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Diabetes and Dermatology

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CHAPTER

7

Diabetic Foot

Swetlina Pradhan, Kinnor Das, Sandipan Dhar

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Learning Objectives

- Why diabetic foot is special entity.
- Assessment of severity of diabetic foot.
- How to manage diabetic foot or ulceration.

INTRODUCTION

Diabetic foot is defined as a condition in which there occurs structural and functional alteration of the foot such as infection, ulceration, or tissue loss that is linked to neuropathy and/or peripheral vascular disease in an individual suffering from diabetes mellitus (DM) or having a history of DM.[1] Because of associated neuropathy the patients with diabetic foot have decreased sensation of pain, temperature, vibration, and fine touch in a sequential manner, which makes them prone to develop complications, such as diabetic foot ulcer, Charcot osteoarthropathy, and amputation. About 25% of people having diabetes get hospitalized and lose their limbs because of diabetic foot complications.[2]

PATHOGENESIS OF DIABETIC FOOT

The pathogenesis of diabetic foot is multifactorial; however, the major underlying causes are neuropathy, peripheral vascular disease, and infection.

- *Neuropathy*: Sensory, motor, and autonomic nervous systems are affected in diabetes. Anatomical foot abnormalities brought on by motor neuropathy result in pressure points and aberrant bone prominences, which make the affected regions more vulnerable to injury. Ulceration and skin disintegration are caused by repeated trauma. With autonomic neuropathy, the lack of sweating causes xerosis. Fissures and ulcers are more likely to form on dry skin. Due to the loss of pain, warmth, and touch feeling brought on by sensory neuropathy, the ulcerated regions

are more vulnerable to recurrent trauma. Together, this causes a persistent, nonhealing ulcer.[3,4]

- *Peripheral vascular disease*: Atherosclerosis occurs prematurely and faster in diabetic patients. Though the whole arterial system can be affected, the bifurcation points of the arterial system are more prone to develop atheroma. The peroneal, anterior, and posterior tibials, which are more distal veins in the lower leg and are often affected, lead to a reduced blood supply. Though neuropathy is the major cause of ulceration in diabetes, vascular compromise adds to the chronicity of ulcers **(Fig. 1)**.[4]
- *Infection—the microbiota of the diabetic foot*: The microbiota of the diabetic foot refers to the microorganisms that inhabit the skin and soft tissues of the foot in people with diabetes. Studies have shown that the microbiota of the diabetic foot is more diverse and includes a higher number of pathogenic bacteria compared to people without diabetes. The most common bacterial species found in diabetic foot infections include *Staphylococcus aureus*, *Streptococcus* species, *Pseudomonas aeruginosa*, and Enterobacteriaceae. Fungal infections are also common, and the most frequently isolated fungi include *Candida* species and *Aspergillus* species. The overgrowth of pathogenic bacteria in the diabetic foot is thought to be due to a combination of factors, including poor blood circulation, nerve damage, and impaired immune function. The chronic hyperglycemia that characterizes diabetes also creates a favorable environment for bacterial growth and impairs the body's ability to fight off infections.[5]

OTHER RISK FACTORS FOR DIABETIC FOOT[2]

Poor glycemic control and duration of diabetes: The likelihood of having diabetic foot increases with the duration of diabetes.



FIG. 1: Peripheral vascular changes in diabetic patient.
Courtesy: Dr Surajit Gorai

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Previous foot problems: Previous foot ulcers or amputations, or any foot deformities, can increase the risk of developing diabetic foot.

Poor foot hygiene: Poor foot hygiene, such as infrequent washing, can increase the risk of developing infections.

Smoking and nicotine intake: Smoking and other forms of nicotine intake reduce blood flow to the feet, and it increases the risk of foot ulcers and infections.

Inappropriate footwear: Tight or ill-fitting shoes, high heels, and shoes that do not provide enough support can increase the risk of foot injuries.

