

**“A CLINICAL STUDY OF COLLAGEN
DRESSING IN PARTIAL THICKNESS BURNS”**

**A DISSERTATION SUBMITTED TO THE TAMILNADU
Dr. MGR MEDICAL UNIVERSITY**

CHENNAI

In partial fulfilment of the Regulations

for the award of the Degree of

M.S. (GENERAL SURGERY) BRANCH-I



DEPARTMENT OF GENERAL SURGERY

TIRUNELVELI MEDICAL COLLEGE

TIRUNELVELI

MAY 2018

CERTIFICATE BY THE GUIDE

This is to certify that the dissertation entitled “**A CLINICAL STUDY OF COLLAGEN DRESSING IN PARTIAL THICKNESS BURNS**” is a bonafide research work done by **Dr.A.MOHAN KUMAR**, Postgraduate M.S. student in Department of General Surgery, Tirunelveli Medical College & Hospital, Tirunelveli, in partial fulfilment of the requirement for the degree of M.S. in GENERAL SURGERY.

Date:
Place: Tirunelveli

Dr.S.AMALAN,M.S.,
Assistant Professor, Department of General Surgery,
Tirunelveli Medical College,
Tirunelveli

CERTIFICATE BY THE HEAD OF THE DEPARTMENT

This is to certify that the dissertation entitled “**A CLINICAL STUDY OF COLLAGEN DRESSING IN PARTIAL THICKNESS BURNS**” is a bonafide research work done by **Dr.A.MOHAN KUMAR**, Postgraduate M.S. student in Department of General Surgery, Tirunelveli Medical College & Hospital, Tirunelveli, under the guidance of **Dr.S.AMALAN.M.S.**, Assistant Professor, Department of Surgery, Tirunelveli Medical College & Hospital, Tirunelveli, in partial fulfilment of the requirements for the degree of M.S. in GENERAL SURGERY.

Date:
Place: Tirunelveli

Dr.V.PANDY, M.S.,
Professor and HOD of General Surgery,
Department of General Surgery,
Tirunelveli Medical College,
Tirunelveli

CERTIFICATE BY THE HEAD OF THE INSTITUTION

This is to certify that the dissertation entitled “**A CLINICAL STUDY OF COLLAGEN DRESSING IN PARTIAL THICKNESS BURNS**” is a bonafide and genuine research work carried out by **Dr.A.MOHAN KUMAR** under the guidance of **Dr.S.AMALAN,M.S.**, Assistant Professor, Department of General Surgery and HOD, Department of General Surgery, Tirunelveli Medical College, Tirunelveli.

Date:
Place: Tirunelveli

Dr.K.Sithy Athiya Munarvah,MD., (Patho)
DEAN
Tirunelveli Medical College,
Tirunelveli

COPYRIGHT

DECLARATION BY THE CANDIDATE

I hereby declare that dissertation entitled “**A CLINICAL STUDY OF COLLAGEN DRESSING IN PARTIAL THICKNESS BURNS**” is a bonafide and genuine research work carried out by me under the guidance of **Dr.S.AMALAN,M.S.**, Assistant Professor, Department of General Surgery, Tirunelveli Medical College, Tirunelveli.

The Tamil Nadu Dr.M.G.R. Medical University, Chennai shall have the rights to preserve, use and disseminate this dissertation in print or electronic format for academic/research purpose.

Date:
Place: Tirunelveli

Dr.A.MOHAN KUMAR,MBBS.,
Postgraduate in General Surgery,
Department of General Surgery,
Tirunelveli Medical College,
Tirunelveli

ACKNOWLEDGEMENT

I am obliged to record my immense gratitude to **Dr.Sithy Athiya Munarvah**, Dean, Tirunelveli Medical College Hospital for providing all the facilities to conduct the study.

I express my deep sense of gratitude and indebtedness to my respected teacher and guide **Dr.S.AMALAN,M.S.**, Assistant Professor and **Prof.Dr.V.Pandy,M.S.**, HOD, Department of General Surgery, Tirunelveli Medical College, Tirunelveli, whose valuable guidance and constant help have gone a long way in the preparation of this dissertation.

I am also thankful to Assistant Professors **Dr.S.Senthil Arumugam,M.S.**, and **Dr.G.Nagalakshmi,M.S.**, for their help.

I express my thanks to all Professors, Associate Professors, Assistant Professors, Staff members of the Department of General Surgery and all my Postgraduates colleagues and friends for their help during my study and preparation of this dissertation and also for their co-operation.

I always remember my family members, especially I thank my wife **Dr.C.Kaviya,M.B.B.S.**, for their everlasting blessings and encouragement.

Lastly, I express my thanks to my patients without whom this study would not have been possible.

Date:
Place: Tirunelveli

Dr. A.MOHAN KUMAR,MBBS.,
Postgraduate in General Surgery,
Department of General Surgery,
Tirunelveli Medical College,
Tirunelveli

CONTENTS

SL. NO.	TOPIC	PAGE NO.
1.	INTRODUCTION	1
2.	AIM AND OBJECTIVES	3
3.	REVIEW OF LITERATURE	4
4.	MATERIALS AND METHODS	46
5.	OBSERVATION AND RESULTS	52
6.	DISCUSSION	75
7.	LIMITATIONS OF THE STUDY	79
8.	CONCLUSION	80
9.	BIBLIOGRAPHY	
10.	REFERENCES	
11.	ANNEXURE I - PROFORMA	
12.	ANNEXURE II - CONSENT FORM	
13.	ANNEXURE III - MASTER CHART	

LIST OF TABLES

TABLE. NO.	DESCRIPTION	PAGE NO.
1.	Classification of Burns	28
2.	Wallace Rule of Nine	31
3.	Lund and Browder chart for estimation of % of TBSA	33
4.	Types of Collagen	43
5.	Gender distribution of the patients (N=60)	52
6.	Frequency distribution of various parameters (N=60)	53
7.	Descriptive statistics of various parameters (N=60)	54
8.	Frequency distribution of parameters according to gender	56
9.	Descriptive statistics of parameters according to gender	58
10.	Descriptive statistics of parameters according to percentage of burns	61
11.	Frequency distribution of parameters according to percentage of burns	64
12.	Percentage of burns distribution of parameters according to gender	67
13.	Frequency distribution of parameters according to percentage of burns and gender	69
14.	Descriptive statistics of parameters according to percentage of burns and gender	71

TIRUNELVELI MEDICAL COLLEGE

INSTITUTIONAL RESEARCH ETHICS COMMITTEE

TIRUNELVELI, STATE OF TAMILNADU, SOUTH INDIA PIN 627011
91-462-2572733-EXT. 91-462-2572944; 91-462-2579785; 91-462-2572611-16
tirc@tvmc.ac.in, tirc@tvmc.ac.in, www.tvmc.ac.in

CERTIFICATE OF REGISTRATION & APPROVAL OF THE TIREC

REF NO: 796/GS/ 2015

PROTOCOL TITLE: A CLINICAL STUDY OF COLLAGEN DRESSING IN PARTIAL THICKNESS BURNS.

PRINCIPAL INVESTIGATOR: DR.A.MOHAN KUMAR, MBBS.,

**DESIGNATION OF PRINCIPAL INVESTIGATOR POST GRADUATE I YEAR IN GENERAL SURGERY
DEPARTMENT & INSTITUTION: TIRUNELVELI MEDICAL COLLEGE, TIRUNELVELI**

Dear, Dr.A.Mohan Kumar, MBBS., The Tirunelveli Medical College Institutional Ethics Committee (TIREC) reviewed and discussed your application during the IEC meeting held on 10.12.15.

THE FOLLOWING DOCUMENTS WERE REVIEWED AND APPROVED


1. TIREC Application Form
2. Study Protocol
3. Department Research Committee Approval
4. Patient Information Document and Consent Form in English and Vernacular Language
5. Investigator's Brochure
6. Proposed Methods for Patient Accrual Proposed
7. Curriculum Vitae of the Principal Investigator
8. Insurance / Compensation Policy
9. Investigator's Agreement with Sponsor
10. Investigator's Undertaking
11. DCGI/DGFT approval
12. Clinical Trial Agreement (CTA)
13. Memorandum of Understanding (MOU)/Material Transfer Agreement (MTA)
14. Clinical Trials Registry-India (CTRI) Registration

<input type="checkbox"/>
<input type="checkbox"/>
<input type="checkbox"/>
<input type="checkbox"/>
<input type="checkbox"/>
<input type="checkbox"/>
<input type="checkbox"/>
<input type="checkbox"/>
<input type="checkbox"/>
<input type="checkbox"/>
<input type="checkbox"/>
<input type="checkbox"/>
<input type="checkbox"/>
<input type="checkbox"/>
<input type="checkbox"/>
<input type="checkbox"/>
<input type="checkbox"/>
<input type="checkbox"/>
<input type="checkbox"/>
<input type="checkbox"/>
<input type="checkbox"/>


THE PROTOCOL IS APPROVED IN ITS PRESENTED FORM ON THE FOLLOWING CONDITIONS

1. The approval is valid for a period of 2 year/s or duration of project whichever is later
2. The date of commencement of study should be informed
3. A written request should be submitted 3weeks before for renewal / extension of the validity
4. An annual status report should be submitted.
5. The TIREC will monitor the study
6. At the time of PI's retirement/leaving the institute, the study responsibility should be transferred to a person cleared by HOD
7. The PI should report to TIREC within 7 days of the occurrence of the SAE. If the SAE is Death, the Bioethics Cell should receive the SAE reporting form within 24 hours of the occurrence.
8. In the events of any protocol amendments, TIREC must be informed and the amendments should be highlighted in clear terms as follows:
 - a. The exact alteration/amendment should be specified and indicated where the amendment occurred in the original project. (Page no, Clause no, etc.)
 - b. The PI must comment how proposed amendment will affect the ongoing trial. Alteration in the budgetary status, staff requirement should be clearly indicated and the revised budget form should be submitted.
 - c. If the amendments require a change in the consent form, the copy of revised Consent Form should be submitted to Ethics Committee for approval. If the amendment demands a re-look at the toxicity or side effects to patients, the same should be documented.
 - d. If there are any amendments in the trial design, these must be incorporated in the protocol, and other study documents. These revised documents should be submitted for approval of the IEC, only then can they be implemented.
 - e. Approval for amendment changes must be obtained prior to implementation of changes.
 - f. The amendment is unlikely to be approved by the IEC unless all the above information is provided.
 - g. Any deviation/violation/waiver in the protocol must be informed.

STANDS APPROVED UNDER SEAL


Dr.K.Shantaraman MD
Registrar, TIREC
Tirunelveli Medical College, Tirunelveli - 627011
State of Tamilnadu, South India




Dr.V.Ramasubramanian MD DM
Member Secretary, TIREC
Tirunelveli Medical College, Tirunelveli - 627011
State of Tamilnadu, South India

CERTIFICATE - II

This is certify that this dissertation work title **A CLINICAL STUDY OF COLLAGEN DRESSING IN PARTIAL THICKNESS BURNS** of the candidate **Dr.A.MOHAN KUMAR,MBBS.,** with registration Number **221511355** for the award of **M.S.** in the branch of **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 page and result shows **0** **percentage** of plagiarism in the dissertation.

Guide & Supervisor sign with Seal.

Document from scholar X URKUND - Log in X Home - URKUND X 000674720 - Clinical sci X

Secure | <https://eureka.orkund.com/view/30072383-856723-8805238402160.VajjoTVUShQTM/LTMMFusTWyMgglAAs>

URKUND Sources Highlights **Michael Kumar A. (michaelkumar10388)**

Document [Clinical study of collagen dressing in partial thickness burns.pdf \(349074720\)](#)

Submitted 2017-09-28 16:23 (+05:00:00)

Submitted by Michael Kumar A. (michaelkumar10388@gmail.com)

Receiver michaelkumar10388@gmail.com

Message Clinical study of collagen dressing in partial thickness burns. [View full message](#)

 of this approx. 12 pages long document consists of text present in 3 sources.

Source **Highlights**

- Bank** Pathy/Thirumani
- Alternative sources**
- Sources not used**

Collagen also promotes fibrogenesis and governs the restoration of new tissue by organized fibers. 5. Re-epithelialization Keratinocytes migration, differentiation and their growth are influenced by collagen. Collagen emerges a provisional matrix for the migration of the keratinocytes by binding with fibronectin. 6. Wound revascularization

45 The formation of scar tissue is retarded by collagen by means of deposition of organized and organized fibers. Collagen also attenuates the amount of collagenase produced by keratinocytes

46 **MATERIALS AND METHODS** Source of data: This study includes in-patients and non-patients with partial thickness 1st and 2nd degree burns of Trivandrum Medical College Hospital Trivandrum. Method of collection of data - All patients were interviewed at per the proforma and a separate clinical examination was done - Patients with partial thickness burns involving >40% of the total body surface area are assessed - Cases were treated with collagen dressing - Cases are assessed for healing time, pain, healing quality, infection and patient compliance. Study design: A prospective study sample size: 60 patients

47 **Inclusion criteria:** All patients with partial thickness burns, involving >40% of the total body surface area - **Burn wounds not older than 24 hours** **Exclusion criteria:** - Patients with full thickness burns - Patients with burns involving >60% of the total body surface area - Patients with electrical and other non-thermal burns - Patients with burn wounds older than 24 hrs - Patients with facial burns - perineal burns **Materials Used:** For Collagen Dressing: The collagen used for this study is a purified reconstituted collagen. The collagen which is free from other components that are normally associated with it in its native state is referred as purified collagen. Reconstitution is the process in which reassembling of the collagen into individual triple helix molecules with or without their tripeptide extensions is done. Then it is brought into solution after which it is reprecipitated into the desired form. Cross-linking of this reconstituted collagen is then done with tanning agents like chromium sulfate or glutaraldehyde, thereby improving its

11:07 09-28-2017

INTRODUCTION

Any scientific research must be properly planned. Such research usually has a rainbow around the corner, which attracts numerous researchers. The chief appeal of a scientific research is the possibility of certain unexpected developments which form a specific pattern out of disorder.

Burn injuries are very painful conditions which usually heal slowly and that too with scarring. They are common entities encountered in our daily clinical practice. Dressings play a vital role in the management of burn wounds.

As burn injuries are common in developing countries, there is an urgent need for a method by which these injuries heal early with less pain, discomfort and scarring.

The major fibrous protein found among the extracellular connective tissues is the collagen. In the whole animal kingdom, collagen is the most plentiful and ubiquitous protein.

The term collagen originated from the greek word 'kola', meaning glue plus gene. Out of the total protein in the human body, 25% is constituted by collagen and it also constitutes about 70% to 80% of skin.

In the past few decades, scientists have developed remarkable interest in employing collagen for collagen.

Hence a need is felt to study the effectiveness of wound healing process in collagen dressing.

AIMS AND OBJECTIVES

To study the effectiveness of collagen dressing in partial thickness burns by means of the following factors

- ❖ Pain
- ❖ Infection
- ❖ Rate of healing
- ❖ Patient compliance
- ❖ Resultant scar

REVIEW OF LITERATURE

HISTORICAL BACKGROUND:

The oldest written and translated record regarding wounds was discovered by Edward Smith in 1862, which was based on an Egyptian papyrus dated back to 1600 B.C. It describes the use of cotton sutures and the technique of bandaging^{1,2}.

The Hippocratic collection of 400 B.C describes wound healing by primary and secondary intention. It also explains about ‘bad’ pus, which was followed by patient’s death and ‘good’ pus, which represents local inflammation and good wound healing².

The four cardinal signs of inflammation i.e. rubor, calor, dolor, tumor are described by Celsus (30 B.C – 45 AD)²

The use of simple dressing techniques was first demonstrated by Ambrosie Pare in the 16th century AD. He also appreciated the value of hemostasis by practicing the ligation of arteries².

