A STUDY ON ANALYSING PREDICTIVE FACTORS FOR MAJOR LOWER EXTREMITY AMPUTATION IN DIABETIC FOOT PATIENTS

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BRANCH – I

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CERTIFICATE

This is to certify that this dissertation entitled "**A STUDY ON ANALYSING PREDICTIVE FACTORS FOR MAJOR LOWER EXTREMITY AMPUTATION IN DIABETIC FOOT PATIENTS** " is a bonafide record of work done by **Dr. PRABAHARAN. D** in the department of General Surgery, Thanjavur Medical College Hospital, Thanjavur during his post-graduate course 2017- 2020. This is submitted in partial fulfillment for the award of M.S. degree examination Branch- I (General Surgery) to be held in May 2020 under the Tamil Nadu Dr.MGR medical university , chennai .

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This is to certify that this dissertation work titled **"A STUDY ON ANALYSING PREDICTIVE FACTORS FOR MAJOR LOWER EXTREMITY AMPUTATION IN DIABETIC FOOT PATIENTS**" of the candidate **Dr. PRABAHARAN.D**. with registration number **221711208** for the award of M.S. degree examination (Branch-I) in General Surgery. I personally verified the urkund.com website for the purpose of plagiarism check. I found that the uploaded thesis file contains from introduction to conclusion pages and the result shows **9** percentage of plagiarism in the dissertation.

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DECLARATION

I declare that this dissertation entitled "**A STUDY ON ANALYSING PREDICTIVE FACTORS FOR MAJOR LOWER EXTREMITY AMPUTATION IN DIABETIC FOOT PATIENTS**" is a record work done by me in the Department of General Surgery, Thanjavur Medical College Hospital, Thanjavur during my post-graduate course from 2017-2020 under the guidance and supervision of Prof. Dr. W. Premalatha Sharon Rose M.S., D.M.R.T., my unit chief and Prof. Dr. K.Sathyabama M.S., Head of the Department of General Surgery, Prof. Dr. V. Kopperundevi M.S., D.G.O., my former unit chief and Prof. Dr. M. Elangovan M.S., former Head of the Department of General Surgery, Thanjavur Medical College. It is submitted in partial fulfillment for the award of M.S. degree examination (Branch-I) General Surgery, to be held in May 2020, under the Tamil Nadu Dr. MGR Medical University, Chennai.

This work has not been submitted previously by me for the award of any degree or diploma from any other university.

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CONTENT

INTRODUCTION

Diabetic foot is defined by World Health Organisation as “The foot of a Diabetes mellitus patient that has the potential risk of pathologic consequences, including infection, ulceration, and/or destruction of deep tissues associated with neurologic abnormalities, various degrees of peripheral vascular diseases and/or metabolic complications of diabetes in lower limb”. One of the most significant complications of diabetes is foot disease, which often leads to amputation was common in developing countries like India.

India is slowly progressing to the top of the world with largest number of Diabetes subjects and is being anticipated to be the “diabetes capital of the world”. Among diabetes related complications, ulceration of the foot is the most common one, affecting 15% of the diabetic patients in their lifetime. Diabetic foot ulcer precedes almost 85% of the amputations.

Diabetes mellites is responsible for approximately 80% of all non traumatic amputations performed every year. After a major amputation 50% of people will need to have other limb amputation within two years. People with history of diabetic foot ulcer have 40% greater 10 year death rate than people with DM alone. It is estimated that 45000 legs are amputated every year in India. In every 30 seconds a leg is lost due to diabetes somewhere in

the world. As population with DM increases, more and more amputation of lower extremity can be expected in future.

Amputation not only affects the physical functional status but also affects the psychosocial status and increases their financial burden by means of hospital stay and treatment and loss of employment.

Our institution is well known for its academic and research activities and has good infrastructure for managing diabetes and its complications. We have a separate ward for diabetic patients for effective management. In department of general surgery, every week we get around 10-12 diabetic patients with foot problems who will be either treated as an outpatient or in patient depending on magnitude of their problem.

Foot ulceration is absolutely preventable and by simple interventions one can reduce amputations up to 80%. Regular evaluation and early treatment are the most effective mechanisms to prevent the devastating diabetic foot complications.

This study was conducted to analyse the predictive factors for major lower extremity amputation in diabetic foot patients.

AIMS AND OBJECTIVES

To analyse various factors which contribute to major amputation in lower extremities in diabetic foot patient.

REVIEW OF LITERATURE

HISTORICAL ASPECT OF DIABETIC FOOT

Until 20th century disease of lower limb in diabetic patients was designated as 'diabetic gangrene' or 'gangrene in diabetic foot'. Significant distinction between dry gangrene which is due to vascular insufficiency and wet gangrene due to infection with normal or near normal blood supply was not made until 1893.

In 1934, Elliot Joslin, one of the pioneers of diabetology, published an article entitled 'The menace of diabetic gangrene', in which he described the common causes of the diabetic foot lesions and he wrote that 'gangrene is not heaven sent but is earth born'. However it was not until the 1950's that diabetic neuropathy, ischemia and infection were finally recognized as precondition of foot complications in diabetes- facts that still hold good today.

EPIDEMIOLOGY OF DIABETIC FOOT IN INDIA

The diabetic foot ulcer prevalence is 3.6% in India. According to the diabetes atlas 2013 published by the International Diabetes Federation, the number of people with DM in India was 65.1 million, which is expected to rise to 142.7 million by 2035.

In a study from south India, it was found that patient without foot problems spent 9.3% of total income, while patients with foot problem spend 32.3% of total income towards treatment.

Increase in prevalence of foot complications in India can be attributed to socio-cultural practices such as barefoot walking, poor hygiene, illiteracy, use of improper foot wear, poor socioeconomic status.

DIABETES MELLITUS

Diabetes mellitus is a metabolic disorder characterised by chronic hyperglycemia along with disturbances in the carbohydrate, fat and protein metabolism which may be attributed to deficiency in secretion of insulin or its actions.

CLASSIFICATION AS DESCRIBED BY AMERICAN DIABETIC ASSOCIATION

1. TYPE I DIABETES

a. Autoimmune

b. Idiopathic

2.TYPE II DIABETES

a. Insulin resistance predominance

b. Insulin secretory defects

3.OTHER TYPES

a. Genetic defect of beta cell dysfunction

b. Genetic defects in the action of insulin

c. disease of exocrine pancreas - pancreatitis, in pancreatectomy, fibrocalculus pancreatopathy

d. endocrinopathies

e. drugs or chemical infection

f. infections-cytomegalovirus, coxsackie virus, congenital rubella

g. other genetic syndromes

4.GESTATIONAL DIABETES.

DIABETIC FOOT:

Diabetic foot defined as a group of syndrome in which neuropathy, ischemia and infection lead to tissue breakdown resulting in morbidity and possible amputation.

The most common precursor for lower limb amputation in diabetic patient is foot ulcer.

RISK FACTORS:

-peripheral motor neuropathy

-peripheral sensory neuropathy

-peripheral autonomic neuropathy

-neuro-osteoarthropathic deformities(charcots)

-vascular insufficiency

-hyperglycemia and other metabolic dearrangements

-maladaptive patient behaviours

-abnormal foot anatomy and biomechanics

-impaired immunological function and wound healing

-previous ulcers /amputations

-injury and ill fitting shoes

-inadequate health education

ANATOMY OF FOOT

The dorsal skin is thinner (2mm thick), lax and can be pinched, while the plantar skin is thick (5mm) and cannot be pinched. The foot has a thick stratum corneum and a thin dermis. The skin is rich in sweat glands on the plantar skin.

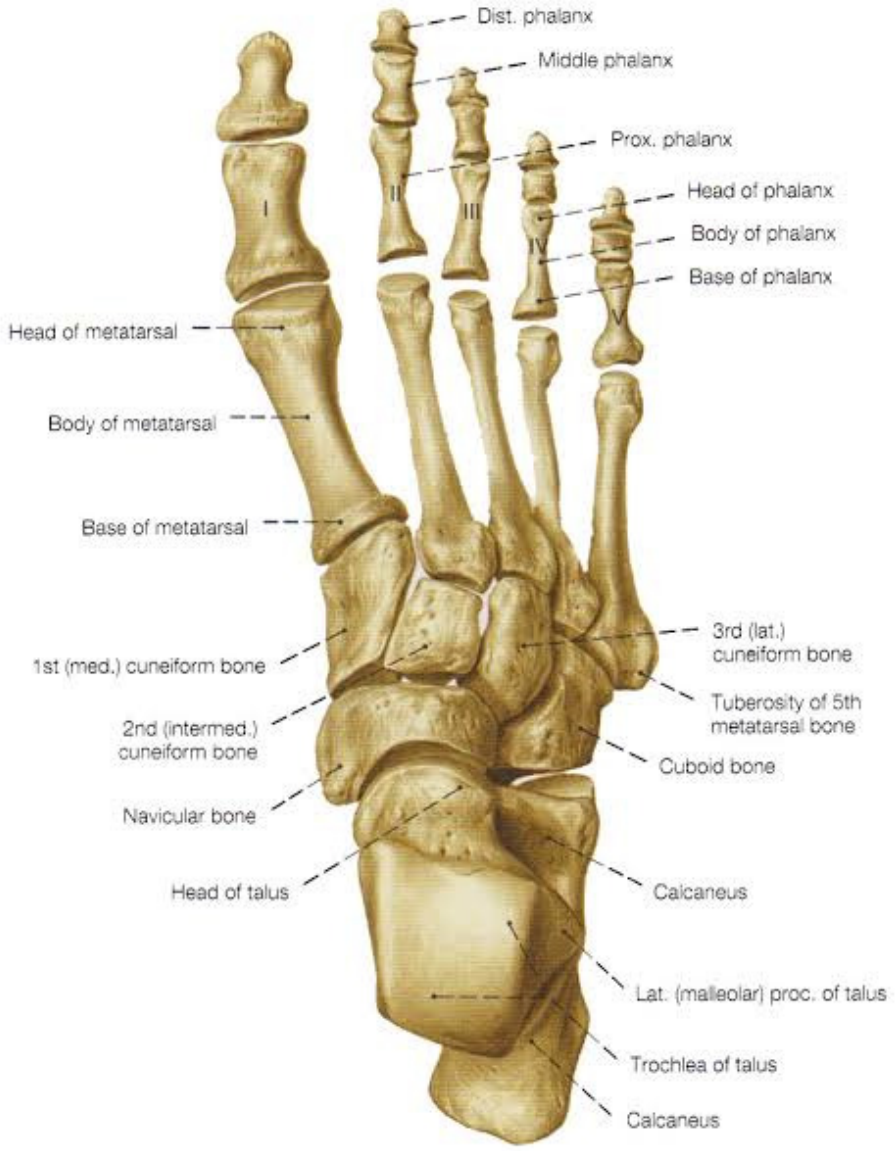
The dermis is bound to underlying fascia to improve grip and to prevent gliding or sliding. Infections of sole tend to point to the dorsum, because of the thick plantar skin. The epidermis gets transformed into the nail matrix. It has three ill- defined layers dorsal, intermediate and ventral layers. It is firmly attached to the epithelium of nail bed. The margins of the nail are overhung by skin folds predisposing to ingrown toe nails. The plantar subcutaneous tissue is more fibrous. The fluid fat is loculated by fibrous septa to provide shock absorption and to prevent gliding or sliding of plantar skin.

Skeleton and fascia of the foot:

The skeleton of the foot is shaped to form arches and adjust to uneven surfaces. There are 7 tarsal bones, 5 metatarsals and 14 phalanges. The superficial fascia of the sole is fibrous and dense. Fibrous bands bind the skin to deep fascia or plantar aponeurosis. The fibrous bands divide the subcutaneous fat into small compartments which serve as cushions and reinforce the spring effect of the arch during walking, running, jumping, etc.