Obesity: Being overweight or obese can increase the risk of developing diabetes and the associated complications, including the diabetic foot.

CLINICAL FEATURES OF DIABETIC FOOT

Diabetic foot is a complication of diabetes that can result in a range of clinical features. These can vary from mild to severe and may progress rapidly without prompt diagnosis and treatment. Diabetic patients have a higher chance of developing peripheral vascular disease, which may lead to a reduction in blood flow. Pain, cramping, and a decrease in temperature in the foot are some of the possible symptoms. Neuropathy can result in numbness, tingling, and loss of sensation in the feet. Ulcerations may occur as a result of cuts, prolonged pressure, or other injuries that go unnoticed due to neuropathy. The ulcers can heal if treated appropriately or can lead to secondary infection. Symptoms of an infection can include redness, warmth, swelling, and pain. Gangrene is a serious complication of the diabetic foot and occurs when there is tissue death due to infection or reduced blood flow. It can result in blackened or discolored skin and a foul odor.[6,7]

Charcot foot: Charcot foot is a rare but serious complication of diabetic neuropathy that can result in foot deformities and fractures. Patients may experience swelling and redness and may have difficulty walking.[8]

The Texas Classification System is a widely used classification system for diabetic foot ulcers. It was developed in 1996 by a group of researchers and clinicians in Texas and is based on the size and depth of the ulcer, as well as the presence of infection and ischemia. The Texas Classification System divides diabetic foot ulcers into four stages:[9]

- *Stage 1*: Superficial ulcer that involves only the skin, with no involvement of underlying structures such as tendons, bones, or joints.
- *Stage 2*: Ulcer involves deeper tissue, such as muscle, tendon, or joint capsule, but without abscess or osteomyelitis.
- *Stage 3*: Includes deep abscess or osteomyelitis, but with intact or reparable soft tissue.
- *Stage 4*: Involves extensive tissue loss, such as gangrene or necrosis that requires amputation.

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In addition to the stages, the Texas Classification System also includes grades that reflect the presence or absence of infection and ischemia. These grades are designated as "A" for the absence of infection or ischemia and "B" for the presence of infection or ischemia.

The Texas Classification System is useful for guiding treatment decisions and predicting outcomes in people with diabetic foot ulcers. Treatment may include wound debridement, pressure offloading, antibiotics, and surgical interventions such as amputation in severe cases. The classification system can also help to identify people at high risk for developing diabetic foot ulcers and guide preventive measures to reduce the incidence of these complications **(Fig. 2)**.

In severe cases of diabetic foot, amputation may be necessary to prevent the spread of infection or gangrene. Risk factors for lower extremity amputation in the diabetic foot include loss of protective sensation, vasculopathy, neuropathy, deformities in foot and callus formation in friction points, restricted articular mobility, overweight, diminished vision, poor glycemic control, use of ill fit footwear, and previous history of foot ulcers or amputations of lower extremities.[9,10]

MANAGEMENT

It includes foot evaluation, relevant investigations, and treatment.[11,12]

Foot evaluation: The first step toward the approach to diabetic foot is a physical examination. Physical examination consists of searching for signs of inflammation or ulceration. Loss of sensation, peripheral pulses, and deformities should also be examined.



