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## Management of Diabetic Foot Complications: A Multidisciplinary Approach



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### ABSTRACT

Diabetes mellitus is a spectrum of heterogeneous disorders which is one of the rapidly growing chronic diseases in the world. It occurs due to impaired response of insulin action, insulin deficiency, increased glucose production and abnormal fat or protein metabolism. The International Diabetes Federation (IDF) Diabetes Atlas, Seventh Edition, 2015, points out that one in 11 adults have diabetes (416 million), among which nearly half (46.5%) of adults with diabetes are undiagnosed. Diabetic foot ulcers are the most devastating, chronic and costliest complication of diabetes. Diabetic foot ulcers can evoke a galore of complications with lower limb amputation being the dreadful one. It can bring months of hospitalization and enormous expenses. Even an acute wound, if untreated can lead to lower limb amputations. Wound healing is a complex purpose which involves a series of events. Phagocytosis, collagen synthesis and mitogenesis to name a few. Chronic foot ulcers with poor vascularization require aggressive treatments like surgical debridement to prevent foot amputations. Patient awareness programs like diabetic foot training program, foot screening programs and patient counseling techniques can control the complications. Treatment of diabetic foot ulcers by the aid of a multidisciplinary approach is gaining popularity globally. The participation of physician, surgeons, podiatrist, microbiologist nursing staff and paramedics had developed an all around efficacy in patient centered health care.



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## INTRODUCTION

Diabetes mellitus is a spectrum of heterogeneous disorders which is one of the rapidly growing chronic diseases in the world. Diabetes mellitus is characterized by hyperglycemia and intolerance to glucose. It occurs due to impaired response of insulin action, insulin deficiency, increased glucose production and abnormal fat or protein metabolism. Globally diabetes mellitus is significantly contributing to healthcare costs but still in most parts its management is poor. Diabetes is mainly classified into Type 1 diabetes, Type 2 diabetes and gestational diabetes among which type 2 diabetes is the greatest contributor of diabetes with affecting up to 90% of diabetic patients worldwide.

The International Diabetes Federation (IDF) Diabetes Atlas, Seventh Edition, 2015, points out that one in 11 adults have diabetes (416 million), among which nearly half (46.5%) of adults with diabetes are undiagnosed, one in seven births are affected by gestational diabetes 542,000 children have type 1 diabetes, and a person dies from diabetes every 6 seconds. The IDF expects that by 2040, one in 10 adults (642 million) will have diabetes. Among diabetic people, about 75% are from developing as well as underdeveloped countries.

India as we know is the 2<sup>nd</sup> most populated country in the world and has a distinction of having largest number of diabetic patients. In India, its socioeconomic and demographic properties are also contributing to the rapid rise in hyperglycemic persons. India has 61 million of its population estimated to be suffering from diabetes which constitutes about 15% of total diabetic population in the world. The diabetic population of India is expected to rise up to 100 million by 2030. It indicates that every 5<sup>th</sup> diabetic person will be an Indian. When compared to the urban areas, rural outskirts are exhibiting less prevalence to diabetes. Obesity, sedentary lifestyle and lack of physical activities are few of underlying causes of rapid rise in number of diabetic patients in urban areas. The studies in India prove that central obesity and insulin resistance are the major reasons behind diabetes of Indians.

In Kerala, a considerably high diabetic prevalence has been identified. Studies in urban areas have exhibited 16.7% of diabetic prevalence when compared to 4.3% of rural areas. The differences in rural and urban areas are indications of sedentary lifestyles, mental stress, dietary patterns and absence of physical activities in urban areas. It is expected to rise rapidly as Kerala is the state with highest number of elderly according to census 2011. The most urbanized cities of Kerala, Ernakulam and Trivandrum had exhibited prevalence of 19.5%

and 16.3% respectively. It shows how lifestyle in urban areas have contributed heavily to diabetic Mellitus. A study conducted in southern Kerala about prevalence of Type 2 diabetes based on geographical conditions have revealed that urban areas (12.4%) have more diabetic prevalence than midlands (8.5%) and coastal areas (2.7%). In Kerala, the studies have indicated that most of diabetic deaths are due to glucose intolerance. Recent studies conducted in India by sree chitra tirunal institute of medical sciences have identified that Kerala tops the list of diabetic prevalence in India with 19.4% of population with diabetic patients. In Kerala, 66.7% of people in the age group of 45-69yrs are suffering from diabetes or prediabetes. Recent conclusions identify that lower as well as higher economic groups have been equally vulnerable to diabetes.

### **Burden of diabetes mellitus**

Diabetes mellitus along with its complications creates a high burden on individuals and society. Diabetes affects a person's productivity and morbidity and can lead to premature mortality. It creates a burden of indirect and direct health care costs on the patient. Medical expenditures of diabetic persons are much higher than that of those not affected by diabetes mellitus. The mean diabetic expenditure of a person according to IDF is 68USD. The world health organization predicted that India will lose a national income of 336M USD on treatment of diabetes and cardiovascular diseases in next 10 years.

