

**A STUDY ON OUTCOME OF DIABETIC FOOT ULCERS
BASED ON WOUND SEVERITY SCORE**

AN OBSERVATIONAL STUDY

Dissertation submitted to

**THE TAMILNADU
Dr. M.G.R. MEDICAL UNIVERSITY**

*In partial fulfillment of the requirement
For the award of*

M.S. GENERAL SURGERY - BRANCH – I



THE TAMIL NADU Dr. M.G.R. MEDICAL UNIVERSITY

MADRAS MEDICAL COLLEGE, CHENNAI.

MAY - 2020

BONAFIDE CERTIFICATE

This is to certify that the dissertation entitled “**A STUDY ON OUTCOME OF DIABETIC FOOT ULCERS BASED ON WOUND SEVERITY SCORE**” is a bonafide record of original work done by **Dr. P. BAGADEESH** under the guidance of **Dr. V. RAMALAKSHMI, M.S.(General Surgery)**, Professor, Institute of General Surgery, Madras Medical College in partial fulfillment of the requirements for MS Degree in General Surgery Branch I examination of the Tamil Nadu Dr.MGR Medical university to be held in May 2020. The period of post graduate study and training from MAY 2017 to MAY 2020.

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DECLARATION

I, Dr.P. BAGADEESH, Post Graduate, Institute of General Surgery, Madras Medical College solemnly declare that this dissertation “**A Study on Outcome of Diabetic Foot Ulcers based on Wound Severity Score**” was prepared by me at Institute of General Surgery, Madras medical college, Chennai, under the guidance and supervision of **Dr. V. RAMALAKSHMI, M.S.(General Surgery)**, Professor, Institute of General Surgery, Madras Medical College, Chennai.

This dissertation is submitted to **The Tamil Nadu Dr.M.G.R. Medical University, Chennai** in partial fulfillment of the University regulations for the award of the degree of **M.S. (General Surgery)**.

Place: Chennai
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I start my thesis in the name of almighty God. I thank him for giving me the privilege to learn from such eminent professors and assistant professors in my department. I express my sincere thanks to Professor **DR. JAYANTHI, M.D., FRCP (Glas)**, The Dean, Madras Medical College for allowing me to conduct the study using the available facilities.

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(Dr. P.BAGADEESH)

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PROFORMA

Name

Age

Sex

In patient no

History

1.Presenting complaints

2.Personal history

3.Past history

4.Family history

General examination

Local examination

1.Ulcer site

2.Ulcer number

3.Probing to bone

4.Palpable pedal pulse

Blood investigations

1.Hemoglobin

2.FBS, PPBS

3.Urea

4.Creatinine

Procedure done

Post operative events

Follow up

INFORMATION SHEET

**TITLE: "ASTUDY ON OUTCOME OF DIABETIC FOOT ULCERS
BASED ON WOUND SEVERITY SCORE"**

Name of Investigator:

Name of Participant:

Purpose of Research: To study the outcome of diabetic foot ulcers

Study Design: Prospective Observational Study

Study Procedures: Patient will be subjected to routine investigations, clinical examination, operative procedure as indicated and the data analysed.

Possible Risks: No risks to the patient

Possible benefits

To patient : Early diagnosis of the severity of disease permits early treatment which in turn improves survival rates, mortality and morbidity.

To doctor & to other people: If this study gives positive results, it can help develop a scoring system which can help in predicting the outcome of the diabetic foot ulcers.

Confidentiality of the information obtained from you: The privacy of the patients in the research will be maintained throughout the study. In the event of any publication or presentation resulting from the research, no personally identifiable information will be shared

Can you decide to stop participating in the study: Taking part in this study is voluntary. You are free to decide whether to participate in this study or to withdraw at any time

How will your decision to not participate in the study affect you: Your decision will not result in any loss of benefits to which you are otherwise entitled.

Signature of Investigator

Signature of Participant

Date :

Place :

PATIENT CONSENT FORM

Study Detail : **“ASTUDY ON OUTCOME OF DIABETIC FOOT
ULCERS BASED ON WOUND SEVERITY SCORE**

Study Centre : Rajiv Gandhi Government General Hospital, Chennai.

Patient's Name :

Patient's Age :

In Patient Number :

Patient may check () these
boxes

I confirm that I have understood the purpose of procedure for the above study. I have the opportunity to ask question and all my questions and doubts have been answered to my complete satisfaction.

I understand that my participation in the study is voluntary and that I am free to withdraw at any time without giving reason, without my legal rights being affected.

I understand that sponsor of the clinical study, others working on the sponsor's behalf, the Ethics committee and the regulatory authorities will not need my permission to look at my health records, both in respect of current study and any further research that may be conducted in relation to it, even if I withdraw from the study I agree to this access. However, I understand that my identity will not be revealed in any information released to third parties or published, unless as required under the law. I agree not to restrict the use of any data or results that arise from this study.

I agree to take part in the above study and to comply with the instructions given during the study and faithfully cooperate with the study team and to immediately inform the study staff if I suffer from any deterioration in my health or well being or any unexpected or unusual symptoms.

I hereby consent to participate in this study

I hereby give permission to undergo complete clinical examination and diagnostic tests including hematological, biochemical, radiological tests and to undergo treatment

Signature/thumb impression

Patient's Name and Address:

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INTRODUCTION

The world health organization (WHO) defines the diabetic foot as an infection, ulceration or destruction of deep tissue associated with neurological abnormalities and various degrees of peripheral vascular disease in the lower limb. The diabetic foot is a syndrome rather than a disease.

In India 30 million people are diabetic and by the year 2025 predicted to have 57 million. Presently India is known as the diabetic capital of the world. Every year 3 to 7 % of diabetics suffer from foot lesion for the first time. Foot ulcers occur in approximately 15% of diabetic peoples, which accounts for 25% of all hospital admissions. Foot ulcers are a common complication of diabetic patients and represent a major source of morbidity. More than 60% of lower extremity amputations are seen in diabetes and 70% of healed ulcers are estimated to reoccur in next 5 years.

In the years between 1958 and 1993 the number of people diagnosed with diabetes multiplied fivefold. By the year 2025 it is estimated that this figure would increase to more than 300 million globally. In the year 2002 globally 82,000 diabetes has undergone amputations. Therefore, by taking simple precautionary measures in diabetic peoples, foot complications can be prevented. If the person has already developed an ulcer recognizing it at the earliest and by proper treatment of the ulcer the limb can be saved.

Foot is an integrated complex of bones arranged in beautiful arches. An aponeurosis nicely bow stringing the arches, long tendons traversing the leg that guy-rope the foot

and the long nerves and artery that branch and reach every miniscule of the foot. The foot and its arch help one walk with grace and maintain the equilibrium of the biped man. In diabetic foot this foot arch is lost and thus the equilibrium. Peripheral neuropathy, peripheral vascular disease, abnormal plantar pressure load, and infection are accepted as the main risk factors for the development of diabetic foot ulcers and amputations. Since diabetic foot wounds and amputations account for a significant part of diabetic related health care costs, several attempts have been made to establish classification systems that help assess the severity of the disease.

Various scoring systems and classification of foot ulcer exists. Different parameters are incorporated in these scoring systems such as ulcer depth, site of ulcer, depth of the ulcer, infection, neuropathy, arterial insufficiency. All these scoring systems are complex and do not predict long term outcome in the patients. Diabetic ulcer severity score is easy enough to be applied in day to day clinical practice and it is one of the latest wound based classification which needs to be validated in our setup.

REVIEW OF LITERATURE

A study conducted by Beckert et al, was a prospective study done with 1000 patients with the diabetic foot ulcer. In this study score 0 had no risk of major amputation, while patients with a score of 1 had a 2.4%, patients with a score of 2 had a 7.7%, patients with a score of 3 had a 11.2% and patients with a score of 4 had a score of 3.8%. High DUSS scoring patients were more likely to undergo surgery and amputation.

In the more than 10 year follow up study conducted by Margoilis et al a cohort of 24.616 individuals with a diabetic neuropathic foot ulcer treated with a multicenter wound care network were studied total of 1653 (6.7%) individuals had an amputation and 46.3% of these amputations were of a toe or ray. The percentage of those who had an amputation varied from 5.6% to 8.4% of those who had an amputation, the percentage that had a minor amputation increased over time from 40% in the earlier year to more than 60% in the later years of observation.

Among various studies on diabetic foot ulcer higher costs were observed among younger patients. Patients with inadequate vascular status, and patients whose ulcer progressed to a higher severity level. A Swedish study investigated costs for managing deep foot infections in 220 patients and categorized them according to clinical outcome. Mean healing time for patients who did not need an amputation was 29 weeks for those who required minor or major amputation. It was 52 weeks and 28 weeks respectively.

A study conducted by Shashikala C. K. et al found that overall 52 of 100 (46%) people had amputations. Major amputation both below and above knee was done for 25% of patients in this study. Minor amputation both toe or fore foot amputation was done in 217% of patients.

In this study of Kaplan Meier analysis, the probability of healing with score 0 was 95%, 91.6% with score 1, 85.7% with score 2, 52.6 % with score 3, 28.5% with score 4. In this study there was 95% probability of healing for score 0 decreasing to 28.5% with score 4.

A study conducted by V. Harikumar et al concluded that most common ulcers were of DUSS score of 3. Major amputation was done in 15 (30%) patients and minor amputation in 12 (24%) patients. Toe amputation was done in total of 15 patients. None of the patients had fore foot amputation. Below knee amputation was done in total of 11 (22%) patients. Majority of the foot ulcers among study population with DUSS sore 0, 1 and 2 healed by primary intention or skin grafting i.e., 1 (100%), 3 (75%) and 4(46.15%) respectively. However, among those with score 3 and 4 majority required amputation i.e., 14 (70%) and 10 (83.33%) respectively. The probability of healing with DUSS score 2, 3, and 4 were 30%, 16% and 7% respectively. The mean time of healing was 77 days. The mean time of amputation was 100 days.

A study conducted by N. J. ShashiKiran found that the most common age group affected with diabetic foot was between 26 – 50 years. Males accounted for 56.7% of patients. Most commonly ulcers were DUSS score of 3 followed by Score 2

Overall 99 of 180 people had amputations in this study. Major amputation was done for 19.44% of patients. Minor amputation was done in 35.6% of patients in this study. 10% with score 1 had amputations, 25.5% with score 2 had amputation, 90.6% with score 3 had amputation, 100.0% with score 4 had major amputation in this study. Amputations were more common in patients with DUSS score of 3 in this study. The probability of healing with score 0 was 90%, 90.6% with score 1, 74.5% with score 2, 34% with score 3 and 23.5% with score 4.

History

In the first half of this century serious foot problems in diabetic patients were described in standard text books under the general description of 'diabetic gangrene'. Inevitably with the passage of time and a greater understanding of the diabetic process, changes in clinical classification and description have occurred. Choyce' in 1923 regarded diabetic gangrene as senile gangrene due to arteriosclerosis, but the condition was rendered more severe by the lowered vitality of the tissues in a diabetic subject. No mention is made of the use of insulin in its management as at that time insulin was not universally available. A decade later in 1933, Rose and Carless' emphasized the importance of impaired resistance of the tissues to bacterial invasion, but considered that sclerosing endarteritis and peripheral neuritis played an important part. Aird in 1957 considered that in young patients, the diabetic gangrene was essentially an infective process occurring in tissue of low bacterial resistance, while in older subjects the cause was mainly arteriosclerotic. Of more recent date, Bailey and Love in 1965 give equal importance to neuropathy, arteriosclerosis and infection.

There is wide variation of the clinical presentation of gangrene in diabetics. In elderly patients the foot was cold and pale and the toes became dark and painful, and with the passage of time the blackened and shrunken digits tended to separate and ultimately the wound healed. The condition was called as 'dry' gangrene. On other hand a much more progressive and dangerous condition could occur. The foot became swollen and dusky in appearance and patches of gangrene occurred in the skin and ulcers developed on the sole of the foot and in the heads of the metatarsal bones. Though pain was not a marked feature, the condition becomes very toxic when the infection spread in the foot and leg. Without effective treatment the condition leads to high mortality. This condition was regarded as wet gangrene. It was realized that 'dry' gangrene could progress to wet gangrene though it was rare for wet gangrene to become 'dry'. Treatment varied according to the type of gangrene.

In cases of dry gangrene where only a single digit was involved, local removal could often be successful. If the foot was involved, a below-knee amputation was indicated, though necrosis of the amputation flaps was liable to occur. In cases of wet gangrene or with deep ulcers of the sole, above-knee amputation was considered mandatory.

EPIDEMIOLOGY

Annually 3 to 7 % of the people with diabetes suffer from the foot lesion for the first time. Foot ulcers approximately occur in 15% of people with diabetes which accounts for 25% of all the hospital admissions with the hospital stay approximately 605 longer than the stay for other causes and the risk of amputation is 15 to 40 times greater in diabetes than in others. About more than 50% of the nontraumatic amputations are mainly due to diabetes and are associated with high rates of mortality, re amputation

and contra lateral limb amputation. Incidence of foot ulcer accounts for 1 to 4%, toe amputation 2.6%, below knee amputation 1.6% and the prevalence of diabetic foot in India was 5.3% to 10.5%.

CLASSIFICATION OF DIABETIC FOOT ULCERS

Wagner Classification :

The Wagner diabetic foot ulcer classification system assesses ulcer depth and the presence of osteomyelitis or gangrene by using the following grades.

Grades:

- 0 - Intact Skin
- 1 - Superficial ulcer of skin or subcutaneous tissue
- 2 - Ulcers extend into tendon, bone or capsule
- 3 - Deep ulcer with osteomyelitis or abscess
- 4 - Partial foot gangrene
- 5 - Whole foot gangrene

The University of Texas Diabetic Foot Ulcer classification System:

The University of Texas system grades diabetic foot ulcers by depth and then stages them by the presence or absence of infection and ischemia.