The ‘salutary’ effect of inflammation in the healing process, the phenomenon of wound contraction and factors that delayed or promoted wound healing were first recognized by John Hunter in 1763 AD².

When compared with open wounds, wounds that are covered with dressing materials heal faster and with less contracture. By forming a barrier between wound and external environment, dressing materials, they may be either biological or non biological, prevent bacterial infection.

John Lister, who is known as the father of antiseptics, published his works on carbolic acid spray during surgical procedures in 1867².

Wounds which are kept moist heal better than those exposed to air was determined by Winter in 1962².

When compared with non-biological dressing materials, biological dressing materials show better adherence to the wounds. Numerous studies have shown that, dressing materials which adhere well to the wound have certain advantages such as reducing pain, limiting infection and optimizing the rate of healing. To conclude, wound healing is far better in wounds that are dressed with biologic materials rather than left exposed or covered with non-biologic materials³.

In 1965, collagen sheet was used to cover wounds for 3 to 4 weeks by Abbenhause and he found that it diminished the fluid loss and it also maintained sterility of the wounds⁴.

The mechanism of triggering adhesiveness of platelets and stimulating “release phenomenon”, thereby producing aggregation of nearby platelets was demonstrated by Mason and Read in 1974⁵.

In 1976, an interesting study was done by Ponten B, Nordgaard. He selected 55 donors and used sterile collagen films as dressing. The aims of his study were to find out whether collagen film could be used as a dressing. He came out with good results in 56% of the cases and fair in 20%. From

this study, he inferred that the donor sites were not painful and the need for frequent dressings was eliminated⁶.

In 1977, De Vore D. T conducted an experimental study in rabbits. He demonstrated that collagen aided in healing of a surgically created mandibular bone defect and he also noticed that there was immediate cessation and marked reduction in bleeding⁷.

In 1978, Gupta R L did an extensive work in the use of collagen sheets as dressing material in the management of burns cases. He found out that, in cases of superficial burns and to a lesser extent in deep burns, collagen sheets were a good biological dressing material. Following application, it prevented wound contamination, loss of serum and electrolytes from the burnt areas⁸.

In a study conducted in 1979 by Levin M P, Tsakinos Pi and Cutright D, they used an enzyme – solubilized calf-skin collagen on the wounds that were prepared in the oral cavity of 5 dogs and 15 rabbits. The results of this study indicated that the membrane was biologically acceptable. Also, the applied collagen did not produce any adverse reaction and causes rapid healing⁹.

In 1981, S.K Bhatnagar, R. Krishnan and T.C Goel applied collagen sheets over burn wounds as biological dressing. They noticed that on using collagen sheets, repeated dressings were not required. There was good adherence of collagen sheets to the wounds and they stayed in place until epithelialisation was completed it casted off gradually and completely.

Besides that, the healing time was much shorter and there was no need for any covering dressing over the collagen sheets. While serving all the purposes of a skin homograft, the collagen sheet did not have the problem of storage, availability and frequent change of dressing¹⁰.

In 1992, the properties of freeze dried cross-linked bovine type I collagen was studied by P.R. Hyder. He investigated its modulus of elasticity, biodegradation rate and swelling ratio. He found that the physical properties of the collagen were consistent with good handling qualities and appropriate of use at a surgical site¹¹.

In 1992, the important biological mechanisms involved in wound healing and the main factors that modify the healing process were reviewed by Mian M, Beghe F. He demonstrated the physiological and pharmacological role of collagen. He also discussed the properties of collagen such as its haemostatic effect, its interaction with platelets, its “scaffold” role for fibroblastic proliferation and its role in increasing fluid exudates and the cellular component. He came out with the conclusion that there is clearly a potential for use of collagen in wound repair¹².

In 1995, bovine collagen membranes were used for covering partial thickness burns by Sakiel S, Grzybowski J and he compared it with porcine skin used as biological dressing. He concluded that collagen membrane can be used as biological dressings and recommended its use for partial thickness burn wound care¹³.

In 1995, the usefulness of collagen membrane as a dressing material in covering raw areas which are created after excision of fibrous bands in patients with oral submucous fibrosis was demonstrated by J N Khanna. He conducted this study on 25 patients and concluded that collagen membrane had specific advantages over other methods used in promoting hemostasis, granulation, epithelialisation and preventing the degree of swelling, contracture and morbidity of donor site¹⁴.

The classification of collagen dressings based on their specific use was done by Purna Sai. K in 2000. He also suggested that collagen dressings satisfy all the requirements of an ideal dressing. At the surface of the wound, collagen dressings provide an environment in which healing may take place at an optimum and maximum rate consistent with the production of a healed wound with an acceptable cosmetic appearance¹⁵.

SKIN- ANATOMY:

The skin comprises of two layers:

1.Epidermis

2.Dermis

These two layers rest on the panniculus adiposus, a fatty subcutaneous layer.

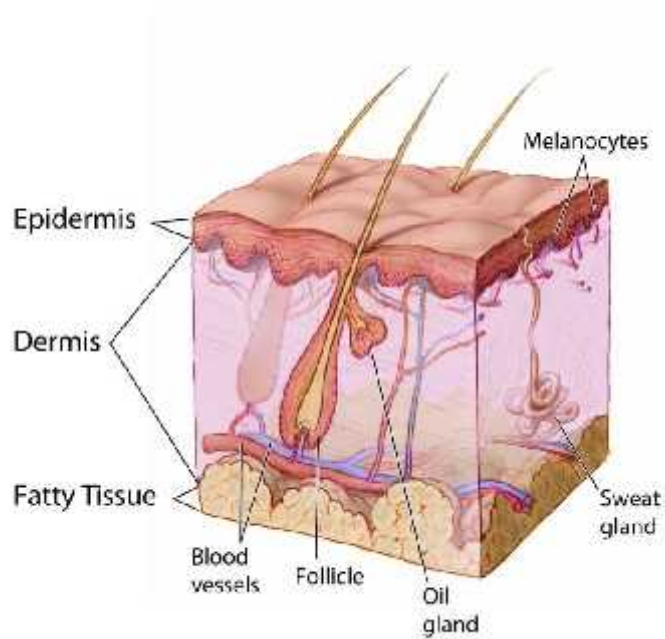


Fig.1: Anatomy of skin

Of these two layers, the superficial epidermis is derived from surface ectoderm. Even though it is ectodermal in origin, this layer is colonized by structures which are derived from other layers such as, Langerhans cells, melanocytes and Merkel cells which are meant for sensing pressure originates from neural crests.

The dermis contains elastic fibers, blood vessels, collagen, sensory structures and fibroblasts and it is derived primarily from mesoderm.

During embryological development, the proliferation and differentiation of ectoderm and the mesoderm beneath it begin at the fourth week. During this period of development, other structures such as hair follicles, nails of fingers and toes, teeth, apocrine, sweat, sebaceous and mammary glands also start to appear.

Of the above mentioned structures, epidermis forms the nails of fingers and toes, while hair follicles and teeth are formed by both epidermis and dermis. The above said glands are nothing but epidermal glands or epidermal appendages, because of their origin.

Skin is considered to be a dynamic organ. At birth, the skin is multilayered. Continuous changes occur in the skin throughout our life as the inner layers of the skin replace the outer layers as they shed. There is also variation in the thickness of the skin depending upon various factors such as sex, age of individual and the anatomic location. The variation is primarily due to a difference in the thickness of the dermis. The epidermal thickness does not vary from one region to the other.

The palms and soles have the thickest skin as the thickness in these sites is 1.5 mm. The post auricular region and the eyelids have the thinnest skin as the thickness in these sites is 0.5 mm. Skin of the males is characteristically thicker than that of the females in all anatomic locations.

EPIDERMIS:

The epidermis consists of the following layers namely stratum germinatum, spinosum, granulosum, corneum and lucidum. The epidermis is a stratified squamous epithelium and it lacks blood vessels of its own. It depends upon the dermis beneath for nutrients and to get rid of the waste products which occurs through the junction between the dermis and epidermis by diffusion. The basal layer, stratum germinatum is immediately

superficial to the dermoepidermal junction. The epidermis consists of keratinocytes in progressive stages of differentiation.

The keratinocytes, as they undergo division and differentiation, migration occurs towards the superficial layers of epidermis. After reaching the uppermost layer of epidermis, the stratum corneum, the keratinocytes are fully differentiated, devoid of their nuclei and ready for shedding. Among the layers of epidermis, stratum corneum has the largest cells. Depending upon the anatomic location, stratum corneum ranges in thickness from 15 to 100 cells. Stratum corneum acts as protective barrier.

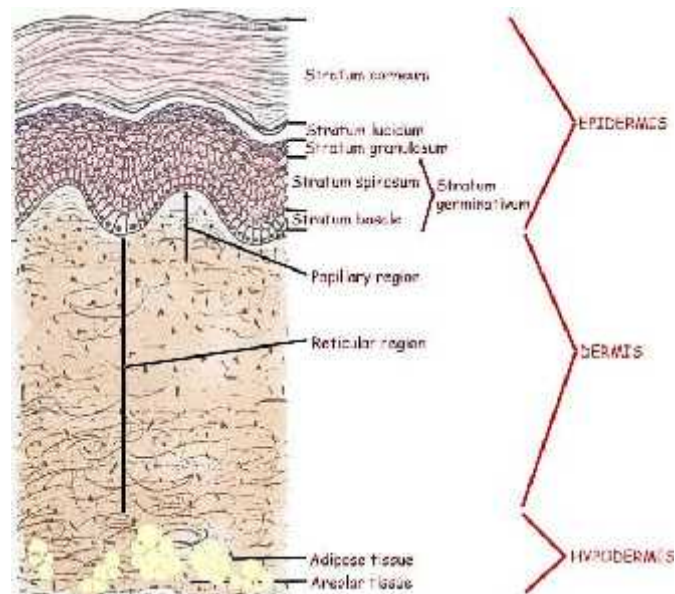


Fig.2 : Layers of is epidermis

The primary function of melanocytes it to produce a pigment named melanin. Melanin has the property of absorbing radiant energy and ultraviolet radiation which are emitted by the sun. Melanosomes are organelles in which the melanin pigment is accumulated and incorporated

into dendrites. By the process of phagocytosis, the melanosomes reach the keratinocytes.

Melanocytes present in various sites which include epidermis, uveal tract, retina, hair follicles and leptomeninges. Melanoma originates from these sites.

The ratio of melanocytes to keratinocytes varies depending upon the anatomic location. In sites which are exposed to the solar radiation, the ratio is 1:4, whereas in areas not exposed to the sun, the ratio may be as low as 1:30.

Difference in complexion among various individuals is primarily due to the size of the melanosomes rather than the amount of melanosomes as the absolute number of melanosomes is found to be same among various races and sexes. The factors which stimulate the production of melanin include melanocyte stimulating hormone (MSH), sun exposure and steroidal hormones.

A gradual reduction is seen in the amount of melanocytes in the epidermis of an individual with aging. The melanocytes have no ability to reproduce as these cells are of neural crest origin.

Langerhans cells are found in all layers of the epidermis except for stratum corneum. These cells function as antigen presenting cells (APC). The langerhans cells, after ingestion of antigens, process them and bind them with major histocompatibility complexes (MHC). These bounded forms are

then presented to lymphocytes for the purpose of activation of the immune system.

Contact hypersensitivity is one such example for the above said activation of the immune system.

DERMIS:

The dermis consists of two layers, the superficial and the deep layers. They are named as papillary and reticular dermis respectively. The papillary dermis comprises of loose connective tissue with capillaries, collagen and is thinner than that of reticular dermis. The thicker reticular dermis comprises of dense connective tissue with larger blood vessels, elastic fibers and bundles of collagen fibers. The other structures which are found in the reticular layer of dermis include mast cells, nerve endings, fibroblasts, epidermal appendages and lymphatics.

The major cell type of the dermis is the fibroblast. They produce and secrete two types of fibers namely, procollagen and elastic fibers. The former is converted into collagen followed by which cross-linking occurs. The tensile strength is provided by these tightly cross-linked collagen fibers. 70% of the weight of the dermis is made up by collagen, primarily Type I and Type III collagen. Type I constitutes about 85%, whereas Type III constitutes 15% of the total collagen.

DERMO-EPIDERMAL JUNCTION:

The dermo-epidermal junction is nothing but a basement membrane. It keeps the epidermis adherent to the dermis. The dermo-epidermal junction comprises of two layers, namely the lamina densa and lamina lucida. The lamina densa is thicker than that of the lamina lucida. The papillary dermis, which is immediately beneath the epidermis has dermal papillae which contain lymphatics. The finger like projections of dermal papillae are surrounded by similar projections from the epidermis, thereby making the dermo-epidermal junction highly irregular and also increases the surface area over which exchange of oxygen, nutrients and waste products occur between the avascular epidermis and dermis.

EPIDERMAL APPENDAGES:

The intradermal epithelial structures which are lined with epithelial cells are called epidermal appendages. These appendages serve as a source of epithelial cells to accomplish re-epithelialisation in situations like abrasions, superficial burns or while harvesting skin graft in which the overlying epidermis is either destroyed or removed. Epidermal appendages comprise of sweat glands, hair follicles, apocrine glands, sebaceous glands and mammary glands

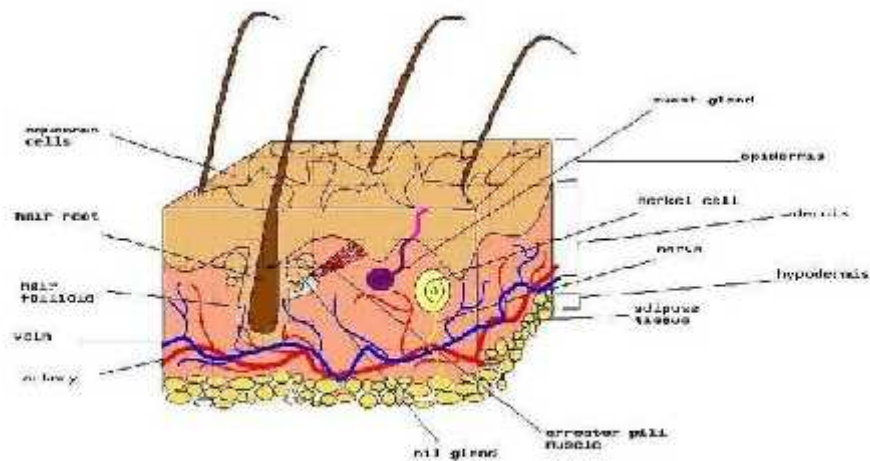


Fig 3: Epidermal Appendages

SEBACEOUS GLANDS:

Sebaceous glands are present universally all over the body. A group of complex oils including cholesterol, cholesterol esters, wax esters and squalene, named sebum, is produced and secreted by these sebaceous glands. The function of the sebum is to lubricate the skin and to protect it against friction. It also helps in keeping the skin more impervious to moisture.

SWEAT GLANDS:

Sweat or eccrine glands are present over the entire surface of the body except for certain areas which include external ear canal, vermilion border of lips, glans penis, inner aspect of the prepuce, labia minora and the nail beds. Each sweat gland has a secretory portion which is present within the dermis is connected to the exterior through a distal duct. Sweat which is produced by the sweat glands, cools the body by evaporation. The sweat

gland activity is controlled by the thermoregulatory centre in the hypothalamus.

APOCRINE GLANDS:

They resemble eccrine glands in structure and are present in the anogenital region and the axillae and as modified glands at various sites, such as Moll's glands in the eyelids, ceruminous glands in the external ear canal and mammary glands in the breast. The apocrine glands serve a vestigial function until puberty after which they start functioning.

