"RANDOMIZED CONTROL TRIAL TO STUDY THE EFFICACY OF TUMESCENT TECHNIQUE OVER NON TUMESCENT TECHNIQUE BY USING ADRENALINE IN HEALING OF SPLIT THICKNESS SKIN GRAFT (STSG) DONOR SITE."

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KARNATAKA

ENDORSEMENT

This is to certify that the dissertation entitled **"RANDOMIZED CONTROL TRIAL TO STUDY THE EFFICACY OF TUMESCENT TECHNIQUE OVER NON TUMESCENT TECHNIQUE BY USING ADRENALINE IN HEALING OF SPLIT THICKNESS SKIN GRAFT (STSG) DONOR SITE"** is a bonafide research work done by **REG NO. BH0115009.**

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LIST OF ABBREVIATIONS USED

STSG	-	Split Thickness Skin Graft
HB	-	Haemoglobin
TC	-	Total count
DC	-	Differential count
BT	-	Bleeding time
CT	-	Clotting time
LFT	-	Liver function test
HIV	-	Human immunodeficiency virus
LTI	-	Left thumb impression
IP NO.	-	In Patient Number
DOA	-	Date of admission
DOS	-	Date of surgery
DOD	-	Date of discharge
PR	-	Pulse Rate
RR	-	Respiratory rate
CNS	-	Central nervous system
CVS	-	Cardiovascular system
RS	-	Respiratory system
MM	-	Millimetre
F	-	Female
M	-	Male
RT	-	Right
LT	-	Left

ABSTRACT

Split thickness skin grafting (STSG) have an important place in many areas of plastic surgery. Though the technique of skin grafting is more or less standardized the treatment of donor site differs greatly and has been topic for debate. Thus it is not uncommon for patients to complain more about pain at the donor site than at the site of surgery. To overcome this the tumescent technique is used now a days. The tumescent technique is very useful in reducing post-operative complications at donor site.

Objective: To study the efficacy of tumescent technique over non tumescent technique by using adrenaline in healing of split thickness skin graft (STSG) donor site on 10^{th}post operative day.

Design: Randomized control trial

Setting: KLES Dr.Prabhakar Kore Hospital and Medical Research centre, Belagavi, Karnataka, India

Population: 90 adult patients requiring STSG for various etiologies between 1^{st} January 2016 to 31^{st} December 2016.

Materials and Methods: The study included 90 adult patients. Half of them underwent tumescent technique and rest 45 underwent non-tumescent technique. Group A patients would undergo sub-dermal infiltration of skin graft donor site with a solution formula of 1 mg (1:1000) adrenaline added to 500 ml of saline.

Both groups will be monitored for donor site healing by inspection on 10th post-operative day.

Results: On 10^{th} postoperative day, the rate of epithelisation in tumescent technique (group A) patient is 80% or more faster than non tumescent technique (group B).

Conclusion: Tumescent technique by using adrenaline is more efficient than non-tumescent technique in the healing of donor site.

KEY WORDS: Split thickness skin grafting, tumescent technique.

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INTRODUCTION

Skin Grafting is a part of dermis and epidermis that has been completely separated from its blood supply and donor site and transferred to another area of the body that is the recipient site.[1,]

Split thickness skin grafting (STSG) are an important aspect of surgery. Skin grafting is very useful procedure to cover the skin defects. And it has two important areas that is recipient and donor area. The care of donor area is, most of the time, neglected as compared to recipient area. And the treatment of recipient area is more or less standard but the treatment of donor site differs greatly and has been topic for debate. Thus it is not uncommon for patients to complain more about pain at the donor site than at the site of surgery. To overcome this the tumescent technique is used now a days.[1]

Skin is a largest organ of our body which acts as a natural protecting shield that prevents penetration of pathogens and protects, from the other infections. It also helps in escape of interstitial fluid. The harvesting of a STSG causes a partial thickness injury and out flow of blood and protein rich exudate from the wound in non-tumescent technique. But in tumescent technique there is minimal blood loss and no exudation so this will help in reduction of the infection at donor site.[2]

After the harvesting of STSG, the new epidermis will grow from proliferation of the remaining epithelial cells at the donor site periphery and reserve cells in the remaining hair follicles, sebaceous glands and sweat glands. This the first phase in the healing of donor site. After the Cell proliferation the migration of cells will occur in outward direction until the wound is re-epithelialized. Complete re-epithelisation

occur in 10-15 days. And this process is faster in tumescent technique as compared to standard non tumescent technique[2].

In this study the tumescent technique is used to harvest the grafts from the donor site and its efficacy is more in view of donor site wound healing. And there are many studies which supports this finding.[2]

Tumescent technique has been practiced for over twenty years. Many studies have proven its usefulness in reducing blood loss.

There is no adequate information regarding adoption of tumescent technique in Split Thickness Skin Graft (STSG) harvesting. Very few studies are available in medical literature regarding this.

This study is designed to give high level of evidence on the results of healing of STSG donor site with the usage of tumescent technique with adrenaline solution, as compared to the conventional method of harvesting STSG without this.