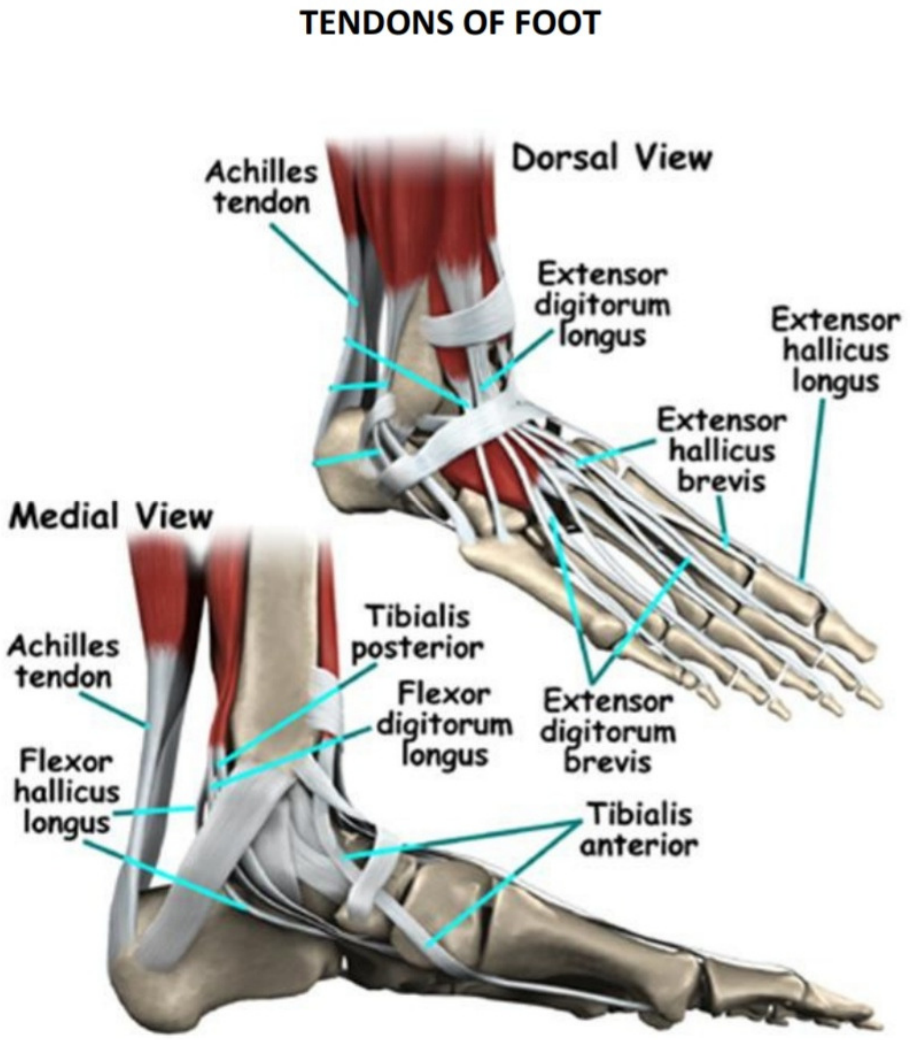
The fascia is thick over weight bearing parts. It contains cutaneous nerves and vessels. The thickened central part of the deep fascia is the plantar aponeurosis.

The plantar aponeurosis fixes the skin of the sole, protects deeper structures and helps in maintaining the longitudinal arches of the foot. It also gives origin to the muscles of the first layer of the sole.



Ligaments of the foot

The ligaments maintain the arches and stability. They have a springing effect in locomotion and also help in shock absorption. The ligaments of the foot are long plantar ligament, plantar calcaneocuboid (shortplantar) ligament, plantarcalcaneonavicular (spring) ligament, deltoid ligament (medial), transverse metatarsal ligament, interosseous ligament.



Muscles and tendons of the foot

There are four layers which help in movement and grip and have a cushioning effect thereby protect nerves and vessels and they suspend arches. First layer includes abductor hallucis longus, flexor digitorum brevis, abductor digiti minimi. Second layer is made of flexor accessorium (quadrates plantaris), tendons of flexor hallucis longus, flexor digitorum

longus and the lumbricals. Third layer is constituted by the flexor hallucis brevis, , transverse and oblique heads of adductor hallucis, flexor digiti minimi brevis. The fourth layer is mainly formed by the interrossei.

Musculo- fascial compartments of the foot

There are four compartments, formed by vertical septa from the plantar aponeurosis extending deep. They are the medial, central, lateral and interosseous compartments. The medial compartment contains medial plantar nerve, artery, vein, and the central (larger) compartment contains lateral plantar nerve, artery and vein.

Nerves of the foot:

Saphenous nerve arises from the femoral nerve. It supplies medial aspect of the foot up to the first metatarsal. **Superficial peroneal (fibular) nerve** is the smaller terminal branch of the common peroneal nerve. It gives cutaneous branches to most of the dorsum of foot including digital branches to medial side of great toe, adjacent sides of second, third, fourth and fifth toes. **Deep peroneal (fibular) nerve** is the terminal branch of the common peroneal nerve. It supplies extensor digitorum brevis and gives cutaneous branch to the adjacent side of great and second toes.

Medial plantar nerve is the largest terminal branch of the tibial nerve. It supplies abductor hallucis, flexor digitorum brevis, flexor hallucis brevis and

first lumbrical muscle. Cutaneous branches supply skin of the medial part of the sole and medial three and half toes.

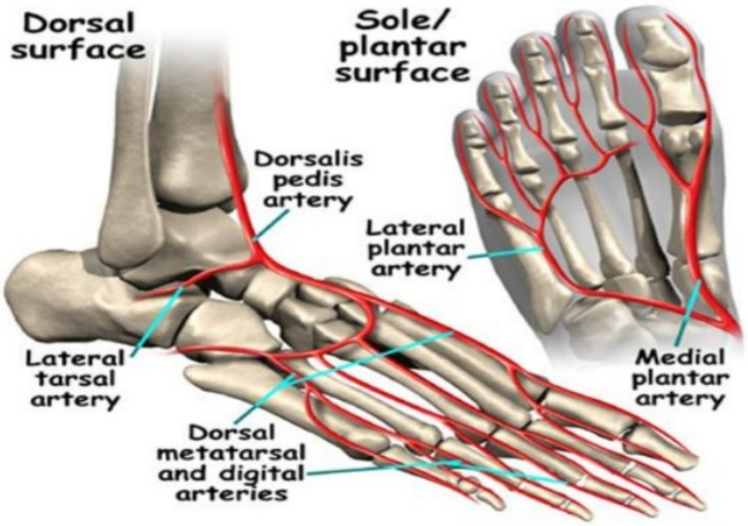
Lateral plantar nerve is the smaller terminal branch of tibial nerve. The main trunk supplies flexor digitorum accessorius, abductor digiti minimi and skin of the sole. It divides into superficial and deep branches.

Sural nerve arises from tibial and common fibular nerves and runs along the short saphenous vein. It supplies lateral side of the foot and fifth toe and all intrinsic muscles of the foot (S2 and S3).

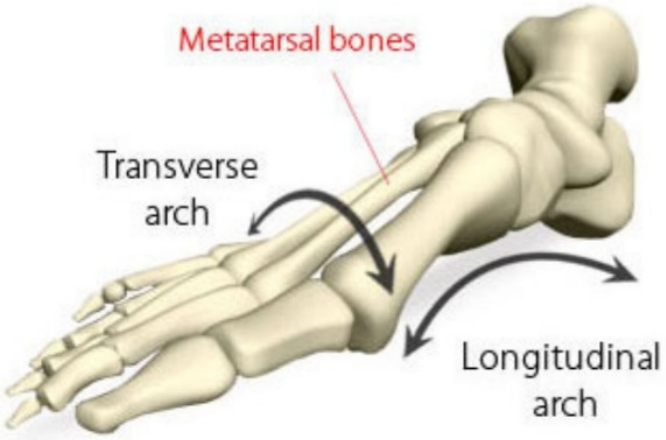
Arterial tree

The dorsalis pedis artery is a continuation of anterior tibial artery and it runs between tibialis anterior and extensor hallucis longus tendons. It may be absent in about 5% of population. It gives arcuate artery, supplying the dorsum of foot and toes. The dorsalis pedis artery dips deep in the first inter-metatarsal space to form the plantar arch, by joining the medial and lateral plantar arteries.

The posterior tibial artery, runs behind the medial malleolus and divides into medial and lateral plantar arteries, supplying the sole and toes. The plantar arch is formed by the medial and lateral plantar arteries with contribution from termination of the dorsalis pedis artery. The digital arteries arise from theplantar arch (plantar aspect) and arcuate artery (dorsally).



VESSELS OF FOOT



ARCHES OF FOOT

Venous drainage

The dorsal venous arch lies in the dorsum of foot over the proximal parts of the metatarsal bones. It receives four dorsal metatarsal veins. These metatarsal veins are formed by the union of two dorsal digital veins. The long saphenous vein is formed by the union of medial end of the dorsal venous arch and the medial marginal vein. The medial marginal vein drains the medial side of the great toe. The short saphenous vein is formed by the union of lateral end of dorsal venous arch and lateral marginal vein. The lateral marginal vein drains the lateral side of the fifth toe. Both the saphenous veins connect to deep veins through the perforating veins.

Lymphatic drainage

Superficial lymphatics drains along both the saphenous veins, short saphenous zone into popliteal group and long saphenous zone into inguinal group. Deep lymphatics drain along the arteries to both popliteal and inguinal groups.

Arches of foot

The arches help to adjust to uneven surfaces. The presence of arches makes the sole concave and this concavity protects the neuro-vascular structures. They are medial and lateral longitudinal arches and the anterior and posterior transverse arches

.

ANATOMY OF LEG

Superficial fascia

Contains superficial veins like great saphenous vein, short saphenous vein, cutaneous nerves like infrapatellar branch of saphenous nerve, saphenous nerve, lateral cutaneous nerve of calf, superficial peroneal nerve, sural nerve, lymphatics, and small unnamed arteries.

Deep fascia

Extension of deep fascia form the septa divide the leg into three compartments :anterior, posterior and lateral.

Anterior compartment

Muscles:

Tibialis anterior

Extensor hallucis longus

Extensor digitorum longus

Peroneus tertius

Vessels: Anterior Tibial vessels

Nerve: Deep peroneal nerve

Lateral Compartment

Muscles:

Peroneus longus

Peroneus brevis

Nerve: Superficial peroneal nerve

Vessels : Peroneal vessels

MEDIAL SIDE OF THE LEG

Formed by medial surface of the shaft of tibia. The greater part of this surface is subcutaneous and is covered by skin and superficial fascia. Three muscles are inserted into the upper part of medial surface of the tibia from three

compartments of the thigh namely Sartorius, gracilis, and semitendinosus forming Guy ropes.

BACK OF THE LEG

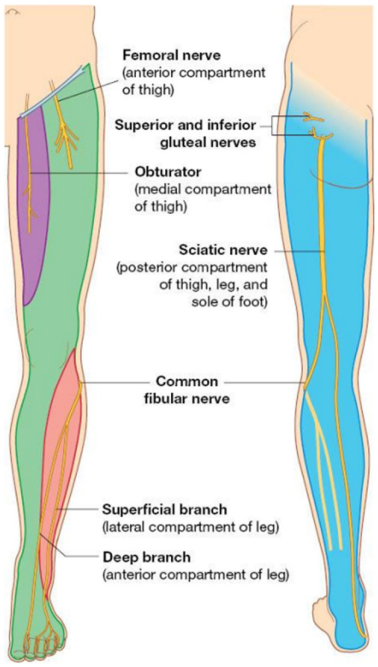
Superficial fascia of the back of the leg contains small and great saphenous veins and their tributaries, several cutaneous nerves, and medial and lateral calcaneal arteries.

Superficial muscles of this area are

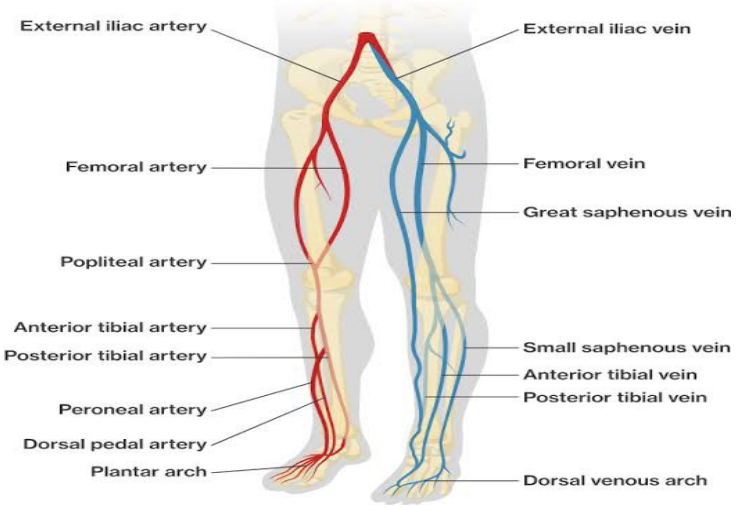
- Gastrocnemius
- Soleus
- Plantaris

Nerve supply to superficial muscles of the back is Tibial nerve. Posterior group of muscles that are present in deep aspect are

- Popliteus
- Flexor digitorum longus



Nerve supply of lower limb



Blood Supply of Lower Limb

ANATOMY OF THE THIGH

FRONT OF THE THIGH

The superficial fascia of the front of the thigh contains great saphenous vein, cutaneous nerves, vessels, lymphatics and lymph nodes.The upper third of the thigh medially contains the femoral triangle, middle third carries the femoral vessels through the adductor canal. Muscles of the frontal aspect of the thigh are

- Sartorius
- Rectus femoris
- Vastus lateralis
- Vastus intermedius
- Vastus medialis

