Chapter 50
Delivering an Effective Foot Care for People with Diabetes

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ABSTRACT
The burden of diabetic foot complications poses a heavy challenge both to the patient and the physician, especially in developing countries like India. The most common causes of foot problems in people with diabetes are sociocultural risk factors like barefoot walking, using improper footwear, poor knowledge of foot care practices and lack of adequate and timely access to podiatry services. Thus, it is quite obvious that if adequate preventive strategies are taken to deal with these risk factors it is possible to reduce the burden of foot ulcers and amputations in people with diabetes. The purpose of this review is to address the various aspects of delivering an effective foot care and the need of using appropriate footwear in diabetic individuals to reduce the burgeoning epidemic of diabetic foot disease.

INTRODUCTION
Foot complications are a major cause of hospital admission for people with diabetes. In developing countries like India, it has been estimated that foot problems may account for about 40% of the health care resources available. This situation needs immediate attention since India has been designated as the “diabetic capital” of the world, with more than 60 million people with diabetes and a future estimation of more than 100 million by the year 2030. The presence of foot complications in people with diabetes increases their health care costs and poses a heavy socioeconomic burden, both to the patient as well as the nation. It has been estimated that the cost of diabetes care for a patient with foot ulcers was more than four times higher (INR 19,020; US$409) than that for a patient without foot ulcers (INR 4,493; US$97). Therefore, effective preventive strategies need to be implemented to reduce this burden of foot complications among the diabetic population. This review will address the essential components of foot care practices including the need for using therapeutic footwear to reduce the occurrence and recurrence of foot ulcers in people with diabetes in India.

Risk Factors Associated with Diabetic Foot
The burden of diabetic foot complications in India and most developing countries is mainly due to various sociocultural practices like barefoot walking, using improper footwear, poor knowledge of foot care practices and lack of adequate and timely access to podiatry services. Thus, it is quite obvious that if adequate preventive strategies are taken to deal with these risk factors it is possible to reduce the burden of foot ulcers and amputations in people with diabetes. The purpose of this review is to address the various aspects of delivering an effective foot care and the need of using appropriate footwear in diabetic individuals to reduce the burgeoning epidemic of diabetic foot disease.

Sociocultural Issues
Sociocultural practices like barefoot walking indoors and in religious places, lack of adequate knowledge on foot care practices and use of improper or ill-fitting footwear have been identified as significant contributors of diabetic foot problems. Habits such as smoking further escalate the problem by causing peripheral vascular disease (PVD) and increasing the risk of neuropathy.

Mechanical Risk Factors
In addition to the above-mentioned sociocultural risk factors, a diabetic subject often have limitations in the range of motion of feet that are rigid, firm and dry. Limited joint mobility is associated with an increased foot pressure and greater chances of foot ulceration. A prospective study on 345 South Indian diabetic patients showed that LJM and high plantar pressure appear to be important determinants of foot ulceration irrespective of the duration of diabetes.

Neurovascular Risk Factors
Uncontrolled blood glucose levels for a prolonged period of time can cause damage to the peripheral nerves, especially in the feet of the diabetic patient. This results in loss of sensation in the feet, which is termed as “peripheral neuropathy”. Neuropathy can be detected by assessing the vibration sensation, pressure perception and thermal sensation in the feet using a tuning fork, the 10 g Semmes-Weinstein monofilament and a Tip Therm instrument, respectively (Figures 1A to C).

Peripheral Vascular Disease
Hypertension and smoking are two major risk factors for coronary artery disease and PVD. A diabetic patient with the habit of smoking has high chances of developing PVD that, in turn, damages the peripheral nerves, leading to neuropathy. A prospective study was conducted on 613 patients with diabetes from Tanzania, Germany and India reported that a lesser prevalence of PVD and yet higher prevalence of amputation rate among Indians was noted when compared with those in Western countries due to progressive infection.