- 0 - Pre or post ulcerative site that has healed
- 1 - Superficial wound not involving tendon, capsule or bone
- 2 - Wound penetrating to tendon or capsule
- 3 - Wound penetrating bone or joint

Within each wound grade there are four stages

Stage A – Clean Wounds

Stage B – Non-ischemic infected wounds

Stage C – Ischemic noninfected wounds

Stage D – Ischemic infected wounds.

Stess and Hetherington Classification

This system divides patients into three categories

- Category 1 → includes the patient with lack of protective threshold, but with no ulcer and no bony destruction
- Category 2 → Includes patients in whom active bone destruction is occurring
- Category 3 → Comprises ulcerated patients with or without bony deformity

Ulcers in this system are sub divided as fundamental or complicated. This classification system does not address vascular insufficiency, nor does it take into account presence or absence of infection.

Treatment based Diabetic Foot index Armstrong:

- Category 0 - Minimal pathology
- Category 1 - Insensate foot
- Category 2 - Comprises ulcerated patients with or without bony deformity
- Category 3 - Demonstrated pathology

- Category 4 - Insensate injury
- Category 4A - Neuropathic ulceration
- Category 4B - Acute Charcot's arthropathy
- Category 5 - Infected diabetic foot
- Category 6 - Devascularised foot

Diabetic Foot Infection Guidelines (DFIG):

- Category 1 → Uninfected wound without purulence or any manifestation or inflammation
- Category 2 → Mild: manifestation of inflammation
- Category 3 → Moderate: Infection in a patient who is systemically well and metabolically stable
- Category 4 → Severe infection in a patient with systemic toxicity or metabolic instability

Simplistic Classification by Frykberg

1. Neuropathic
2. Ischemic
3. Neuro-ischemic

Diabetic Ulcer Severity Score (DUSS)

This scoring system was developed by Beckert (2006). Beckert et al categorized diabetic foot ulcer according to a severity score ranging from 0 – 4 using wound based parameters.

Palpable pedal pulse	Present = 0	Absent = 1
Probing to bone	No Probing = 0	Yes = 1
Ulcer location	Toe = 0	Foot = 1
Number of ulcers	Single = 0	Multiple = 1

Diabetic ulcer severity score (DUSS) was calculated by adding these separate grading to a theoretical maximum of 4.

Various wound classification systems are used that attempt to encompass different characteristics of an ulcer like site, depth the presence of neuropathy, infection and ischemia etc. Peripheral vascular disease, infection and increasing wound depth are usually associated with poor clinical outcomes the progressive cumulative effect of these comorbidities contributes to a greater likelihood of a diabetic foot ulcer leading to a lower limb amputation.

DUSS (Diabetic Ulcer Severity Score) have found that healing was independently associated with peripheral arterial disease, ulcer depth and site and ulcer number. Four clinically defined parameters namely palpable pedal pulses, probing to bone, ulcer location and presence of multiple ulcerations were assessed. A new diabetic ulcer severity score (DUSS) was created from these parameters. A lower DUSS score was strongly association with healing.



DUSS – 1 Single ulcer present on foot with palpable pulse, with no bone probing



DUSS – 2 Single ulcer over lateral aspect of foot with bone probing and palpable pedal pulses



DUSS – 3 Ulcer present over dorsum of foot with bone probing and absent pulse



DUSS – 4 Multiple ulcer over sole of foot with absent pulse and bone probing

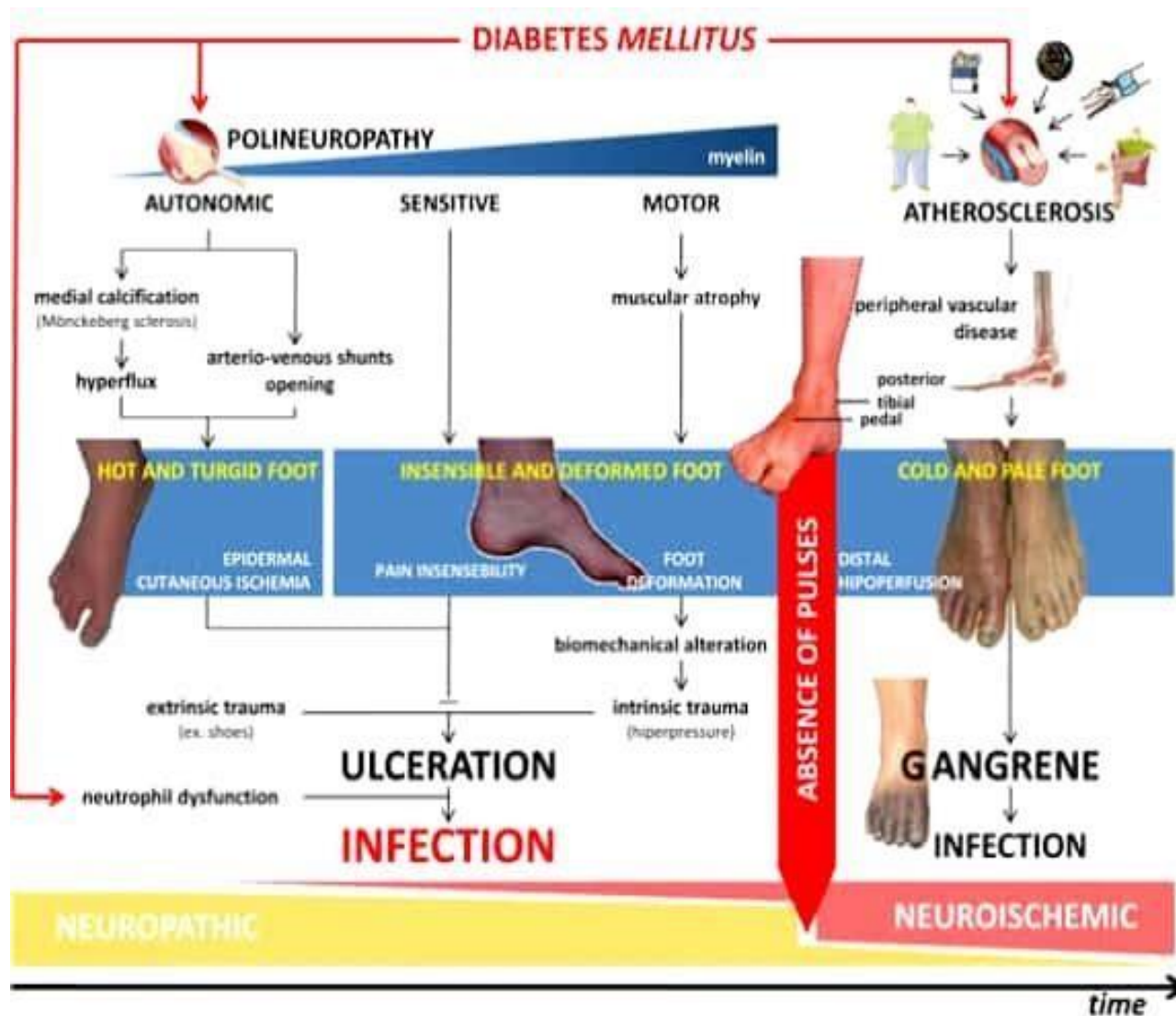
PATHOLOGY

The pathophysiology of diabetic foot ulcers has neuropathic, vascular and immune system components, these all show a base relationship with the hyperglycemic state of diabetes. Because of hyperglycemia, oxidative stress occurs on nerve cells which leads to neuropathy. Additional nerve dysfunction follows from glycosylation of nerve cell proteins leading to further ischemia. Motor, autonomic and sensory components of neuropathic foot ulcers are due to these cellular changes. Imbalance of flexors and extensors, anatomic deformities and eventual skin ulcerations are due to damage to motor neurons of the foot musculature. Impairment of sweat gland function occurs due to damage of autonomic nerves and also the foot may develop decreased ability to moisturize skin, leading to epidermal cracks and skin breakdown. Usually patients may not notice foot wounds because of decreased peripheral sensation. Because the blood supply required to heal a diabetic foot ulcer is greater than that needed to maintain intact skin, chronic ulceration can develop.

Vascular changes occur in diabetic foot ulcers were due to hyperglycemia induced changes in the peripheral arteries of the foot and begin on the cellular level. Increase in plasma thromboxane A2 levels and decrease in vasodilators are due to endothelial cell dysfunction. This leads to vasoconstriction and plasma hyper coagulation in peripheral arteries leading to ischemia and increased risk of ulceration.

Immune changes include reduced healing response in diabetic foot ulcers. There is an inhibition of healing due to increased T lymphocyte apoptosis, which was observed in patients with diabetic foot ulcers

Hyperglycemia leads to non-enzymatic cross-linking of collagen. This makes their connective tissue stiffer. So, they get stiff joints and tight Achilles tendons. Stiff joints and deformities such as hammer toes and hallux valgus leads to ulceration due to high pressure points on foot.



PRACTICAL ASSESSMENT

This can be divided into three parts

- History
- Examination
- Investigations

HISTORY

Every attempt should be made to encourage the patient to be open and non-defensive;

the history can be divided into the following sections:

- Presenting complaint
- Past foot history
- Diabetic history
- Past medical history
- Family history
- Drug history
- Psychosocial history.

PRESENTING COMPLAINT

Some patients are usually asymptomatic due to neuropathy. The presenting complaints are usually one of the following

- Skin breakdown - ulcer
- Swelling
- Colour change of the skin
- Pain.

PAST FOOT HISTORY

- Previous presence of the ulcers and treatment taken
- Amputations if any,
 1. Major amputation
 2. Minor amputation
- Peripheral angioplasties
- Peripheral arterial bypasses.

DIABETIC HISTORY

- Type of diabetes 1 or 2
- Diabetes duration
- Treatment of diabetes
 1. Insulin or
 2. Oral hypoglycaemic agents

PAST MEDICAL HISTORY

- Serious illness if any (example- cancer, rheumatoid arthritis, etc.)
- Accidents
- Injuries
- Hospital admissions
- underwent any Operations.

DRUG HISTORY

- Any drugs taken presently
- Known allergies

FAMILY HISTORY

- Diabetes in family members
- Other serious illness

- Cause of death of first and second degree relatives.

PSYCHOSOCIAL HISTORY

- Occupation of the patient
- Number of cigarettes smoked per day
- Amount of alcohol taken per day
- Psychiatric illness
- Home circumstances

Type of accommodation

Lives alone

Lives with relatives or friends.

EXAMINATION

The examination should be performed systemically and it consists of five parts

- Inspection
- Palpation
- Neurological assessment
- Footwear assessment
- General examination

INSPECTION

Systematically the foot should be examined first the right and then the left, including dorsum, sole, lateral and medial border, heel back, malleolus and interdigital space of the toes. The following should be assessed,

- Skin
- Callus
- Nails

- Swelling
- Deformity
- Color
- Necrosis
- Limited joint mobility

SKIN

The general features of the skin should be assessed, especially look for the skin breakdown. The skin is dry and fissured with prominent dilated veins in neuropathic foot. In ischemia and neuropathy hair loss was present. Thin, shiny and wrinkled skin was present in ischemia due to atrophy of the subcutaneous tissue. The classical sign of skin breakdown is the foot ulcer. Abrasion, fissures and bullae are the first sign of skin breakdown. Look for other skin lesions on the leg as well as the foot including,

- Necrobiosislipoidicadiabeticorum
- Diabetic dermopathy – shin spots



Fissures over the sole of foot



Necrobiosis lipoidica diabetorum over dorsum of foot

CALLUS

These are thickened areas of keratosis which develop at the sites of high pressure and friction. Callus forms diffuse plaques. Hemorrhage within the callus is an important cause of ulceration.



Callus over sole of foot

NAILS

Nail and nail bed inspection is very important. Periungual tissues is the common site of ulceration. The following should be assessed,

- Nail structure
- Nail bed colour
- Nail abnormalities
- Signs of nail infection

SWELLING

The major factor predisposing to ulceration is the swelling of the foot and often exacerbates a tight fit inside poorly fitting shoes. It also impairs the healing of already established ulcers. Swelling may be bilateral or unilateral. It may involve the foot or be limited to the toes.

Causes of bilateral foot swelling include:

- Cardiac failure
- Renal impairment secondary to diabetic nephropathy
- Chronic venous insufficiency
- Neuropathic edema secondary to diabetic neuropathy
- Primary lymphoedema

Causes of unilateral foot swelling are usually associated with local pathology in the foot or leg. These include:

- Infection, when it is usually associated with erythema and a breakdown in the skin
- Charcot foot (a unilateral hot, red, swollen foot; sometimes the swelling can extend to the knee)
- Gout, which may present as a hot, red, swollen foot

- Trauma, fracture, muscle or tendon rupture, often associated with bruising
- Deep vein thrombosis
- Venous insufficiency
- Secondary lymphoedema commonly due to the malignancy
- Common peroneal nerve palsy
- Localized collection of pus or blood in the foot, which may present as a fluctuant swelling
- Revascularization of a limb.

Swelling of the toe can be due to:

- Trauma
- Fracture
- Soft tissue infection
- Osteomyelitis
- Gout
- Charcot toe.

DEFORMITY

The common deformities include:

- Pes cavus
- Fibrofatty padding depletion (FFPD)
- Hammer toes
- Claw toes
- Hallux valgus
- Charcot foot
- Deformities related to the previous trauma and surgery

COLOUR

It is important to observe the color of foot including the toes. Color changes may be localized or diffuse. The Common color changes are red, blue, white or black.

Causes of the red foot

- Cellulitis
- Critical ischemia, especially on dependency –dependent rubour
- Charcot foot
- Gout
- Burn or scald.