Nerve supply : Femoral Nerve

MEDIAL ASPECT OF THE THIGH

Muscles

Adductor longus

Adductor brevis

Adductor magnus

Gracilis

Pectineus

Obturator externus

Nerve supply

Obturator nerve

Accessory obturator nerve

Arterial supply

Obturator artery

Medial circumflex femoral artery

BACK OF THE THIGH

Muscles

Semitendinosus

Semimembranosus

Biceps femoris

Nerve supply Sciatic nerve

Vascular supply

Lateral circumflex femoral

Medial circumflex femoral vessels

PATHOPHYSIOLOGY OF DIABETIC FOOT

The predisposing factors to pathologic changes in the foot of diabetic are

1. Metabolic factor-hyperglycemia
2. Vascular Changes
3. Neuropathy\
4. Infections

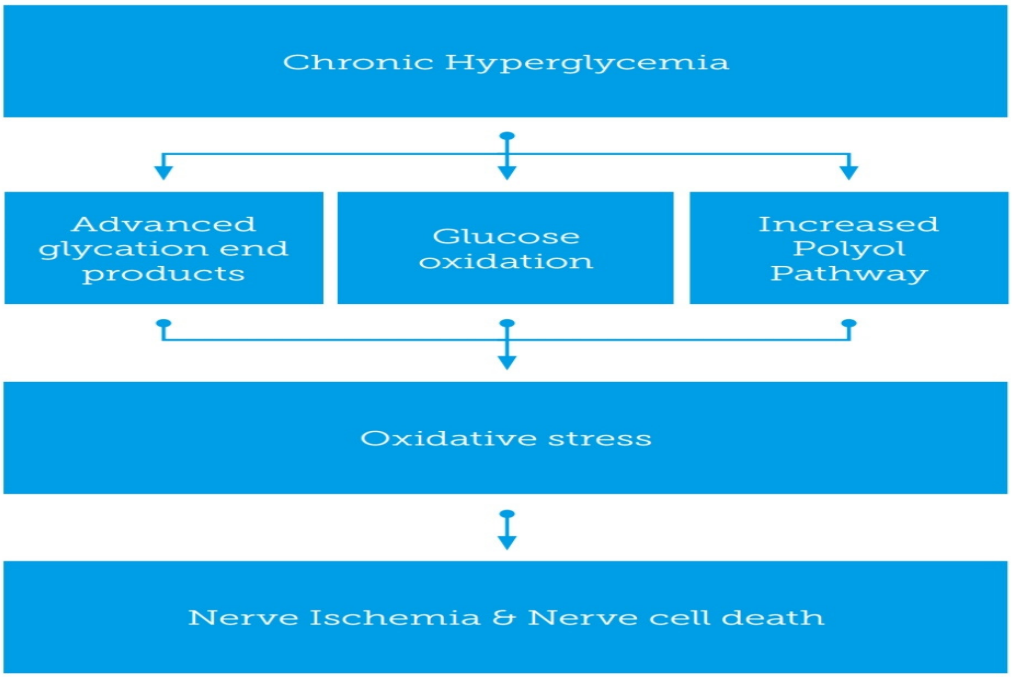
HYPERGLYCEMIA:

Hyperglycemia results in increased levels of sorbitol in the cells which acts like an osmolyte a competitive inhibitor of myoinositol uptake. This preferential shunting of glucose through the sorbitol pathway results in decreased mitochondrial pyruvate utilisation and decreased energy production. This process is termed as hyperglycemia induced pseudo hypoxia.

Diabetic neuropathy

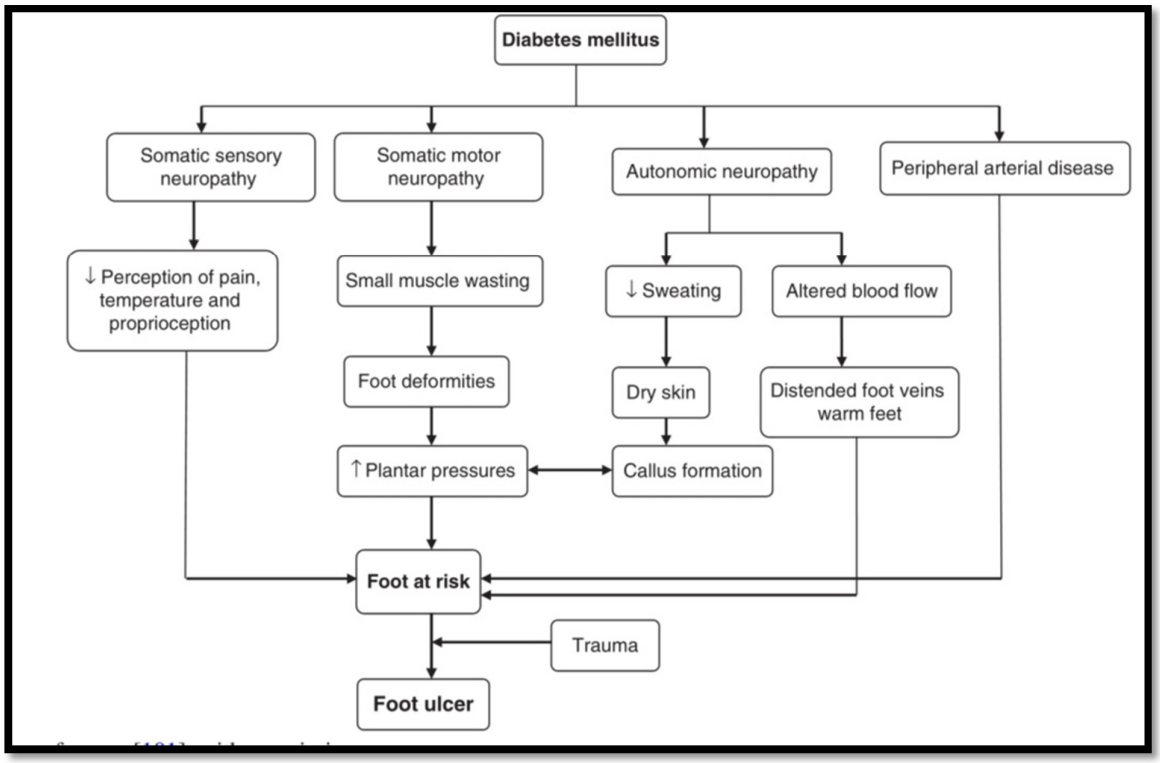
The most important factor leading to amputation for the person with diabetes is peripheral neuropathy and the resulting insensitive foot. Diabetic neuropathy affects sensory, autonomic and motor neurons of the peripheral nervous system, which is to say that every type of nerve fibre is affected.

Diabetic peripheral neuropathy may be divided into two main types, acute sensory neuropathy and chronic sensorimotor neuropathy(most common).



Biochemical dysfunctions leading to neuropathy includes increased advanced glycosylation end products(AGE'S),defective polyol pathway, neuro vascular alterations and impaired resistance to oxidative stress. The manifestations of sensory neuropathy are paresthesia, reduced pain perception, loss of joint sense, loss of vibration sense, glove and stocking anaesthesia, Charcot joints. Motor neuropathy presents as weakness of muscles, paralysis of small muscles of foot producing deformed toes. Autonomic neuropathy is characterized by the micro circulatory derangement of the tissues of the foot. There will be abnormal sweating and in some

absence of sweating, dry foot with lot of cracks in the sole, calcification of medium sized arteries and loss of thermoregulation.



ANGIOPATHY

Diabetes can affect both macro and microcirculation. In patients with Diabetes, atherosclerosis develops at an early age. Medial calcification, Diffuse intimal fibrosis and Atherosclerosis are the most common macrovascular changes observed with Diabetes. The most common risk factors associated to vascular component are dyslipidaemia, hypertension, duration of Diabetes, severity of the disease, smoking, Insulin resistance. Moss and colleagues said that current smokers less than 30 years of age were more prone to ulcerate.

Cessation of smoking is associated with a decrease the atherogenic process. Hypertension is almost twice common in diabetics compared to non-diabetics. Arteriosclerosis, specific diabetic microangiopathy and diabetic which vascular disease causing lesion of nerves are ischemia caused by occlusion of vessels, altered permeability of capillaries causing osmotic and fibrillosis are the micro vascular changes observed with Diabetes. The typical histological changes are thickening of capillary basement membrane, proliferative changes in arterioles and arteries which include enlargement and proliferation of endothelial cells. Enlargement of endothelial cell is a feature in diabetes leading to small vessel occlusion, causing foot ulceration termed 'small vessel disease' with the presence of palpable pulses in the foot.

Increased resting blood flow due to denervated sympathetics causing loss of vasoconstriction, with loss of regulation in circulation in the arterio-venous vessels. A 'capillary steal' phenomenon is induced leading to shunting of blood away from the capillaries leading to reduced skin nutrition. This explains paradoxical ulceration despite increased blood flow.

PERIPHERAL VASCULAR DISEASE

Peripheral vascular disease occurs at an early age in diabetic patients . It is highly likely to involve vessels below popliteal artery. The mechanism by metabolic derangements. In western countries, vascular alterations is an

important factor for foot ulcerations causing major amputations later . Minor trauma and antecedent infections increase blood requirement beyond the capacity, leading to ischemia and ulceration. Patients presents with intermittent claudication, rest pain and nocturnal pain. Nocturnal pain and rest pain are relieved by keeping legs in dependent position. The circulation is predominantly caters to the splanchnic area during sleep, resulting in decreased perfusion of the lower extremities resulting in ischemic neuritis that disturbs sleep. The features of the ischemic limb are cold feet with absent pulses, delayed venous filling with blanching on elevation. There is loss of hair, thickened nails, and the skin appears shiny. Clinical assessment of the peripheral circulation is extremely useful in the assessment of outcome.

INFECTION

Infection is defined by invasion of the tissues with proliferation of microorganisms causing tissue damage with or without an associated inflammatory response by the host. Foot sepsis accounts for about 70% of all infections. Adherence of granulocytes and other WBC functions like phagocytosis are impaired in diabetes. T cell function is impaired and cell mediated immunity is depressed. Hyperkeratosis in foot is mistaken for a corn and removing it using rusted nail and safety pin is the foremost reason leading to amputation. Absent sweating leads to cracks and fissures in foot which are

portals of infection. Organisms may be causative , commensal, contaminant or coexisting polymicrobial. Most common is polymicrobial infection. Staphylococcus aureus and Beta hemolytic streptococci are the most commonly involved pathogens in acute infections. In Chronic wounds, Enterococci, Enterobacteriaceae, Obligate anaerobes, Pseudomonas, Fungi are the pathogens involved.

CLASSIFICATION

Wagner classification system

Grade Lesion

0 No open lesions: may have deformity or cellulitis

1 Superficial ulcer

2 Deep ulcer to tendon or joint capsule

3 Deep ulcer with abscess, osteomyelitis, or joint sepsis

4 Local gangrene- forefoot or heel

5 Gangrene of entire foot

This most valuable grading for the diabetic ulcer foot designed by William Wagner. It is also known as WAGNER-MEGITT'SCLASSIFICATION. This system help to analyse the progress of the patient, both positive and negative outcomes, and to standardize the treatment plan

CLASSIFICATION – UNIVERSITY OF TEXAS

Aetiology (Stage) included -

Staging

–Stage A: No infection or ischemia

–Stage B: Infection present

–Stage C: Ischaemia present

–Stage D: Infection and ischaemia present.

Grading

–Grade 0: Epithelialized wound

–Grade 1: Superficial wound

–Grade 2: Wound penetrates to tendon or capsule

–Grade 3: Wound penetrates to bone or joint

PEDIS SYSTEM

The classification system is based on perfusion, extent, depth/ tissue loss, infection and sensation.

PEDIS classification system.

Grade	Perfussion	Extent	Depth	Infection	Sensation	Score
1	No PAD	Skin Intact	Skin intact	None	No Loss	0
2	PAD, No CLI	<1cm^2	Superficial	Surface	Loss	1
3	CLI	1-3cm^2	Fascia, muscle, tendon	Abscess, Fascitis, Septic athritis		2
4		>3cm^2	Bone or joint	SIRS		3

RUTHERFORD GRADING

Grade 0 – Asymptomatic

Grade 1 – Claudication present

Grade 2 - Rest pain present

Grade 3- Minor tissue loss such as non-healing ulcer focal gangrene with diffuse pedal ischemia, and major tissue loss such as gangrene extended above tarsometatarsal level

Grade 4 – functional foot, No longer salvageable.

EDMONDS AND FOSTER CLASSIFICATION SYSTEM:

The system is based on the ankle-brachial index. The ulcers are classified into neuropathic or neuroischemic.

MACFARLANE AND JAFFECOATE CLASSIFICATION SYSTEM-SAD SYSTEM

Ulcers are classified on the basis of size (area and depth), sepsis, arteriopathy , denervation.