HAIR FOLLICLES:

Hair follicles are distinct structures formed by both layers of the skin. They are present all over the surface of the body except the palms, soles, labia minora, clitoris, glans penis, certain portions of fingers and toes and mucocutaneous junctions.

The secretions of the sebaceous glands most often open into the hair follicles and the entire complex constitutes the pilosebaceous unit.

The hair bulb is the base of the hair follicle and the deep portion of the hair follicle is connected to the superficial dermis by erector pili which are a smooth muscle. Under the control of the sympathetic nervous system, contraction of the erector pili causes the hair follicle to assume a more vertical orientation¹⁶.

ANATOMY OF HAIR FOLLICLE:

A cyclical pattern is exhibited by hair growth which comprises of three phases, namely, anagen, catagen and telogen. Anagen and the telogen are the growth and resting phases respectively. Catagen phase is the transition between anagen and telogen. Depending on the anatomic location, these phases vary in length. In an anatomic location, hair follicles are present in all the three phases of hair growth at any one time¹⁷.

BLOOD SUPPLY OF THE SKIN:

Blood vessels which supply the skin named cutaneous vessels arise from the named source vessels which lie beneath. Angiosome is termed as a three dimensional vascular territory from bone to skin which is supplied by each source vessel. Angiosomes which lie adjacent to each other have vascular connections through small caliber anastamotic vessels. The cutaneous vessels arise in either of the following two ways, i.e direct branches from source arteries or as terminal branches of muscular vessels. They are termed as septocutaneous or fasciocutaneous and musculocutaneous perforators respectively.

These vessels, on their way to the skin surface, traverse the adjacent connective tissue framework and give branches to the surrounding structures such as bone, nerve, fat, fascia and muscle. After emerging from the deep fascia, they move towards the skin to form plexuses in the sub dermal and dermal layers. Superficial and deep plexuses are horizontally arranged in the

dermis and these plexuses are interconnected through communicating vessels. Ultimately, there is extensive anastomosis between the cutaneous vessels of adjacent areas to form an excellent vascular network within the skin. This explains the reason for the survival of random skin flap.

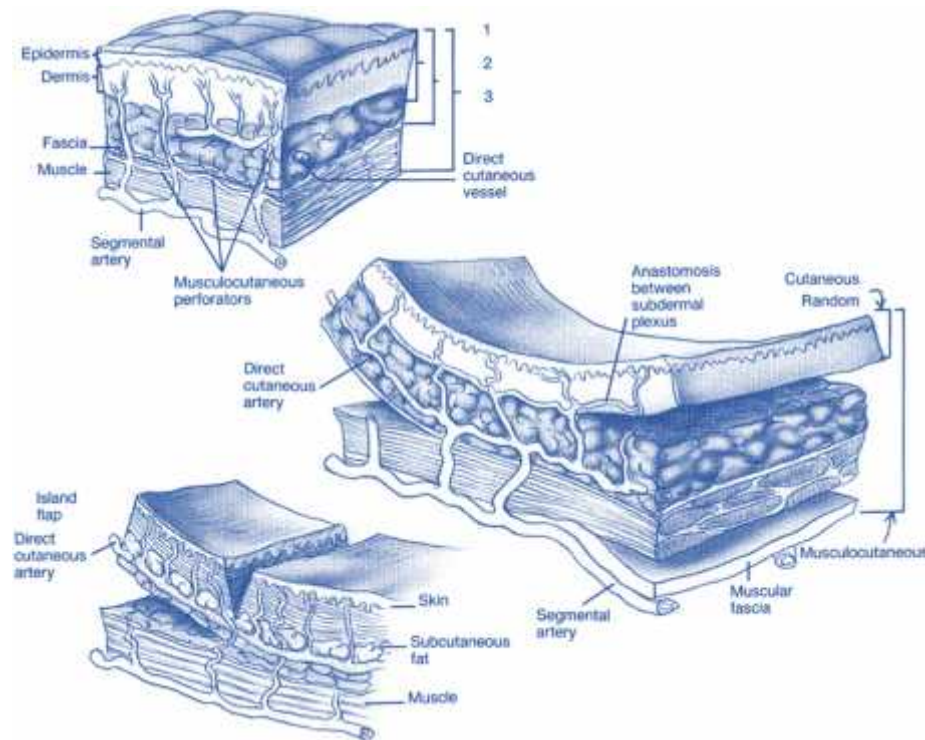


Fig 4: Blood Supply of Skin

Cutaneous vessels play a vital role in the thermoregulation of the human body. Convection from these vessels is an important aspect besides heat loss from sweat evaporation and natural heat conductivity property of the skin. By means of regulation of cutaneous blood flow, large amounts of heat can be exchanged and this flow is ten to twenty times than that of required for the purpose of essential metabolism and oxygenation. The vasoconstriction and vasodilatation of the cutaneous vessels are controlled

by the thermoregulatory centre in the hypothalamus through the sympathetic nervous system¹⁸.

LYMPHATICS:

The main functions of the lymphatics are scavenging antigenic substances, foreign material and bacteria and conserving plasma proteins. They arise within the dermal papillae, then reach the plexus beneath the dermis and finally form larger lymphatic channels. These channels finally join the venous circulation after filtering through numerous lymphnodes.

SKIN INNERVATION:

In order to avoid extremes of temperature, pressure, mechanical or traumatic forces, skin has an excellent property of sensory perception. Light touch is detected by Merkel cells and Meissner corpuscles. Pressure is detected by specialized structures called pacini corpuscles.

Naked nerve endings which are present in the basal layer of epidermis are responsible for pain transmission. Ruffini corpuscles and Krause bulbs detect heat and cold respectively. Cutaneous nerves travel along with the blood vessels to the skin. A dermatome is defined as the area supplied by a single segment of the spinal cord or by a single spinal nerve. Overlapping may be seen between adjacent dermatomes which should be kept in mind while performing field blocks with local anesthesia.

MECHANISM OF WOUND HEALING:

Repairing tissues after inflammation and replacing dead or injured cells in the human body is critical to survival. Whenever cells and tissues are damaged by injurious agents, a series of events is initiated by the host to remove these injurious agents, restrict the damage and prepare the remaining surviving cells for replication. Regeneration and healing are the two important processes involved in the repair of damage of tissue caused by wounds, surgical resection and various types of chronic injury. Regeneration leads to restitution of lost tissues whereas healing includes collagen deposition and scar formation besides restoring original structures.

The wound healing is the prototype of tissue repair. It is a changing and dynamic process. Inflammation, granulation tissue formation, tissue remodeling and scarring are the various phases in the process of wound healing. Simple cutaneous incisional wounds usually heal by first intention, whereas large cutaneous wounds heal by second intention. The latter generates a significant amount of scar tissue.

STAGES OF WOUND HEALING:

A. Inflammation:

The initial event is aggregation of platelets around the exposed collagen. The intrinsic clotting cascade is stimulated by the factors secreted by the platelets which interact with and strengthen the platelet aggregate into a stable hemostatic “plug”. Variety of growth factors and cytokines are released by the platelets. These include insulin-like growth factor, transforming growth factor-beta, platelet derived growth factor and epidermal growth factor. Variety of inflammatory cells such as neutrophils, eosinophils and monocytes are attracted by these cytokines to the wound site and thereby initiating the inflammatory phase.

The inflammatory cells, mainly neutrophils, macrophages and eosinophils migrate to the wound sites and secrete proteolytic enzymes.

Many peptides are formed during wound healing by the action of these proteolytic enzymes on the macromolecular constituents of the extracellular matrix. These peptides play a main role in recruiting cells such as mononuclear cells, macrophages and neutrophils by the chemotactic effect.

TNF-a secreted by the activated macrophages stimulate the production of IL-1b, which causes up-regulation of matrix metalloproteinase expression and it is mitogenic for fibroblast. Deposition of collagen in the wound is influenced by these pro-inflammatory cytokines, TNF-a and IL-1b.

Migration of epithelial cells, vascular endothelial cells and fibroblasts into the wound is stimulated by these growth factors. This increase in the cellularity of the wound marks the beginning of proliferative phase.

B. Proliferation:

Fibroblast proliferation is stimulated by the products produced by the degradation of collagen. The growth factors secreted by these fibroblasts aid in the formation of the extracellular matrix. Vascular endothelial cell proliferation is also stimulated by these collagen cleavage products.

These vascular endothelial cells in turn produce numerous growth factors, which induce angiogenesis. Granulation is achieved through a vascularised extracellular matrix. The migration and proliferation of keratinocytes is also stimulated by the collagen cleavage products, followed by which a variety of cytokines and growth factors are secreted by keratinocytes. Re-epithelialisation is achieved once these keratinocytes migrate to the newly formed granulation tissue from the edge of the wound.

C. Remodelling:

For an optimum healing of a wound, a balance is required between the production of new components of the scar matrix and degradation of these components by matrix metalloproteinases. These include collagenase, gelatinase and stromelysin.

Fibroblasts are the major source of matrix metalloproteinases besides synthesizing collagen, proteoglycans and elastin. As the scar matures, there

is a decrease in the density of capillaries in the wound and angiogenesis ceases. This results in the creation of a strongest scar.

BURNS:

Ever since man discovered fire, his curiosity has grown enormously to uncover mystery hidden within it. Some went on ascribing divinity to it. Many ancient cultures show the evidence of people worshipping fire. Some are seen to walk over it during certain occasions, on the ember. As the time passed, man started using it for cooking, disposing waste and for other activities.

Fire was perhaps, man's first double edged sword; for throughout history, it has served as well destroyed mankind. It may boil and bake. At the same time, may God forbid, it burns and 'buries' people. Unfortunately, there is yet no suitable or at least an equal substitute for fire.

Despite knowing the deadliness of fire, man still continues to be callous and 'indifferent' towards handling fire.

The various risk factors include the following,

1. Cooking on open fires
2. Explosion of pressure stoves
3. Instability of small stoves
4. Use of open fires to keep warm during winters
5. Use of inflammable materials in housing and furnishing
6. As means of suicide

Burns are also one of the means of committing violence, especially against women.

Accidentology, which is concerned with research, is expected to offer great insights into such problems related to burns.

The two basic factors which determine the effect of heat on the human body are temperature and time. Anatomy of skin and hypodermis also influence the degree of damage caused by heat. Sweat glands which are present in the dermis and the vascular supply, with blood flowing in the hypodermis serve as remarkable thermo-regulators in the human body.

Whenever a burn occurs, it results in coagulative necrosis of the tissues. The depth of a burn wound depends upon two factors. The temperature to which the skin is exposed and the duration for which the skin is exposed. The depth also depends upon the specific heat of the causative agent.

Causes Of Burns:

1. Flame :

Burns caused by oxidized, superheated air which may cause vesication on the body surface.

2. Hot liquids :

Hot liquids when come in contact with the skin lead to scalds.

3. **Contact Burns :**

When a highly heated solid body or a molten metal applied to the body for a very short time, it may produce only a blister and reddening corresponding in size and shape to the material used. It will cause destruction or even charring of parts upon contact for some time.

4. **Explosions :**

Burns caused by explosions in coal mines or of gun powder are usually very extensive and produce blackening and tattooing due to driving of the particles.

5. **Iatrogenic :**

Burns due to X-rays are usually because of faulty exposure and may vary from mere redness of skin to dermatitis with loss of hair and epidermis and pigmentation.

6. **UV Rays :**

Burns by ultraviolet rays (the sun or mercury vapor lamp) produce erythema / acute eczematous dermatitis

7. **Chemicals :**

Burns from corrosive substances show ulcerated patches and are usually free from blisters. Corrosion means to destroy something by chemical action. Strong acids produce dark leathery burns upon the skin. Strong alkalis cause sloughing and leave moist, slimy and grayish areas.

8. **Burns by electricity and lightning :**

Electric burns may be due to contact with electric circuit or by flash burns, which usually accompanies a short circuit. The latter are essentially same as by flame. Burns by lightning, may appear in the form of arborescent markings on the surface of skin, looking like branches of a tree.

9. **Radiant heat burns :**

They are caused by heat waves, a type of electromagnetic wave

10. **Microwave burns :**

They are well demarcated, full thickness burns.

Burns Pathophysiology:

Burns injuries trigger the release of inflammatory mediators in large amounts in both the wound and in other tissues. They in turn produce constriction and dilatation of blood vessels, marked increase in the capillary permeability and edema.

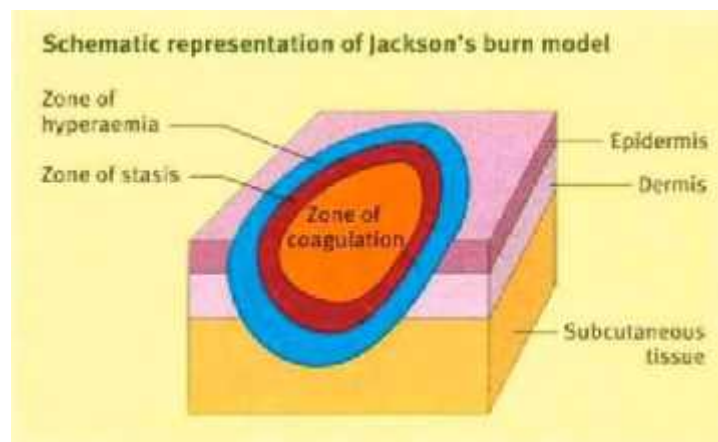


Fig 5: Pathophysiology of Burns

In response to the changes in the Starling forces caused by burns, generalized edema occurs in both the burned and unburned skin. There is marked decrease in the interstitial hydrostatic pressure in the burned skin initially. In the non-burned skin, there is an associated mild increase in the interstitial pressure. Due to the protein loss caused by increased capillary permeability, interstitial oncotic pressure increases and plasma oncotic pressure decreases. As a result of these events, generalized edema occurs. As the interstitial pressure is lower, the edema is greater in the burned tissues.

In case of burns, much of the injury is received by the skin. But once the inciting focus is removed, the response developed by the local tissues cause injury to the deeper layers.

There are three zones in the area of cutaneous injury, namely zones of coagulation, stasis and hyperemia.

The zone of coagulation is the necrotic area of a burn wound. The zone of stasis is the area surrounding the zone of coagulation where there is a moderate degree of insult and tissue perfusion is decreased. Depending on the environment of the wound, the zone of stasis may proceed further. It can either survive the insult or progress to coagulative necrosis. Vessel leakage and vascular damage are present in the zone of stasis. In the burn wounds, thromboxane A₂, which produces vasoconstriction, is present in large

quantity. Inhibitors of these substances may be applied locally to improve blood flow.

The third zone is the zone of hyperemia, which surrounds the burn wound and is characterized by vasodilatation as a result of inflammation. This is the zone from which the healing process begins. This zone consists of clearly viable tissue and they are not at risk for further necrosis.

Burn Depth:

The degree of tissue damage determines the depth of a burn. Burn depth is categorized to the following degrees based on the extent of injury in the epidermis, dermis, subcutaneous fat and surrounding structures.

There are various classifications for burns which are given below,

Table 1: Classification of Burns

Degree of damage	Dupuytren's	Hebra's	Wilson's
Erthema / Redness Vesication	1 st degree 2 nd degree	1 st degree 1 st degree	Epidermal
Damage to superficial skin	3 rd degree	2 nd degree	Dermo-epidermal
Damage to whole skin	4 th degree	2 nd degree	Dermo-epidermal
Damage to muscles	5 th degree	3 rd degree	Deep
Damage to deeper tissues including bone etc	6 th degree	3 rd degree	Deep

When the injuries are confined to the epidermis, they are called first degree burns. They appear erythematous, blanch to the touch, painful and have an undisrupted epidermal barrier. An example for first degree burns is sunburn.