Cellulitis – dorsum of foot

Causes of the red toe

- Cellulitis
- Osteomyelitis
- Ischemia
- Gout
- Chilblains
- Dermatitis/eczema.

Causes of the blue foot

- Cardiac failure
- Chronic pulmonary disease
- Venous insufficiency (often with the brownish pigmentation—haemosiderosis).

Causes of the blue toe

- Severe infection
- Ischemia.

The foot may have a pale white appearance in severe ischemia, especially on elevation. In acute ischemia, the foot is pale, often with purplish mottling.

NECROSIS

The areas of necrosis and gangrene can be identified by the presence of black or brown devitalized tissue. Such tissue may be wet or dry.

Causes of the black toe

- Severe chronic ischemia
- Acute ischemia
- Emboli
- Bruise
- Blood blister
- Shoe dye
- Application of henna
- Tumour (melanoma).

PALPATION

Palpation of the diabetic foot should be done to assess

- Pulses
- Foot temperature
- Edema
- Crepitus

PULSES:

The ischemia of the foot is assessed by the palpation of the pulses.

The dorsalispedis pulse is palpated by using the index, middle and ring finger together, lateral to the extensor hallucis longus tendon on the dorsum of the foot.

The posterior tibial pulse is palpated below and behind the medial malleolus



Palpation of the dorsalispedis artery



Palpation of the posterior tibial artery

TEMPERATURE OF THE FOOT

By using the back of the hand skin temperature is compared between the both feet.

Local rise of temperature is due to inflammation which may be due to infection, fracture, charcot's osteoarthopathy or soft tissue trauma. Causes of the increased temperature includes,

- Cellulitis
- Charcot foot
- Gout
- Deep vein thrombosis
- Venous insufficiency

Causes of cold foot

- Acute ischemia
- Chronic ischemia
- Cardiac failure

EDEMA: Edema suspected on inspection can be confirmed by gentle digital pressure applied for a few seconds.

CREPITUS: Very occasionally palpation may reveal gas in tissues as a fine crackling sensation.

NEUROLOGICAL ASSESSMENT

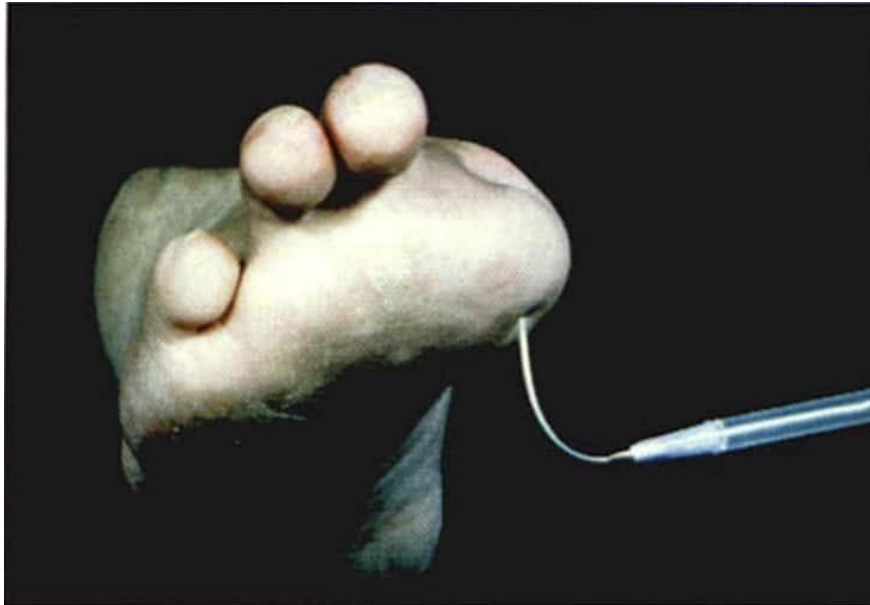
Inspection will usually reveal signs of motor and autonomic neuropathy but sensory neuropathy must be detected by a sensory screening test or a simple sensory examination.

Motor neuropathy: The classical sign of a motor neuropathy is a high medial longitudinal arch, leading to prominent metatarsal heads and pressure points over the plantar forefoot and the complicated assessment of motor power in the foot or the leg is not usually necessary, but it is advisable to test the dorsiflexion of the foot to detect a foot drop secondary to a common peroneal nerve palsy and which is usually unilateral and will affect the patient's gait.



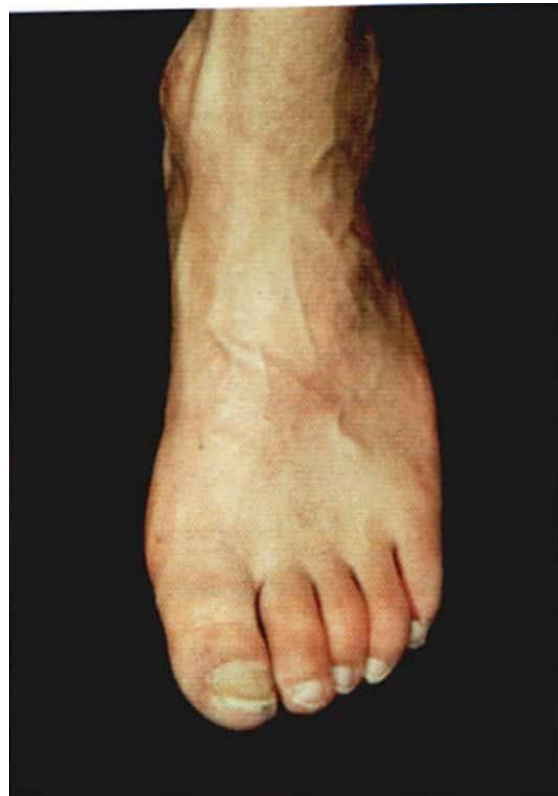
Neuropathic foot features – high medial longitudinal arch and claw toes

Sensory neuropathy: The patients with sensory neuropathy has no pain even when the patient had significant foot ulcer. Painless ulcer is the definite evidence of the peripheral neuropathy. It is very important that the patients who have sufficient neuropathy to render them susceptible to foot ulceration, this is carried out by using monofilament which is applied perpendicular to the foot buckles at a given force of 10 g. Ability to feel that level of pressure provides the protective sensation against foot ulceration.



A monofilament is applied perpendicular to the foot and pressed until it buckles at a given force of 10 g

Autonomic neuropathy: Dry skin with fissuring and distended veins over the dorsum of the foot are the signs of autonomic neuropathy. Dry skin is due to decreased sweating and dilated veins are secondary to arteriovenous shunting.



Distended veins secondary to autonomic neuropathy

FOOTWEAR ASSESSMENT:

It is important to examine the both shoes and socks.

GENERAL EXAMINATION: This includes the following systems

- Cardiovascular system
 - Respiratory system
 - Abdomen
 - Eyes
1. Visual activity
 2. fundus

INVESTIGATIONS

NEUROLOGICAL :-The degree of the neuropathy can be assessed by the use of biothesiometer or neurothesiometer. In both the devices the vibration is used which when applied to the foot delivers the vibratory stimulus ,if the patient not able to feel the stimulus of 25 volts then the patient is at high risk of ulceration.



The neurothesiometer

VASCULAR :A small hand held Doppler can be used to quantify the vascular status. The pressure index which is the ratio of ankle systolic pressure to brachial systolic pressure, it is used to assess the vascular status of the limb. In normal subjects the pressure index is usually >1 . In ischemia the pressure index is <1 , thus the absent pulse and the pressure index <1 confirms ischemia.



Hand held doppler

SKIN TEMPERATURE: Digital skin thermometer is helpful to follow up the clinical assessment of the skin temperature. Infrared thermometer is ideal and skin temperatures are compared between similar areas on each foot.



Digital skin thermometer

LABORATORY : The baseline investigations are useful in most of the patients,

- Full blood count
- Serum electrolytes
- Urea and creatinine
- Serum bilirubin, alkaline phosphatase, gamma glutamyl transferase, aspartate transferase.
- Blood glucose and HbA1c
- Serum triglycerides and cholesterol

RADIOLOGICAL : X ray of the foot will be required to detect:

- Osteomyelitis
- Fracture
- Charcot foot
- Gas in soft tissues
- Foreign body



Gas in soft tissues of thigh

CLINICAL PATTERN OF DIABETIC FOOT LESIONS

1. Infections
2. Ulcers
3. Gangrene
4. Joint lesions

INFECTIONS

Infection in the diabetic foot was classified as mild, moderate, severe.

1. Non limb threatening infections

Infection usually confined to the superficial part like skin and subcutaneous tissue with minimal cellulitis and no pus formation.

2. Moderate infection

Infections are deep and involve the fascia, muscle, tendon, joints or bones. This usually present as cellulitis of 0 -2cms in diameter or a plantar abscess and they may cause systemic symptoms. There is a risk of amputation in moderate infections.

3. Severe infection

This is a deep infection with more than 2 cm of cellulitis, lymphangitis, gangrene, and or necrotizing fasciitis. There is a threatening limb loss and systemic toxicity occurs in severe infections. Moderate and severe infections are called as limb threatening infections.

4. Bacterial infections

Staphylococcus aureus and beta hemolytic streptococci are the most common organisms responsible for the acute infections and also the common cause for cellulitis in non-ulcerated skin. when the patient treated with antibiotics for some time then the wound culture shows polymicrobial organisms mostly bacteroids and various anaerobic gram positive cocci. Pseudomonas is usually isolated from indurated and wet wounds. In severe infections anaerobes and gram negative organisms are predominate than gram positive pathogens. Severity of the infection usually does not predict the causative organism. Gram positive cocci like staphylococci and streptococci pathogens are usually responsible for life threatening infections. Methicillin resistant staphylococcus and enterococci are most commonly responsible for diabetic foot infections in hospitalized patients.



Staphylococcal infection over dorsum of foot

5. Necrotising fasciitis

It is a rapidly progressive infection located in the superficial and deep fascial planes with secondary necrosis of the subcutaneous tissues. Subcutaneous air is seen in x rays if the causative organism is the gas producing bacteria. Necrotizing fasciitis moves along the deep fascial planes therefore requiring rapid treatment.



Necrotising fasciitis of lower limb

6.Fungal infections:

Poor foot hygiene, hyperhidrosis and accumulation of moist debris in the webs are the predisposing factors responsible for the fungal infections. Tinea pedis is the most common form of chronic fungal infection. Redness, itching, scaling, erosion, soaking of the skin with fluid usually occurs in the late phase of the fungal infections. Trichophytonmentagrophytes, Trichophytonrubrum, Epidermophytonfloccosum may be found in the wound.



Tinea pedis over dorsum of foot

7. Bone infection – osteomyelitis:

The patients with long standing ulcers and deep infections should be evaluated for the presence of bone infection. When the ulcer diameter of 2 cm or greater and the depth is greater than 3 cm there is a possibility of ulcer being complicated by osteomyelitis. The presence of high white blood cell count, erythrocyte sedimentation rate and C reactive protein indicated there is a possibility of high complications



Osteomyelitis of foot

ULCERS

Ulcers are the usually presentation of the diabetic foot lesion and associated with infection. Diabetic ulcers are classified as,

1. Neuropathic ulcers :

Metatarsal heads, plantar aspect of the great toe, heel or over bony prominence in a charcot type joint are the areas of high plantar pressure points, ulcers usually develop in these areas. In diabetic patients with foot ulcers neuropathy is present in 85 – 90%. These ulcers are painless, unless they are complicated by infection. The base of the ulcer is red with a healthy granulation tissue.

The evidence of peripheral neuropathy like hypoesthesia or loss of sensation of light touch, pain, vibration, temperature, absence of Achilles tendon reflexes, abnormal vibration perception threshold, dry skin, atrophy of the small muscles of the feet, distended dorsal veins are present. Peripheral pulses are usually present, the temperature may be normal or warm.



Neuropathic ulcer

2. Ischemic ulcers :

These are painful ulcers present in the borders of the dorsal aspect of the feet and toes or between toes. Accounts for 38 – 52 % of cases of foot ulcers. History of intermittent claudication is present, its base is yellowish or necrotic (black). On examination there are signs of peripheral vascular disease like cool skin, cyanosis, loss of hair, onychodystrophy and absence of the peripheral pulses. Angiography and non invasive tests like duplex or triplex ultrasound examination, segmental pressure measurement and plethysmography are used to confirm the diagnosis.



Ischemic ulcer

3. Neuroischemic ulcers:

There is a mixed etiology of both neuropathy and ischemia present in these type of ulcers.

GANGRENE: Death of tissue with putrefaction of the macroscopic portion of the tissue is called gangrene. Diabetic gangrene is the gangrene of the fully vascularised foot, usually presents with rapid onset, painless with large area of necrosis. There may be associated systemic illness, signs of deep infection and the important feature is the presence of the ankle pulse.



Diabetic gangrene

JOINT LESIONS

Charcot osteoarthropathy (NeuroOsteoarthropathy, Charcot arthropathy, Diabetic Neuropathic Osteoarthropathy – DNOAP)

Prevalence is between 1 and 7.5% bilateral involvement occur in 6 – 40% of the patients, this is one of the serious complications of diabetes. Peripheral somatic neuropathy and autonomic neuropathy along with adequate blood supply of the foot is responsible for the development of complication. Presents in patients who have diabetes for more than 15 years and the mean age of presentation is 60 years.



Charcot joint

MANAGEMENT OF DIABETIC FOOT LESIONS

The Management of diabetic foot ulcers comprises of,

1. Off loading
2. Debridement
3. Use of appropriate dressings,
4. Medical and Surgical treatment of infection.
5. Vascular reconstruction and or amputation or reconstructive foot surgery when necessary.