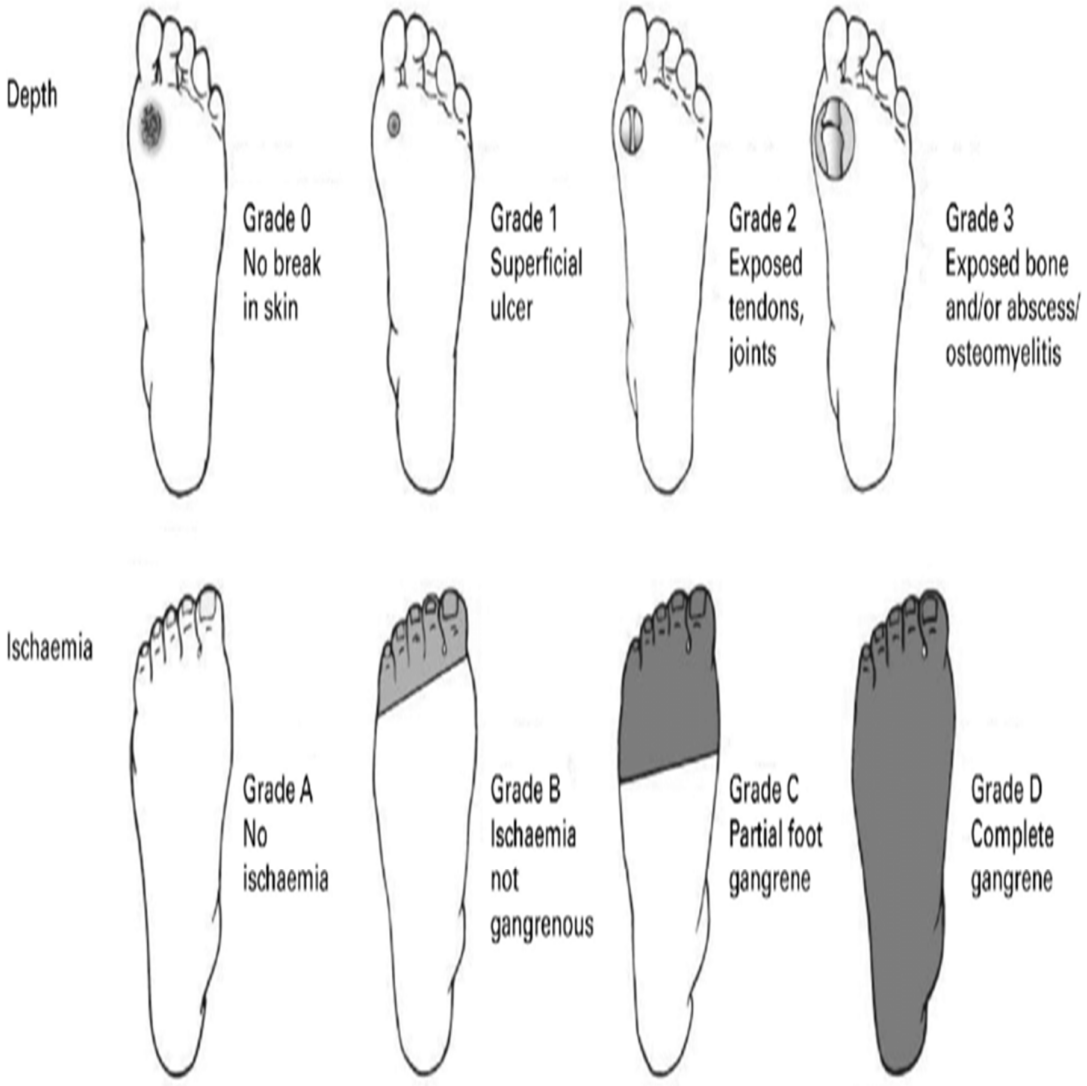
SINBAD CLASSIFICATION:

Site, ischemia, neuropathy, bacterial infection and depth are factors that are considered under this system.

Category	Definition	SINBAD score	Equivalent S(AD)SAD categories
Site	Forefoot	0	—
	Midfoot and hindfoot	1	—
Ischemia	Pedal blood flow intact: at least one pulse palpable	0	0–1
	Clinical evidence of reduced pedal blood flow	1	2–3
Neuropathy	Protective sensation intact	0	0–1
	Protective sensation lost	1	2–3
Bacterial infection	None	0	0–1
	Present	1	2–3
Area	Ulcer $<1cm^2$	0	0–1
	Ulcer $\geq 1cm^2$	1	2–3
Depth	Ulcer confined to skin and subcutaneous tissue	0	0–1
	Ulcer reaching muscle, tendon or deeper	1	2–3
Total possible score		6	—

BRODSKY CLASSIFICATION

Based of depth and ischemia.



ASSESSMENT OF DIABETIC FOOT ULCER

Proper assessment of diabetic foot includes adequate history, clinical examination and investigations.

HISTORY

A complete history will aid in assessing the severity and risk of foot ulceration. A good history includes duration of diabetes, treatment history, comorbidities, past medical or surgical history and any other complications of DM like retinopathy or nephropathy.

CLINICAL EXAMINATION

ASSESSMENT OF NEUROPATHY

1) Filament test – Semmes-Weinstein monofilament is used to detect the diminished sensation of foot.

2) Testing for vibration sense in toes and over the malleoli using biothesiometer.

3) Loss of joint position is common in diabetic neuropathy. Joint sense of great toe is commonly tested. severe neuropathy produces small muscle wasting in the foot which leads to collapse of arches and deformity of toes which ultimately results in ulcer formation.

ASSESSMENT OF VASCULAR DISEASE.

It starts with inspection of the foot for hue of toes, nicotine staining of fingers, thinning of skin due to loss of subcutaneous tissue and acral ulcers. Palpation of pulses such as femoral, popliteal, and dorsalis pedis remains the corner stone of screening for peripheral vascular disease. Absence of distal pulse is a sure sign of significant arterial disease. Ankle brachial index (ABI) is a simple method of assessing vascular insufficiency by dividing ankle systolic pressure by brachial systolic pressure. Normal is 1+/- 0.1. If ABI is more than 0.9, repeat every two to three years. If ABI is 0.5 to 0.89, repeat within three months and treat cardiovascular risk factors. If ABI is less than 0.5, refer for vascular work up and management.

INTEGRATED EXAMINATION OF DIABETIC FOOT

In practice the examination of foot is divided into four main parts: inspection, palpation, vascular status, and neurological examination.

INSPECTION

The foot should be fully inspected including dorsum, sole, back of the heel, and interdigital areas with full assessment.

-colour

-deformity

-swelling

-callus

-Infection

-Necrosis

-appearance of nail

-ulceration/gangrene

PALPATION

Pulse should be palpated and temperature of skin is compared between both feet using back of the examiner's hand. Measurement of skin temperature is particularly helpful in Charcot foot where digital skin thermometer is used.

VASCULAR STATUS

All the peripheral pulses must be examined and compared with normal limb. In lower limb femoral, popliteal, anterior tibial, posterior tibial and dorsalis pedis arterial pulses must be examined.

NEUROLOGICAL EXAMINATION

Peripheral sensory neuropathy should be examined by biothesiometry or monofilament or by performing simple sensory

examination. Motor function should be examined by looking for muscle wasting or electrophysiological test. Autonomic functions examined by quantitative sweat test or thermograph of skin temperature.

WET GANGRENE WITH CELLULITIS

DRY GANGRENE OF GREAT TOE

DRY GANGRENE OF FOOT

DEEP ULCER WITH TENDONS EXPOSED

LABORATORY INVESTIGATIONS

-Fasting /postprandial blood sugar level

-Complete blood count

-Renal function test

-Urine for glucose and ketones

-HbA1c

-ESR

-Wound culture and sensitivity

IMAGING STUDIES

The complex nature of diabetic foot disease along with its complications predispose it to various infections and non – infectious process. Hence imaging presentations are more likely to vary because of lack of specificity in complex clinical situations. Obviously it will be a great challenge to interpret the imaging studies in diabetic foot disease. Hence these imaging studies should be restricted to confirm a diagnosis and to treat the patients.

Plain X – rays are always the first imaging study in diabetic patients who are presenting with signs and symptoms of foot ulcer. X-ray finding in diabetic foot infection for example osteomyelitis will not

be able to demonstrate in an obvious osseous changes for upto two weeks. Plain X-rays are mainly indicated to detect osteomyelitis, osseolysis, fractures/dislocations seen in neuropathic arthropathy, arterial calcification and soft tissue gas shadows.

The role of CT scans come in to play only when X-rays do not show any suspected bone or joint pathology. CT scan provides high anatomical details and resolution of bone with osseous fragmentation and also subluxation of joints are visualized better. Though 99Technitium scan lacks specificity in neuropathic patients, they are also used in evaluation of diabetic foot infections. For early detection of osteomyelitis, fracture, charcot's arthropathy the threephase bone scans are beneficial. All these imaging modalities when combined with other scintigraphic procedures like WBC scans have a higher specificity. Gallium 67 citrate is used along with 99Tc scan to help in the diagnosis of osteomyelitis and acute osteo arthropathy.

Indium 111 leukocyte scans, TcGG-labelled white cell scan have high sensitivity and specificity to distinguish between osteomyelitis and neuropathic arthropathy. Even though these investigations are costly and time consuming, they are available in most of the hospitals which aim at an early identification of bone infections. MRI scan is also used in evaluating soft tissue, bone, pathologies. Indications for MRI are

osteomyelitis, deep seated abscesses, septic arthropathy and tendon rupture. MRI has high sensitivity for bone infection and it is readily available. It can be used for planning surgical interventions. Even though it is costlier, MRI has been accepted widely in the treatment of diabetic foot ulcers.

OTHER INVESTIGATIONS

Other investigations include arterial Doppler study, transcutaneous oxygen tension measurement, Harris Mat which is not only useful in qualitative measurement of plantar pressure but also useful in identifying vulnerable areas of ulceration.

MANAGEMENT OF DIABETIC FOOT

The main aim in the treatment of diabetic foot ulcer is to obtain wound closure as early as possible. In diabetic patients the rate of lower limb amputation can be reduced by treatment of foot ulcer and reducing the rate of occurrence. The treatment objectives are summarized as follows

- control co morbidities

- ensuring adequate vascularity

- Assessing psychosocial factors

- Ulcer appraisal

- Ulcer bed preparation

- Relieving pressure

EDUCATION

Self-education has shown to reduce 50% of cases by foot self-care. Patient should be educated about risk factors, importance of foot care, foot hygiene, use of proper foot wear and blood sugar monitoring.

MEDICAL MANAGEMENT

For successful management, it is important to access the diabetic status, severity of infection and general nourishment of the patient.

- Diabetic diet
- Oral hypoglycaemic drugs
- Insulin therapy
- Correction of fluid and electrolyte imbalance
- Antibiotic therapy- limiting cellulitis and spread of infection.

DRESSINGS

Dressings are done to keep the wound clean and free. Materials used should not cause injury to wound.it should confer moisture balance, protease sequestrations, growth factor stimulation, antimicrobial activity,o_2

permeability, granulation tissue formation and re epithelialisation. It is classified as active and passive dressing.

PASSIVE DRESSING-used as protective function and for acute wounds since they absorb exudates and good protection.

ACTIVE DRESSING –mostly used for chronic wounds since they adapt easily and give a moist environment.

ADVANCED DRESSINGS:

-Films

-Hydro Gels

-Hydro Colloids

-Alginates

-Foams

-Silver Impregnated Materials

DEBRIDEMENT

It is removal of necrotic and senescent tissues as well as foreign infected bodies from the wound. It will reduce bacterial counts stimulate production of local growth factors. There are several types of debridement.

-Surgical

-Enzymatic

-Autolytic

-Mechanical

-Biological

OFFLOADING:

Commonly known as pressure modulation, it is important for management of neuropathic ulcer in diabetic patients. The most effective technique is total contact casts.

Total contact cast is minimally padded and moulded carefully to shape of the foot with a heel for walking, relieves pressure from ulcer and distributes over entire foot. Disadvantage of total contact cast was need for expertise, improper use results in skin irritation or ulceration.

TOTAL CONTACT CAST

ADVANCED THERAPIES:

Hyperbaric oxygen therapy(HBOT):

It has shown promise in the treatment of serious cases of non healing diabetic foot ulcer, which are resistant to other therapeutic methods. It involves intermittent administration of 100 % oxygen usually in daily sessions.

During each session, patient breathed pure oxygen at 1.4-3.0 absolute atmosphere during 3 periods of 30 minutes intercalated by 5 minutes interval in hyperbaric chamber.

ELECTRICAL STIMULATION:

Electrical stimulation is reported as a perfect adjunctive therapy for diabetic foot ulcer healing. There is a substantial body of work that supports the effectiveness of electrical stimulation for diabetic foot ulcer healing.

NEGATIVE PRESSURE WOUND THERAPY:

Negative pressure wound therapy is a non-invasive wound closure system that uses controlled, localised negative pressure to improve healing of acute and chronic wounds. This system uses latex free and sterile polyurethane or polyvinyl alcohol foam dressing that is fitted at the bedside to the appropriate size for every wound. Most commonly 80- 125 mmHg of negative pressure is used either continuously or in cycles.

BIOENGINEERED SKIN:

Bioengineered skin (BES) has been used during the last decade as a new therapeutic method to treat diabetic foot ulcer. This method replaces the degraded and destructive milieu of extracellular matrix with introduction of new ground substance matrix with cellular components. BES product cells are seeded into scaffolds and cultured in vitro. It accelerate healing by actively secreting growth factors during the repair process.

VAC THERAPY

Delivery of intermittent or continuous sub-atmospheric pressure through a specialized pump connected to open-celled foam surface dressing covered with an adhesive drape to maintain a closed environment. It increases blood flow, decreases local tissue edema, removes excessive fluid and proinflammatory exudates from the wound bed.