### **Diabetic complications**

#### **Diabetic neuropathy**

Progressive diabetes can result in damage or destruction of nerve cells leading to a disorder termed as peripheral neuropathy. Peripheral neuropathy can be mononeuropathy where only a single nerve will be damaged or polyneuropathy which occurs when multiple nerves are destroyed. Peripheral neuropathy as a resultant of diabetes shows symptoms like pain, numbness and even loss of sensation on extremities.

#### **Diabetic retinopathy**

Prolonged blood sugar levels can lead to damage of retinal blood vessels thereby resulting in impairment of vision. People with hyperglycemia for significant number of years are

vulnerable to diabetic retinopathy. In some cases, growth of abnormal blood vessels on retinal surface and macular oedema can lead to diabetic retinopathy.

### **Peripheral Vascular disorders**

Peripheral vascular disease or peripheral artery disease is a blood disorder which produces a condition of narrowed blood vessels, spasms and altered blood flow. Prolonged diabetes, smoking and ageing are the major risk factors behind PVD. Peripheral vascular disease is characterized by pain and fatigue on the legs. Inflammation plaques and tissue damage can block the arteries and veins and thereby result in PVD.

### **Diabetic foot disorders**

Diabetic foot ulcers are the most devastating, chronic and costliest complication of diabetes. DFU as defined by WHO is “an ulceration of foot associated with different grades of ischemia, neuropathy and infection”. If diabetic foot is not treated properly it can lead to its extremely devastating complication, that is, lower limb amputation. Diabetic foot ulcers can evoke a galore of complications with lower limb amputation being the dreadful one. It can bring months of hospitalization and enormous expenses.



**Fig 1.1 Grade 2 and grade 3 diabetic foot ulcers**

## Pathophysiology of foot ulcers

Even an acute wound, if untreated can lead to lower limb amputations. A wound can be defined as a tear in the epithelial integrity of skin. Sometimes it can go deep into the tissues, subcutaneous fat and even the bones. Wound healing is a complex process which involves a series of events. Phagocytosis, collagen synthesis and mitogenesis to name a few. Extracellular matrix synthesis and remodeling helps the wound to restore its normal anatomical structure. In hyperglycemic patients, the wound healing process is affected by the hyperosmotic effects of DM. Another factor that retards wound healing is wound hypoxia. The microvascular and macrovascular properties of diabetes mellitus hinder the wound healing.

## Risk factors

Foot infections, age, sex, smoking habits, race and progressive hyperglycemic levels are the underlying risk factors of diabetic foot ulcers. History of wounds, osteomyelitis, nonhealing gangrenous ulcers are also risk factors in diabetic foot ulcers.

## Classification of foot ulcers

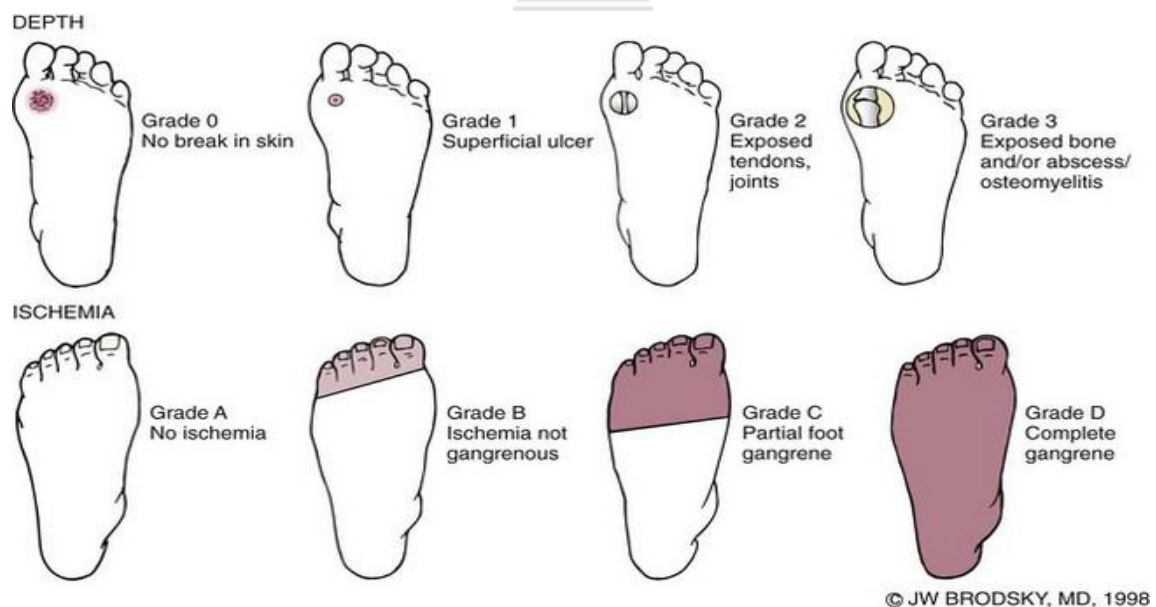


Figure 1.2 University of Texas diabetic foot ulcer classification system

### **Wagner Meggit system of foot ulcer grading**

Wagner Meggit system assessed the wound depth and presence of gangrene for classification of ulcers. Presence osteomyelitis was a significant factor in grading of ulcers. They classified the foot ulcers into six grades,