1. Off-loading:

Biomechanical changes are most frequent consequence of diabetic neuropathy resulting in an altered pressure load on the sole of the foot. So consistent pressure relief is important for prevention and healing of the diabetic foot

ulcers. Total contact casting is most effective method of off-loading. The off-loading techniques are

- Accommodative dressings – Patellar tendon – bearing braces
- Assistive devices – Removable walking braces
- Callus removal – Scotch cast boot
- Foot Casts – Shoe cutouts
- Orthoses - Therapeutic shoes
- Padded hosiery –Total contact casting.

2. Debridement:

Debridement is the removal of devitalized contaminated tissue from within or adjacent to a wound, until surrounding healthy tissue is exposed and it is commonly done in diabetic foot ulcers. The aim of the debridement is to remove fibrin and death necrotic tissue and to produce a clean, well vascularized wound bed. Types of debridement are as follows:

- ❖ Sharp Surgical – by using scalpels, is the gold standard for wound preparation.
- ❖ Chemical debridement – by use of anti septic polysaccharide beads and pastes.
- ❖ Mechanical using wet to dry dressings, hydrotherapy, wound irrigation and dextranomers.
- ❖ Autolytic debridement – Hydrogels, hydrocolloids and transparent films.
- ❖ Biosurgery – by using maggots

- ❖ Enzymatic – by using chemical enzymes such as collagenase, papain or trypsin in a cream or ointment base.

3. Dressings:

Broad spectrum of wound dressings is currently unavailable

- ❖ Traditional Dressings – By gauze and absorbent cellulose
- ❖ Films
- ❖ Foams
- ❖ Alginates
- ❖ Enzymatic dressings

Surgical Management

1. Surgical decompression
2. Role of amputation
3. Role of vascular management

1. Surgical decompression : (fasciotomy)

Forefoot decompression

Plantar space decompression

Foot and leg decompression

2. Role of Amputation:

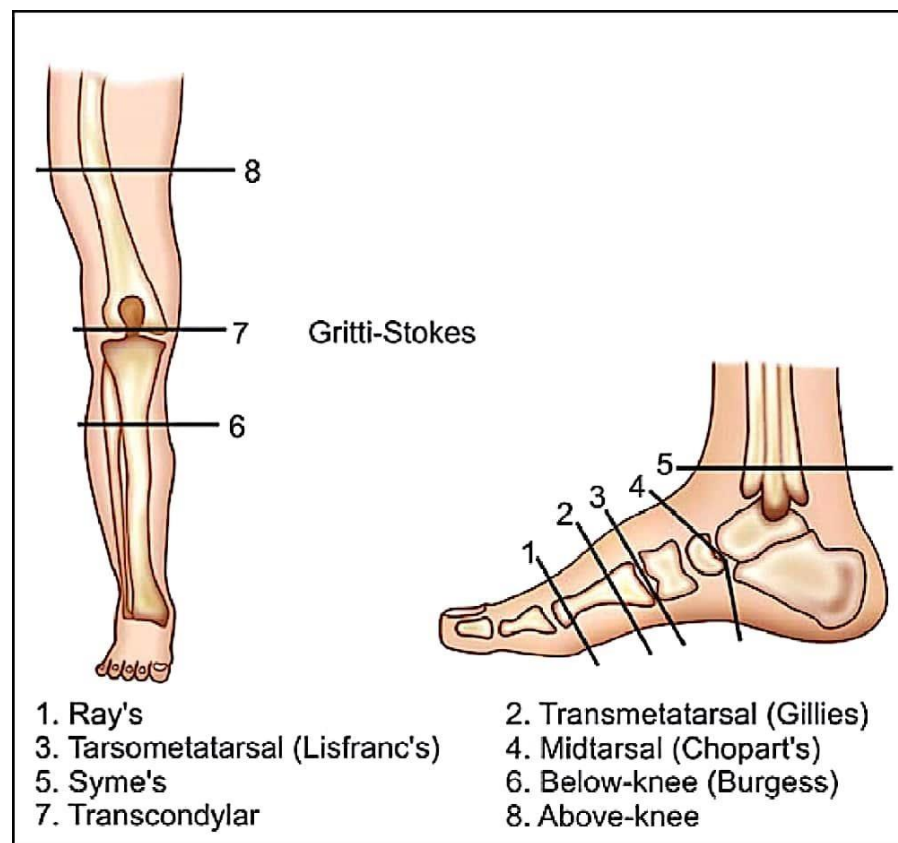
The factors deciding amputation are

- Age
- Nephropathy

- Major Vessel disease
- Gross neuropathy
- Presence of gangrene
- Involvement of bone
- Presence of infection
- Uncontrolled diabetes

Types of amputation done are

- Toe amputation
- Ray amputation
- Trans metatarsal amputation
- Below knee amputation
- Through knee amputation
- Above knee amputation



Toe amputation:

This type of amputation was done in conditions like trauma, vascular and septic causes. In trauma the toe should be amputated at the base of the first phalanx so the joint capsule of metatarsophalangeal joint is kept intact. One or two toes can be amputated if needed by retaining the other toes. When only 2nd toe is amputated it is done at over close to the first interphalangeal joint otherwise if amputated more proximally it can cause valgus deformity of the great toe.



Second toe amputation

Ray amputation:

In this type of amputation the corresponding head of the metatarsal should be removed. The push off power was lost while walking if one or two toes was amputated, the racquet incision is placed at the metatarsophalangeal joint and incision is deepened directly to the bone then proximal flap is raised close to the bone. Digital vessels of toe are ligated near the distal end of the wound, the metatarsal head should be removed otherwise the granulation tissue was not formed over the head. By using

the bone cutter the head was usually removed. The wound was closed by using suture if active infection was not present.



Transmetatarsal amputation:

In this type the amputation was done proximal to the neck of the metatarsals and distal to the base, usually done if the distal part of the dorsum of foot between the toes is necrosed or found to be non-viable. Patient can able to wear normal shoes after this procedure. On the plantar aspect the incision is close to the digits, dorsal side incision is 3 cm distal to the toes and incision deepened and the flexors are cut individually. All the matatarsals are transected 2 cm from the base, the deep fascia and skin sutured with the suture line in the dorsal aspect.



Transmetatarsal amputation

Below knee amputation:

It is done in infections, trauma and peripheral vascular diseases. Posterior flap is used in peripheral vascular disease and equal flap is used in trauma patients. Flap is contraindicated if the stump is less than 7.5cm. Long posterior flap with suture placement over the anterior aspect is mainly used, prosthesis placement is better here with greater range of movements without limping and support. It is also called as Burgess Amputation. Here skin is incised around one third circumference of the lower leg 15 cm from tibial tuberosity over anterior aspect and incision deepened. Tibialis anterior is divided and anterior tibial vessels are identified, ligated and cut, muscles around the tibia are divided and tibia is transected by using gigle saw. Fibula should be cut 1 cm above the cut end of tibia, nerve should pulled out and cut without suturing. Other groups of muscles are divided and the bleeding vessels ligated. Posterior group of muscles are sutured across the bone end, to the periosteum in front. Stump length should be 14 to 17cm from the knee joint. Minimal length required for

prosthesis is 8 cm. suction drains or corrugated drain should place in the wound, adequate dressing pad should be placed over the stump and pressure bandage using crepe is placed. Stump maturation occurs in 8 weeks then prosthesis can be used.



Below knee amputation

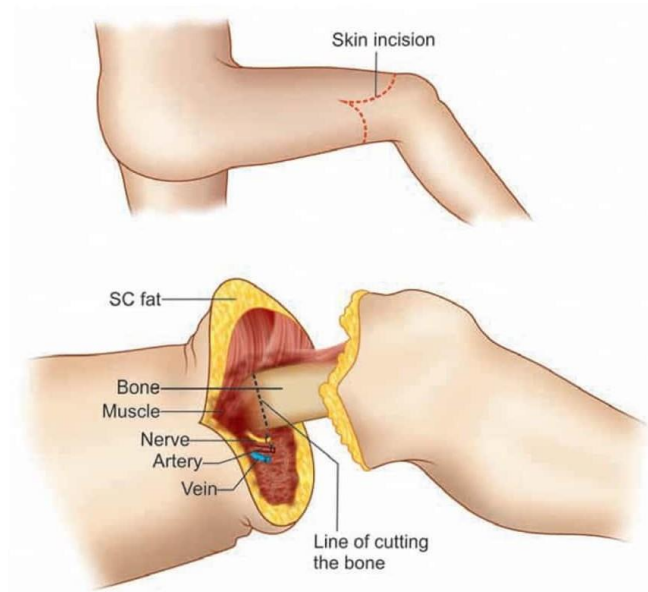
Knee joint disarticulation:

It is done in non functional damaged knee joint where below knee amputation is not possible. This procedure is indicated in non ambulating bed ridden patients, very ill patients and the patients who need locked knee prosthesis or end bearing stump. It is contraindicated in ischemic patients. Its disadvantages are cosmetically inferior, less vascular, poor healing and prosthesis controlled gait is difficult to achieve. It is done in prone position through the anterior incision and the incision deepened and curved towards midline in the popliteal fossa 2.5cm above the joint line. Vessels and nerves are identified and ligated, posterior muscles and joint capsule is cut, joint is opened, ligaments and patellar tendon is cut, patella is retained. Patellar

tendon is sutured to cruciate ligament and retinaculum to hamstrings. Wound closed and anteroposterior longitudinal scar is formed.

Above knee amputation:

It is indicated in trauma, ischemia, sepsis and gangrene which is spreading above. It is contraindicated in children and if the stump is less than 7.5cm. Usually equal anterior and posterior flaps are used. Ideally the required length of the stump is 25cm from the tip of greater trochanter. Femoral vessels are ligated, the femur is transected, sciatic nerve pulled out and cut and the accompanying vessels should be ligated separately. Quadriceps is sutured to hamstrings, suction drain is kept and skin closed soft crepe bandage dressing is placed.



Above knee amputation

Ideal level of amputation:

The level at which the amputation should be performed depends on

1.Extent of disease: The normal vascularized part of the limb proximal to the gangrenous part was identified and the amputation should be carried out through this level. While doing amputation adequate skin and subcutaneous tissue bleeding should be present at the level of amputation, otherwise healing not occurred.

2.Function of the stump: The level of amputation should be such that it should be ideal for artificial limb fitting and only then the proper function of the stump can be obtained. The optimal length is 25 to 30 cm measured from the tip of the greater trochanter for thigh in above knee amputation and 15 cm from tibial tuberosity for lower leg in below knee amputation.

The ideal stump: The stump should be

- Optimal length
- End of the stump should be smoothly rounded
- Stump should be firm
- Opposing group of the muscles should be sutured together over the end of the bone, known as myoplasty
- Vascularity of the flaps should be normal
- No projection spur of the bone
- Stump should not be under tension

Prevention:

Diabetic patients have high risk of foot complications like amputations, so regular health education about foot care must be provided, half of the amputations in diabetics can be avoided by taking proper self-care.

AIM

To predict the outcome of the diabetic foot ulcers based on clinical scoring system –

Diabetic ulcer severity score (DUSS)

OBJECTIVES

To study the progress of ulcer healing in diabetic patients

To study the different techniques of surgical interventions needed in the management of diabetic foot ulcers

To study the incidence of amputations in patients with diabetic foot ulcers

MATERIALS AND METHODS

METHODOLOGY AND TECHNIQUES

SOURCE OF DATA

100 Diabetic patients with diabetic foot ulcer attending general surgery outpatient clinic or admitted in Madras medical college and hospital

STUDY PLACE

Madras medical college and Hospital

STUDY DESIGN

Prospective observational study

SAMPLE SIZE

100 Patients

STUDY PERIOD

January 2018 to June 2019

INCLUSION CRITERIA

1. Age limit 40 to 70
2. All patients who have Diabetes mellitus as per WHO criteria with foot ulcers
 - Symptoms of diabetes + random blood sugar >200 mg/dl
 - Fasting blood sugar >110 mg/dl
 - 2 hour post prandial plasma glucose level >200 mg/dl
3. All diabetic foot ulcers irrespective of the duration

EXCLUSION CRITERIA

1. Ulcer located above ankle
2. All non diabetic foot ulcers
3. Venous stasis ulcer with diabetes
4. Ulcer with evidence of gangrene

100 patients attending general surgery outpatient clinic and admitted in general surgery department in Madras medical college and hospital are studied prospectively during this study period.

- A detailed clinical history was taken for all patients
- Proper clinical examination was done for all the patients
- Patients are followed up regularly
- Patients who underwent surgical procedures are noted

DIABETIC ULCER SEVERITY SCORE (DUSS)

Ulcers were scored by the below mentioned variables. Diabetic ulcer severity score (DUSS) was calculated by adding these separate scored variables to a theoretical maximum of 4.

DUSS SCORING SYSTEM

VARIABLES	SCORE 0	SCORE 1
PALPABLE PEDAL PULSE	PRESENCE	ABSENCE
PROBING TO BONE	NO	YES
ULCER SITE	TOES	FOOT
ULCER NUMBER	SINGLE	MULTIPLE

Standard treatment care was given to all these patients, which included oral hypoglycemic or insulin for good control of diabetes, health education, antibiotics and regular wound care. Healing was defined as complete epithelisation or healing after skin grafting. Amputation rate was defined as the percentage of patients undergoing either minor or major amputation within the observation period. Toe or forefoot amputations were taken as minor amputation and below or above amputation were taken as major amputation. Dressings were done every day for in patients and patients who were discharged are followed up in the surgical outpatient clinic for DUSS scoring once in fortnight for 1st month, then once in a month till the ulcer healed or for a minimum period of up to 6 months. Ulcer healing was assessed as mentioned earlier.