OBJECTIVES

To study the efficacy of tumescent technique by using adrenaline in healing of the split thickness skin graft (STSG) donor site.

REVIEW OF LITERATURE

Ever since the historic days of skin grafting the search for an ideal donor site management and healing of donor site is a very important topic for discussion.

The tumescent technique was initially used to perform liposuction and it was presented in 1986 Second World Congress at Philadelphia on Liposuctionand first published in 1987 in peer reviewed journal[1].

From the Greek word "Tumuds" the word tumescent was derived which means "Swollen". Dr. Jeffrey Klein in 1987 first used this term to describe this technique. Tumescent technique is the sub dermal injection of fluid and this technique will swell up tissue surface.[1]

It will reduce blood loss through epinephrine induced vasoconstriction as well as hydrostatic compression.[1]

Tumescence with a fluid containing a vasoconstrictor (like adrenaline) prior to the harvesting skin graft reduces blood loss and thus reduces incidence of collection of blood clots over the donor site and give firmness to surgical area.[2]

Blood is an excellent medium for infection to flourish. By reducing the collection of blood at the donor site incidence of infection is reduced, thus improving the rate of healing.[3]

This technique is very useful in minimizing blood loss in burns surgery. Because of this, blood transfusion rate is reduced in post burn surgery patients which shortens the hospitalization.[4]

Tumescent anesthesia is widely used in the liposuction, hair transplantations, mastectomy, burns excision and grafting and it has good effect in controlling blood loss and wound healing will be better as compared to normal surgery.[1]

By this technique bleeding was minimal and the operations were thus performed easily and rapidly. This technique is simple, effective and safe which facilitates anesthesia in large area of body surface which leads to less bleeding and easy surgical dissection and hydrodissection allowing fast and easy surgery.[5]

There are some additives in tumescent anesthesia like crystalloid, epinephrine, sodium bicarbonate and hyaluronidase and out of all this epinephrine diluted with saline is more effective[2] .

The studies related to tumescent technique started to establish the co-relation between the healing of donor site as compared to normal technique.

There are other studies which compare the blood loss and also the post-operative pain at donor site.

Barret et al. reported that among the children with burns, topical treatment that is infiltration of donor site with adrenaline and thrombin together reduced blood loss compared to the use of tropical thrombin alone.[2]

In another study, Sherdan and Szyfelbein showed that adrenaline clysis of burns and donor site significantly reduced intraoperative and perioperative blood loss among children with burns[2].

There was one more study in burns patient by Kahalley et al who demonstrated that infiltration of donor sites and burn wounds with a saline-vasopressor solution could reduce intraoperative blood transfusion.

According to one study there is 500 ml less blood loss in the burns group which had higher epinephrine concentration, as compared to the other group, where blood loss was more[4].

In a study of the surgical treatment of burns and post burn sequelae in pediatrics patients, Bussolin et al successfully utilized the tumescent infiltration and adrenaline under general anesthesia, and assessed the intra and post-operative course, post-operative pain and requirement of analgesics. And the surgical advantages are clearly mentioned in this study regarding the easy dissection and blood less donor site[5]

The maximum safe dose of tumescent local anesthesia of 55mg/kg lidocaine, recommended by the American Society of Dermatological Surgery in 1997 seems to be safe in most of the patients[8].

Tumescent anesthesia technique has been reported to have antibacterial effects also due to lidocaine has bacteriostatic properties, which are enhanced by the addition of sodium bicarbonate and the washout effect of the solution commonly used in tumescent local anaesthesia[8].

Robetson et al did a case control study where tumescent technique significantly reduced blood loss during burn surgery [9].

Fujito et al reported a study showing successful excision burn scar with no intra operative bleeding by using tumescent technique[9].

Gacto et al study showed reduced intra operative bleeding in donor site injected with tumescent fluid. This study also shows reduced post-operative pain and accelerated re-epithelisation at donor site injected with tumescent fluid [9.]

Historical aspect:-

Baronion[22] performed the first successful skin graft in 1804 in a lamb. But Jacques Reverdin, a Swedish medical student studying in Paris placed a 2-3mm epidermal graft on a granulating wound in 1869. This led to enthusiasm in the arena of skin grafting throughout the Europe[23].

Carl Theirsch, a prominent German surgeon was the first to recognize the importance of preparing the recipient bed. Theirsch described removal of the granulation tissue from the wound before applying the graft which dramatically improved the graft uptake. Otto Lanz a Swedish surgeon described the meshing technique.[25]

It was not until 1929 when VilrayPapin Blair and James Barret Brown from St. Louis described their technique and success with split thickness skin grafting.[26,27]

The challenge was how to harvest the graft from donor site which led to the development of instruments that could be useful for harvesting the graft. The first among these was the knife devised by Humby. A Humby's knife was a razor with a guard which prevented the surgeon from cutting deep during harvest. Earl Padgett an American surgeon in association with engineer named Hood designed a dermatome that could set specific thickness in 1939. Just after six years later James Barret Brown introduced the first power driven dermatome.

All three above dermatome referred dermatomes are still in use today. Because of the works of Riverdin, Theirsch, Lanz, Blair and Brown Surgeons today approach skin grafting with confidence, expecting success with each graft.