SURGERY:

WOUND CLOSURE:

Wound closure is attempted once the ulcer is clean with healthy granulation tissue. Primary closure is possible for small wounds, tissue loss can be covered with help of skin graft, flap or commercially available skin substitutes.

Split thickness skin grafts are preferred over full thickness grafts. Flaps can be either local for small wounds or free flaps for large wounds.

REVASCULARISATION SURGERY:

Patient with peripheral ischemia with significant functional disability should undergo surgical revascularisation technique if medical management fails. This may reduce the amputation risk in patient with ischemic diabetic foot ulcer.

The procedure involves open (bypass grafting or endarterectomy) or endovascular techniques (angioplasty with or without stent).

AMPUTATIONS

- Amputations, an unpleasant but often a last step when all measures fail which can be either curative or emergent.
- It can be performed earlier to allow for earlier return to work or better functional status.

- Amputation level selection aims at achieving balance between preservation of limb length and function with the ability of the wound to heal properly.
- Currently available vascular intervention made 'limb sparing' more and more feasible. Endovascular restoration of vascularity made it possible to do more distal amputations. Pre amputation vascular intervention should be done to limit the level of amputation and also to improve proper stump healing.

Various amputations of lower extremity are

- Ray's amputation
- Transmetatarsal (Gillies)
- Tarsometatarsal (lisfranc's)
- Midtarsal (chopart's)
- Syme's
- Below-knee (Burgess)
- Transcondylar
- Above-knee

The three most common indications for major lower extremity amputations are

- Chronic critical limb ischaemia
- Acute limb ischaemia

• Major infection due to diabetic malperforans ulcers with normal arterial blood supply.

GOALS

The goals of major lower extremity amputations are:

• remove the nonviable tissue

• provide a stump with best chance to heal

• provide a stump with best chance of long term function-ambulation with prosthesis.

IDEAL STUMP

• The ideal stump should have adequate blood supply and heal adequately.

• Stump should have rounded gentle contour with adequate muscle padding

• should have sufficient length to bear prosthesis

• should have thin scar which does not interfere with prosthetic function

• Joint proximal to amputation stump should show full range of movements.

GENERAL PRINCIPLES APPLICABLE TO AMPUTATION SURGERY

SKIN

Flaps should be sutured in a tension free manner and the scar should be well healed and non-adherent to the bone.

MUSCLE

Opposing muscles are sutured together over the bone ends, both to cover divided bone and to balance the muscle action on the stump.

NERVE

Neuroma should be prevented by dividing the nerve at a higher level by applying adequate traction and allowing it to retract into the stump under cover of muscles.

BLOOD VESSELS

Blood vessels require ligation. Visible bleeding alone does not indicate optimum level of amputation. Wound healing in reality is dependent on micro-circulation. Vessels must be suture ligated, arteries and veins in separate group to avoid iatrogenic AV fistula formation.

BONES

Bone should be divided at higher level and ends must be bevelled so as to avoid protruding bone that will interfere with healing of stump and also result in a painful end bearing stump.

STUMP DRESSINGS

A cotton wool followed by crepe bandage is commonly used dressing for the amputation stump. A rigid cast support 71 enables wound protection, contracture prevention and oedema reduction.

TYPES OF AMPUTATION

RAY AMPUTATION

Amputation of the toe with the head of metatarsal or metacarpals.

TRANSMETATARSAL AMPUTATION (GILLIES')

Amputation is done proximal to the neck of the metatarsals, distal to the base.

LISFRANC'S AMPUTATION (TARSOMETATARSAL)

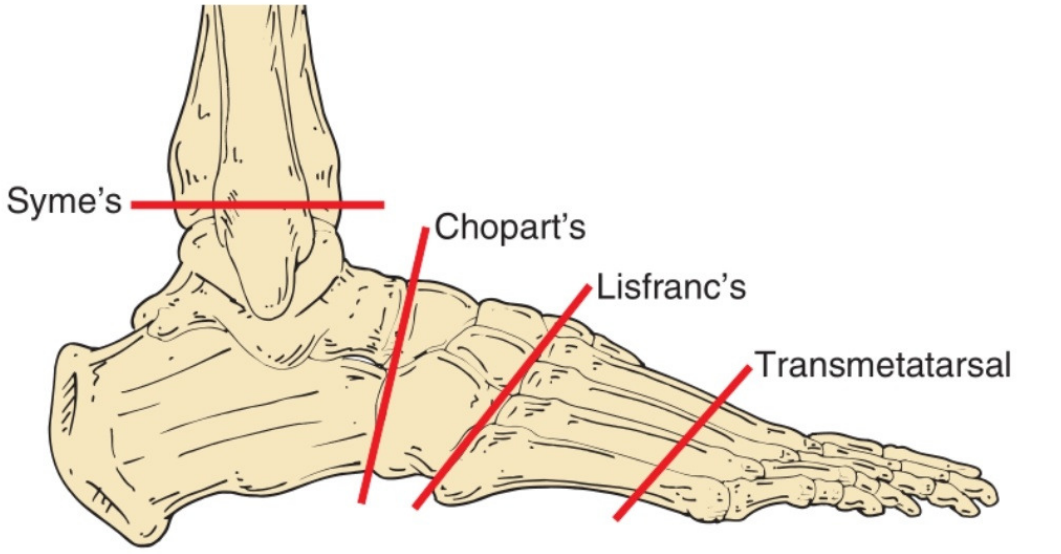
Here tarsometatarsal joint is disarticulated with a long volar flap.

CHOPART'S AMPUTATION (MIDTARSAL)

Here talonavicular and calcaneocuboid joints are disarticulated. Tibialis anterior is sutured to the drilled talus bone. A long volar flap is used and immobilized for six weeks after surgery.

SYME'S AMPUTATION

It is removal of the foot with calcaneum and cutting tibia and fibula just above the ankle joint with retaining heel flap (dividing both malleoli).Heel flap is supplied by medial and lateral calcaneal vessels. Elephant boot is used for the limb after syme's amputation. Many patients walk well with syme's stump without difficulty. It is presently mainly used in trauma (crush injuries) and malignancies of the distal part of the foot.



TYPES OFAMPUTATION

PIROGOFF'S AMPUTATION

It is like syme's amputation except the posterior part of the calcaneum is retained along with heel flap. It provides longer stump than syme's amputation.

TRANSTIBIAL(BELOW-KNEE) AMPUTATION

Knee joint is spared. The ideal stump is 15cms long

The advantages of preserving the knee joint are

- lower kinetic energy requirement
- near normal gait
- Ease of using prosthesis
- Self Sufficiency and reduced dependancy
- Quicker rehabilitation
- Less expensive prosthesis

KNEE DISARTICULATION(THROUGH-KNEE) AMPUTATION

It is through the joint and does not disturb the bone. It is used in patients with poor general condition and those who are not amenable to prosthetic mobilization

TRANSFEMORAL(ABOVE-KNEE) AMPUTATION

About 12-15cm of lower end of femur should be removed. Usually equal anterior and posterior flaps are used. If femur length less than 10cms this procedure is not possible. If femur length is less than 10 cms, then should proceed with hip disarticulation. The marked reduction in limb length drastically reduces propulsive power and manipulation of the prosthesis.

Efficient ambulation depends solely on the user's ability to mobilize the artificial knee joint in the prosthesis.

CURATIVE VERSUS EMERGENT SURGERY

Performance of amputation in the elective setting may not always be a possibility. When serious infections such as gas gangrene are starting to set in, it becomes mandatory to perform an emergency amputation. Before surgical intervention, pre-existing infection should be dealt with. Elective amputations are usually curative ie, primary wound healing is facilitated by raising flaps and closing the wound primarily. Emergency amputations aim at removal of necrotic tissue only and not at healing the stump primarily. Subsequent surgery may be required to close the wound once the infection has been controlled.

COMPLICATIONS OF AMPUTATION SURGERY

Early complications:

- Hemorrhage
- Infection
- Haematoma

Late complications:

- Pain
- Flap necrosis
- Ring sequestrum formation
- Ulceration of the stump

• Painful scar

• Phantom limb

POSTOPERATIVE PERIOD AFTER AMPUTATION

• Regular physiotherapy

• Regular dressing

• Crutch is used initially

• After 3 months prosthesis is used

• Rehabilitation

MATERIALS AND METHODS

DESIGN OF STUDY

Prospective observational study

STUDY POPULATION

100 patients

STUDY PERIOD

December 2017 to November 2018

STUDY PLACE

Department of General Surgery

Thanjavur Medical College

SELECTION OF STUDY

INCLUSION CRITERIA

All patients aged 12 years or more with diabetic foot infection admitted in department of general surgery, Thanjavur medical college hospital during the period of study.

EXCLUSION CRITERIA

1) Paediatric age group less than 12 years.

2)Immunocompromised individuals like HIV, TB, and malignancy.

3) Those who expired at the time of admission.

CONSENT

Individual Informed and written consent.

METHODOLOGY

SOURCE AND DATA

Patients admitted as in-patients, diagnosed as diabetic foot.

METHODS OF COLLECTION OF DATA

- Details of case
- Full history
- Clinical examination
- Biochemical investigations
- Radiological investigations
- Bacteriological tissue culture

BIOCHEMICAL INVESTIGATION

- Haemoglobin
- Complete blood count
- Renal function test

RADIOLOGICAL INVESTIGATIONS

- X-ray of the concerned local part

BACTERIOLOGICAL INVESTIGATIONS

- Culture from ulcer site for Gram positive and gram negative bacteria and their antibiotic sensitivity pattern

OBSERVATION AND RESULTS

An analysis of 100 cases of diabetic foot was done. These cases were treated in different surgical units in the department of general surgery, Thanjavur Medical college hospital.

TOTAL NUMBER OF PATIENTS – 100

CONSERVATIVELY MANAGED – 57

MAJOR AMPUTATIONS – 27

- Amputation at trans tibial level (Below knee amputation)- 22
- Above knee amputation - 05

MINOR AMPUTATIONS – 16

- Toe disarticulation-00
- Ray amputation -13
- Mid-tarsal amputation- 00
- Tarso-metatarso amputation -03
- Syme's amputation-00

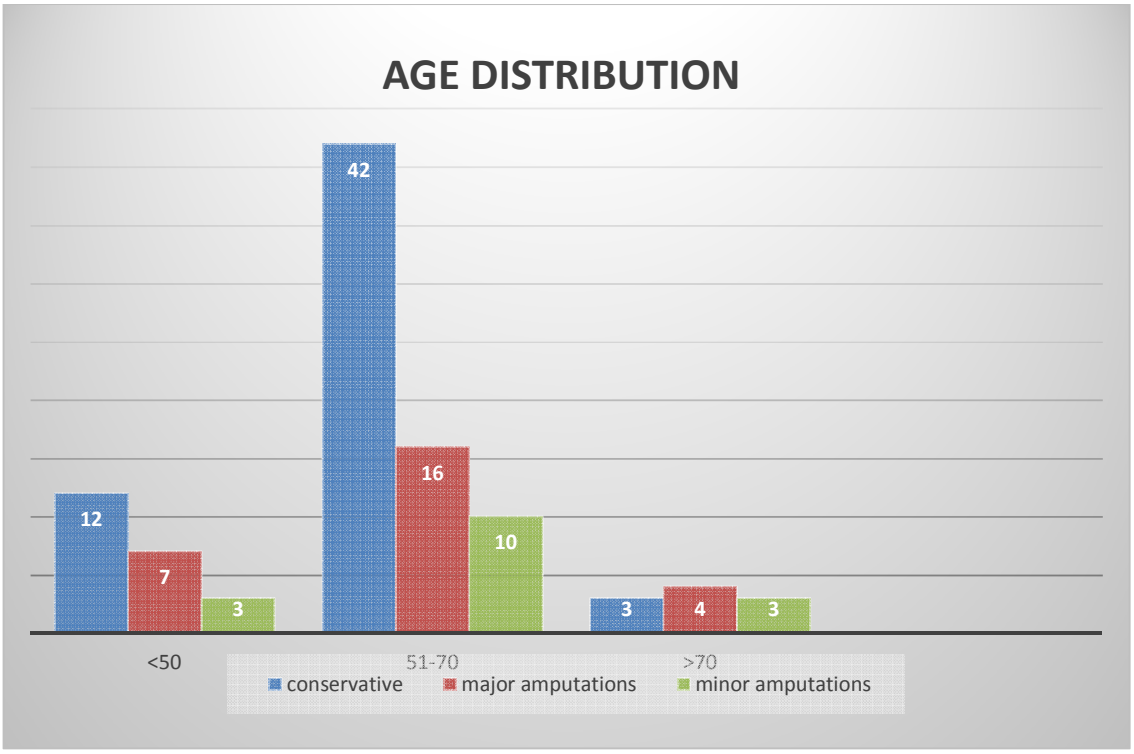
OBSERVATIONS AND RESULTS

1) AGE DISTRIBUTION

Age distribution of 100 cases studied at Thanjavur Medical college hospital, youngest patient was 32 years old, and eldest patient was 80 years old. Highest number of cases were found in the age group of 51-70 years.