First degree burns heal without any scars and the treatment options include topical soothing applications and oral NSAIDs.

The second degree burns differ from that of the first degree burns by the presence of some degree of damage to the dermis. Second degree burns may be superficial or deep depending upon the depth of injury to the dermis. Superficial burns are erythematous and often blister. Superficial dermal burns are usually painful because of exposed nerve endings. One such example is scald injury from boiling water.

Superficial dermal burns with the help of retained epidermal appendages such as hair follicles and sweat glands, spontaneously reepithelialize in 7 to 14 days. Following the healing process, such burns leave behind some slight skin discoloration.

The burns which extend into the reticular dermis are termed deep dermal burns. Such burns do not blanch to touch, have a pale and mottled appearance but the patient can experience pain at these sites. Deep dermal burns, by the process of re-epithelialisation from structures such as, hair follicles and sweat gland keratinocytes heal in about 14 to 35 days. Due to the loss of dermis, the deep dermal burns heal with severe scarring.

Burns involving both the epidermis and the dermis are called third degree burns. Painless hard, leathery eschar which may be black, white or cherry red is the characteristic appearance of third degree burns. They must heal by re-epithelialisation as the epidermal and dermal appendages are destroyed. The full thickness and deep dermal burns must be treated with excision and skin grafting for timely healing of such wounds.

Burns involving the structures underneath the skin, such as muscle, bone are called fourth degree burns.

Assessment of burn depth comes with experience. It is essential to determine the accurate burn depth because the treatment differs with the degree of burns as the full thickness burns require operative intervention whereas the first degree burns heal with local treatment.

The recent advancement in this field is the multi-sensor laser Doppler flowmeter. This device helps in determining the burn depth. Various studies suggest that this flowmeter is superior to the clinical assessment in determining the burn depth and assessing the requirement of skin grafting.

This latest gadget may revolutionize the standard of care in the future¹⁹.

Burn Size:

The Wallace rule of nine is the method generally used to assess the burn size. In adults, the head and neck and each upper limb are assumed as 9% of the total body surface area. Each lower limb and the anterior and

posterior aspects of the trunk are assumed as 18% each. The genitalia and the perineum are considered to be 1% of the total body surface area.

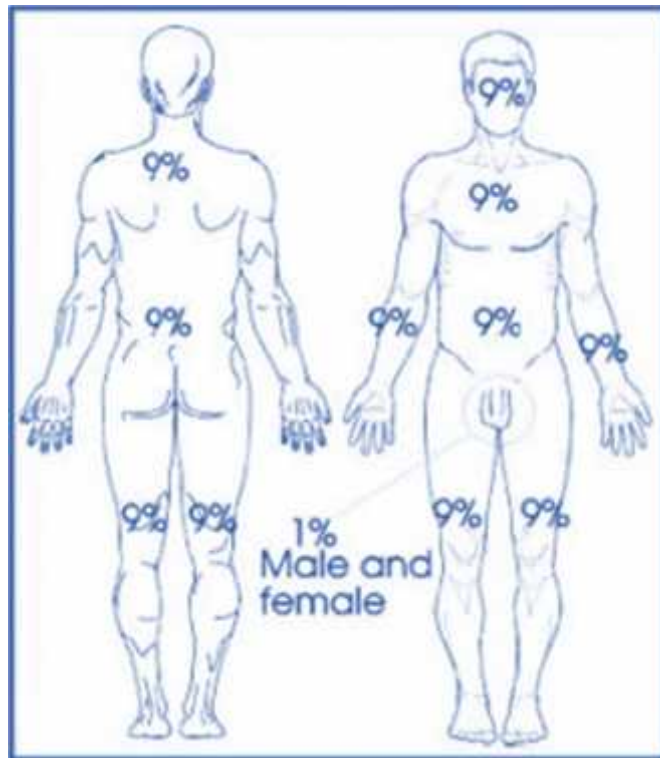


Fig 6: Wallace Rule of Nine

Table 2: Wallace Rule of Nine

Part of the body	Percentage of the whole body surface
Head and neck	9
Front of chest	9
Back of chest	9
Front of abdomen	9
Back of abdomen	9
Right upper limb	9
Left upper limb	9
Front of right lower limb	9
Back of right lower limb	9
Front of left lower limb	9
Back of left lower limb	9
Pudendal area	1
Total	100

Another method which is used to estimate smaller burns is to assume the area of the open hand of the patient to be more or less equal to 1% of the total body surface area. The measurement by this method should be transposed visually onto the wound for the purpose of determination of burn size. This method is quite useful in assessing splash burns and other burns of mixed distribution.

The estimation of burn size in children and infants is different from that of the adults. The surface area is smaller in their lower extremities when compared with their head and neck regions. Infants have as much as 21% of the total body surface area in the head and neck regions and 13% in each of the lower limb. These values approach the adult proportions as age advances. Hence in children and infants, burn size is estimated by using Lund and Browder chart.

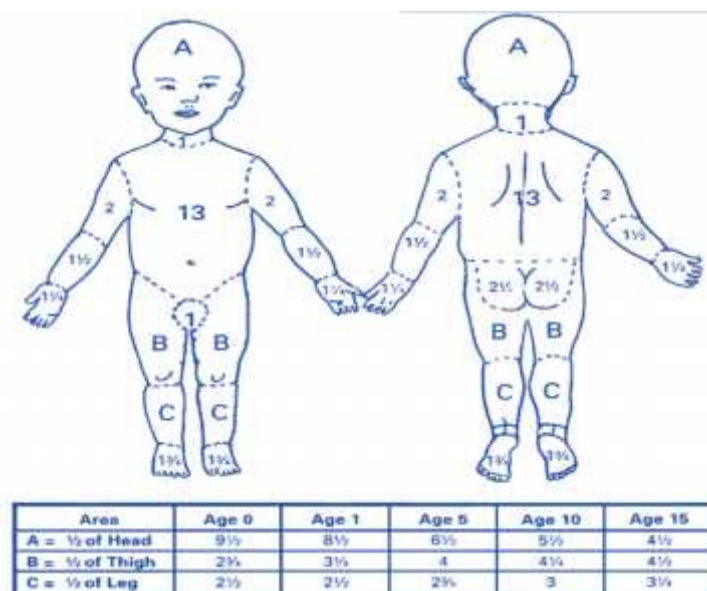


Fig 7: Lund and Browder chart

Table 3: Lund and Browder chart for estimation of % of TBSA

Area	0-1 Yr	1-4 Yr	5-9 Yr	10-14 Yr	15 Yr	Adults
Head	19	17	13	11	9	7
Neck	2	2	2	2	2	2
Ant.Trunk	13	13	13	13	13	13
Post.Trunk	13	13	13	13	13	13
Rt.Buttock	2.5	2.5	2.5	2.5	2.5	2.5
Left Buttock	2.5	2.5	2.5	2.5	2.5	2.5
Genitalia	1	1	1	1	1	1
Rt.Upper arm	4	4	4	4	4	4
Lt.Upper arm	4	4	4	4	4	4
Lt.Lower arm	3	3	3	3	3	3
Rt. Lower arm	3	3	3	3	3	3
Lt. Hand	2.5	2.5	2.5	2.5	2.5	2.5
Rt. Hand	2.5	2.5	2.5	2.5	2.5	2.5
Rt. Thigh	5.5	6.5	8	8.5	9	9.5
Lt. Thigh	5.5	6.5	8	8.5	9	9.5
Rt. Leg	5	5	5.5	6	6.5	7
Lt. Leg	5	5	5.5	6	6.5	7
Rt. Foot	3.5	3.5	3.5	3.5	3.5	3.5
Lt. Foot	3.5	3.5	3.5	3.5	3.5	3.5

WOUND CARE:

While resuscitating a patient with burn injury, after assessing the airway, one should focus their attention to the burn wound. Treatment varies depending upon the characteristics and the size of the wound but all of them are done with a aim of painless and rapid healing.

Current therapy for the management of burn wounds comprises of three stages namely, assessment, management and rehabilitation. To start with the burn depth and burn size are assessed followed by which the management phase begins, which include thorough cleaning and debridement of the burn wound. Then appropriate covering materials are used to dress the wound, which serve numerous functions.

First, the dressing provides protection to the damaged epithelium, reduces the colonization of bacteria and fungi in the wound and it maintains the extremities in the desired position of function by the splinting action.

Second, the dressing acts as a barrier thereby reducing heat loss by evaporation and minimize cold stress.

Third, as the burn wounds are painful, the dressing serves comfort.

The type of dressing to be applied on the burn wound varies. Since there is only minimal loss of barrier function in case of first degree wounds, dressing is not required in such cases. Topical salves can be applied to minimize the pain and to keep the skin moist. Oral non-steroidal antiinflammatory drugs can be given to control pain.

Second degree burns must be treated in either of the following ways. Daily dressing with topical antibiotics, gauze pads with cotton and elastic bandages, or the wounds can be covered with temporary biologic or synthetic dressings. The third degree and deep dermal burns must be treated with excision of the necrosed tissue and skin grafting. The role of dressing in such cases is to hold the proliferation of bacteria in check until surgery is performed.

BURN WOUND DRESSINGS:

The various types of dressings which can be used in case of burn injuries are given below,

1. Antimicrobial Salves : Silver sulfadiazine, mafenide acetate, bacitracin, neomycin, polymyxin B, nystatin, mupirocin.
2. Antimicrobial Soaks : 0.5% Silver nitrate, 5% Mafenide acetate, 0.025% Sodium hypochlorite, 0.25% Acetic acid.
3. Synthetic coverings : Opsite, biobrane, transcyte, integra
4. Biologic coverings : Xenograft, allograft

Synthetic and Biologic Dressings:

Nowadays antimicrobial dressings are replaced by synthetic and biologic dressings in current clinical practice. Such synthetic and biologic dressings besides providing an effective barrier to evaporate losses, serve as stable coverage for burn wounds and also decrease pain in them. These dressings do not impair epithelialisation unlike most topical antimicrobials.

Biologic coverings include allograft (cadaver skin) and xenograft (pig skin). The synthetic dressings include Biobrane, Transcyte and Integra. These dressings are applied over the wound before bacterial colonization occurs. Hence such dressings are applied within 72 hours of injury. Biologic and synthetic dressings are used either for covering second degree wounds under which the epithelialisation occurs or to cover third degree burn wounds as a temporary cover before applying autograft. Each type of dressing has its own merits and demerits.

Biobrane:

Biobrane is a type of synthetic dressing material which is manufactured in the form of a sheet. It is made up of collagen-coated silicone. On application, Biobrane gets adherent to the wound in about 24 to 48 hrs. This sheet makes the wound bed relatively painless, acts as an effective barrier to the loss of moisture from the wound and eliminates the need for repeated dressings. Once epithelialisation is completed, Biobrane sheet can be easily stripped off from the wound. When using this dressing over burn wound, one must be careful that massive exudate does not get collected beneath the Biobrane sheet, as it may aid as an optimum environment for the proliferation of bacteria and subsequent wound infection. Biobrane sheets are used as dressings for the donor sites and also for superficial second degree burns.

Transcyte:

Transcyte is a type of synthetic dressing which contains growth factors prepared from lysed fibroblasts grown in culture. Studies report that the use of transcyte has reduced the incidence of autografting and the length of hospital stay. It has the benefit of stimulated wound healing along with other advantages of Biobrane. Transcyte and Biobrane have similar applications, with Transcyte can also be used to cover deep second degree wounds which heal with stimulation²⁰.

Integra:

Integra is a product that is made up of a combination of collagen matrix and silicone sheet. Collagen matrix serves as dermal substitute which on application engrafts into the wound. The silicone sheet serves as epidermal substitute and it is removed after two weeks and replaced with autograft.

Integra can be used to close full thickness burns and also serve as a dermal equivalent thereby inhibiting future scarring. The demerits of Integra are absence of antimicrobial properties and it may be complicated by wound infections. In addition to that, it requires two operations for covering the wound, as the silicone layer must be removed and replaced two to three weeks after application. One of the remarkable advantages of Integra is limitation of scarring. It is due to the presence of collagen matrix which serves as the dermal substitute²¹.

Biological dressings include xenograft and allograft. The former is obtained from the pig skin while the latter is obtained from cadaver donors. These are applied over the burn wounds to serve the functions of the normal skin. The disadvantage with these types of dressings includes with passage of time, they will be rejected by usual immune mechanisms and they may slough out.

Since patients with extensive burns are usually immunocompromised, these biological dressings will not be rejected for the first several weeks. Hence these dressings are used as a temporary means of dressing in cases of massive partial thickness burns. The demerits with allograft include increased risk of transmission of viral diseases.

Silver Sulfadiazine:

Silver sulphadiazine is a topical antibacterial which is being used for a long time as a topical burn cream on second and third degree burns. It curtails the proliferation of bacteria on the damaged skin. Studies conducted have shown that it promotes the healing process.

Silver sulfadiazine is a sulpha derivative and it is available as 1% solution suspended in a water soluble base. This chemical has very less penetration through the skin as it is poorly soluble. The mechanism of action of silver sulphadiazine on burn wounds was extensively studied. On application, silver is bound by bacteria. Sulfadiazine exhibits synergistic action when combined with subinhibitory levels of silver sulfadiazine. The

slow and study actions of silver sulfadiazine with serum and other body fluids which contain sodium chloride are responsible for its efficacy. In this way, the silver ions are delivered into the wound environment.

COLLAGEN – AN OVERVIEW:

Structure Of Collagen:

About 15% of the human body is made up of proteins which are natural polymers. Collagen comprises the major protein of the extracellular matrix. In mammals, collagen is the most abundant protein as it constitutes about 25% of the total protein. About 70% to 80% of the skin (dry weight) is comprised of collagen.



Fig 8: Collagen

The unique feature of collagen is the triple stranded helical structure. Collagen serves as a structural scaffold in various tissues. The main types of

collagen found in connective tissue include Types I, II and III. Among the collagen found in the human body, 90% is comprised of these types.

FUNCTION OF COLLAGEN IN WOUND HEALING

Collagen not only functions as a structural support but along with the collagen derived fragments control many important cellular mechanisms such as synthesis of numerous proteins, cell shape and differentiation and migration.

The most abundant structural constituent of the dermal matrix is the Type I collagen. Through the formation of gelatin, collagenase helps in the dissociation of keratinocytes from the collagen rich matrix. Extracellular matrix regulates the cellular functions. Various specialized cell surface receptors process and transduce the information into the cells which is provided by the extracellular matrix macromolecules²².

The major functions of these receptors include initiation of migration of epithelial cells, deposition of collagen, contraction of wounds and induction of matrix degrading collagenase.

A polypeptide with the repeating sequence (Gly – X – Y) forms the basic unit of collagen. Gly, X and Y represent Glycine, proline and hydroxyproline.

The molecule thus formed twists into a left-handed helix. A triple helix is formed, when these left handed helices wrap around each other. The molecule may be made up of either 2 or 3 different alpha chains, or 3

identical alpha chains, depending on the type of collagen. There may be a continuous stretch of triple helix or it may be interrupted by non-collagenous segments.