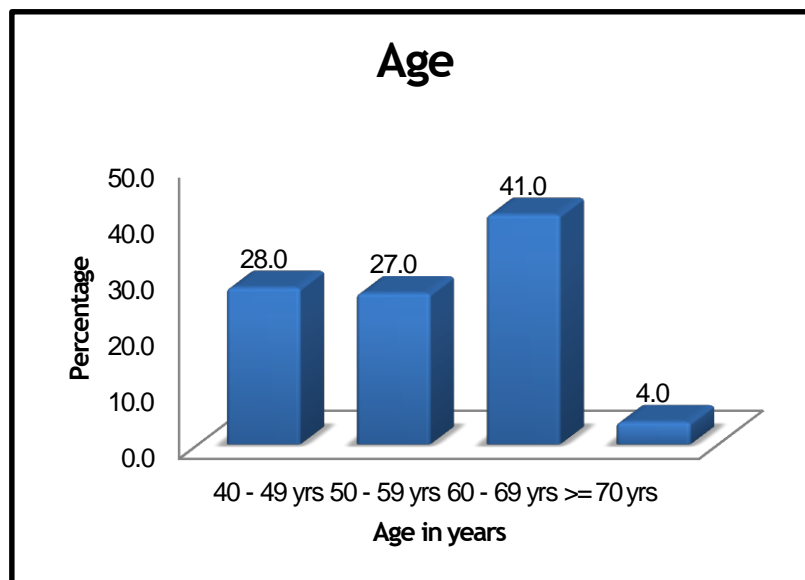
DATA ANALYSIS

The collected data were analysed with IBM.SPSS statistics software 23.0 Version. To describe about the data descriptive statistics frequency analysis, percentage analysis were used for categorical variables and the mean & S.D were used for continuous variables. To find the significance in categorical data Chi-Square test was used. In the above statistical tool the probability value 0.05 is considered as significant level.

RESULTS

Age-wise distribution of study population

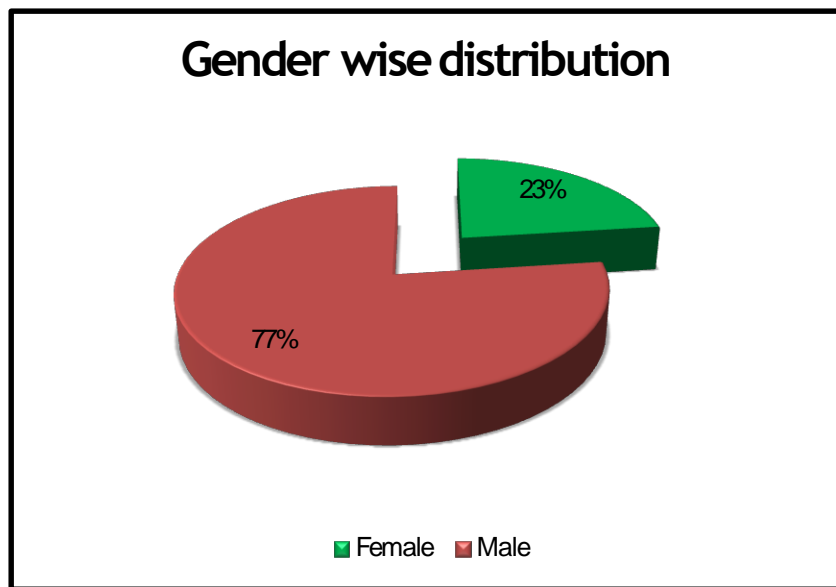
AGE			
		Number of patients	Percentage
	40 - 49 yrs	28	28.0
	50 - 59 yrs	27	27.0
	60 - 69 yrs	41	41.0
	>= 70 yrs	4	4.0
	Total	100	100.0



Most common age group with diabetic foot was between 60 – 69 years, n=41. The second group is between 40 – 49 years in our study.

Gender wise distribution of study population

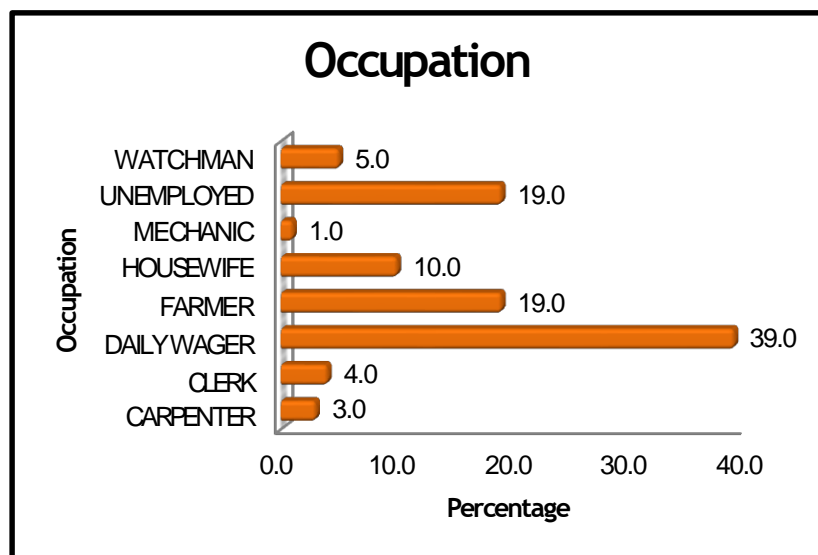
SEX			
		Number of patients	Percentage
	Female	23	23.0
	Male	77	77.0
	Total	100	100.0



Males were commonly affected by diabetic foot ulcers accounting to 77% in our study

Occupation wise distribution of study population

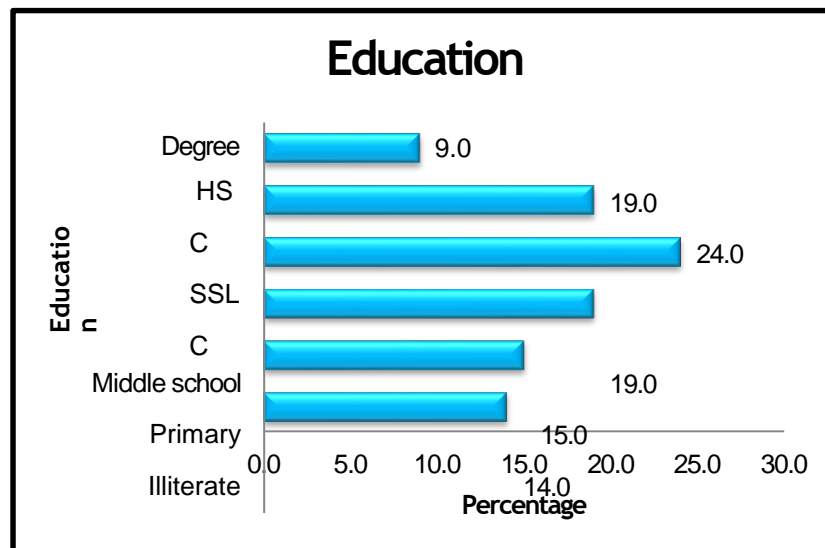
OCCUPATION		
	Number of patients	Percentage
CARPENTER	3	3.0
CLERK	4	4.0
DAILY WAGER	39	39.0
FARMER	19	19.0
HOUSEWIFE	10	10.0
MECHANIC	1	1.0
UNEMPLOYED	19	19.0
WATCHMAN	5	5.0
Total	100	100.0



Daily wagers were commonly affected by diabetic foot ulcer around 39% in our study.

Education wise distribution of study population

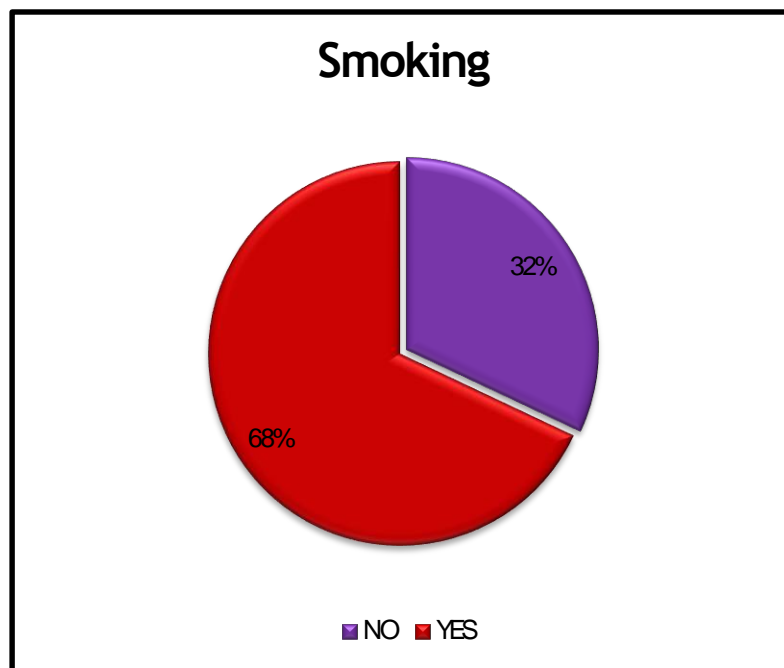
EDUCATION			
		Number of patients	Percentage
	Illiterate	14	14.0
	Primary	15	15.0
	Middle school	19	19.0
	SSLC	24	24.0
	HSC	19	19.0
	Degree	9	9.0
	Total	100	100.0



Among the study population 24% of the patients studied upto 10th standard.

Distribution of smoking among the study population

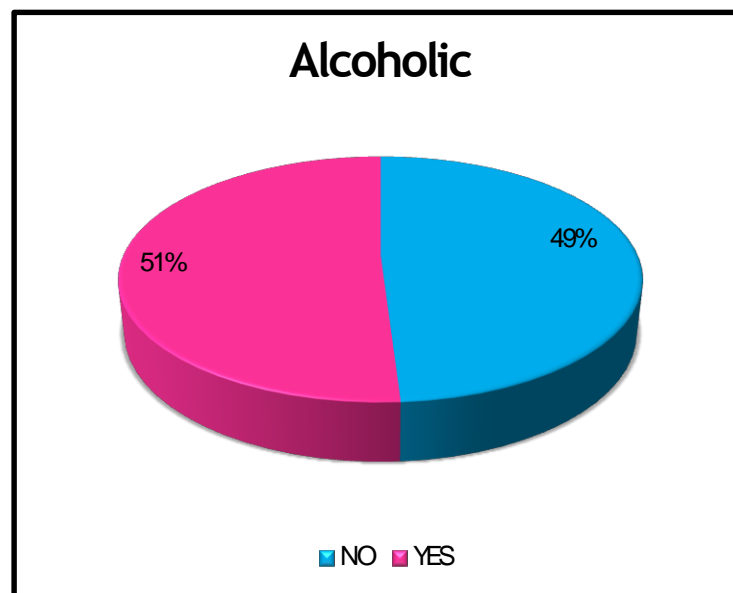
SMOKING			
		Number of patients	Percentage
	NO	32	32.0
	YES	68	68.0
	Total	100	100.0



Among the study population 68% of the patients have smoking habit.

Distribution of alcohol intake among study population

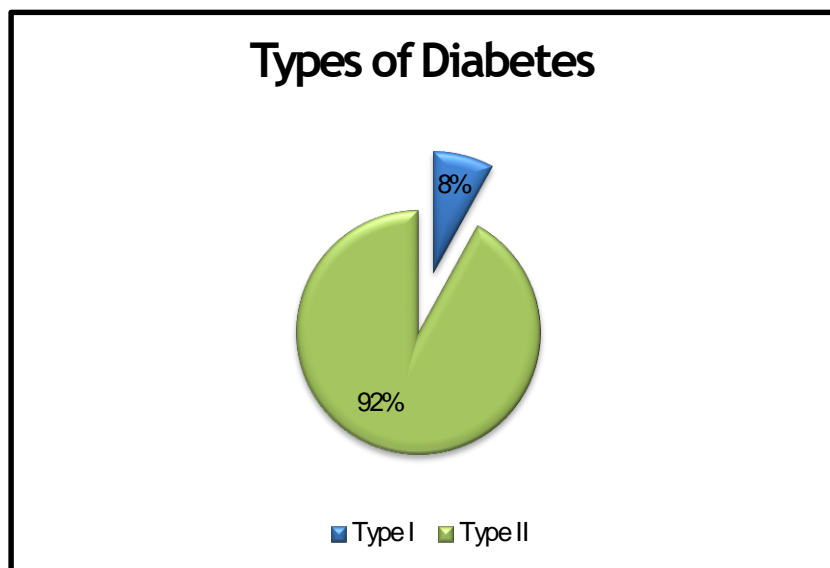
ALCOHOLC			
		Number of patients	Percentage
	NO	49	49.0
	YES	51	51.0
	Total	100	100.0



Among study population 51% of the patients were alcoholic.