Risk Factors for Amputation
Several risk factors such as foot infection, vascular complications, ischemia, neuropathy, depth of wound and grade of infection are the causes of amputation in people with diabetes. Recurrence of ulcers is quite common due to some common factors like ethnicity,
local trauma and delayed referral to the physician. A patient follows a series of sequenced referrals after unsuccessful home therapy: first visit to a local physician for application of unproven remedies, followed by visit to primary care centers, district hospitals and regional hospitals, where health care providers might not be familiar with management of diabetic foot, which often leads to sepsis because of resulting delays. By the time the patient is referred for specialist care an ulcer has often progressed to gangrene or systemic infection leading to inevitably poor outcome.¹⁴

Effective Foot Care

A multicentric study from India reported that a majority of Indian diabetic patients (65%) seldom followed proper foot care practices. Involvement of family members in foot care was also very less (2%) and professional help was sought by only 2% of subjects. While 90% of the study subjects wore footwear outside the house only 3% of them did so inside the house. Hawaii slippers were the most commonly used footwear (49%) followed by sandals (14%). Special diabetic footwear and shoes were used by only 8% of the study population. Improper footwear use, injury while doing a foot care procedure and unknown causes equally contributed to the development of foot complications.¹⁵

Considering this situation, it is necessary to stress the need for proper and effective foot care practices in people with diabetes, including those at high-risk of developing foot complications. The most essential components of foot management are: (a) regular inspection and examination of the at-risk foot, (b) identification of the at-risk foot and (c) treatment of ulcers and infections.

Regular Inspection and Examination

A person with diabetes, irrespective of the presence or absence of symptoms of foot complications, has to be examined at least once a year for potential foot problems. A patient with probable risk factors should be examined every 6 months. Examination of the feet should be done thoroughly, with the patient’s shoes and socks removed and the patient in lying down and standing up positions.¹⁶,¹⁷ The following aspects of feet must be considered during examination of the feet:

- **History:** Previous ulceration or amputation, barefoot walking practices, and access to health care
- **Neuropathy:** Symptoms such as tingling or pain in the lower limbs
- **Skin:** Color, temperature and edema
- **Bone/joint:** Deformities (e.g. claw toes, hammer toes) or bony prominences
- **Footwear/socks:** Assessment of both inside and outside.

Identification of the At-risk Foot

Most often, the at-risk foot can be identified by the presence of neuropathy. Sensory loss due to polyneuropathy can be assessed by measuring the pressure perception, vibration perception and heat and cold sensation. After identification of the at-risk foot, the patient can be assigned to a risk category, which could guide the subsequent management.¹⁷ Usually, the at-risk patients have two types of neuropathy, which are:

1. Sensory neuropathy—with or without foot deformities/bony prominences/signs of peripheral ischemia/previous ulceration or amputation
2. Nonsensory neuropathy.

Prevention of High-risk Conditions

Distal symmetric polyneuropathy is one of the most important predictors of ulcers and amputation. The development of neuropathy
can be delayed significantly by maintaining the glycemic levels to as near normal as possible. Smoking cessation should be encouraged to reduce the risk of vascular disease complications. Timely referral to a foot care specialist is critical.16

Treatment of Ulcers and Infections
In a high-risk patient, callus and nail and skin pathology should be treated regularly, preferably by a trained foot care specialist. If possible, foot deformities should be treated nonsurgically (e.g. with an orthosis). For foot ulcers, it is important to identify the causes, type, site and depth and signs of infections of the ulcer before starting treatment procedures. Treatment of foot ulcers must combine the following strategies:17

- Relief of pressure and protection of the ulcer (by offloading)
- Restoration of skin perfusion (management of ischemia)
- Treatment of infection (effective debridement and appropriate antibiotics)
- Proper glycemic control
- Local wound care (regular wound inspection and consideration of advanced techniques like negative pressure wound therapy in postoperative wounds).

In addition to the above aspects of delivering foot care practice, it is also essential to impart foot care education in a structured and organized manner not only to the patient but also for his/her family members, and the health care provider. The aim of an effective education session must be to enhance motivation and skills in foot care practices. The educator must demonstrate the skills, such as how to cut nails appropriately. It is also essential to evaluate whether the person with diabetes has understood the messages, is motivated to act, and has sufficient self-care skills. Furthermore, physicians and other health care professionals should receive periodic education to improve care for high-risk individuals.17 Following is a list of foot care practices that should be instructed to the patients as a part of the educational program:

- Daily feet inspection, including areas between the toes
- The need for another person with skills to inspect the feet (if the patient has impaired vision, self-attempt of foot care must be avoided)
- Regular washing of feet with careful drying, especially between the toes
- Water temperature, which should always be below 37°C
- Not using a heater or a hot-water bottle to warm ones feet
- Avoidance of barefoot walking indoors or outdoors and of wearing of shoes without socks
- Chemical agents or plasters to remove corns and calluses, which should not be used
- Daily inspection and palpation of the inside of the shoes
- Not wearing tight shoes or shoes with rough edges and uneven seams
- Use of lubricating oils or creams for dry skin, but not between the toes
- Daily change of socks
- Wearing of stocking with seams inside out or preferably without any seams
- Never wearing tight or knee-high socks
- Cutting nails straight across
- Corns and calluses, which should be cut by a health care provider
- Patient’s awareness of the need to ensure that feet are examined regularly by a health care provider
- Notifying the health care provider at once if a blister, cut, scratch, or sore has developed.