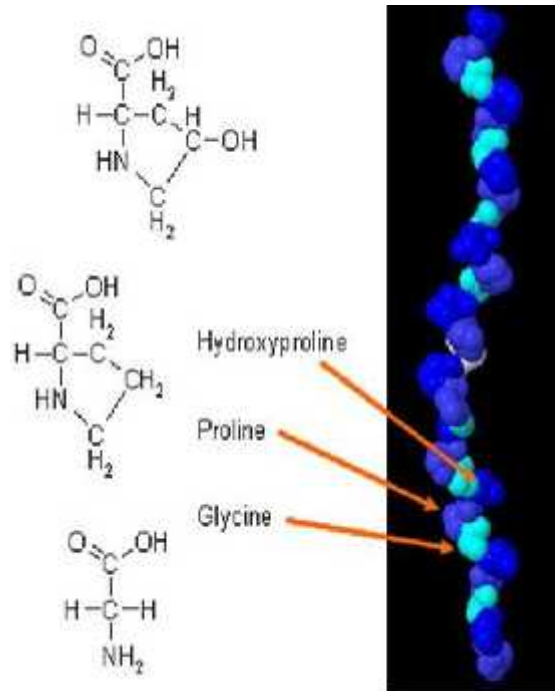


Fig 9 : Composition of Collagen

Every third position in the repeating amino acid sequence is occupied by glycine, within the triple helical domain. As larger amino acids will not fit into the structure of the triple helix, Glycine is very essential for the triple helical conformation.

X and Y positions are usually occupied by proline. Y position may be occupied by hydroxyproline, which are unique amino acids present in the collagen. Numerous lysine derived inter and intramolecular cross-links are present which stabilizes the collagen molecule.

Types Of Collagen:

Collagen constitutes a group of proteins and about 19 different types of collagen have been studied. These collagen types have been classified into three groups, based on the ability of the collagens to form fibrils.

The first group of collagens is called fibril forming collagens. They form banded fibrils and they are the most easily recognized forms of collagens. The collagens belong to this group include Type I, II, III, V and XI collagens.

In the proteins present in the second group of collagens, noncollagenous sequences interrupt the collagenous domains. The collagens belong to this group include Types IX, XII, XIV and XIV collagens. These collagen types are unique because they contain glycosaminoglycans covalently linked to the protein.

The third group called non-fibrillar collagens, which include Types IV, VI, VII and X. They also include network forming collagens, anchoring fibrils and invertebrate cuticle collagens. With short triple helical collagen domains, these collagens constitute to form sheets of proteins.

Tissue Distribution Of Collagen:

A mixture of collagen types is present in all the tissues. Different collagen types are present in variable proportions and also differ in their structural organization²³.

Table 4: Types of Collagen

Type of collagen	Site
Type I	The most abundant collagen, which is present in scar tissue and tendons
Type II	Cartilage
Type III	Granulation tissue
Type IV	Basal lamina
Type V	Interstitial tissue
Type VI	Interstitial tissue
Type VII	Epithelia
Type VIII	Endothelial cells
Type IX	Cartilage
Type X	Hypertrophic and mineralizing cartilage
Type XI	Cartilage
Type XII	Interacts with types I and III

Collagen's Role In Wound Healing:

1. Hemostasis

Platelet membrane has specific receptor sites on which binding of collagen occurs. This initiates the release of certain substances which cause adhesion and aggregation of platelets.

2. Wound debridement

Collagen has chemotactic effect on neutrophils and monocytes. Macrophages are formed from monocytes which act as scavengers and phagocytose foreign bodies.

3. Granulation and angiogenesis

Collagen releases substances which help in the growth of new capillaries. These new capillaries are responsible for the deposition of new fibers.

4. Fibroblastic activity

Collagen has a chemotactic effect on fibroblasts thereby stimulating their migration and proliferation. Collagen also promotes fibrillogenesis and governs the restoration of new tissue by organized fibers.

5. Re-epithelialisation

Keratinocytes migration, differentiation and their growth are influenced by collagen. Collagen arranges a provisional matrix for the migration of the keratinocytes by binding with fibronectin.

6. **Wound remodeling**

The formation of scar tissue is reduced by collagen by means of deposition of oriented and organized fibers. Collagen also determines the amount of collagenase produced by keratinocytes.

MATERIALS AND METHODS

Source of data:

This study includes in-patients and out-patients with partial thickness (1st and 2nd degree) burns of Tirunelveli Medical College Hospital Tirunelveli.

Method of collection of data:

- All patients were interviewed as per the proforma and a complete clinical examination was done, wound swab was taken for all patients before applying collagen dressing.
- Patients with partial thickness burns involving <40% of the total body surface area are assessed.
- Cases were treated with collagen dressing.
- Cases are assessed for healing time, pain, healing quality, infection and patient compliance.

Study design:

A prospective study

Sample size:

60 patients

Inclusion criteria:

- All patients with partial thickness burns, involving <40% of the total body surface area
- Burn wounds not older than 24 hours

Exclusion criteria:

- Patients with full thickness burns
- Patients with burns involving >40% of the total body surface area
- Patients with electrical and other non-thermal burns
- Patients with burn wounds older than 24 hrs
- Patients with facial burns / perineal burns

Materials Used:

❖ *For Collagen Dressing:*

The collagen used for this study is a purified reconstituted collagen. The collagen which is free from other components that are normally associated with it in its native state is referred as purified collagen. Reconstitution is the process in which reassembling of the collagen into individual triple helical molecules with or without their telopeptide extensions is done. Then it is brought into solution after which it is regrouped into the desired form.

Cross-linking of this reconstituted collagen is then done with tanning agents like chromium sulphate or gluteraldehyde, thereby improving its

tensile strength to make it insoluble. Besides lowering its antigenicity, the cross-linking decreases its rate of resorption.

The collagen membranes are available in various dimensions such as 5 x 5 cm, 10 x 10 cm and 25 x 25 cm. the thickness of these collagen membranes is 0.6 mm. Sterilization of these collagen membranes is done by gamma irradiation and marketed in aluminium pouch packing, which contains a mixture of isopropyl alcohol and water. It has a shelf life of about 5 years at ambient temperature.

Technique of Application:

❖ ***Collagen Dressing:***

In the operating room, under strict aseptic precautions, under general anesthesia, the burn wound were washed thoroughly with normal saline. Necrotic tissue and dead skin were removed from the burn wound.



Fig 10: Collagen application

Collagen sheets were washed and rinsed in normal saline before application to remove all traces of preservation fluid. Sheets were applied firmly over the burn areas without over stretching of the sheet. In order to remove all air bubbles between the wound and the collagen sheet, we used the back of the thumb forces to apply a little pressure from one end of the dressing to the other end. We used a dryer to ensure adhesion of the collagen sheet to the burn wound. For circumferential burn areas especially in the extremities we applied collagen sheets with a linear gap in the entire length of the extremity to give an allowance for the edema of the extremities to avoid compression effect. Patients were advised to avoid wetting of collagen sheet. After 24 hours, follow up were undertaken for assessment of 'take up' of the collagen sheet, pain level and comfort. Using visual analog pain scale, pain was recorded after application. Collagen sheets were taken up in 55 patients. About 5 patients had collection of fluid underneath the collagen sheet, which was let out by making small nicks in the collagen sheet, discharged fluid was subjected to culture and sensitivity. Culture and sensitivity report was positive for staphylococcus aureus for two patients, E.coli, Klebsiella and pseudomonas for one patient respectively, they were treated with appropriate antibiotics according to the sensitivity reports. Infection were settled but with delayed healing and with good scars. Patients were followed up on day 1,2, 7 and 14 days, the dried

and lifted up peripheries in the collagen sheet were clipped off gradually till the wound heals.

Collagen sheet peels off as the wound heals & epithelialization occurs; we placed a saline moist pad over Collagen dressing for few minutes to facilitate easy removal.

Results analysis:

The results obtained using the following criteria: Pain score is based on the own words of the patients as pain being subjective. It is on a visual analogue score of 0 to 10. Pain score is elicited after 24 hrs of application of the dressing. 0 refers to no pain and 10 refer to maximum pain tolerable by the patient



Fig11:Pain scale

- Infection in the burn wounds is assessed visually by presence or absence of any pus beneath the dressing. When there is presence of any infection, pus is sent for culture and sensitivity.
- Number of days required for complete epithelialisation of the wound is measured as the rate of healing
- Scar formed at the burn wound sites is marked as either good or bad, depending upon the degree of contracture.
- Compliance of the patient is elicited by the feedback given by the patient regarding the comfortability of the dressing during followup.

OBSERVATION AND RESULTS

Table 5: Gender distribution of the patients (N=60)

Gender	Frequency	Percentage
Male	34	56.7
Female	26	43.3

Table 5 shows the gender distribution of the patients. There were totally 60 patients of which 34 were male and 26 were female.

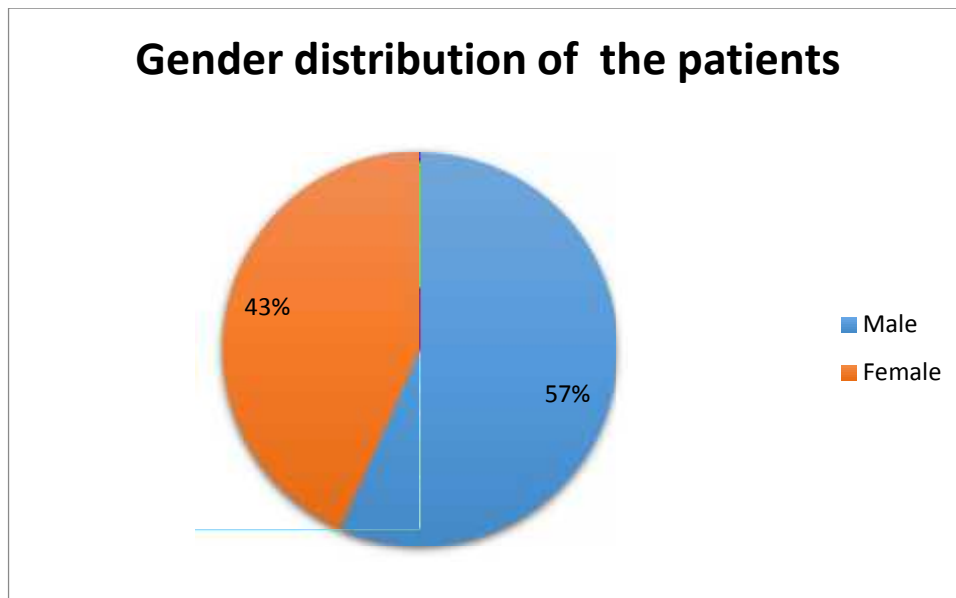


Table 6: Frequency distribution of various parameters (N=60)

Parameter		Frequency	Percentage
Infection	Absent	55	91.7
	Present	5	8.3
Compliance	Good	58	96.7
	Bad	2	3.3
Scar	Good	60	100.0

Table 6 describes the frequency distribution of Infection (present or absent), Compliance (good or bad) and scar formation among the 60 patients. Infection was absent in 55 patients (91.7%). Compliance was good in 58 patients (96.7%) and all 60 patients had good scar formation.

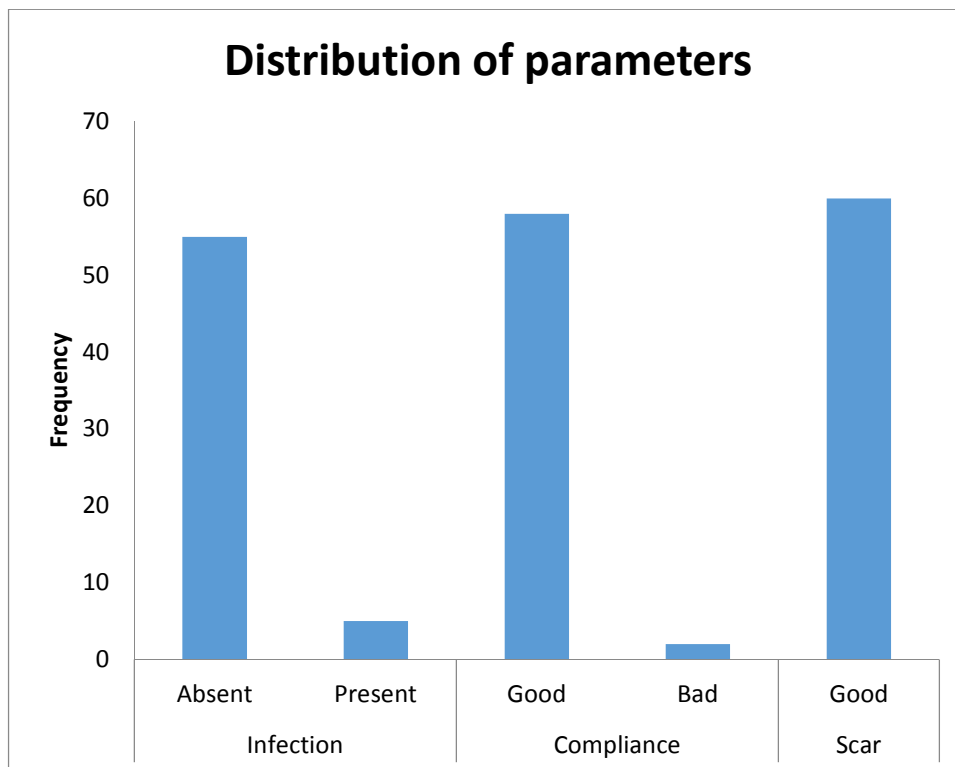


Table 7: Descriptive statistics of various parameters (N=60)

Parameter	Minimum	Maximum	Mean	Std. Deviation
Age (in years)	13	92	38.48	15.61
Pain Score	2	5	2.85	1.07
Rate of Healing (in days)	6	20	11.57	3.59

Table 7 shows the descriptive statistics of age, pain score and rate of healing of 60 patients. The mean age of the patients was 38.48 ± 15.61 years. The minimum and maximum age of the patients was 13 and 92 years respectively. The mean pain score was 2.85 ± 1.07 . The minimum and maximum pain score was 2 and 5 respectively. The mean time taken for healing (rate of healing) was 11.57 ± 3.59 days. The minimum and maximum time taken for healing (rate of healing) was 6 and 20 days respectively.

Descriptive statistics of various parameters

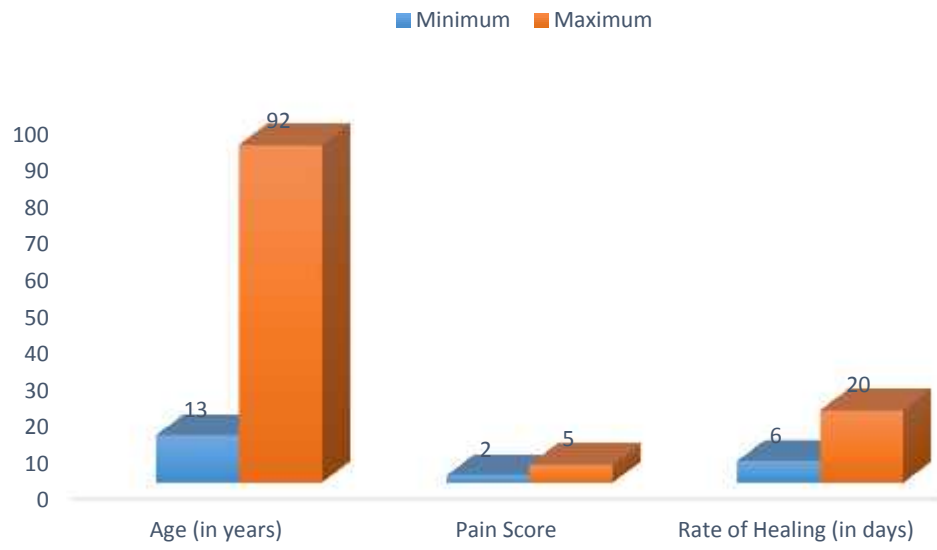


Table 8: Frequency distribution of parameters according to gender

Gender	Parameter		Frequency	Percentage
Male (N=34)	Infection	Absent	31	91.2
		Present	3	8.8
	Compliance	Good	32	94.1
		Bad	2	5.9
	Scar	Good	34	100.0
Female (N=26)	Infection	Absent	24	92.3
		Present	2	7.7
	Compliance	Good	26	100.0
	Scar	Good	26	100.0

Table 8 describes the frequency distribution of parameters according to gender. There were 34 males and 26 females. Among male patients, 31 patients (91.2%) did not have any infection; 32 patients' (94.1%) compliance was good and in 34 patients (100%) the scar formation was good. Among female patients, infection was absent in 24 patients (92.3%); compliance and scar formation was good in all 26 (100%) patients.