Distribution among type 1 and type 2 diabetic patients

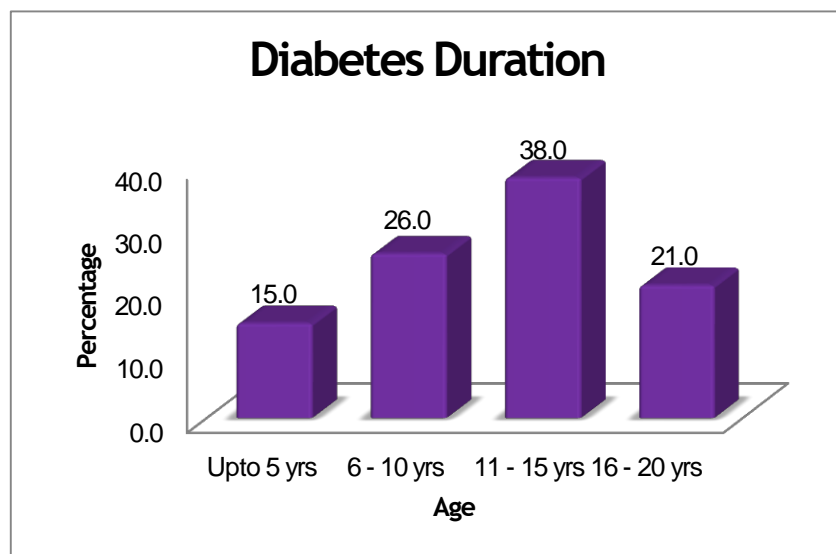
TYPE OF DIABETES			
		Number of patients	Percentage
	Type I	8	8.0
	Type II	92	92.0
	Total	100	100.0



Among study population 8 % of the patients were found to have type 1 diabetes and the remaining patients were type 2 diabetics

Duration of diabetes in study group

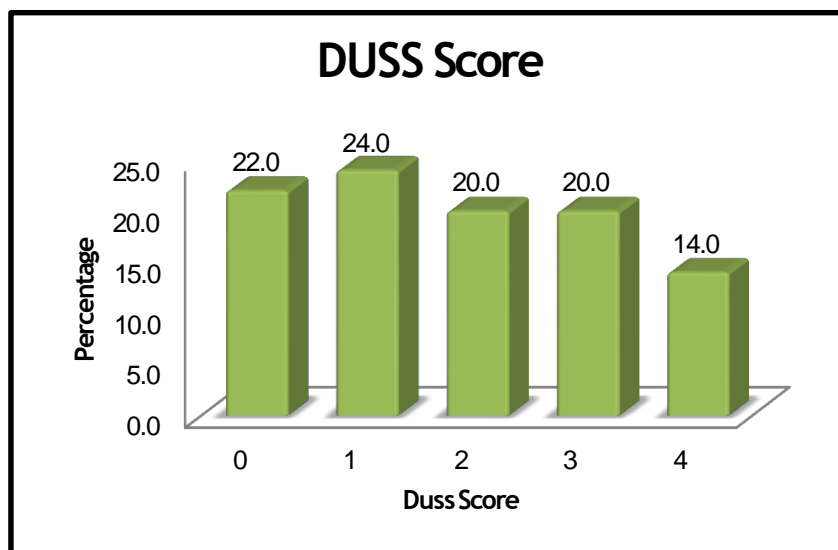
DIABETES DURATION			
		Number of patients	Percentage
	Upto 5 yrs	15	15.0
	6 - 10 yrs	26	26.0
	11 - 15 yrs	38	38.0
	16 - 20 yrs	21	21.0
	Total	100	100.0



38% of the study population are having diabetes for 11 to 15 years presenting with foot ulcers

Distribution of DUSS score among study population

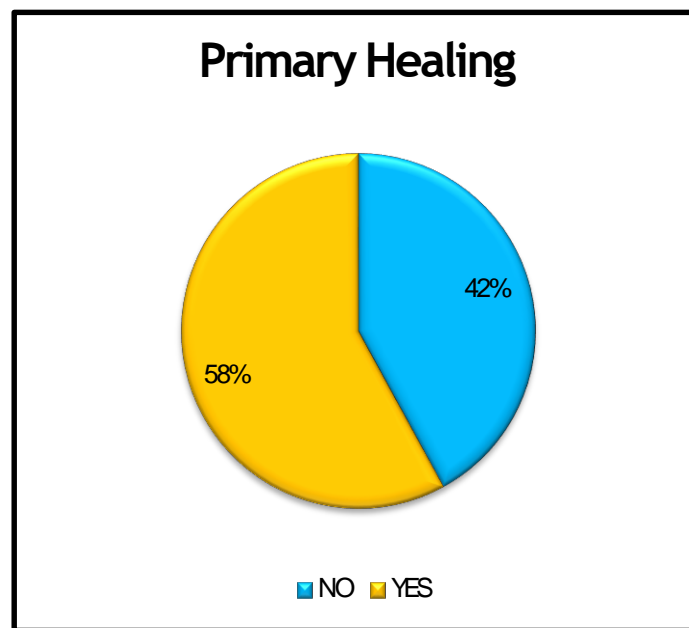
DUSS SCORE			
		Number of patients	Percentage
	0	22	22.0
	1	24	24.0
	2	20	20.0
	3	20	20.0
	4	14	14.0
	Total	100	100.0



Most commonly ulcers were of DUSS score of 1 followed by score 2 and 3.

Primary healing distribution among study population

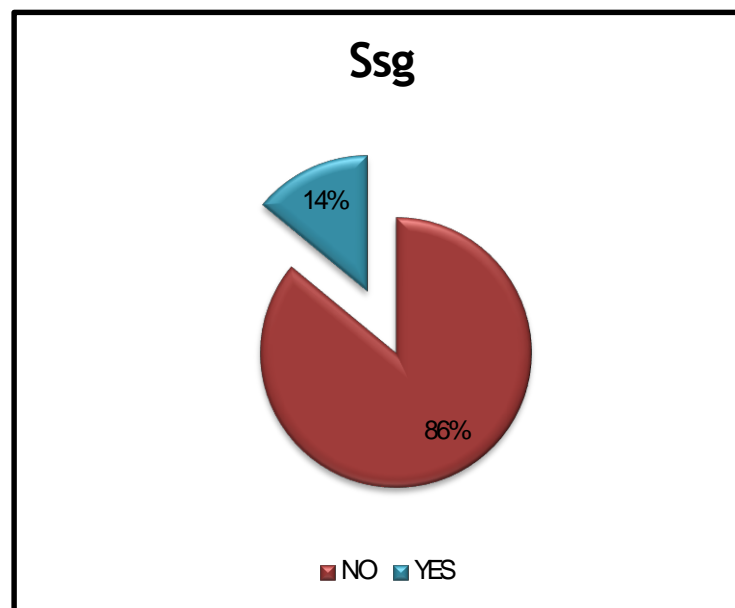
PRIMARY HEALING			
		Number of patients	Percentage
	NO	42	42.0
	YES	58	58.0
	Total	100	100.0



Among study population 58% of the patients having diabetic foot ulcers were healed primary.

SSG distribution among study population

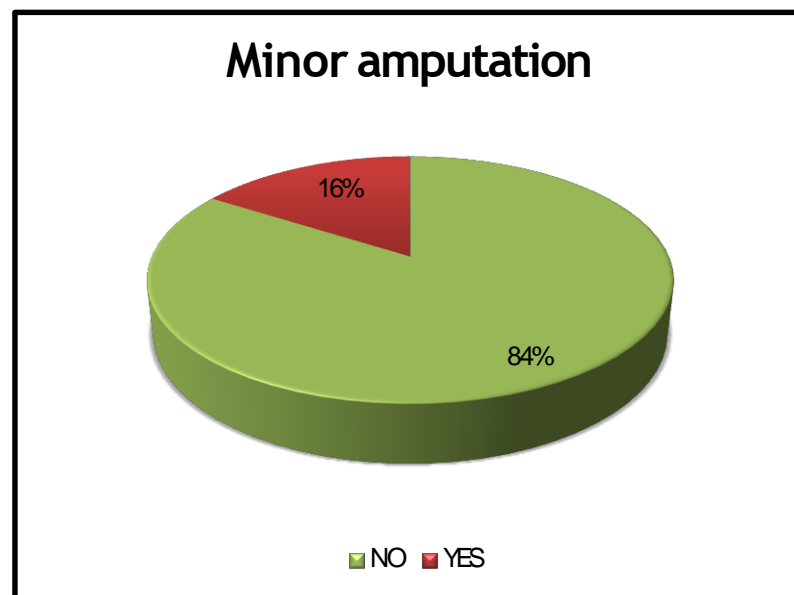
SSG			
		Number of patients	Percentage
	NO	86	86.0
	YES	14	14.0
	Total	100	100.0



Among study population 14 % of the patients having diabetic foot ulcers underwent split thickness skin grafting.

Minor amputation among study population

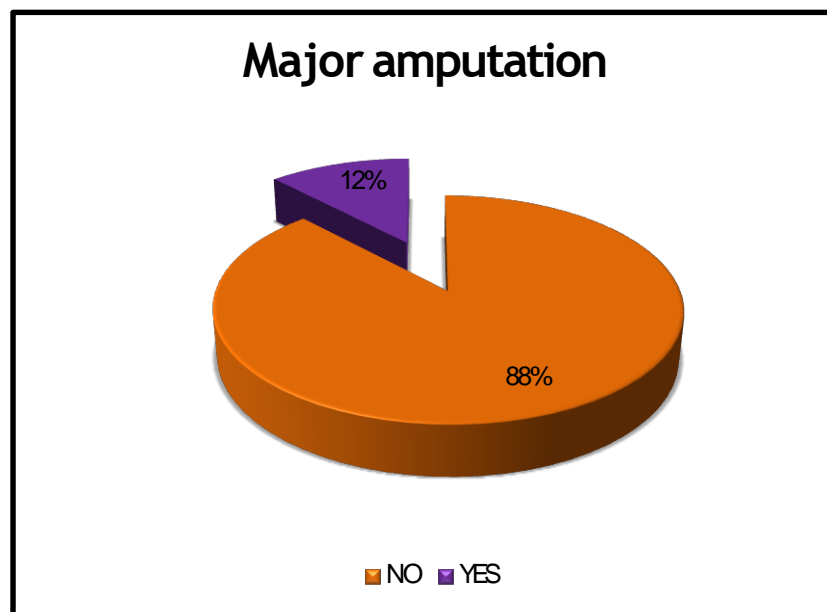
MINOR AMPUTATION			
		Number of patients	Percentage
	NO	84	84.0
	YES	16	16.0
	Total	100	100.0



Minor amputation was done for 16% of patients in our study.

Major amputation among study population

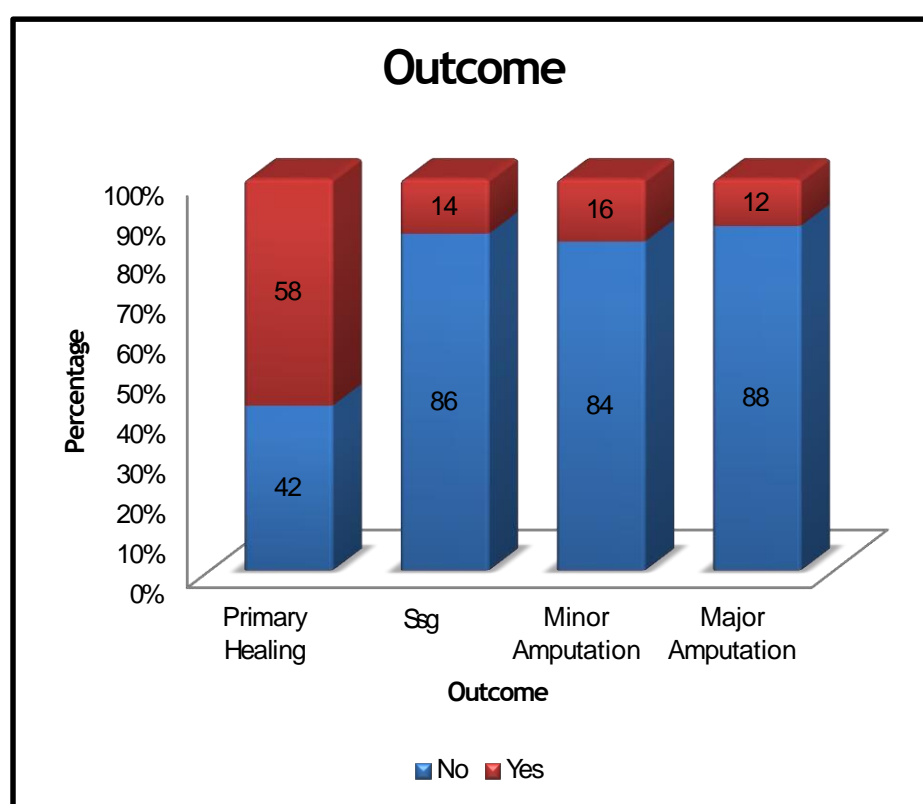
MAJOR AMPUTATION			
		Number of patients	Percentage
	NO	88	88.0
	YES	12	12.0
	Total	100	100.0



Major amputation was done in 12% of patients in our study.