- Grade 0(pre or post operative wounds)
- Grade 1(Partial/fully thickened ulcers)
- Grade 2(affecting tendon or capsule)
- Grade 3(Deep wound with ischemia)
- Grade 4(partial wound gangrene)
- Grade 5(complete foot gangrene)

### **Treatment of foot infections**

#### **Early diagnosis**

A multidisciplinary approach with regular foot care and diagnosis can ensure an effective foot care system. The nursing staffs and the physicians can motivate the patients to engage in regular foot check up and prevent chronic ulcerations.

#### **Wound dressing**

The therapeutic strategies like use of acrylics, alginate dressings, foam adhesives and hydrogels. These dressings were of significant roles in promoting wound healing. Hydrocolloids promoted autolytic debridement and enhanced the development of polyurethane films. Foam adhesives impart iodine and silver to the wounds but sometimes promote macerations. Sodium hypochlorite and silver sulphadiazine is used along with povidone-iodine to ensure wound care.

#### **Treatment of microbial infections**

The infectious wounds were assessed for presence of microbial infections. The isolated specimens were analyzed and different bacterial types were found. Staphylococcus aureus

was the most predominant gram positive bacteria among infections. The gram negative bacterias isolated were E. Coli and Pseudomonas aureginosa. The studies suggest that cefoperazone sulbactam, amoxicillin and clavulanate were the best in therapy. For the treatment of MRSA, it was indicated that vancomycin produced the best results. A well structured antibiotic pattern is important in treatment and management of DFI.

### **Surgical debridement in chronic complications**

Chronic foot ulcers with poor vascularization require aggressive treatments to prevent foot amputations. Surgical debridement was done by detaching ulcerated tissues and vascularization was ensured. The purulents and the edema formed were removed surgically and nonvital tissues were debrided and thereby promoting fusion of joints. They can be categorized into mechanics, enzymatics, biologics, lithics and surgery. Calcanectomy is another mode of amputation where distal flap and plantar fat pad can be preserved. It is a below knee amputation technique that is used in conditions like calcaeo-osteomyelitis.

### **Hyperbaric oxygen therapy**

Hyperbaric oxygen therapy helps in wound healing by diffusion of oxygen into the ulceration. The applied pressure will be kept above the atmospheric pressure. The oxygen therapy promoted fibroblast proliferation, formation of blood vessels and bacteriocidal activities. Even though HBO therapy was relatively safe it expressed adverse effects like middle year bartaruma and reversible myopia.

### **Wound bed approach**

The wound bed preparation is an important strategy in management of diabetic foot ulcers. It involves approaches like tissue management, control of inflammation and infection, moisture balance and epithelial advancement. The wound bed preparation approach has helped in potentiating the healing ability of chronic diabetic ulcers. The method had helped in treating the most recalcitrant of ulcers and prevented the unwanted complications and ultimately diabetic foot amputations as well as mortality.

### **Management of foot ulcers**

Poor knowledge on diabetes and its complications emphasizes on the need for patient education on foot ulcers and need for aggressive ulcer care. Awareness should be created

about administration of medications, lifestyle modifications and identification of foot ulcer symptoms. Patient awareness programs like diabetic foot training program, foot screening programs and patient counseling techniques can control the complications. Foot care centers and diabetic clinics should be set up for regular screening practices.

Religious practices, walking barefoot and bites from animals are few of the cultural factors in India which complicates foot ulcers. The selection of footwear in ulcerated patients gains massive popularity due to its ability in management of risk factors. The selection of shoes and socks depends upon protecting the soles from wound punctures and prevention of hallux rigidus.

## CONCLUSION

Diabetes and its complications create an invasive burden among the patients. Diabetic foot ulcers result in lower extremity amputation and thereby deteriorate the social and financial well being of a patient. Early diagnosis and foot screening practices are significant in control and management of foot disorders. The risk factors should be identified and advanced therapeutic modalities should be adopted. Surgical debridement, selection of suitable antibiotic regimen, foot screening practices, hyperbaric oxygen therapy and regular wound dressing are the advanced foot ulcer modalities.

Treatment of diabetic foot ulcers by the aid of a multidisciplinary approach is gaining popularity globally. The participation of physician, surgeons, podiatrist, microbiologist nursing staff and paramedics had developed an all around efficacy in patient centered health care. The selected team should be provided with training and support by the aid of audiovisual packages in patient education. A multidisciplinary approach can motivate the patients into self care and thereby extend health care activities.

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