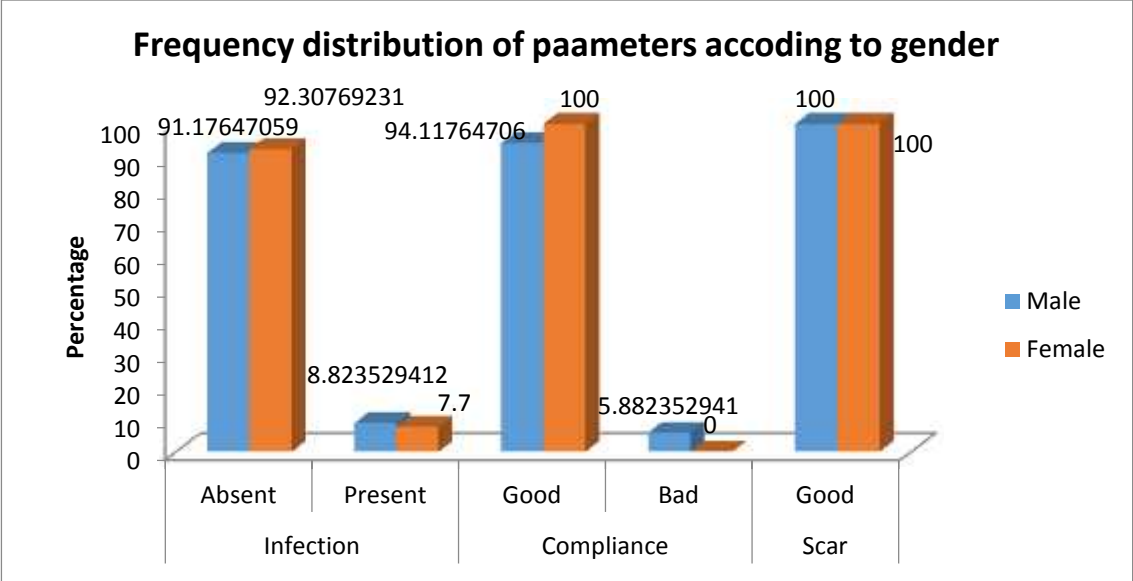
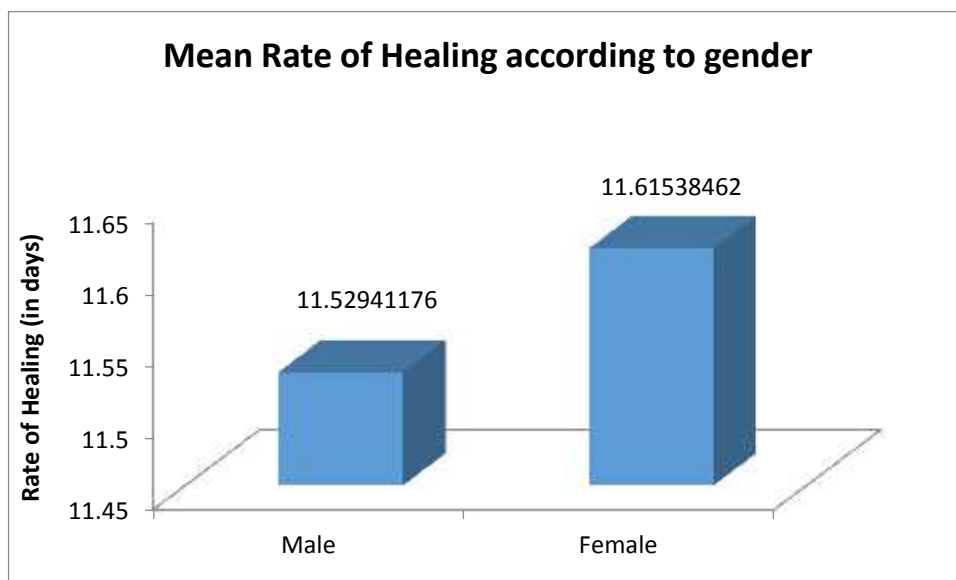
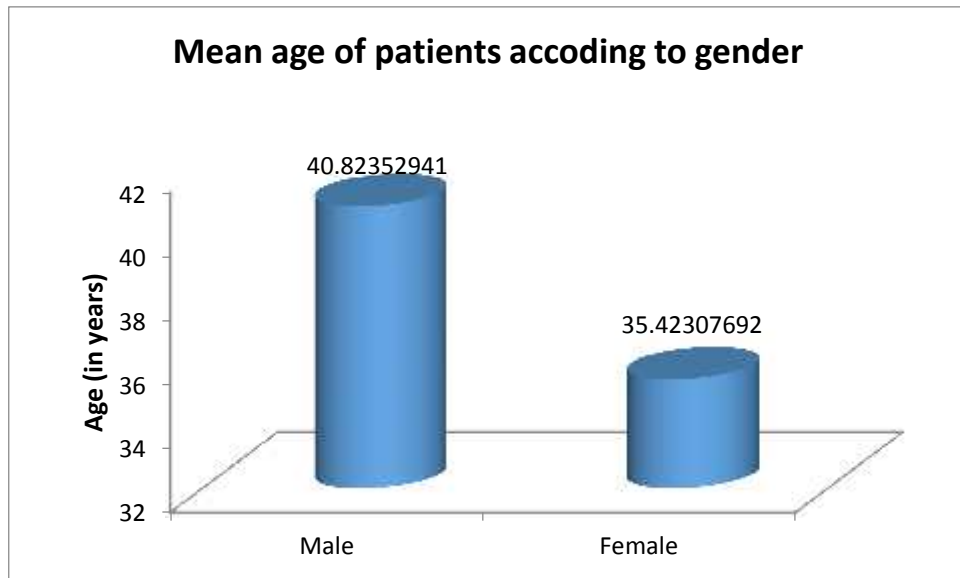


Table 9: Descriptive statistics of parameters according to gender

Gender	Parameter	Minimum	Maximum	Mean	Std. Deviation
Male (N=34)	Rate of Healing (in days)	6	20	11.53	3.65
	Pain Score	2	5	2.65	.98
	Age (in years)	13	92	40.82	17.38
Female (N=26)	Rate of Healing (in days)	7	20	11.62	3.58
	Pain Score	2	5	3.12	1.14
	Age (in years)	18	65	35.42	12.62

Table 9 shows the descriptive statistics of age, pain score and rate of healing according to the gender. Among the male patients, the mean age was 40.82 ± 17.38 years. The minimum and maximum age of the patients was 13 and 92 years respectively. The mean pain score was $2.65 \pm .98$. The minimum and maximum pain score was 2 and 5 respectively. The mean time taken for healing (rate of healing) was 11.53 ± 3.65 days. The minimum and maximum time taken for healing (rate of healing) was 6 and 20 days respectively. Among the female patients, the mean age was 35.42 ± 12.62 years. The minimum and maximum age of the patients was 18 and 65 years

respectively. The mean pain score was 3.12 ± 1.14 . The minimum and maximum pain score was 2 and 5 respectively. The mean time taken for healing (rate of healing) was 11.62 ± 3.58 days. The minimum and maximum time taken for healing (rate of healing) was 7 and 20 days respectively.



Mean Pain Score of patients according to gender

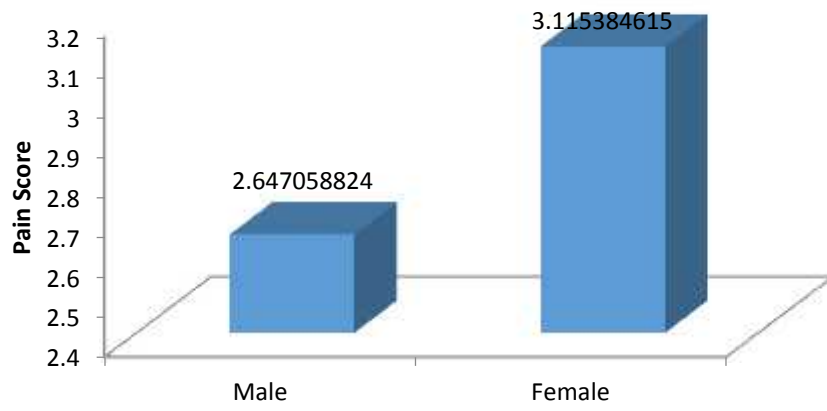


Table 10: Descriptive statistics of parameters according to percentage of burns

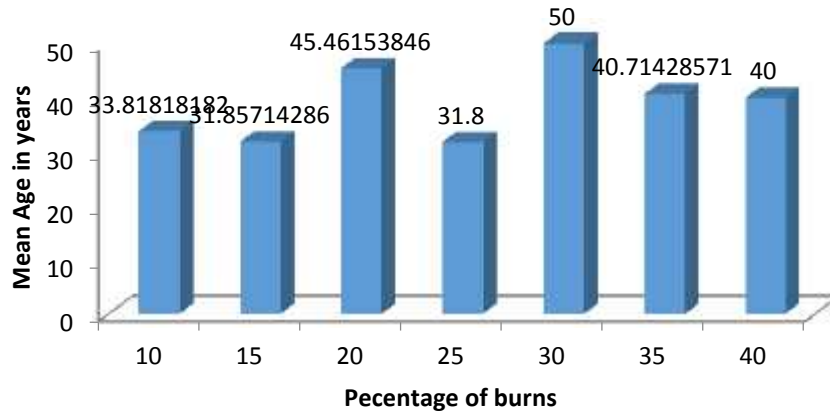
Burns percentage	Parameter	Minimum	Maximum	Mean	Std. Deviation
10 (N=11)	Rate of Healing	6	12	7.91	1.70
	Pain Score	2	2	2.00	.00
	Age	13	59	33.82	16.15
15 (N=7)	Rate of Healing	7	12	8.86	1.68
	Pain Score	2	2	2.00	.00
	Age	16	57	31.86	14.21
20 (N=13)	Rate of Healing	8	18	11.54	2.76
	Pain Score	2	2	2.00	.00
	Age	28	70	45.46	13.05
25 (N=10)	Rate of Healing	8	14	11.40	1.84
	Pain Score	3	3	3.00	.00
	Age	18	92	31.80	21.94
30 (N=4)	Rate of Healing	9	20	13.00	4.83
	Pain Score	3	4	3.25	.50
	Age	38	71	50.00	14.90
35 (N=7)	Rate of Healing	10	17	13.71	2.50
	Pain Score	3	4	3.71	.49
	Age	27	60	40.71	13.51
40 (N=8)	Rate of Healing	12	20	16.63	2.45
	Pain Score	5	5	5.00	.00
	Age	32	48	40.00	5.58

Age in years; Rate of healing in days.

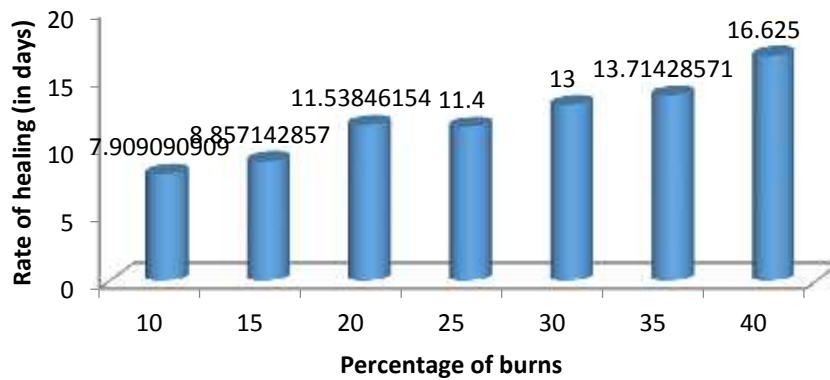
Table 10 shows the descriptive statistics of age, pain score and rate of healing according to percentage of burns. There were totally 11 patients with 10% burns. Their mean age was 33.82 ± 16.15 years; mean pain score was 2 and

the time taken for healing (rate of healing) was 7.91 ± 1.70 days. Seven patients presented with 15% burns. Their mean age was 31.86 ± 14.21 years; mean pain score was 2 and the time taken for healing (rate of healing) was 8.86 ± 1.68 days. There were 13 patients with 20% burns. Their mean age was 45.46 ± 13.05 years; mean pain score was 2 and the time taken for healing (rate of healing) was 11.54 ± 2.76 days. Ten patients presented with 25% burns. Their mean age was 31.80 ± 21.94 years; mean pain score was 3 and the time taken for healing (rate of healing) was 11.4 ± 1.84 days. Four patients had 30% burns. Their mean age was 50 ± 14.9 years; mean pain score was 3.25 ± 0.50 and the time taken for healing (rate of healing) was 13 ± 4.83 days. There were totally seven patients with 35% burns. Their mean age was 40.71 ± 13.51 years; mean pain score was 3.71 ± 0.49 and the time taken for healing (rate of healing) was 13.71 ± 2.50 days. Eight patients presented with 40% burns. Their mean age was 40 ± 5.58 years; mean pain score was 5 and the time taken for healing (rate of healing) was 16.63 ± 2.45 days.

