

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*VELCRO USA, Inc, PO Box 5218, 406 Brown Ave, Manchester, NH 03108.

find that smooth leather soles facilitate movement.[7] Sole thickness affects performance. A sole thicker than 0.5 cm protects the foot against irregularities in terrain but impedes late stance and may increase shoe weight excessively. A thin sole deprives the tender foot of protection against rough pavement. The distal portion of the sole should curve upward slightly to aid the late stance phase of gait.

The final major portion of the shoe is the heel. Low, broad heels suit most aging people, affording maximum stability and distributing load equally between the anatomic heel and the metatarsal heads. A wedged heel continuous with the sole is especially stable. The bottom of the heel should be rubber to prevent the wearer from slipping. A heel made entirely of compressible material aids the individual with an ankylosed ankle to simulate plantar flexion in the early stance phase.

CONSERVATIVE FOOT MANAGEMENT

Many foot disorders presented by geriatric patients are amenable to conservative, or nonsurgical, care. Among the most common disorders are metatarsalgia, plantar callosities, and toe deformities. Management of these problems illustrates the general approach that can be followed for other foot conditions. Understanding the pathomechanics of a given disorder is fundamental to effective action.

Women constitute the majority of patients presenting foot disorders, particularly metatarsalgia, plantar callosities, and toe deformities. Years of wearing high-heeled shoes, which concentrate stress on the forefoot, and shoe types with pointed, shallow toe boxes may contribute to the problem.

A primary goal of foot management is to decrease pain. This objective may be accomplished by transferring weight-bearing forces from sensitive sites to portions of the foot that can tolerate compression and shear stress more readily. Pain may also be lessened by limiting shearing motion within hypersensitive joints. The goal may be satisfied by judicious shoe selection. For some individuals, however, the appropriate shoe will require internal or external modifications, or both.

Several means are often available to achieve specific therapeutic goals. A removable or stationary insert, for example, might be constructed and installed over the inner sole of the shoe. The removable insert affords versatility, while the stationary insert ensures proper positioning under the foot. A three-quarters length insert terminating just proximally to the metatarsal heads leaves adequate room for the toes. A full-length insert, if removable, is less likely to dislodge inside the shoe. Compared with modifications to the outer surface of the sole, inserts can be contoured more precisely to the shoe. Leather or rubber attached to the outer sole is easily adjusted or replaced but, in addition to being noticeable, may jeopardize the elder's stability during walking and will erode more quickly than inserts. Inserts, however, occupy space and may crowd the toes unless shoe size provides the needed volume. Some patients benefit from a combination of external and internal modifications to the shoe sole and heel, thereby retaining needed room inside the shoe while avoiding an overly conspicuous external modification.

A simple way to gauge the patient's response to modifications is to use a sandal with VELCRO® strips on the inner and outer soles. Wedges, bars, and other Velcro®-covered components may be attached, affording the clinician the opportunity to observe their effect before permanent modifications and orthoses are ordered.[12] It is most important, however, that the elderly person not wear sandals on a permanent basis, because sandals fail to shield the toes.[13]

Metatarsalgia, Plantar Callosities, and Hammertoes

Forefoot pain and deformity are vivid evidence of mechanical disturbance of the foot. High-heeled shoes overload the forefoot. In addition, individuals with rigid pes cavus are apt to display toe deformities because excessive weight is borne on the forefoot and on the heel. Pes planus, however, may also encourage similar malalignment, because the foot fails to supinate during mid-stance, reducing the effectiveness of forefoot propulsion. Arthritis can also contribute to the problem of metatarsalgia, whereby chronic erosion of cartilage and bone causes plantar subluxation of the metatarsals, resulting in pressure atrophy of the plantar fat pad under the ball of the foot.[5,14] With metatarsal head malalignment, the proximal phalanx slips dorsally into the hammer position, often developing excruciating dorsal keratoses. Displacement is aggravated by muscle imbalance. Intrinsic muscles fail to flex the metatarsophalangeal joints as their tendons bowstring dorsally, while the long flexor muscles are rendered inoperative because of stretching over the plantarly protruding metatarsal heads. Toe deformities are most common among individuals who wear slippers,[7] because they compel the wearer to grasp the slipper with the clenched toes to keep it from leaving the foot during the swing phase of gait.

Regardless of the cause of metatarsalgia, the patient loses propulsive force during late stance and walks more slowly[16] with shorter steps, increased lateral trunk sway, and abnormally great flexion at the hips, knees, and ankles[8] as compared with individuals with pain-free feet. Patients with metatarsalgia experience pain when walking on cement sidewalks and must contend with limited shoe choice.

In addition to the general guidelines for shoe selection already noted, the patient with a forefoot disorder should have shoes with resilient soles to protect the sensitive metatarsal heads from undue impact. A polyethylene foam insert cushions the foot and provides total contact for maximum force distribution.[3,16,17] Foam inserts, however, are less durable than inserts of more viscoelastic materials. The resilient anterior pad can be combined with a more rigid material in the posterior portion of the insert to stabilize the rear foot.[8]

A metatarsal pad tapering to its anterior border can be placed immediately behind the metatarsal heads to transfer some load from them to the more tolerant shafts. The pad can be glued to the shoe's smooth leather inner sole, or, more conveniently, can be incorporated into an insert that can be worn in all shoes having been manufactured over the same last. Severe plantar callosities require that the inner sole be excavated and padded.[14] Because callosities often result from abnormal mechanics at the hindfoot and midfoot, the pain associated with the callous may often be relieved by balancing the deformities with appropriate shoe inserts. Weight transfer is enhanced by a leather or firm rubber metatarsal bar affixed transversely to the outer sole.[15] The apex of the bar is beneath the metatarsal shafts. In addition to lessening the load on the metatarsal heads, the bar assists transition through the stance phase by shortening the distance through which the foot must travel. A drawback of the bar is that it may upset the balance of a frail elder because the sole no longer will be flat.

Toe pads can aid in pressure reduction. The toe-crest pad consists of a narrow fabric loop slid over the dorsum of an