Chi-Square test

Age	Conservative		Major Amputation		Minor Amputation		Total		Statistical inference
	n	%	*n*	%	*n*	%	*n*	%	
Below 50yrs	22	38.6%	9	33.3%	3	18.8%	34	34.0%	X^2=10.686 Df=4 .030<0.05 **Significant**
51 to 70yrs	35	61.4%	16	59.3%	10	62.5%	61	61.0%	
71yrs & above	0	.0%	2	7.4%	3	18.8%	5	5.0%	
Total	57	100.0%	27	100.0%	16	100.0%	100	100.0%	

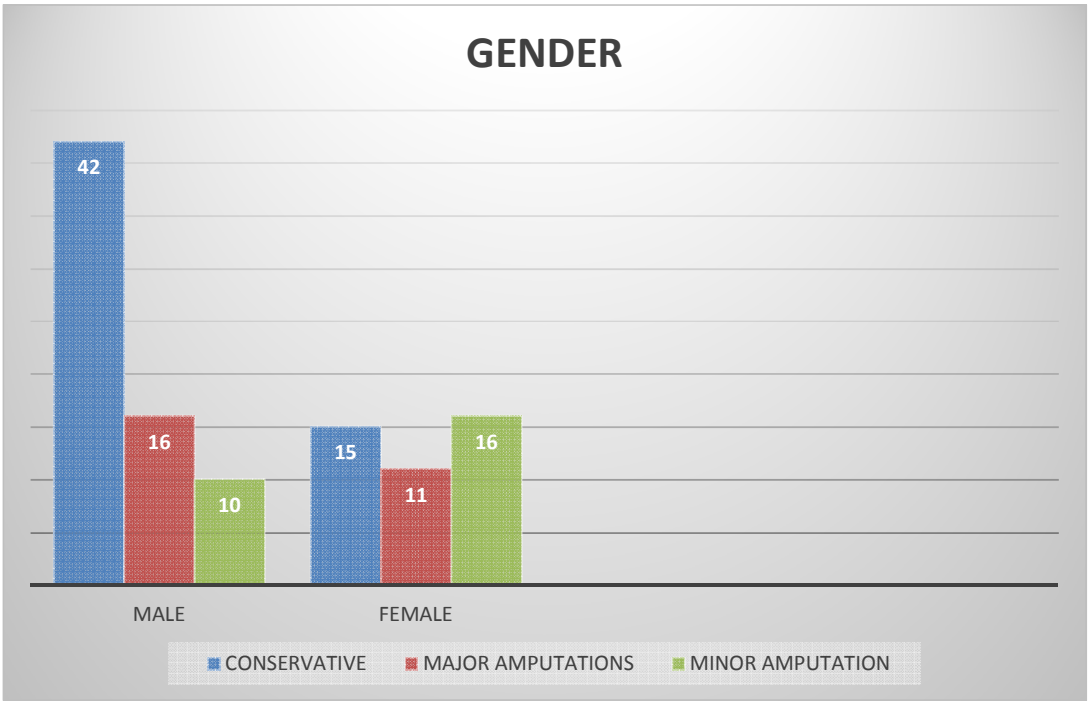

AGE DISTRIBUTION
42
16
12
10
7
3
3
4
3
<50
51-70
>70
conservative
major amputations
minor amputations

2) SEX DISTRIBUTION

Out of 100 patients, 68 were male and 32 were females.

Sex	Conservative	Major Amputations	Minor Amputations
MALE	**42**	**16**	**10**
FEMALE	**15**	**11**	**16**

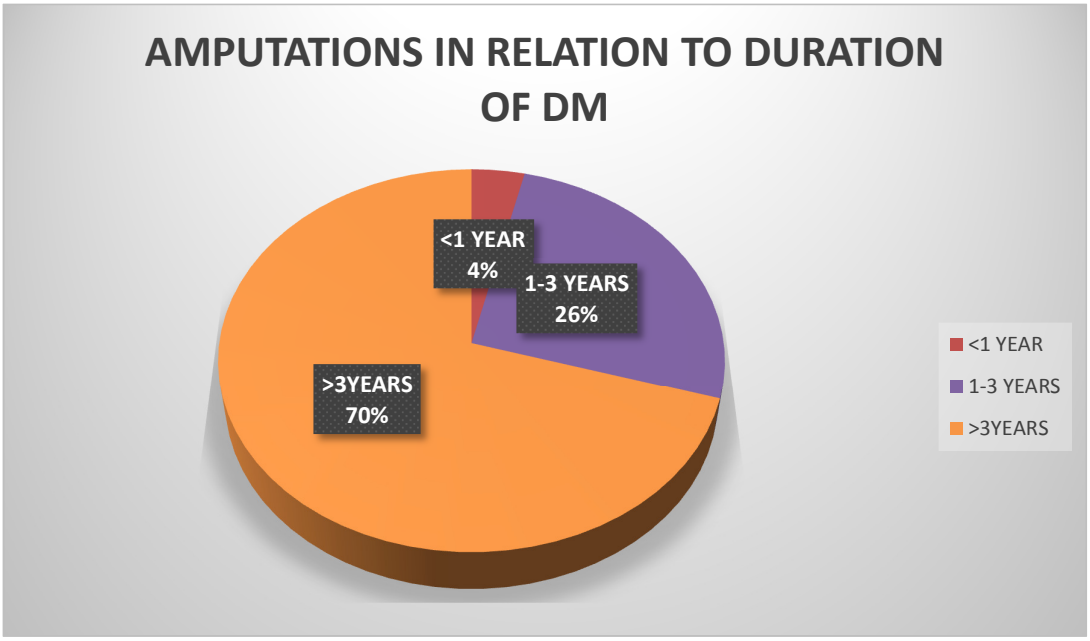
Males are more commonly affected in diabetic foot and amputation rates are also higher compared to females.



3) DURATION OF DIABETES MELLITUS:

Duration Of Dm	Amputation
<1 year	01
1-3 year	07
>3 years	19

Risk of amputation increases with increase in duration of diabetes.

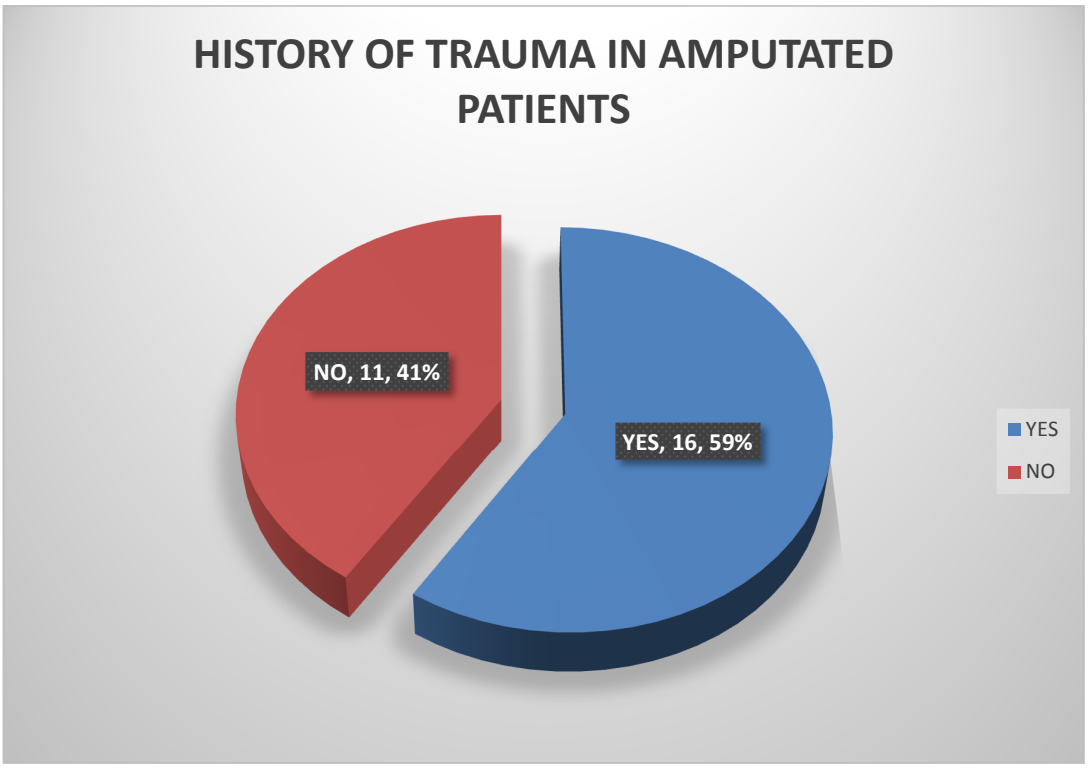


4) INCIDENCE OF *TRAUMA*

Chi-Square test

H/O Trauma	Conservative		Major Amputation		Minor Amputation		Total		Statistical inference
	n	***%***	***n***	***%***	***n***	***%***	***n***	***%***	
Yes	15	26.3%	16	59.3%	15	93.8%	46	46.0%	X^2=25.489 Df=2 .000<0.05 **Significant**
No	42	73.7%	11	40.7%	1	6.3%	54	54.0%	
Total	57	100.0%	27	100.0%	16	100.0%	100	100.0%	

Out of 27 amputation,16 cases have exposed to some kind of trauma before the onset of lesion.


HISTORY OF TRAUMA IN AMPUTATED PATIENTS
NO, 11, 41%
YES, 16, 59%
YES
NO

5)PRESENCE OF GANGRENE

Gangrene	Conservative	Major Amputations	Minor Amputations
ABSENT	57	0	0
PRESENT	0	27	16

100% of patients with complete gangrene ended up in minor or major amputation.

Chi-Square test

Gangrene	Conservative		Major Amputation		Minor Amputation		Total		Statistical inference
	n	***%***	***n***	***%***	***n***	***%***	***n***	***%***	
Yes	0	.0%	27	100.0%	16	100.0%	43	43.0%	X^2=100.000 Df=2 .000<0.05 **Significant**
No	57	100.0%	0	.0%	0	.0%	57	57.0%	
Total	57	100.0%	27	100.0%	16	100.0%	100	100.0%	

6) PULSE STATUS OF THE CONCERNED PART

Pulse Status	Amputation
PRESENT	00
ABSENT	27

100 % of patients with absent pulse went for amputation.

Chi-Square test

Pulse status	Conservative		Major Amputation		Minor Amputation		Total		Statistical inference
	n	%	*n*	%	*n*	%	*n*	%	
Yes	56	98.2%	0	.0%	16	100.0%	72	72.0%	X^2=95.127 Df=2 .000<0.05 **Significant**
No	1	1.8%	27	100.0%	0	.0%	28	28.0%	
Total	57	100.0%	27	100.0%	16	100.0%	100	100.0%	

7) BONY INVOLVEMENT

Bony Involvement	Conservative	Major Amputation	Minor Amputation
PRESENT	00	04	03
ABSENT	56	23	13

In case of osteomyelitis, out of 7 patients, all patients resulted in amputation.

Chi-Square test

Osteomyelitis	Conservative		Major Amputation		Minor Amputation		Total		Statistical inference
	n	***%***	***n***	***%***	***n***	***%***	***n***	***%***	
Yes	0	.0%	4	14.8%	3	18.8%	7	7.0%	X^2=10.216 Df=2 .006<0.05 **Significant**
No	57	100.0%	23	85.2%	13	81.3%	93	93.0%	
Total	57	100.0%	27	100.0%	16	100.0%	100	100.0%	

8) INFECTIONS

Bacteriological Study	Amputation
No Microorganisms	03
Microorganisms Noted	24

Out of 27 amputations, 24(89%) are infected with microorganisms. Common organisms are Staphylococcus aureus, Klebsiella , Pseudomonas, E.coli and Proteus.