Mean Age of patients according to percentage of burns



Mean rate of healing of patients according to percentage of burns



Mean pain score of patients according to percentage of burns

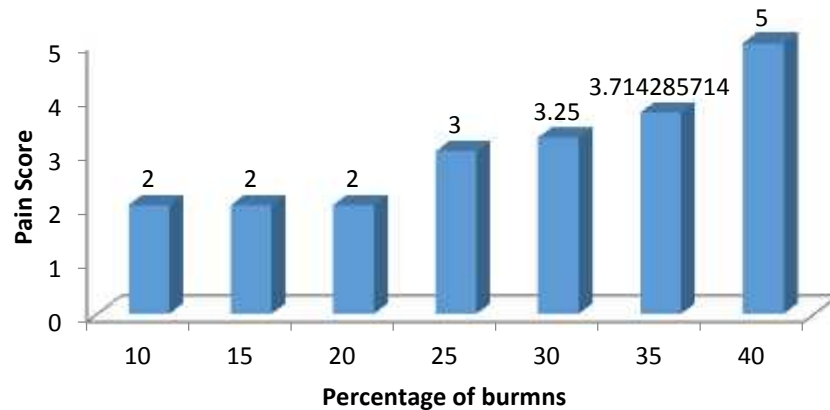
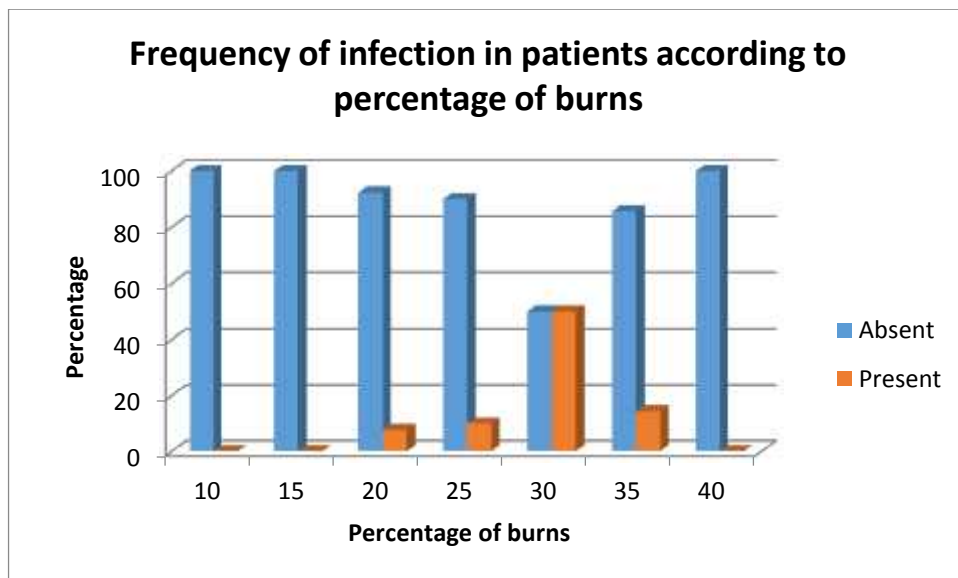


Table 11: Frequency distribution of parameters according to percentage of burns

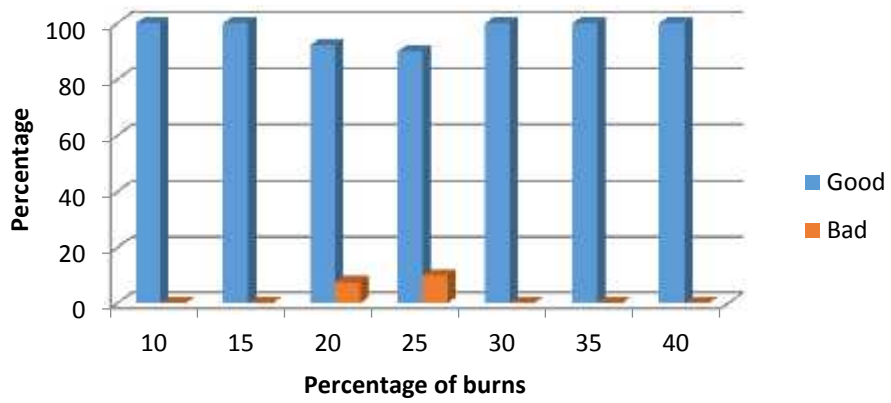
Burns percentage	Parameter		Frequency	Percentage
10 (N=11)	Infection	Absent	11	100.0
	Compliance	Good	11	100.0
	Scar	Good	11	100.0
15 N=7)	Infection	Absent	7	100.0
	Compliance	Good	7	100.0
	Scar	Good	7	100.0
20 (N=13)	Infection	Absent	12	92.3
		Present	1	7.7
	Compliance	Good	12	92.3
		Bad	1	7.7
	Scar	Good	13	100.0
25 (N=10)	Infection	Absent	9	90.0
		Present	1	10.0
	Compliance	Good	9	90.0
		Bad	1	10.0
	Scar	Good	10	100.0
30 (N=4)	Infection	Absent	2	50.0
		Present	2	50.0
	Compliance	Good	4	100
	Scar	Good	4	100.0
35 (N=7)	Infection	Absent	6	85.7
		Present	1	14.3
	Compliance	Good	7	100.0
	Scar	Good	7	100.0
40 (N=8)	Infection	Absent	8	100.0
	Compliance	Good	8	100.0
	Scar	Good	8	100.0

Table 11 shows the frequency distribution of Infection, compliance and scar formation according to percentage of burns. There were totally 11 patients with 10% burns. In all the patients, infection was absent, compliance and

scar formation was good. Seven patients presented with 15% burns. In all the patients, infection was absent. compliance and scar formation was good. There were 13 patients with 20% burns. There was no infection and good compliance in 12 (92.3%) patients; scar formation was good in all 13 patients. Ten patients presented with 25% burns. There was no infection and good compliance in 9 (90%) patients; scar formation was good in all 13 patients. Four patients had 30% burns. Infection was absent in 2 (50%) patients. Compliance and scar formation was good in all 4 patients. There were totally seven patients with 35% burns. Six (85.7%) patients did not have any infection. Compliance and scar formation was good in all patients. Eight patients presented with 40% burns. In all 8 patients, infection was absent, compliance and scar formation was good.



Frequency of compliance in patients according to percentage of burns



Frequency of scar formation in patients according to percentage of burns

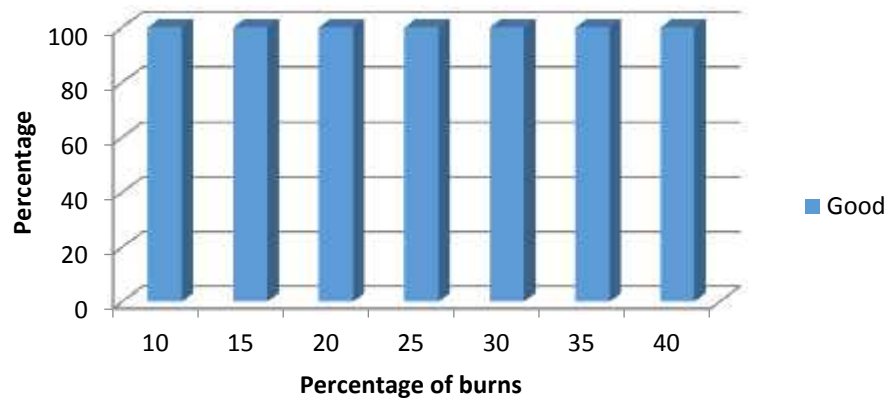


Table 12: Percentage of burns distribution of parameters according to gender

Percentage of burns	Gender		Total
	Male	Female	
10	6	5	11
15	4	3	7
20	10	3	13
25	7	3	10
30	2	2	4
35	1	6	7
40	4	4	8

Table 12 shows the percentage of burns distribution according to gender. Among 11 patients with 10% burns, 6 were male. In patients with 15% burns, 4 were male. Ten out of 13 were male in patients with 20% burns. Seven out of 10 were male in patients with 25% burns. Totally 4 patients had 30% burns of which, 2 were male. Only one out 7 was male in patients with 35% burns. Out of 8, four were male in patients with 40% burns.

Percentage of burns distribution of parameters according to gender

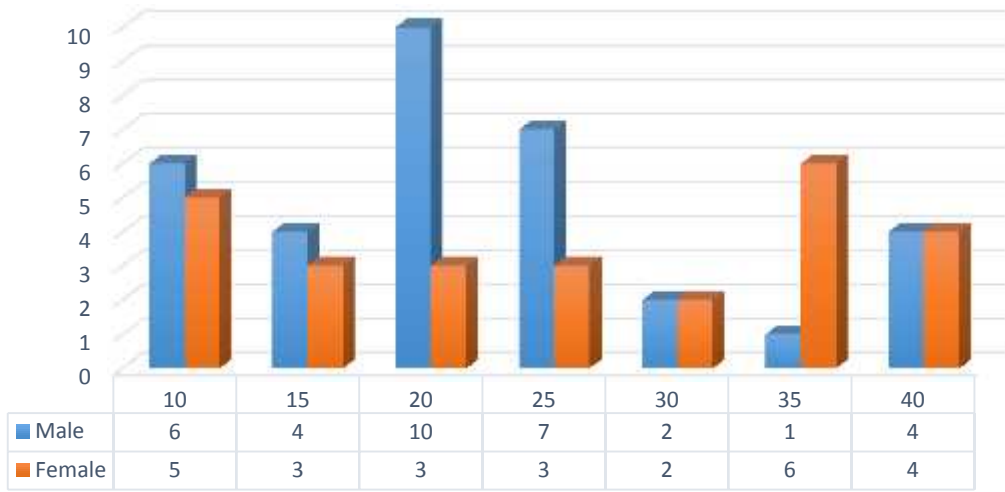


Table 13: Frequency distribution of parameters according to percentage of burns and gender

Gender	Parameter		Percentage of burns							
			10	15	20	25	30	35	40	
Male	Infection	Absent	6 (100)	4 (100)	9 (90)	6 (85.7)	1 (50)	1 (100)	4 (100)	
		Present			1 (10)	1 (14.3)	1 (50)			
	Compliance	Good	6 (100)	4 (100)	9 (90)	6 (85.7)	2 (100)	1 (100)	4 (100)	
		Bad			1 (10)	1 (14.3)				
	Scar	Good	Good	6 (100)	4 (100)	10 (100)	7 (100)	2 (100)	1 (100)	4 (100)
			Absent	5 (100)	3 (100)	3 (100)	3 (100)	1 (50)	5 (83.3)	4 (100)
Female	Infection	Present					1 (50)	1 (16.7)		
		Good	5 (100)	3 (100)	3 (100)	3 (100)	2 (100)	6 (100)	4 (100)	
	Scar	Good	Good	5 (100)	3 (100)	3 (100)	3 (100)	2 (100)	6 (100)	4 (100)
			Absent							

Table 13 shows the frequency distribution of infection, compliance and scar formation according to percentage of burns and gender. In males with 10 (6 patients), 15 (4 patients), 35 (1 patient) and 40 (4 patients) percent burns, none of the patients had any infection. In patients with 20, 25 and 30 percent burns 9, 6 and 1 patient did not have infection out of 10, 7 and 2 patients respectively. Compliance was good in all patients with 10, 15, 30, 35 and 40 percent burns. In patients with 20 and 25 percent burns 9 and 6 patients out of 10 and 7 patients respectively had good compliance. Scar formation was good in all the patients across all the burns patient. Among female gender, in patients with 10, 15, 20, 25 and 40 percent burns all (5, 3, 3, 3, and 4 respectively) did not have any infection. In patients with 30 and 35 percent burns, 1 and 5 patients out of 2 and 6 respectively did not have any infection. Compliance and scar formation was good across all the patients with different percentage of burns.

Table 14: Descriptive statistics of parameters according to percentage of burns and gender

Gender	Percentage of Burns	Parameter	Minimum	Maximum	Mean	Std. Deviation
Male	10	Rate of Healing	6	12	8.00	2.1
		Pain Score	2	2	2.00	.0
		Age	13	59	38.33	21.0
	15	Rate of Healing	7	12	9.25	2.2
		Pain Score	2	2	2.00	.0
		Age	16	57	35.00	17.2
	20	Rate of Healing	8	18	11.60	3.1
		Pain Score	2	2	2.00	.0
		Age	28	70	44.80	12.2
	25	Rate of Healing	9	14	11.71	1.7
		Pain Score	3	3	3.00	.0
		Age	18	92	35.29	25.8
	30	Rate of Healing	9	20	14.50	7.8
		Pain Score	3	3	3.00	.0
		Age	41	71	56.00	21.2
	35	Rate of Healing	12	12	12.00	.
		Pain Score	3	3	3.00	.
		Age	36	36	36.00	.
	40	Rate of Healing	16	18	17.00	1.2
		Pain Score	5	5	5.00	.0
		Age	38	48	43.75	4.2

Gender	Percentage of Burns	Parameter	Minimum	Maximum	Mean	Std. Deviation
Female	10	Rate of Healing	7	10	7.80	1.3
		Pain Score	2	2	2.00	.0
		Age	19	35	28.40	6.0
	15	Rate of Healing	8	9	8.33	.6
		Pain Score	2	2	2.00	.0
		Age	21	40	27.67	10.7
	20	Rate of Healing	10	12	11.33	1.2
		Pain Score	2	2	2.00	.0
		Age	28	65	47.67	18.6
	25	Rate of Healing	8	12	10.67	2.3
		Pain Score	3	3	3.00	.0
		Age	18	29	23.67	5.5
	30	Rate of Healing	11	12	11.50	.7
		Pain Score	3	4	3.50	.7
		Age	38	50	44.00	8.5
	35	Rate of Healing	10	17	14.00	2.6
		Pain Score	3	4	3.83	.4
		Age	27	60	41.50	14.6
	40	Rate of Healing	12	20	16.25	3.5
		Pain Score	5	5	5.00	.0
		Age	32	42	36.25	4.2

Table 14 describes the descriptive statistics of age (in years), pain score and time taken for healing (rate of healing in days) according to percentage of burns and gender. Among male patients, in those with 10% burns, the mean age is 38.33 ± 21 years. The mean pain score is 2 and the mean rate of healing is 8 ± 2.1 days. Among patients with 15% burns, the mean age is 35 ± 17.2 years. The mean pain score is 2 and the mean rate of healing is 9.25 ± 2.2 days. In patients with 20% burns, the mean age is 44.8 ± 12.2 years. The mean pain score is 2 and the mean rate of healing is 11.6 ± 3.1 days. In patient with 25% burns, the mean age is 35.29 ± 25.8 years. The mean pain score is 3 and the mean rate of healing is 11.71 ± 1.7 days. In patients with 30% burns, the mean age is 56 ± 21.2 years. The mean pain score is 3 and the mean rate of healing is 14.5 ± 7.8 days. In patients with 35% burns, the mean age is 36 years. The mean pain score is 3 and the mean rate of healing is 12 days. In patient with 40% burns, the mean age is 43.75 ± 4.2 years. The mean pain score is 5 and the mean rate of healing is 17 ± 1.2 days. Among female patients, in those with 10% burns, the mean age is 28.4 ± 6 years. The mean pain score is 2 and the mean rate of healing is 7.8 ± 1.3 days. In patient with 15% burns, the mean age is 27.67 ± 10.7 years. The mean pain score is 2 and the mean rate of healing is 8.33 ± 0.6 days. In patient with 20% burns, the mean age is 47.67 ± 18.6 years. The mean pain score is 2 and the mean rate of healing is 11.33 ± 1.2 days. In patient with 25% burns, the mean age is 23.67 ± 5.5 years. The mean pain score is 3 and

the mean rate of healing is 10.67 ± 2.3 days. In patient with 30% burns, the mean age is 44 ± 8.5 years. The mean pain score is 3.5 ± 0.7 and the mean rate of healing is 11.57 ± 0.7 days. In patient with 35% burns, the mean age is 41.5 ± 14.6 years. The mean pain score is 3.83 ± 0.4 and the mean rate of healing is 14 ± 2.6 days. In patient with 40% burns, the mean age is 36.25 ± 4.2 years. The mean pain score is 5 and the mean rate of healing is 16.251 ± 3.5 days.

DISCUSSION

- Denuded areas are devoid of this protection thereby delaying wound healing by exposing vulnerable areas of subcutaneous tissues to infection.
- The orderly ingrowth of epithelium needs a layer of collagen to act as the scaffold on which it grows and arranges itself. Denuded areas are unable to provide this effectively, leading to formation of extensive scars and even keloids.
- The intact epithelium provides a protective layer over cutaneous nerves otherwise these areas expose the nerves and cause pain and tenderness.
- Wounds that are left uncovered are prone to infection and scarring with additional clinical problems. It has been well documented that the incidence of infection and degree of contraction are considerably reduced when wounds are dressed with biologic materials rather than left exposed or dressed with non-biologic material during healing.
- It was observed that xenogenous collagen membrane had good conformability in lining mucosa and skin i.e. it was supple and adapted to the wound no matter what the contour was.

Infection

- Infection of the wound is one of the most common complications because of the presence of necrotic tissue and tissue ischemia in burns

and presence of dirt in abrasions as most of them are traumatic. Infection in turn leads to delayed healing of the wound. Reduction in the infection rate improves the quality of life.

- In my study, infection was present in 8.3% of the patients (5/60), which indicates lower rate of infection with collagen dressing. None of the cases showed any adverse reaction to the collagen, proving its safety as a biological dressing. This result is in accordance with Gupta RL²⁴.