FIG. 2: Ulceration over the heel in a diabetic patient.
Courtesy: Dr Kinnor Das

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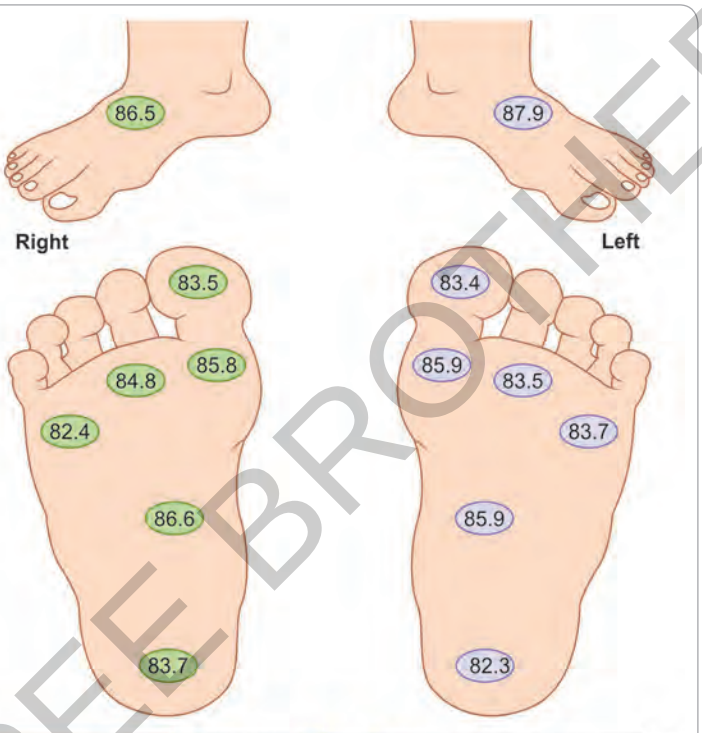
Planter thermal monitoring: Planter soft tissue biomechanics in diabetes patients are altered. Rapid rise of temperature in high pressure zones suggests risk of ulceration. Temperature asymmetry might also signify ulcer risk. With simple tools we can identify those areas. Many researches are going on to devise wearable footwear that will give signals and inputs about planter skin and soft tissue conditions. Here is an example of thermal monitoring in **Figure 3**.



Measurement points	Right foot	Left foot	Difference (°F)
Great toe	83.5	83.4	0.1
I MTH	85.8	85.9	0.1
III MTH	84.8	83.5	1.3
V MTH	82.4	83.7	1.3
Instep	86.6	85.9	0.7
Heel	83.7	82.3	1.4
Dorsum	86.5	87.9	1.4

[Elevated temperature gradients between feet >4°F (>2.2°C) were considered to be 'at risk' of ulceration due to inflammation]

Remarks: Not recorded

FIG. 3: Planter thermal monitoring report showing temperature difference in bilateral planter aspect.
(MTH: metatarsal head)
Courtesy: Dr Surajit Gorai

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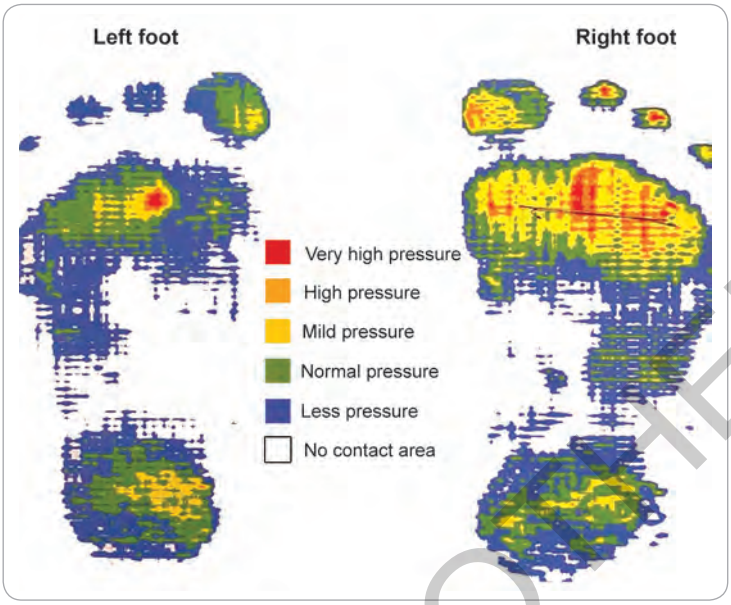

FIG. 4: Planter pressure report showing more pressure over anterior aspect of right foot.
Courtesy: Dr Surajit Gorai

Foot pressure monitoring: Exact assessment of foot pressure monitoring of planter surface can help to determine high risk areas for ulceration. Biomechanics of foot associated with peripheral neuropathy can alter pressure zones of foot leading to high chance of mechanical damage of planter surface. Gait correction, pressure offloading, and footwear change help to prevent dreaded complications. Example of planter pressure report is shown in **Figure 4**.