Appropriate Footwear
There is a long clinical tradition in the use of footwear for the prevention and healing of plantar foot ulcers in the diabetic patient.18

Inappropriate footwear is a major cause of ulceration. Appropriate footwear should be used both indoors and outdoors and should be adapted to the altered biomechanics and deformities. Patients without loss of protective sensation can select off-the-shelf footwear by themselves. In patients with neuropathy and/or ischemia, extra care must be taken when fitting footwear, particularly when foot deformities are also present. The shoe should not be too tight or too loose. The inside of the shoe should be spacious enough to accommodate the foot comfortably. The internal width should be equal to the width of the foot at the site of the metatarsal phalangeal joints, and the height should allow enough room for the toes. The toe box is a very important part of the footwear; a high and rounded or oblique toe box offers the best fit by allowing the toes to fit and move comfortably inside the shoe (Figures 2A and B). A shoe with a tapered or pointed toe box is inappropriate for the diabetic foot, because it applies pressure to the toes and forces them into an unnatural posture, leading to calluses, ulcers and eventual deformity. Shoe fit must be evaluated with the patient in standing position, preferably at the end of the day. If the fit is too tight because of deformities or if there are signs of abnormal loading of the foot (e.g. hyperemia, callus, ulceration), patients must be referred for special footwear (advice and/or construction), including insoles and orthoses.18 In general, the following guidelines can be followed while prescribing footwear for a diabetic patient:18

- The patient’s choice of material, color and style should always be considered as far as possible
- Shoes made in a trainer style or athletic style are often acceptable by young patients
- Shoe soles should be thick enough to prevent puncture by nails or thorns
- Shoe fastenings (laces or straps) should be adjustable so as to accommodate swelling or edema. Patients should be taught to rest the heel of the shoe on the ground and move the foot well back into the shoe, before securing the fastenings
- Shoes should be checked at every clinic visit and reassessed frequently for excessive wear and tear and the changing needs of patients
- Abnormal foot biomechanics can cause uneven patterns of wear and make the shoe troublesome for use, which necessitates the need for regular review of footwear
- Shoes that become worn down should be brought in for early repair, if possible, and the orthotist should supervise repair of the shoes.

There are several research studies suggesting that use of appropriate/therapeutic footwear can significantly reduce the incidence of ulceration and prevent amputations. In a study by Uccioli et al.18 it
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was shown that customized footwear was beneficial for patients with previous foot ulceration and for those considered at high-risk of foot ulceration. Reulceration occurred in 58% of patients who resumed wearing their own footwear, compared with 28% of those who wore therapeutic footwear. A cohort study by Viswanathan et al. found that the use of therapeutic footwear resulted in reduction of plantar pressure by 10-19% and a significantly lower ulcer occurrence at 9 months compared to the control group wearing footwear with a hard leather board insole. An analysis of studies that tested a variety of prefabricated and custom-made therapeutic footwear designs, hosiery (socks) and running shoes showed that shoes with a rocker-bottom outsole were found to be effective in reducing forefront peak pressures, and footwear with some sort of moulded insole also provided significant reductions in plantar pressure.

Therefore, every diabetic patient must be advised on the use of proper footwear, and the need for using therapeutic footwear in cases of high-risk patients should also be emphasized in this context to prevent the development of foot deformities and ulceration, which can go a long way in saving the limb from amputation.

CONCLUSION

It is possible to reduce the burden of diabetic foot complications by educating the patient on foot care practices and the various risk issues involved through a well-organized diabetic foot care team with podiatric specialists. It has been shown that simple foot care management advice such as daily examination of feet, how to perform a pedicure, and usage of proper footwear was effective in reducing foot complications and preventing newer problems and surgery, thereby preventing severe morbidity and health care costs. Therefore, management of diabetic foot ulcer requires a holistic approach, including revascularization and surgical procedures as well as treatment of infection, edema, pain, metabolic disturbances, malnutrition, comorbidities, wound care and biomechanical offloading. This can be achieved through an efficient foot care team consisting of diabetologist, vascular and podiatric surgeon, diabetes educator and nurse and an orthotist.

REFERENCES