Overall outcome distribution among study population

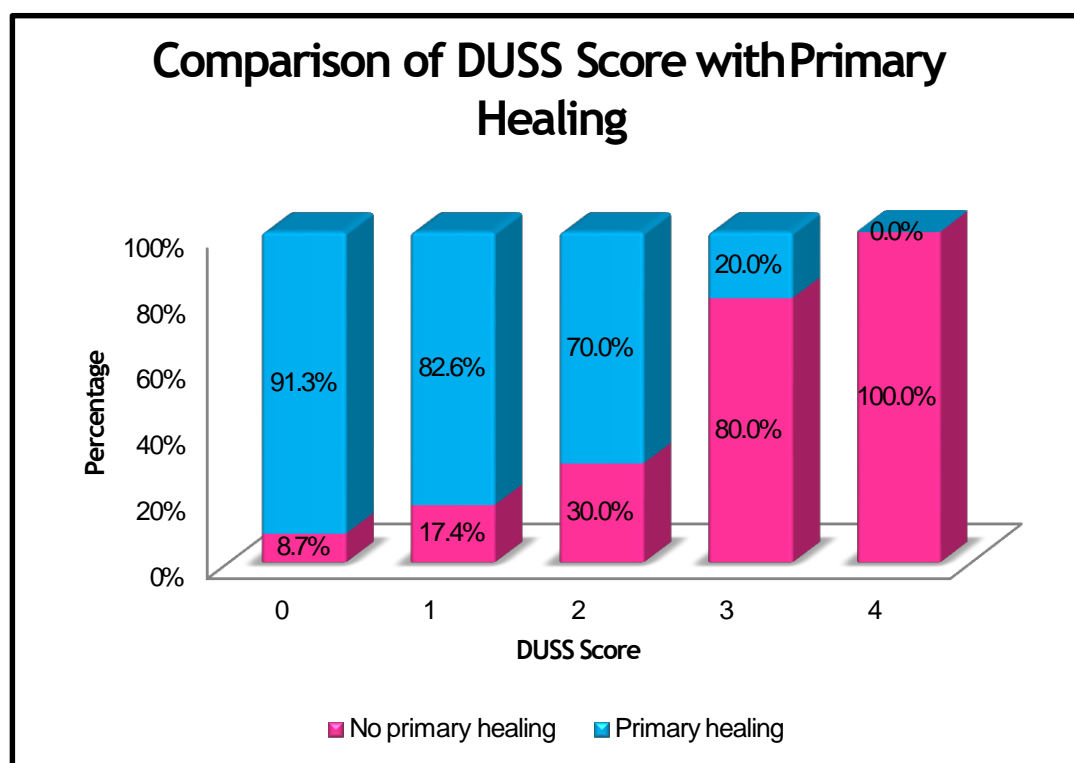
	No	Yes
Primary Healing	42	58
SSG	86	14
Minor Amputation	84	16
Major Amputation	88	12



Among study population 58% of the patients having diabetic foot ulcers was healed primary, 14% of the patients underwent split thickness skin grafting. Minor amputation was done in 16% and major amputation was done in 12% of the patients.

COMPARISON OF DUSS SCORE WITH PRIMARY HEALING							
		PRIMARY HEALING		Total	χ ² -value	P-value	
		NO	YES				
DUSS SCORE	0	Count	2	20	22	48.56	0.0005 **
		%	8.7%	91.3%	100.0%		
	1	Count	4	20	24		
		%	17.4%	82.6%	100.0%		
	2	Count	6	14	20		
		%	30.0%	70.0%	100.0%		
	3	Count	16	4	20		
		%	80.0%	20.0%	100.0%		
	4	Count	14	0	14		
		%	100.0%	0.0%	100.0%		
Total		Count	42	58	100		
		%	42.0%	58.0%	100.0%		

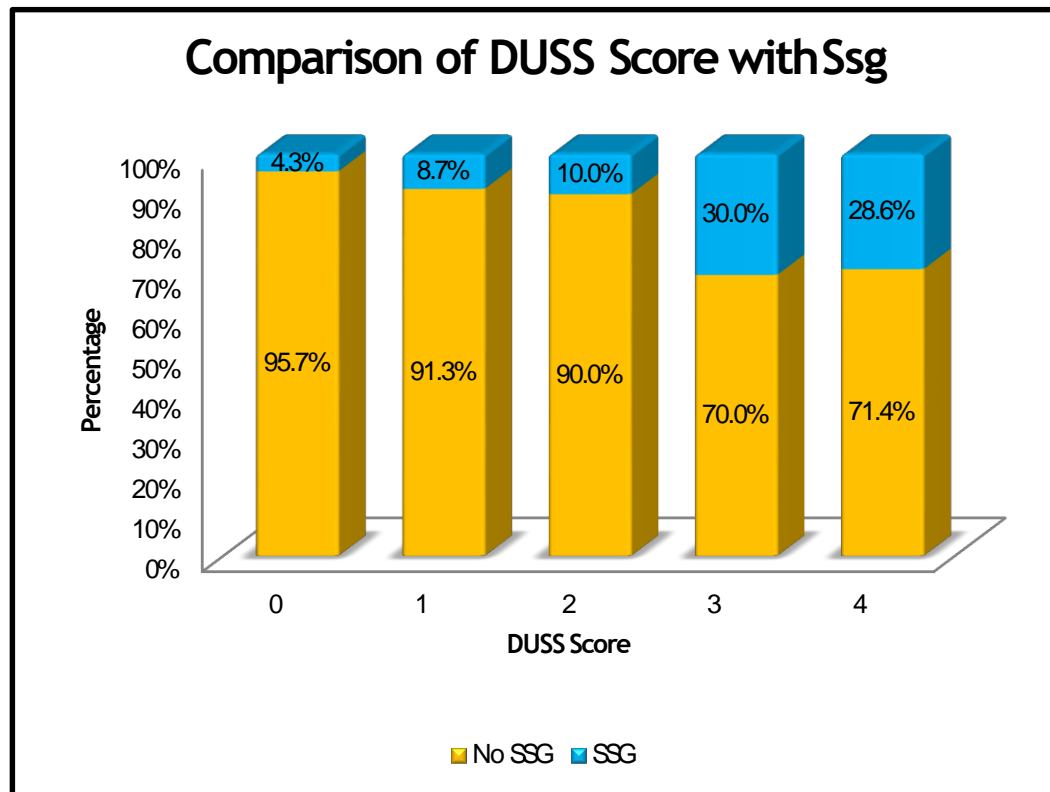
** Highly Significant at P < 0.01 level



Among study population primary healing of the diabetic foot ulcers was occurred in 91.3% of the patients with score 0, 83.6% of the patients with score 1, 70% of the patients with score 2, 20% of the patients with score 3 and 0% of the patients with score 4.

COMPARISON OF DUSS SCORE WITH SSG							
			SSG		Total	χ ² -value	P-value
			NO	YES			
DUSS SCORE	0	Count	22	0	22	8.7	0.0005 **
		%	95.7%	4.3%	100.0%		
	1	Count	22	2	24		
		%	91.3%	8.7%	100.0%		
	2	Count	18	2	20		
		%	90.0%	10.0%	100.0%		
	3	Count	14	6	20		
		%	70.0%	30.0%	100.0%		
	4	Count	10	4	14		
		%	71.4%	28.6%	100.0%		
Total		Count	85	15	100		
		%	85.0%	15.0%	100.0%		

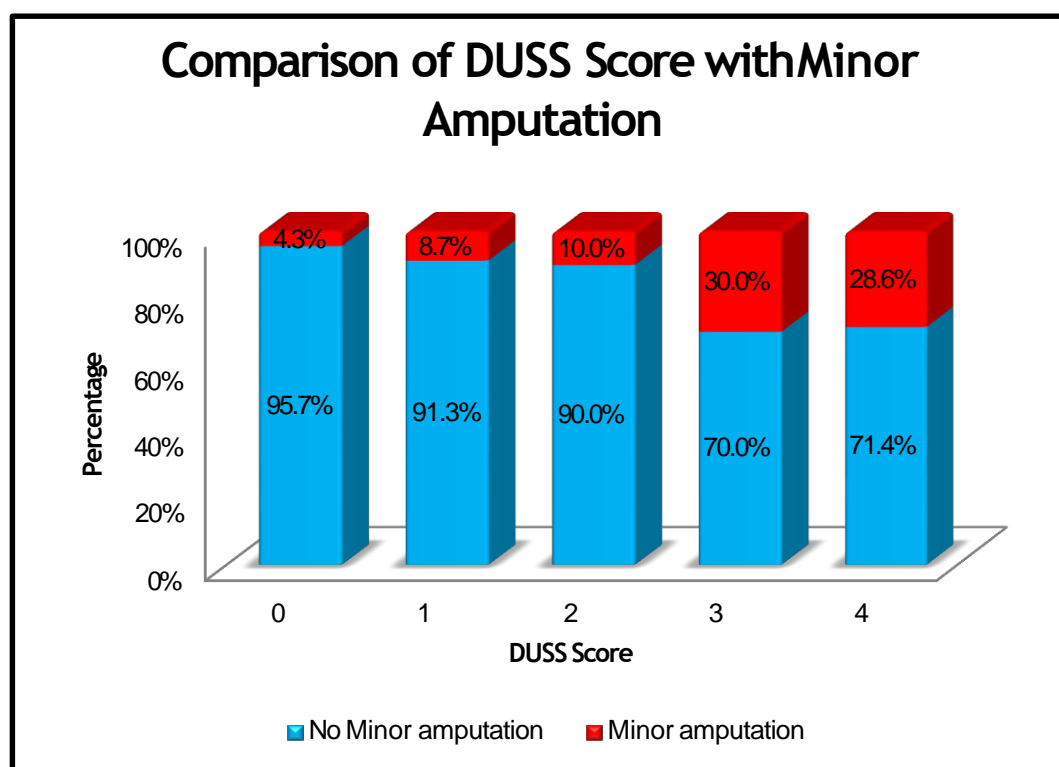
** Highly Significant at P < 0.01 level



Among study population split thickness skin grafting was done for 4.3% of the patients with score 0, 8.75 of the patients with score 1, 10% of the patients with score 2, 30 % of the patients with score 3 and 28.6% of the patients with sore 4.

COMPARISON OF DUSS SCORE WITH MINOR AMPUTATION							
		MINOR AMPUTATION		Total	X ² -value	P-value	
		NO	YES				
DUSS SCORE	0	Count	20	2	22	8.708	0.0005 **
		%	95.7%	4.3%	100.0%		
	1	Count	22	2	24		
		%	91.3%	8.7%	100.0%		
	2	Count	18	2	20		
		%	90.0%	10.0%	100.0%		
	3	Count	14	6	20		
		%	70.0%	30.0%	100.0%		
	4	Count	10	4	14		
		%	71.4%	28.6%	100.0%		
Total		Count	85	15	100		
		%	85.0%	15.0%	100.0%		

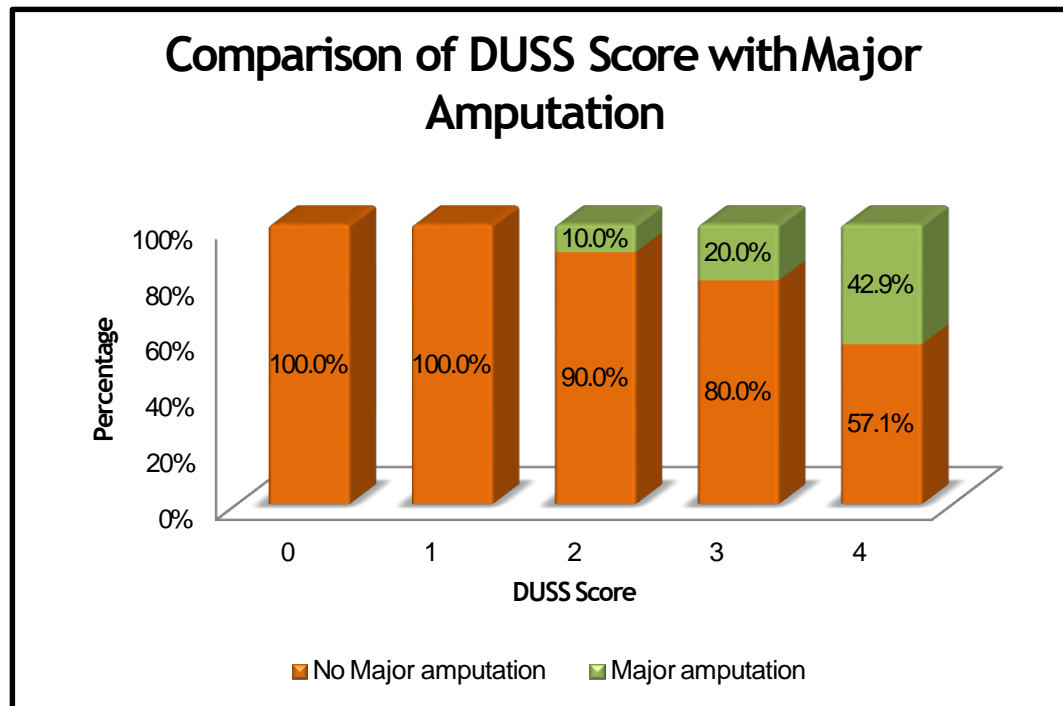
** Highly Significant at P < 0.01 level



Among study population minor amputation was done for 4.3% of the patients with score 0, 8.7% of the patients with score 1, 10% of the patients with score 2, 30% of the patients with score 3 and 28.6% of the patients with score 4.

COMPARISON OF DUSS SCORE WITH MAJOR AMPUTATION							
		MAJOR AMPUTATION		Total	X ² - value	P-value	
		NO	YES				
DUSS SCORE	0	Count	22	0	22	20.18	0.0005 **
		%	100.0%	0.0%	100.0%		
	1	Count	24	0	24		
		%	100.0%	0.0%	100.0%		
	2	Count	18	2	20		
		%	90.0%	10.0%	100.0%		
	3	Count	16	4	20		
		%	80.0%	20.0%	100.0%		
	4	Count	8	6	14		
		%	57.1%	42.9%	100.0%		
Total		Count	88	12	100		
		%	88.0%	12.0%	100.0%		

** Highly Significant at P < 0.01 level



Among study population major amputation was done for 10% of the patients with score 2, 20% of the patients with score 3, 42.9% of the patients with score 4 and no major amputation for the patients with score 0 and 1.

DISCUSSION

Total of 100 diabetic patients with foot ulcers irrespective of duration of ulcers attending surgical outpatient clinic or admitted in Madras Medical College and hospital were studied based on the inclusion and exclusion criteria mentioned earlier. Most common age group in our study was between 60 and 69 years, second group being between 40 and 49 years. Mean age group was 57 years. A study conducted during the year 2004 through the 2002 National Hospital discharge survey, evaluated 275,000 in patient records from 500 hospitals from 1996 onwards. This study showed that elderly diabetic patients had twice the risk of developing a foot ulcer, three times the risk of developing a foot abscess and four times the risk of developing osteomyelitis.