Pain Score:

- Burn wounds are painful conditions due to the exposed nerve endings and as a result of this reduction of pain, patient morbidity is significantly reduced.
- Collagen when used over the raw area provides the coverage for sensitive nerve endings thereby diminishing degree of pain significantly.
- The average pain score in the range of 0 to 10 was 2.85 in the collagen dressing, which is statistically significant reduction in pain. This result is in accordance with the study conducted by Rajendra Desai²⁵.

Rate Of Healing:

- Rate of healing is measured by the number of days required for complete epithelialisation of the wound. By decreasing the number of

days required for healing, patient can return back to normal activities faster.

- Healing was achieved on an average of 11.57days, in collagen dressing. This shows that collagen dressing helps in decreasing healing time. This was consistent with the study of Gupta RL, which shows a healing time of range from 10 to 14 days²⁶.

Scar:

- The appearance of wound was restored to normal texture in about a month. Scar was assessed by the amount of scar contracture at the end of 4 weeks.
- In my study, 100% of patients in collagen dressing had good scars. Hence collagen helps in tissue remodeling and gives a better scar when compared to other dressing. This is in concurrence with the study done by Demling RH²⁷.

Patient Compliance:

- Patients were asked to give feedback during follow-up regarding the comfortability of the dressing and the resultant scar after healing of the wound. Collagen dressing was considered comfortable as it was only one time application unless there was infection unlike conventional dressing in which the patient had to be subjected to dressings at regular intervals subjecting them to painful stimuli over the raw nerve endings. The resultant scar was good in a significant

amount of patients in collagen dressing group, hence there was better patient satisfaction.

- Patient compliance in the collagen dressing was good about 96.7%. Hence there was better compliance rate observed with collagen dressing. This result was in accordance with the study conducted by Gerding RL²⁸.

LIMITATIONS OF THE STUDY

- ▶ The study was conducted in tertiary care government setting and may differ from those obtained from primary care setting or private sector.
- ▶ Sample size is small.
- ▶ The study did not include an important and more useful issue of cost and availability of collagen dressing.

Therefore, the need for further randomized control studies that have a large number of patients and are accurately designed has to be recognized from the present study.

CONCLUSION

- Collagen serves as the second skin to the burn wounds and it is the ideal dressing to be used in patients with partial thickness burns.
- Following the application of the collagen dressing over the burn wounds, pain was drastically reduced.
- The infection rate in the burn wounds was effectively controlled by collagen dressing as it forms a temporary barrier between the environment and the wound.
- Collagen dressing leads to faster healing rate with complete epithelialisation of the burn wounds.
- To conclude, collagen sheet decreases pain, reduces the need for analgesics, aids in early healing, limits the associated complications such as infection of the burn wounds. As the resultant scar is better in majority of the patients using collagen, the morbidity of the patients is also reduced to some extent.
- In view of the excellent tolerance and simple application of the collagen membrane, it can be recommended as an effective temporary biological dressing material in the management of partial thickness burns.



COLLAGEN DRESSING



SCARS AFTER COLLAGEN DRESSING

BIBLIOGRAPHY

1. Lazarus GS, Cooper DM, Knighton DR et al. Definitions and Guidelines for Assessment of Wounds and Evaluation of Healing. Arch Dermatol 1994; 130; 489-493.
2. John. W. Madden, Arnold. J Arem. Wound healing; biologic and clinical features. The biologic basis of modern surgical practice. Edition XIII; Vol I; Page 193.
3. Moore KL, Persuad TVN. The integumentary system. Essentials of Embryology and Birth Defects. 5th edition. 1998:481-96.
4. Abbenhause J.L Collagen sheets as a dressing for large excised areas. Surgical forum 1965; 16; 477.
5. Mason. R.G and Read M.S. Some effects of a microcrystal line collagen preparation on blood. Hemostasis 1974; 3;31
6. Ponten B, Norgaard. The use of collagen film (Cutycol) as a dressing for donor areas in split skin grafting. Scand J Plast Reconst Surg. 1976;10(3);237-40.
7. De Vore D. T. Collagen xenograft for bone replacement. The effect of aldehyde induced crosslinking on degydration rate. Oral Surg Oral Med & Oral Path 1977;43; 677-683.
8. Gupta et al. Fate of Collagen sheet for artificial created wounds. Indian Journal of Surgery 1978; 40; 641.

9. Levin MP, Tsaknis PJ, Cutright DE. Healing of the oral mucosa with the use of collagen artificial skin. *J Periodontol* 1979; 50(5); 250-3.
10. Dr. S.K. Bhatnagar, Dr. R. Krishnan, Dr. T.C. Goel. Utility of collagen sheet as a skin substitute. *Journal of Plastic Surg* 1981; 14; 11. 11.
11. P. R. Hyder, P. Dowell, G. Singh and A. E. Dolby. Freeze-dried, Cross linked Bovine Type I Collagen; Analysis of Properties. *J Periodontol* 1992; 63; 182-186.
12. Mian M, Beghe F, Mian E. Collagen as a pharmacological approach in wound healing. *Int J Tissue React.* 1992; 14 Suppl; 1-9.
13. Sakiel S, Grzybowski J. Clinical application of new bovine collagen membranes as a partial-thickness burn wound dressing. *Polim Med.* 1995; 25(3-4); 19-24.
14. Khanna J N, Andrade et al. Oral submucous fibrosis: A new concept in management. *Int. J. Oral and maxillofacial Surg.* 1995; 24(6);433.
15. Purna Sai K, Mary babu: Collagen based dressings – A review. *Burns* 2000; 26; 54.
16. Carlson BM. Integumentary, skeletal and muscular systems: Human Embryology and Developmental Biology. 1st 1994: 153-81.

17. Poblet E, Jimenez F, Ortega F. The contribution of the erector pili muscle and sebaceous glands to the follicular unit structure. *J Am Acad Dermatol*. Aug 2004; 51(2): 217-22
18. Taylor GI, Pan WR. Angiosomes of the leg: anatomic study and clinical implications. *Plast Reconstr Surg*. Sep 1998;102(3):599-616; discussion 617-8.
19. Holland AJ, Martin HC, Cass DT: Laser Doppler imaging prediction of burn wound outcome in children. *Burns* 2002;28:11-17.
20. Desai MH et al, Conservative treatment of scald burns is superior to early excision. *J Burn Care Rehabil* 1991;12:482-484.
21. Barret et al, Cost-efficacy of cultured epidermal autografts in massive pediatric burns. *Ann Surg* 2000; 231:869-876.
22. Montesano et al. In vitro rapid organization of endothelial cells into capillary-like networks is promoted by collagen matrices. *J Cell Biol*.1983;97:1648-1652.
23. Prockop D.J. and Kivirikko K. Collagens: molecular biology, diseases and potentials for therapy. *Ann. Rev. Biochem*. 1995; 64:403-434.
24. Gupta RL. Role of collagen sheet cover in burns – a clinical study. *Indian J Surgery* 1978; 40 (12):646

25. Rajendra Desai et al. Role of collagen in Pre Prosthetic Surgery. JIDA 1998;69;136.
26. Gupta RL. Fate of collagen sheet cover for artificially created raw areas – an experimental study. Indian J Surgery 1978; 40 (12): 641-45.
27. Demling RH. Desanti L. Management of partial thickness facial burns (comparison of topical antibiotics and bioengineered skin substitutes). J Burn Care and Rehabilitation.
28. Gerding RL et al. Biosynthetic skin substitutes versus 1% silver sulphadiazine for treatment of inpatient partial thickness thermal burns. J Trauma 1988;28:1265.

ANNEXURES

PROFORMA

Name :

Age :

Sex :

IP/OP number :

Mode of injury causing burns :

Time since burns :

Degree of burns :

Percentage of burns :

Collagen Dressing

Pain score after 24 hrs :

:

Evidence of infection Present Absent

Rate of healing in days :

Number of dressings done : Good Bad

Scar after healing : Good Bad

Patient compliance : Good Bad

**நோயாளிகளுக்கு அறிவிப்பு மற்றும் ஒப்புதல் படிவம்
(மருத்துவ ஆய்வில் பங்கேற்பதற்கு)**

ஆய்வு செய்யப்படும் தலைப்பு:

பங்கு பெறுவரின் பெயர்:

பங்கு பெறுவரின் வயது:

		பங்கு பெறுவர் இதனை குறிக்கவும் ✓
	நான் மேலே குறிப்பிட்டுள்ள மருத்துவ ஆய்வின் விவரங்களை படித்து புரிந்து கொண்டேன். என்னுடைய சந்தேகங்களை கேட்கவும், அதற்கான தகுந்த விளக்கங்களை பெறவும் வாய்ப்பளிக்கப்பட்டுள்ளது என அறிந்து கொண்டேன்.	<input type="checkbox"/>
	நான் இவ்வாய்வில் தன்னிச்சையாக தான் பங்கேற்கிறேன். எந்த காரணத்தினாலோ எந்த கட்டத்திலும், எந்த சட்ட சிக்கலுக்கும் உட்படாமல் நான் இவ்வாய்வில் இருந்து விலகி கொள்ளலாம் என்றும் அறிந்து கொண்டேன்.	<input type="checkbox"/>
	இந்த ஆய்வு சம்பந்தமாகவோ, இதை சார்ந்து மேலும் ஆய்வு மேற்கொள்ளும் போதும் இந்த ஆய்வில் பங்குபெறும் மருத்துவர் என்னுடைய மருத்துவ அறிக்கைகளை பார்ப்பதற்கு என் அனுமதி தேவையில்லை என அறிந்து கொள்கிறேன். நான் ஆய்வில் இருந்து விலகிக் கொண்டாலும் இது பொருந்தும் என அறிகிறேன்.	<input type="checkbox"/>
	இந்த ஆய்வின் மூலம் கிடைக்கும் தகவலையோ, முடிவையோ பயன்படுத்திக் கொள்ள மறுக்க மாட்டேன்.	<input type="checkbox"/>
	இந்த ஆய்வில் பங்கு கொள்ள ஒப்புக் கொள்கிறேன் எனக்கு கொடுக்கப்பட்ட அறிவுரைகளின் படி நடந்து கொள்வதுடன், ஆய்வை மேற்கொள்ளும் மருத்துவ அணிக்கு உண்மையுடன் இருப்பேன் என்று உறுதியளிக்கிறேன். என் உடல் நலம் பாதிக்கப்பட்டாலோ, அல்லது எதிர்பாராத, வழக்கத்திற்கு மாறான நோய்குறி தென்பட்டாலோ உடனே இதை மருத்துவ அணியிடம் தெரிவிப்பேன் என உறுதி அளிக்கிறேன்.	<input type="checkbox"/>

பங்கேற்பவரின் கையொப்பம் / இடம்

கட்டைவிரல் ரேகை

பங்கேற்பவரின் பெயர் மற்றும் விலாசம்

ஆய்வாளரின் கையொப்பம் / இடம்

ஆய்வாளரின் பெயர்

மையம்

கல்வியறிவு இல்லாதவர்க்கு (கைரேகை வைத்தவர்களுக்கு) இது அவசியம் தேவை

சாட்சியின் கையொப்பம் / இடம்

பெயர் மற்றும் விலாசம்

S.No	Name	Age/ Sex	IP NO	% of Burns	Pain Score	Infection	Rate of Healing	Complainece	Scar
1	Muthu Priya	21/F	13921	15	2	N	8	Good	Good
2	Manimekalai	18/F	9249	25	3	N	12	Good	Good
3	Suresh	30/M	9319	10	2	N	6	Good	Good
4	Kaliyappah	40/M	77851	20	2	N	14	Good	Good
5	Mariyammal	32/F	77852	40	5	N	18	Good	Good
6	Sathish Kumar	16/M	26	15	2	N	7	Good	Good
7	David durai	13/M	27	10	2	N	7	Good	Good
8	Gomathy	24/F	2604	25	3	N	8	Good	Good
9	Devika	22/F	72470	15	2	N	8	Good	Good
10	Nambi	52/M	73594	20	2	N	8	Good	Good
11	Santhanam	60/F	28672	35	4	P	10	Good	Good
12	Muthuraj	51/M	56142	20	2	N	8	Good	Good
13	Jeyanathan	41/M	53169	30	3	N	9	Good	Good
14	Mariammal	50/F	55803	30	3	P	11	Good	Good
15	Saravanan	27/M	33025	25	3	N	12	Good	Good
16	Murugan	38/M	57096	20	2	N	9	Good	Good
17	Balaji	17/M	58347	10	2	N	7	Good	Good
18	Pathirakalai (a) Pappathi	28/F	58275	10	2	N	7	Good	Good
19	Kali	48/M	60169	20	2	N	12	Good	Good
20	Muthukumar	19/M	13925	25	3	N	12	Good	Good
21	Poovaiah	24/M	13928	25	3	N	14	Good	Good
22	Dharmadurai	28/M	14481	20	2	N	14	Good	Good
23	Pandy	48/M	17941	40	5	N	16	Good	Good
24	Valli	32/F	18882	35	4	N	15	Good	Good
25	Arumugam	57/M	22171	15	2	N	12	Good	Good
26	Saraswathi	50/F	22761	20	2	N	12	Good	Good
27	Santhosi	28/F	27972	20	2	N	12	Good	Good
28	Ganesan	38/M	32096	40	5	N	18	Good	Good
29	Arumugam	29/M	37767	15	2	N	10	Good	Good
30	Sailappan	59/M	39384	10	2	N	8	Good	Good
31	Petchiammal	36/F	41059	40	5	N	12	Good	Good

S.No	Name	Age/ Sex	IP NO	% of Burns	Pain Score	Infection	Rate of Healing	Complainece	Scar
32	Chinnaiah	71/M	42079	30	3	P	20	Good	Good
33	Manikandan	38/M	43660	15	2	N	8	Good	Good
34	Marilakshmi	29/F	45693	25	3	N	12	Good	Good
35	Chelladurai	44/M	48820	40	5	N	16	Good	Good
36	Kanniyammal	40/F	50797	15	2	N	9	Good	Good
37	Ramesh	32/F	53532	10	2	N	7	Good	Good
38	Rani	35/F	63532	35	4	N	12	Good	Good
39	Pathrakali	28/F	58275	10	2	N	10	Good	Good
40	Saranya	19/F	62004	10	2	N	7	Good	Good
41	Kannan	35/M	629118	25	3	N	9	Good	Good
42	Esakki Muthu	36/M	64709	35	3	N	12	Good	Good
43	Subramaniyan	49/M	61713	20	2	P	10	Good	Good
44	Chitraselvi	35/F	65031	10	2	N	8	Good	Good
45	Vandimalaiyan	32/M	67949	25	3	N	10	Good	Good
46	Sankaran	53/M	69568	10	2	N	12	Good	Good
47	Arumugam	45/M	71851	40	5	N	18	Good	Good
48	Ramalakshmi	27/F	72513	35	3	N	14	Good	Good
49	Bakyiamery	35/F	77257	40	5	N	20	Good	Good
50	Ahmed Meeran	92/M	77631	25	3	P	12	Bad	Good
51	Thalavammal	35/F	79486	35	4	N	16	Good	Good
52	Dharmaraj	70/M	366	20	2	N	18	Bad	Good
53	Santhamariselvan	42/M	81790	20	2	N	12	Good	Good
54	Krishnammal	42/F	82685	40	5	N	15	Good	Good
55	Eswari	38/F	1365	30	4	N	12	Good	Good
56	Parvathi	65/F	3985	20	2	N	10	Good	Good
57	Balakrishnan	58/M	14150	10	2	N	8	Good	Good
58	Arumugaraj	30/M	15926	20	2	N	11	Good	Good
59	kalimuth	18/M	17495	25	3	N	13	Good	Good
60	Lakshmi	60/F	18971	35	4	N	17	Good	Good

*A- Absent

*P- Present