Monofilament study of sole: It is done to identify peripheral neuropathy.

INVESTIGATIONS

Biochemical investigation: Monitoring the glucose level is fundamental. Other blood tests can check for markers of inflammation or infection, which can indicate the presence of an infection or inflammation in the foot. In case of ulceration, a sample may be taken from the wound for gram stain, culture, and sensitivity testing. This can help identify the microbe causing the infection and determine the most appropriate antibiotic treatment.

Radiologic investigations: Investigations such as X-rays, computed tomography (CT) scans, and magnetic resonance imaging (MRI) can provide detailed images of the bones, joints, and soft tissues in the foot. These studies can help identify any bone infections, abscesses, or other structural problems that may be contributing to foot problems. Doppler ultrasound can be used to detect any aberration in blood circulation in the lower limb.

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Electrophysiological investigation: A nerve conduction study can be undertaken to diagnose any nerve damage or neuropathy and the extent of nerve involvement.

TREATMENT

The International Working Group on the Diabetic Foot (IWGDF) has developed evidence-based guidelines for the prevention and management of diabetic foot problems.[13] The main goals of treatment for diabetic foot are to prevent infection, promote healing, and reduce the risk of amputation. Treatment may involve wound care, offloading, debridement, antibiotic therapy, or surgery.

Offloading: It refers to reducing pressure on the affected foot to promote healing. Offloading can be accomplished with devices such as therapeutic shoes, casts, or braces.

Antibiotic therapy: Antibiotics may be necessary to treat infections in the diabetic foot. Antibiotic therapy should be guided by wound culture results and tailored to the specific bacteria causing the infection.

Surgery: Surgical intervention may be necessary to remove infected tissue, drain abscesses, or reconstruct the foot.

Therapeutic footwear: Available data recommends using therapeutic shoes for diabetic patients to protect the feet and avoid ulceration. Diabetic therapeutic footwear should have a footbed that distributes pressure and relieves the burden on high-risk regions, uppers that protect and alleviate stress on the dorsum while limiting shear motion, and outsoles that limit joint motion and change load distribution.[14]

Adjuvant treatment:

- Granulocyte colony-stimulating factor (G-CSF) may be used in the treatment of diabetic foot infections as an adjuvant. The administration of G-CSF results in the liberation of neutrophil endothelial progenitor cells from the bone marrow and an improvement in the function of neutrophils.[15]
- *Negative pressure wound therapy (NPWT)*: NPWT is a relatively new noninvasive supplemental treatment that drains fluid from open wounds utilizing a sealed dressing and tubing connected to a collecting container under controlled negative pressure and a vacuum-assisted closure (VAC) mechanism. It has been shown that employing subatmospheric pressure dressings, available commercially as a VAC device, is an effective method for accelerating wound healing.[16]

Glycemic control: Optimal glycemic control is essential for the prevention and management of diabetic foot problems.

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Screening and assessment: All patients with diabetes should undergo a foot examination at least once a year to assess their risk for developing diabetic foot.

Prevention: Patients with diabetes should be educated about proper foot care, including daily foot inspections, appropriate footwear, and avoiding smoking. Regular follow-up with healthcare providers is recommended to monitor the progression of the disease and make necessary adjustments in the treatment plan.

These guidelines are designed to provide a standardized approach to the prevention and management of diabetic foot problems. Healthcare providers should work closely with their patients to develop an individualized treatment plan that takes into account the patient's specific needs and circumstances.