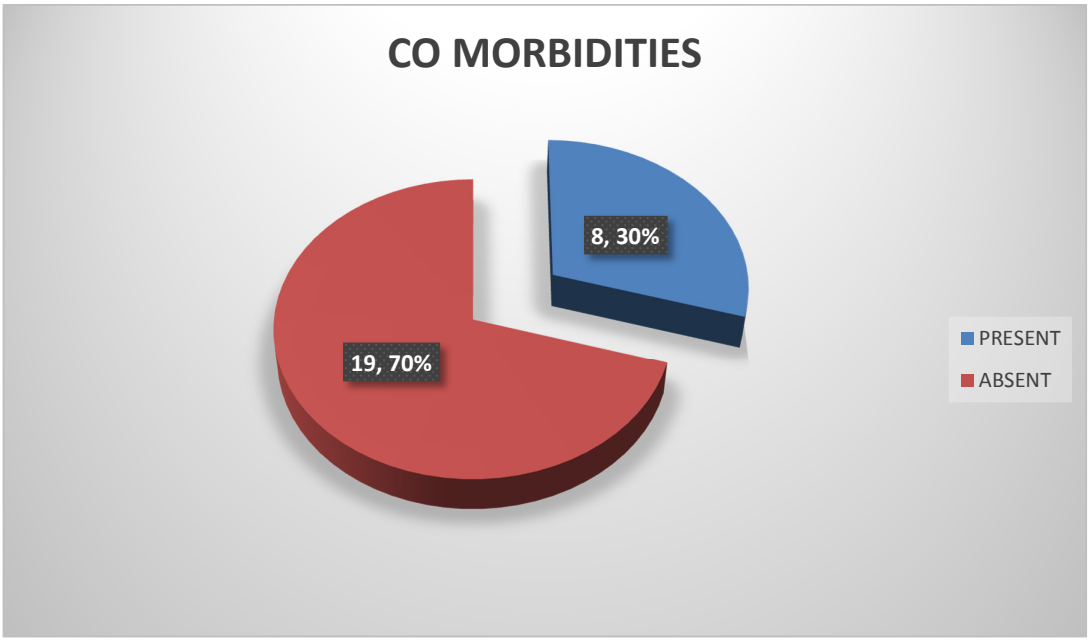
Chi-Square test

Infection	Conservative		Major Amputation		Minor Amputation		Total		Statistical inference
	n	%	*n*	%	*n*	%	*n*	%	
Yes	11	19.3%	24	88.9%	8	50.0%	43	43.0%	X^2=36.582 Df=2 .000<0.05 **Significant**
No	46	80.7%	3	11.1%	8	50.0%	57	57.0%	
Total	57	100.0%	27	100.0%	16	100.0%	100	100.0%	

9) CO- MORBIDITIES

Co Morbidities	Amputation
Present	08
Absent	19

Out of 27 amputations, 8 patients have other comorbidities such as systemic hypertension, CAD, CKD, etc.



10) GRADING OF ULCER

Grade	Conservative	Major Amputations	Minor Amputations
Grade 1	04	00	00
Grade 2	53	00	00
Grade 3	00	12	02
Grade 4	00	10	14
Grade 5	00	05	00

Patients were arbitrarily divided into two groups according to Wagner's Grading system (low grade 0-2; High grade 3-5). Amputation rates are higher in Grade III and above.

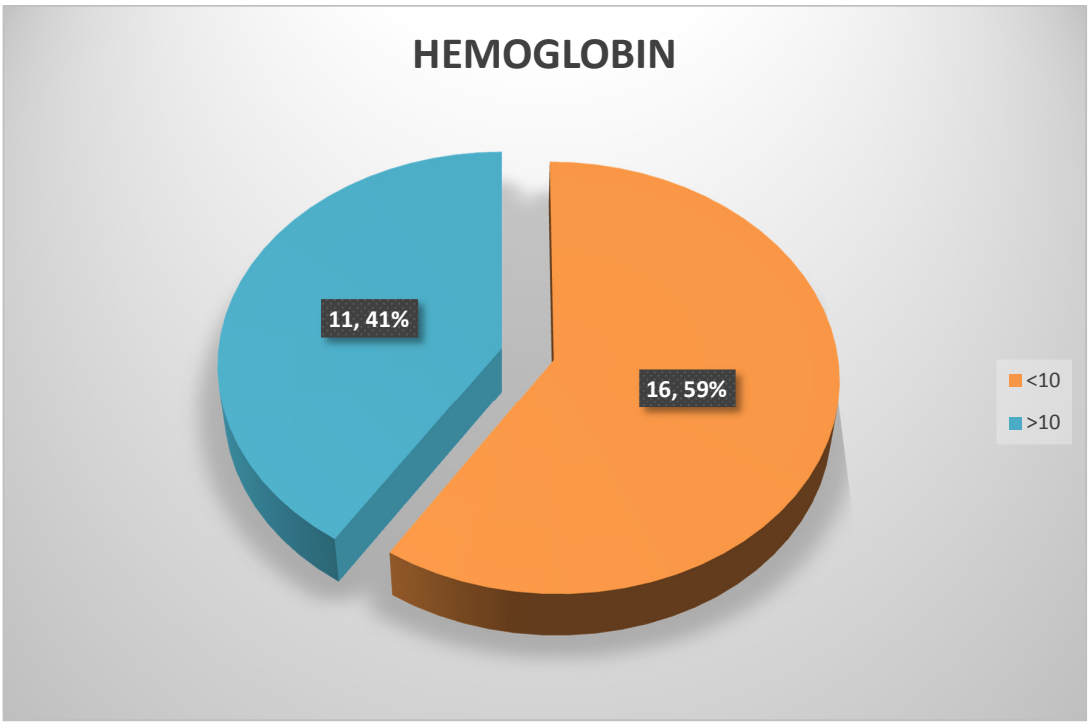
Chi-Square test

Grade	Conservative		Major Amputation		Minor Amputation		Total		Statistical inference
	n	*%*	*n*	*%*	*N*	*%*	*n*	*%*	
One	5	8.8%	0	.0%	0	.0%	5	5.0%	X^2=131.090 Df=8 .000<0.05 **Significant**
Two	52	91.2%	0	.0%	0	.0%	52	52.0%	
Three	0	.0%	12	44.4%	1	6.3%	13	13.0%	
Four	0	.0%	10	37.0%	15	93.8%	25	25.0%	
Five	0	.0%	5	18.5%	0	.0%	5	5.0%	
Total	57	100.0%	27	100.0%	16	100.0%	100	100.0%	

11) HAEMOGLOBIN

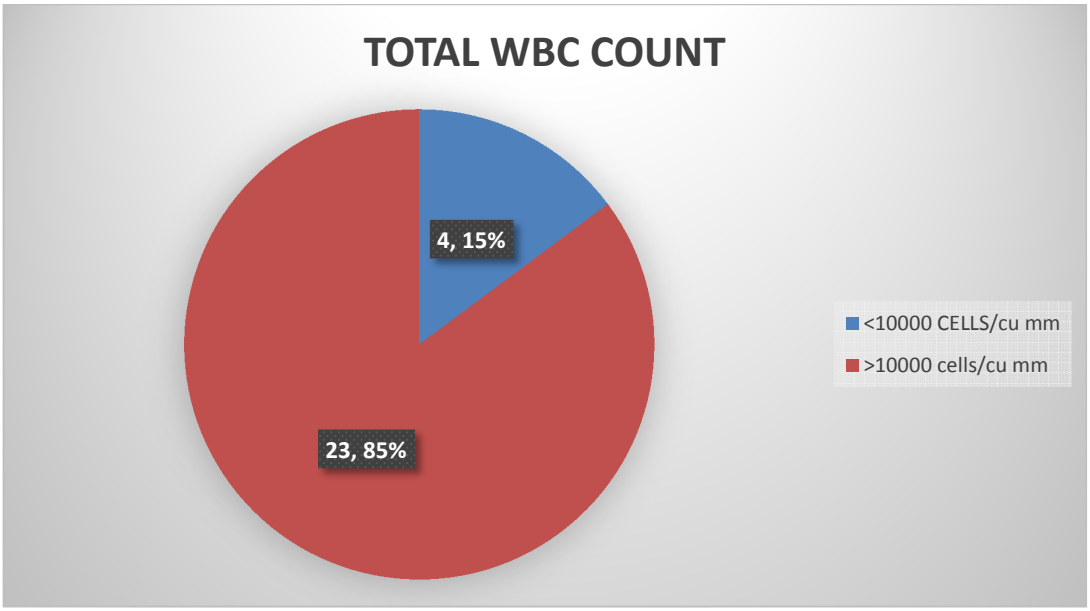
Hb % (in gms)	Amputations
<10	16
>10	11

Out of 27 amputations, 16 patients have Hb <10gm%. Haemoglobin is responsible for the cellular oxygen supply. Amputation tendency increases with fall in haemoglobin level due to reduced oxygen supply.



12) TOTAL WBC COUNT

Total count reflects the rate of wound infection, and hence amputation rate increases with increase in total WBC.



Chi-Square test

WBC	Conservative		Major Amputation		Minor Amputation		Total		Statistical inference
	n	*%*	*n*	*%*	*n*	*%*	*n*	*%*	
<10000	30	52.6%	3	11.1%	1	6.3%	34	34.0%	X^2=20.612 Df=2 .000<0.05 **Significant**
>10000	27	47.4%	24	88.9%	15	93.8%	66	66.0%	
Total	57	100.0%	27	100.0%	16	100.0%	100	100.0%	

DESCRIPTIVE STATISTICS

	N	**Min.**	**Max.**	**Mean**	**S.D**
Age	100	31	80	55.13	10.220
Duration in years	100	1	10	4.13	2.377
Hb %	100	5.90	13.80	10.0430	1.32926
WBC	100	6800	29000	12027.55	4313.794

SUMMARY

Diabetes incidence is increasing worldwide, especially in India. Foot ulcer was one of the major complications of diabetes, they have poor tendency to heal which results in long stay in hospital for treatment.

Present study was conducted at Thanjavur medical college hospital to analyse predictive factors for major lower extremity amputation in diabetic foot patients. A total of 100 diabetic foot patients were included in the study to evaluate with the help of relevant history, clinical examination, appropriate investigations and treatment which includes surgical interventions.

Among 100 patients in the study, 27 patients underwent major amputation and 16 patients underwent minor amputation. In our study adequate glycaemic control to be achieved with insulin or oral hypoglycaemic drugs.

DISCUSSION

- Diabetic foot infection should be treated aggressively to prevent morbidity and mortality of the patient.
- In this study, the overall amputation rate in diabetic patients was high as 43% of which major amputation as 27% and minor amputation as 16%. Similar high rate of amputation was also reported in Yesil et al (37.1%), Uysal et al (33.2%), Jeon et al (48.9%), Wang et al(29.6%). Most of the patients in this study presented to surgery department when infection or gangrene already occurred.
- In our study, amputations were common in male gender and 5^{th}-7^{th} decades of age. Armstrong DJ et al, Most RS et al, have reported increasing age and male gender are unavoidable risk factors for amputation.
- Presence of gangrene and absence of pulse status contributes to increased rate of amputations. Peripheral arterial disease characterised by atherosclerotic occlusive disease of lower limb and is one of the macrovascular complications high in diabetic patients.
- Wagner's grading III- V have higher rates of amputations. Higher grade was strongly associated with amputation in our study. Oyibo et al reported that Wagner grade significantly correlated with the risk of

amputation. Calhoun et al reported that increased Wagner grade was associated with higher treatment failure.

- In this study, diabetic foot ulcer was common in patients having diabetes for more than 3years. Patients with longstanding diabetes definitely develop foot ulcer at some point of time. Longer the patient with diabetes more chance of landed up with amputation. Walters et al found that increasing duration of diabetes was a risk factor of amputation.
- In our study, diabetic patient with osteomyelitis underwent amputation, if there was extensive soft tissue loss leads to bony infection. Osteomyelitis present with failure of local part to heal. Berendt E et al reported that osteomyelitis in diabetic foot leads to more chance of amputation.
- We have observed higher levels of total WBC counts due to infection increases the risk of amputation.
- Haemoglobin is responsible for the cellular oxygen supply. Amputation tendency increases with fall in haemoglobin level due to reduced oxygen supply.
- Foot ulcer in diabetic patient is common, and frequently leads to lower limb amputation.

- The eurodiale study reported that overall amputation rate in diabetic patient was 37.1%with limb ischemia,osteomyelitis,presence of gangrene and ulcer depth being identified as major predictors of lower limb amputation.
- Sen P,et al.Diabetes Metab Res Rev 2019 studied 379 diabetic foot patients.126 patients underwent amputation.This study conclude osteomyelitis, arterial occlusion, ulcer duration, ulcer depth and infection as risk factors for amputation.
- Yesil S,et al.(Athens)2009 data collected from 510 patients with diabetic ulcer. This study shows limb ischemia, osteomyelitis, presence of gangrene, wagner classification were major independent predictors of overall amputation.
- Xu B, et al. 2017 data of 1771patients with diabetic foot at Air force general hospital of PLA analysed,323 of them were underwent amputation. It concluded as Wagner's grade, ischemia of lower limb and infection are associated with amputation.
- Gurlek A, et al. analysed 147 Turkish diabetic patients with diabetic foot. 36.7% undergone amputation. Presence of peripheral vascular disease, osteomyelitis and gangrene were identified as significant predictors of amputation.

- Ravichandran K.S. et al conducted in 200 diabetic foot patients, the author evaluated the risk factors of amputation are poor glycaemic control, duration of diabetes, peripheral neuropathy, and poor podiatric care.
- Multi- disciplinary approach to therapy is needed. The main component of management that ensures successful and rapid healing of diabetic foot ulcer include education, blood sugar control, wound debridement, advanced dressing, off loading, surgery and advanced therapies are used clinically. These approach should be used whenever feasible to reduce high morbidity and risk of serious complications.
- Amputation is usually used as a last resort in non salvageable limbs.
- Care of the foot takes place at 3 levels:

- Patient must take routine measures to take care of his/her foot
- Early lesion require expert care either from podiatrist or from a experienced doctor.
- Advanced lesion require specialised care.

- The best way is make use of multi disciplinary professionals who are committed to limb salvage. Team members involved are physician, nurse, endocrinologist, podiatrist, neurologist, vascular surgeons, orthopedician, physiotherapist, social worker and home care nurse.