In our study male population were commonly affected around 77% and female were 23%. Based on occupation daily wages are commonly affected by diabetic foot ulcers with 39% , next being the farmers with 19%, smoking increases the risk of developing diabetic foot ulcers, in our study 68% of the smokers and 32% of the non-smokers developed foot ulcers. 51% of the diabetics who are taking alcohol and 49% of the non-alcoholics developed diabetic foot ulcer in our study. Patients having diabetes for long duration are prone to develop diabetic foot ulcers. In our study diabetes duration between 11 and 15 years are commonly affected by diabetic foot ulcers and was 28%.

55% of the patients who are taking treatment for diabetes both oral hypoglycemic agents and human insulin developed diabetic foot ulcers in our study and 45% of the patients who are not taking treatment for diabetes developed foot

ulcers. Among study population out of 100, 58 patients with foot ulcers, the wound was healed primarily, and 14 patients underwent split thickness skin grafting.

Toe amputation accounts for the majority of the diabetes related lower limb amputation. The age adjusted lower extremity amputation rate in the year 2002 among persons with diabetes was highest for toe level amputation (2.6 per 1000 persons) and followed by below knee amputation (1.6 per 1000 persons) Generally the lower extremity amputation rate is 15 to 40 times higher in diabetic versus non-diabetic population. Amputation rate is 50% higher in men compared to women. In our study minor amputation like toe amputation and fore foot amputation was done in 16% of the study population and major amputations like above knee and below knee amputation were done in 12% of the study population.

When the DUSS score was compared with primary healing 91.3% of the patients with score 0, 82.6% of the patients with score 1, 70% of the patients with score 2, 20% of the patients with score 3 and 0% of the patients with score 4, the wound underwent primary healing after wound dressing regularly.

By comparing the DUSS score with split thickness skin grafting, none of the patients with score 0, 8.7% of the patients with score 1, 10% of the patients with score 2, 30% of the patients with score 3 and 28.6% of the patients with score 4 underwent split thickness and skin grafting. On comparing minor amputation with DUSS scoring, 4.3% of the patients with score 0, 8.7% of the patients with score 1, 10% of the patients with score 2, 30% of the patients with score 3 and 28.6% of the patients with score 4, underwent minor amputation for diabetic foot ulcer.

On comparing the DUSS score with major amputation, none of the patients with score 0 and 1, 10% of the patients with score 2, 20% of the patients with score 3 and 42.9% of the patients with score 4 underwent major amputation. In our study none of the patients with score 0 and 1 underwent major amputation. Major amputation increases in the patients with DUSS score of 3 and 4.

CONCLUSION

Diabetic ulcer severity scoring (DUSS) system provides an easy diagnostic tool for predicting probability of healing or amputation by combining four clinical assessable wound based parameters. Study groups can be stratified depending on severity of ulcers and thus can help provide a simple, streamlined approach in clinical setting without need of any advanced investigative tool, but it does not alter the procedure of wound management.

In this study patients with lower DUSS scores did not require any major amputation, whereas those with higher scores required major amputation as a part of their management. The results of this study corroborate with similar studies performed with DUSS scores in other center. Therefore DUSS score is a simple and easily reproducible that can be used in patients with diabetic foot ulcers in routine surgical practice..

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S.NO	NAME	AGE	SEX	OCCUPATION	EDUCATION	SMOKING	TYPE OF DIABETES	ALCOHOLC	DIABETES DURATION	TREATMENT TAKEN	DUSSSCORE	PRIMARY HEALING	SSG	MINOR AMPUTATION	MAJOR AMPUTATION
1	KUPPUSAMY	43	M	FARMER	8	YES	2	NO	5	YES	0	YES			
2	MANI	65	M	MECHANIC	10	YES	2	YES	8	YES	1	YES			
4	MUTHUMARI	48	F	HOUSEWIFE	10	NO	2	NO	3	NO	0	YES			
4	KANNIAPPAN	64	M	FARMER	0	YES	2	YES	5	NO	1	YES			
5	HARIHARAN	55	M	WATCHMAN	8	YES	2	YES	10	YES	2		YES		
6	MANIKANDAN	67	M	DAILY WAGER	8	YES	2	YES	15	NO	2	YES			
7	OMPRAKASH	66	M	UNEMPLOYED	10	YES	2	NO	5	YES	3		YES		
8	MARIAPPAN	42	M	CARPENTER	12	YES	1	YES	21	YES	4			YES	
9	KAVERI	58	F	CLERK	DEGREE	NO	2	NO	16	YES	4				YES
10	JOWLY	60	M	DAILY WAGER	5	YES	2	NO	15	YES	3		YES		
11	MANI	51	M	DAILY WAGER	10	NO	2	NO	11	NO	1	YES			
12	PREM	69	M	FARMER	0	NO	2	NO	4	NO	0			YES	
13	BABY	70	F	DAILY WAGER	10	YES	2	NO	2	YES	1	YES			
14	RAMASAMY	64	M	CLERK	DEGREE	YES	2	NO	1	YES	1	YES			
15	PALANI	67	M	DAILY WAGER	12	YES	2	YES	14	YES	2	YES			
16	GNANAM	56	M	DAILY WAGER	0	YES	2	YES	15	NO	3		YES		
17	RANI	42	F	WATCHMAN	12	NO	2	NO	3	NO	2			YES	
18	ARANGANATHAN	43	M	DAILY WAGER	10	NO	2	NO	6	YES	3			YES	
19	GANI	44	M	DAILY WAGER	10	YES	1	YES	18	NO	4				YES
20	THANGAM	70	M	FARMER	20	YES	2	NO	4	YES	4			YES	
21	KANNAN	66	M	DAILY WAGER	5	YES	2	NO	10	YES	0	YES			
22	VJAYA	68	F	DAILY WAGER	0	NO	2	NO	8	YES	3			YES	
23	VINAYAM	45	M	FARMER	8	YES	2	YES	4	NO	2				YES
24	LINGAM	54	M	UNEMPLOYED	8	NO	2	NO	1	NO	4				YES
25	CHINNASAMY	55	M	DAILY WAGER	12	NO	2	NO	3	YES	2	YES			
26	VIMALA	48	F	DAILY WAGER	10	NO	2	NO	5	YES	0	YES			
27	NAGARAJ	49	M	UNEMPLOYED	8	YES	2	YES	8	YES	3			YES	
28	SHIVAN	47	M	DAILY WAGER	5	YES	2	YES	13	NO	0	YES			
29	RAM	68	M	FARMER	5	NO	2	NO	14	YES	2	YES			
30	NAGAMMA	66	F	HOUSEWIFE	0	NO	2	NO	11	NO	1	YES			
31	SUBBARAO	64	M	CLERK	DEGREE	YES	2	YES	2	NO	4		YES		
32	MINIAPPAN	62	M	DAILY WAGER	5	YES	2	YES	1	YES	3				YES
33	VENKATESH	61	M	DAILY WAGER	8	NO	2	NO	1	YES	1	YES			
34	RADHA	56	F	HOUSEWIFE	0	NO	2	NO	5	NO	0	YES			
35	GOPAL	50	M	UNEMPLOYED	12	NO	2	YES	7	YES	2	YES			
36	MUDALIYAR	49	M	DAILY WAGER	0	YES	1	NO	16	YES	1			YES	
37	RAHIMA	47	F	DAILY WAGER	10	NO	2	NO	8	NO	3				YES
38	AYANAR	61	M	FARMER	12	NO	2	YES	5	YES	2	YES			

39	GOVINDHAN	63	M	DAILY WAGER	0	NO	2	YES	3	NO	0	YES			
40	ANITHA	43	F	DAILY WAGER	8	NO	2	NO	3	YES	1	YES			
41	RAJA	48	M	UNEMPLOYED	8	YES	2	YES	6	YES	4		YES		
42	RANGAN	46	M	DAILY WAGER	0	YES	2	YES	5	YES	3	YES			
43	DAVID	52	M	FARMER	5	YES	2	NO	2	NO	1	YES			
44	EDWIN	58	M	CARPENTER	8	YES	2	NO	3	YES	0	YES			
45	JOE	51	M	DAILY WAGER	10	YES	2	YES	5	NO	2	YES			
46	HARIDAS	61	M	FARMER	10	NO	2	NO	7	NO	3	YES			
47	BHARAT	67	M	UNEMPLOYED	5	YES	2	NO	5	NO	0	YES			
48	AMBIKA	63	F	HOUSEWIFE	8	NO	2	NO	2	NO	1		YES		
49	HARIDAS	57	M	DAILY WAGER	8	NO	2	YES	2	YES	0	YES			
50	JOTHI	40	F	HOUSEWIFE	12	NO	1	NO	15	YES	0	YES			
51	CHELLAM	56	M	DAILY WAGER	10	YES	2	YES	12	NO	1	YES			
52	DAYALAN	67	M	UNEMPLOYED	12	NO	2	YES	12	NO	2	YES			
53	SILAMBARASAM	45	M	DAILY WAGER	12	YES	2	YES	10	YES	0	YES			
54	MALAR	56	F	HOUSEWIFE	10	NO	2	NO	8	YES	3	YES			
55	SHANMUGAM	67	M	CLERK	DEGREE	YES	2	YES	7	YES	4		YES		
56	SIVA	56	M	FARMER	5	YES	2	NO	2	NO	1	YES			
57	WILSON	55	M	DAILY WAGER	8	YES	1	YES	16	YES	2		YES		
58	ANITHA	60	F	HOUSEWIFE	10	NO	2	NO	4	NO	0		YES		
59	KAVIN	42	M	DAILY WAGER	12	YES	2	YES	8	YES	3	YES			
60	LINGASAMY	45	M	DAILY WAGER	10	YES	2	YES	10	YES	4			YES	
61	UDAYAKUMAR	67	M	UNEMPLOYED	12	YES	2	YES	10	NO	1	YES			
62	JOTHI	60	F	HOUSEWIFE	5	NO	2	NO	12	YES	3		YES		
63	FERNADAS	45	M	UNEMPLOYED	8	YES	2	YES	5	YES	0	YES			
64	SAMY	55	M	FARMER	12	YES	2	YES	6	YES	2	YES			
65	THANGARAJ	56	M	UNEMPLOYED	10	YES	2	NO	7	NO	1	YES			
66	ROHINI	41	F	HOUSEWIFE	5	NO	2	NO	3	NO	0	YES			
67	HARI	46	M	UNEMPLOYED	DEGREE	YES	2	YES	3	YES	3			YES	
68	JAI	70	M	DAILY WAGER	12	YES	2	NO	2	YES	1	YES			
69	CHINNASAMY	68	M	DAILY WAGER	10	YES	1	YES	20	YES	0	YES			
70	RADHAI	63	F	FARMER	5	YES	2	NO	3	NO	2	YES			
71	VEERAPPAN	65	M	UNEMPLOYED	8	YES	2	YES	2	YES	3			YES	
72	INIYAN	55	M	UNEMPLOYED	0	YES	2	YES	2	YES	2			YES	
73	RANGAN	60	M	FARMER	10	YES	2	YES	4	NO	1	YES			
74	SHIVARAJ	63	M	UNEMPLOYED	12	YES	2	NO	4	YES	0	YES			
75	SEENU	51	M	DAILY WAGER	12	YES	2	YES	4	NO	3		YES		
76	DAVIDRAJ	57	M	DAILY WAGER	10	YES	2	NO	3	YES	4			YES	
77	GOVINDHAN	47	F	FARMER	DEGREE	NO	2	NO	15	NO	1	YES			
78	FERNADAS	44	M	UNEMPLOYED	12	NO	2	YES	14	NO	0	YES			
79	HARI	65	M	FARMER	10	YES	2	YES	10	YES	2				YES

80	SHANMUGAM	66	M	DAILY WAGER	5	YES	2	NO	5	YES	4	YES		
81	KARTHICK	61	M	DAILY WAGER	8	YES	2	YES	4	NO	1	YES		
82	KRISHNA	51	M	DAILY WAGER	0	YES	2	YES	6	NO	0	YES		
83	VANITHA	53	F	FARMER	12	NO	2	NO	2	NO	2	YES		
84	ELAYARAJA	67	M	FARMER	10	YES	2	YES	2	YES	4			YES
85	CHERAN	68	M	CARPENTER	5	YES	2	YES	1	YES	3	YES		
86	PERUMAL	70	M	WATCHMAN	5	YES	2	YES	5	YES	1	YES		
87	KRISHNAN	48	M	UNEMPLOYED	8	YES	2	YES	1	NO	0	YES		
88	KANMANI	54	F	UNEMPLOYED	10	NO	1	NO	21	NO	2	YES		
89	ALBERT	58	M	UNEMPLOYED	DEGREE	YES	2	YES	5	YES	3		YES	
90	MANI	67	M	WATCHMAN	5	YES	2	NO	7	YES	4			YES
91	GANGA	65	F	DAILY WAGER	8	NO	2	NO	5	NO	1	YES		
92	ARUMUGAM	62	M	FARMER	8	YES	2	YES	13	NO	3			YES
93	ANANDHI	61	F	DAILY WAGER	0	YES	2	NO	10	NO	0	YES		
94	KUPPUSAMY	56	M	FARMER	12	YES	2	YES	1	NO	2	YES		
95	MANI	66	M	DAILY WAGER	10	YES	2	YES	12	YES	1		YES	
96	DAVID	67	M	WATCHMAN	0	YES	2	YES	6	YES	4			YES
97	PREM	40	M	DAILY WAGER	DEGREE	YES	2	YES	6	NO	3			YES
98	SHANMUGAM	45	M	DAILY WAGER	0	YES	2	NO	8	NO	2	YES		
99	KAVIN	46	M	UNEMPLOYED	12	YES	2	YES	8	YES	1		YES	
100	SHANTHI	56	F	HOUSEWIFE	10	NO	1	NO	15	NO	0	YES		