CONCLUSION

Someone, somewhere in the globe, loses a limb as a consequence of the problems caused by diabetes every 20 seconds. Millions of diabetic patients across the world are dealing with diabetic foot complications. It is important to understand and diagnose and manage diabetic foot-related complications to avert complications.

Key Points

- Diabetic foot is having a complex etiology superadded with infection.
- Clinical examination of foot helps to detect it early.
- Pressure, temperature, and neuropathy assessment can help to identify high risk zones and can prevent ulceration.
- Modern therapies can treat diabetic foot well and can prevent amputation in many cases.

REFERENCES

1. Alexiadou K, Doupis J. Management of Diabetic Foot Ulcers. Diabetes Ther. 2012;3(1):4.
2. Rossboth S, Lechleitner M, Oberaigner W. Risk factors for diabetic foot complications in type 2 diabetes—A systematic review. Endocrinol Diabetes Metab. 2021;4(1):e00175.
3. Bowering CK. Diabetic foot ulcers. Pathophysiology, assessment, and therapy. Can Fam Physician. 2001;47(5):1007-16.
4. Bandyk DF. The diabetic foot: Pathophysiology, evaluation, and treatment. Semin Vasc Surg. 2018;31(2-4):43-8.
5. Jneid J, Lavigne JP, La Scola B, Cassir N. The diabetic foot microbiota: A review. Hum Microb J. 2017;5-6:1-6.
6. Khanolkar MP, Bain SC, Stephens JW. The diabetic foot. QJM. 2008;101(9):685-95.
7. Pendsey SP. Understanding diabetic foot. Int J Diabetes Dev Ctries. 2010;30(2):75-9.

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8. Rogers LC, Frykberg RG, Armstrong DG, Boulton AJM, Edmonds M, Van GH, et al. The Charcot Foot in Diabetes. J Am Podiatr Med Assoc. 2011;101(5):437-46.
9. Armstrong DG, Lavery LA, Harkless LB. Validation of a Diabetic Wound Classification System: The contribution of depth, infection, and ischemia to risk of amputation. Diabetes Care. 1998;21(5):855-9.
10. Lin C, Liu J, Sun H. Risk factors for lower extremity amputation in patients with diabetic foot ulcers: A meta-analysis. PLoS One. 2020;15(9):e0239236.
11. Wieman TJ. Principles of management: the diabetic foot. Am J Surg. 2005;190(2):295-9.
12. Kalish J, Hamdan A. Management of diabetic foot problems. J Vasc Surg. 2010;51(2): 476-86.
13. Bakker K, Apelqvist J, Lipsky BA, Van Netten JJ; International Working Group on the Diabetic Foot. The 2015 IWGDF guidance documents on prevention and management of foot problems in diabetes: development of an evidence-based global consensus. Diabetes Metab Res Rev. 2016;32(S1):2-6.
14. Cavanagh PR. Therapeutic footwear for people with diabetes. Diabetes Metab Res Rev. 2004;20(S1):S51-5.
15. Cruciani M, Lipsky BA, Mengoli C, de Lalla F. Granulocyte-colony stimulating factors as adjunctive therapy for diabetic foot infections. Cochrane Database Syst Rev. 2013;(8):CD006810.
16. Ji S, Liu X, Huang J, Bao J, Chen Z, Han C, et al. Consensus on the application of negative pressure wound therapy of diabetic foot wounds. Burns Trauma. 2021;9:tkab018.

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Skin-related problems in diabetic patients are plenty such as necrobiosis, xerosis, nonhealing ulcers, and many more termed as diabetic dermopathy. Implications of skin changes are lying in diagnosis as well as management of the disease. Unfortunately, they are not summarized in book from worldwide. This book is a proper reference book on this matter and hope to encompass all aspects such as pathogenesis, all types of lesions, and their management in detail. It will act as reference book for academicians, dermatologist, and medicine and diabetes practitioners.

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Printed in India

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ISBN 978-93-5696-177-7