- Patient education is important in case of diabetic foot. The advice given to patients include
    - Do not smoke
    - Inspect feet daily for blisters, cuts and scratches.
    - Do not walk bare foot.
    - Avoid extreme temperature.
    - Wash feet daily, dry carefully, especially between the toes.
    - If feel cold at night ,wear socks
    - Do not wear sandals with thongs between the toes

CONCLUSION

From the above study, the following factors are considered as predictive factors for major lower extremity amputation in diabetic foot patients.

-Presence of gangrene

-Pulse status of concerned part

-Presence of osteomyelitis

-Duration of diabetes

-Total wbc count

-Wegener's grading of ulcer(grade 3 or more)

-Soft tissue infection

Amputation was a palliative or life saving procedure. Major amputation has devastating socioeconomic consequences. One condition which proves maximum that "Prevention is better than cure".

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PROFORMA

NAME: **DOA:**

AGE: **DOS:**

SEX: **DOD:**

WARD: **IP No.:**

CHIEF COMPLAINTS:

HISTORY AND CLINICAL DETAILS:

Duration of Diabetes:

Treatment history:

History of trauma:

Co-morbidities:

Current drug intake:

Past medical and surgical history:

Family history:

Local examination:

Pulse status of the concerned part:

Presence of gangrene:

Wagner's grade of ulcer:

Investigations:

Blood sugar:

Haemoglobin:

Renal function test:

Total WBC count:

X-ray of concerned part:

Culture report:

PROCEDURE DONE:

SL. NO.	NAME	AGE/SEX	DURATION IN YEARS	H/O TRAUMA	GANGRENE	PULSE STATUS	OSTEOMYELITIS	INFECTION	COMORBIDITIES	WAGNER'S GRADE	Hb %	WBC	TREATMENT
1	Ramachandran	68/m	2	no	yes	-	no	yes	yes	III	10	15600	BKA
2	mary stella	61/f	10	yes	yes	+	no	yes	no	IV	8.8	17100	Ray
3	mariyappan	44/m	10	yes	yes	+	no	yes	no	IV	10.2	10800	Ray
4	rajendran	63/m	5	yes	yes	+	yes	yes	no	IV	10.6	16300	FFA
5	thangaponnu	55/f	1	no	yes	-	no	yes	no	III	10.2	12400	BKA
6	sagaya mary	48/f	10	yes	yes	-	no	yes	no	III	12.2	10500	BKA
7	pitchai	70/m	4	yes	no	+	no	no	no	II	10.8	14800	WD
8	sabapathi	65/m	4	no	no	+	no	yes	no	II	7.9	10800	WD
9	mani	55/m	2	yes	yes	-	yes	yes	no	IV	8.8	10800	BKA
10	jeevananadham	45/m	5	yes	yes	-	no	no	no	IV	9	23100	BKA
11	nagaiyan	42/m	5	no	no	+	no	yes	no	II	8.8	27100	WD
12	natarajan	60/M	6	yes	yes	+	no	yes	no	III	11.6	29000	Ray
13	ambikapathy	50/F	3	yes	yes	-	yes	yes	yes	V	12.2	18500	BKA
14	palaniyammal	50/F	10	no	no	+	no	no	no	II	8.3	9600	WD
15	vembu	45/F	3	no	yes	-	no	yes	no	III	9.8	9800	BKA
16	ansari	65/M	3	yes	yes	+	no	no	no	IV	9	24000	FFA
17	senthil kumar	41/M	3	no	yes	+	no	no	no	IV	9	10900	Ray
18	palanisamy	61/M	5	no	no	+	no	yes	no	II	10.3	14300	WD
19	marimuthu	55/M	4	yes	no	+	no	no	no	II	9.4	11400	WD
20	vasanthi	55/F	2	no	yes	-	no	no	no	IV	8	14700	BKA
21	kuppusamy	71/M	10	no	yes	-	no	yes	no	III	9.8	14600	AKA
22	santha	58/F	4	no	no	+	no	no	no	II	10.1	11200	WD
23	mariyayee	60/F	5	yes	yes	+	no	no	no	IV	10.8	12800	Ray
24	ambika	60/F	8	yes	yes	-	no	no	yes	V	10.8	12100	AKA
25	selvam	50/M	2	no	no	+	no	no	yes	II	9.8	8600	WD
26	veerapathiran	50/M	4	no	no	+	no	no	no	II	10.1	9800	WD
27	manivannan	58/M	5	yes	yes	+	no	yes	no	IV	9.4	10200	Ray
28	gurusamy	62/M	2	no	yes	-	no	yes	no	III	5.9	7000	AKA
29	chandra	50/F	4	no	no	+	no	yes	no	II	10.2	6800	WD
30	vanarajan	52/M	2	yes	yes	+	no	yes	no	IV	9.8	10100	FFA
31	swamyvel	65/M	2	no	yes	-	no	yes	no	III	11	28000	BKA
32	ganesan	32/M	1	yes	no	+	no	no	no	II	10.3	9900	WD
33	seethalakshmi	50/M	5	yes	no	+	no	no	no	II	9.8	10100	WD
34	baawaji	70/M	3	no	yes	-	no	yes	yes	III	7.4	12100	BKA

35	perumal	52/M	4	no	no	+	no	no	yes	II	9.1	10000	WD
36	alagammal	62/F	8	yes	no	+	no	no	no	II	10.4	8400	WD
37	mahalingam	65/M	2	no	no	+	no	no	yes	II	9.9	6800	WD
38	jerina begum	34/F	5	yes	yes	+	no	yes	no	IV	9.9	16700	Ray
39	aayisha	39/F	3	no	no	+	no	no	no	II	8.9	10100	WD
40	chellapandian	54/M	8	yes	yes	-	yes	yes	no	III	10.4	12600	AKA
41	vitula	55/F	4	no	yes	-	no	yes	no	V	7.9	18900	BKA
42	palanisamy	50/M	2	no	no	+	no	no	no	II	10.8	9400	WD
43	karuppian	54/M	1	no	no	+	no	no	no	II	10.1	8800	WD
44	kaliyamoorthy	53/M	3	no	no	+	no	no	no	II	9.2	10200	WD
45	anbunathan	55/M	3	yes	yes	-	no	yes	no	IV	8.8	8700	BKA
46	govindaraj	65/M	2	yes	yes	+	yes	no	no	IV	10.1	8800	Ray
47	thangam	50/F	4	no	no	+	no	yes	no	II	8.2	10800	WD
48	kamalanathan	57/M	5	yes	no	+	no	yes	no	II	7.9	10200	WD
49	devendran	31/M	1	no	no	+	no	no	no	I	9.4	8700	WD
50	jayalakshmi	47/F	2	yes	yes	-	no	yes	no	IV	8.9	15500	BKA
51	sampath	58/M	6	no	no	+	no	no	no	II	11.4	10000	WD
52	ganesan	65/M	4	yes	no	+	no	no	no	II	10.8	11100	WD
53	abdullah	72/M	8	no	yes	-	yes	yes	yes	V	7.6	14100	BKA
54	sitharthan	55/M	4	no	no	+	no	no	no	II	8.3	7100	WD
55	rajendran	55/M	2	no	no	+	no	no	no	II	10.2	9800	WD
56	saroja	75/F	8	yes	yes	+	yes	yes	yes	IV	10.1	12,400	Ray
57	rajamanikkam	63/M	4	no	no	+	no	no	no	II	9.4	10500	WD
58	neelavathi	54/F	6	no	yes	-	no	yes	yes	V	8	16800	AKA
59	kandasamy	70/M	4	no	no	+	no	yes	no	II	11.4	7100	WD
60	veerasamy	80/M	10	yes	yes	+	no	no	yes	IV	9.2	11,300	Ray
61	tamilarasan	52/M	2	yes	no	+	no	no	no	II	13.8	10100	WD
62	arokiyamary	35/F	1	no	no	+	no	no	no	II	9.9	11800	WD
63	kumar	56/M	6	yes	yes	-	no	yes	no	IV	11.1	14600	BKA
64	kandasamy	70/M	5	yes	yes	+	no	no	no	IV	10.8	13900	Ray
65	lakshmanan	63/M	3	no	no	-	no	yes	no	II	12.1	8700	WD
66	raginimary	55/F	2	no	no	+	no	no	no	I	10.4	7800	WD
67	valli	45/F	5	yes	yes	-	no	yes	no	IV	8.8	11000	BKA
68	krishnammal	75/F	8	yes	yes	+	no	no	no	IV	8.9	10200	Ray
69	govindarajan	70/M	5	yes	no	+	no	no	no	II	10.7	12100	WD
70	tamilarasi	58/F	6	yes	yes	-	no	yes	yes	III	9.1	18800	BKA
71	latha	40/F	2	no	no	+	no	no	no	II	9.7	9600	WD
72	selvam	31/M	2	no	no	+	no	no	no	II	13.1	8800	WD
73	anthonyraja	40/M	3	yes	yes	-	no	yes	yes	IV	10.8	12100	BKA
74	rajendran	58/M	5	yes	no	+	no	yes	no	II	10.4	8100	WD
75	palaniammal	50/M	2	no	no	+	no	no	no	II	9.2	8900	WD

76	marimuthu	62/M	5	yes	no	+	no	no	no	II	11.3	10100	WD
77	ganesan	50/M	5	no	no	+	no	no	no	II	12.1	10800	WD
78	tamilselvam	52/M	4	yes	yes	-	no	yes	no	III	11.1	14700	BKA
79	kuppusamy	40/M	2	no	no	+	no	no	no	II	10.9	12100	WD
80	palanisamy	61/M	4	no	no	+	no	no	no	II	11.4	9200	WD
81	raja	40/M	2	no	no	+	no	yes	no	II	10.6	10200	WD
82	selvapandian	45/M	2	yes	yes	-	no	yes	no	IV	10.6	12200	BKA
83	shanthi	45/F	4	no	no	+	no	no	no	II	10.2	14100	WD
84	senthil kumar	45/M	1	no	no	+	no	no	no	II	13	9800	WD
85	muthusamy	68/M	6	yes	no	+	no	no	yes	II	10.4	11600	WD
86	gopal	62/M	4	yes	no	+	no	no	no	I	12.8	10200	WD
87	neelavathi	70/F	10	yes	yes	-	no	yes	yes	IV	8.8	15700	BKA
88	durairaj	54/M	3	no	no	+	no	no	no	II	10.7	9800	WD
89	selvi	58/F	4	yes	yes	+	no	no	no	IV	7.8	12100	Ray
90	rajam	60/F	3	no	no	+	no	no	no	II	10.4	11300	WD
91	selvaraj	54/M	2	no	no	+	no	no	no	II	11.2	12100	WD
92	rasu	61/M	2	no	no	+	no	no	no	II	9.7	8200	WD
93	vijayakumar	50/M	4	yes	yes	-	no	yes	no	III	10.2	14600	BKA
94	anbalagan	58/M	5	no	no	+	no	no	no	II	11.3	12100	WD
95	suresh	51/M	2	no	no	+	no	no	no	II	10.8	9100	WD
96	ramasamy	60/M	5	yes	no	+	no	no	no	I	11.3	9700	WD
97	selvam	48/M	1	no	no	+	no	yes	no	II	9.8	10000	WD
98	ragavan	47/M	2	no	no	+	no	no	no	II	10.4	7700	WD
99	rajeswari	60/F	4	yes	no	+	no	no	no	I	11.2	10100	WD
100	mary	58/F	3	no	no	+	no	no	no	II	11.1	8800	WD
		WD	und Debridement				FFA	efoot amputation					
		BKA	w knee amputation				Ray	ay amputation					
		AKA	e knee amputation										

ஆராய்ச்சிக்கான ஒப்புதல் கடிதம்

ஆராய்ச்சி தலைப்பு: சர்க்கரை நோயின் தீவிரத்தினால் கால் இழப்பதற்கான காரணங்களை கண்டறிதல்.

புற நோயாளி எண் : தேதி :

பெயர் : வயது :

இனம் : ஆண் / பெண்

இந்த ஆய்வின் நோக்கம் மற்றும் விவரங்கள் எனக்கு தெளிவாக அறிவிக்கப்பட்டது. எனக்கு விளக்கப்பட்ட விஷயங்களை நான் புரிந்துகொண்டு நான் என் விருப்பத்தினைத் தெரிவிக்கிறேன்.

இந்த ஆய்வின் நன்மைகளைப் பற்றி மருத்துவர் மூலம் தெரிந்து கொண்டேன்.

இந்த ஆய்வில் பிறரின் நிர்பந்தமின்றி என்னுடைய சொந்த விருப்பத்தின்பேரில் பங்கு பெறுகிறேன் மற்றும் நான் இந்த ஆய்விலிருந்து எப்போது வேண்டுமானாலும் விலகிக் கொள்ளலாம் என்பதனையும் அறிந்துகொண்டேன்.

நான் என்னுடைய விருப்பத்தின்பேரில் முழு ஒப்புதலுடன் இந்த மருத்துவ ஆய்வில் என்னை சேர்த்துக்கொள்ள சம்மதிக்கிறேன்.

மருத்துவர் கையொப்பம் **பங்கேற்பாளர் கையொப்பம்**

நாள் :

இடம் : தஞ்சாவூர்.