The tumescent technique was initially used to perform liposuction and it was presented in 1986 the Second World Congress at Philadelphia on Liposuction and first published in 1987 in peer reviewed journal[1.]

The word tumescent was derived from the Greek word "Tumuds" which means "Swollen". Dr. Jeffrey Klein in 1987 first used the term to describe this technique. Tumescent technique is the subdermal injection of fluid which will swells up the tissue surface.[1]

It will reduce blood loss through epinephrine induced vasoconstriction as well as hydrostatic compression.[1]

Anatomy and physiology of skin[29]

The skin is the largest organ of the body, with a total area of about 20 square feet. The skin protects us from microbes and the elements, helps regulate body temperature, and permits the sensations of touch, heat, and cold. It play an important role as a sensory organ and is important in vitamin-D metabolism. Skin consists of two distinct layers, and epidermis and dermis.

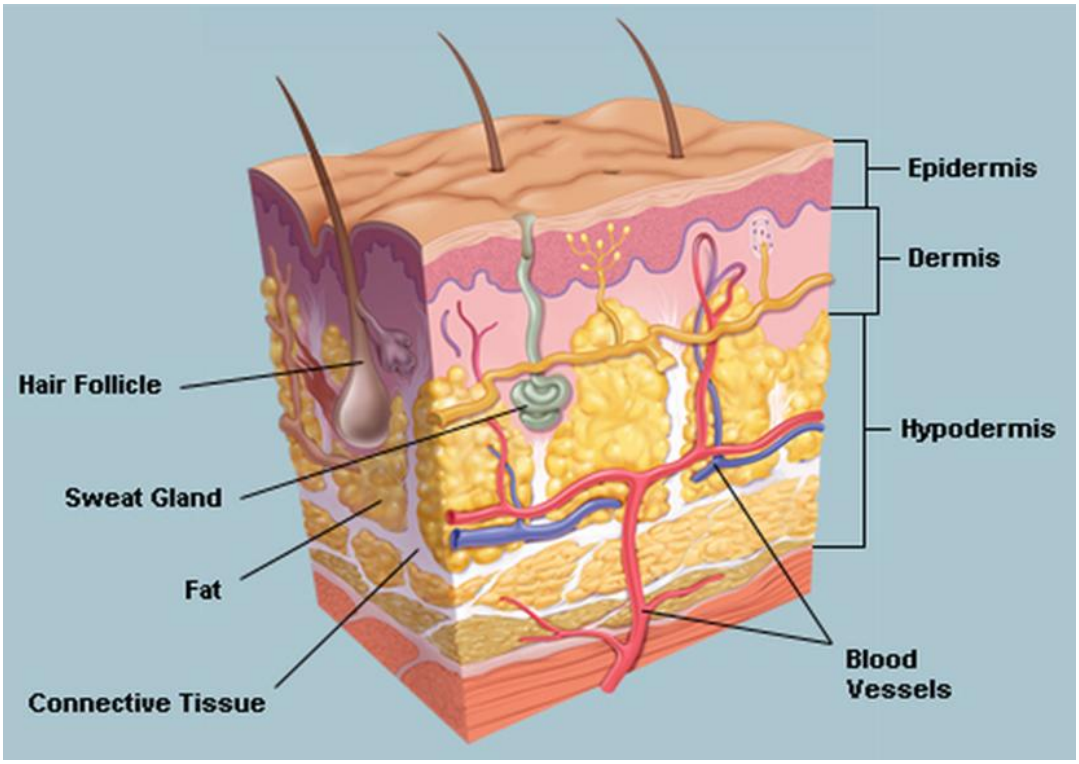


FIG. 1- LAYERS OF SKIN

1-The epidermis, the outermost layer of skin and it is avascular. The principal function of epidermis is cornification; which develops a tough layer of dead cells that are capable of withstanding the rigors of the environment and provides a waterproof barrier and creates our skin tone. The epidermis is composed of keratinised stratified squamous epithelium and can be further subdivided into five layers: the stratum basale (deepest), the stratum spinosum, the stratum granulosum, the stratum lucidum and the stratum corneum (superificial). It accounts for 5 per cent Epidermis.

The primary purpose of the epidermis is to provide a protective layer between an organism and its environment. Through the process of cornification, a layer of dead cells envelopes the organism and acts as a barrier. Cornification begins in the basal layer, where the cells are columnar or cuboidal. These cells in the basal layer

contain large oval nuclei and basophilic cytoplasm. Within this layer, the cells synthesize tonofilaments.

The tonofilaments aggregate throughout the cells' ascent through the epidermis andbecome the keratinous protein that fills the mature cornified keratinocyte. In the next layer, the cells take on a polygonal because of cell to cell connections called desmosomes. These cell to cell connectins resemble spines on electron microscopy, hence the name stratum spinosum. Near the top of the spinous layer, the keratinocyte begins producing keratohylin granules, which become prominent as the cell ascends to stratum granulosum. These granules contain histidine rich protein called profilaggrin. As the cell matures, the profilaggrin is degraded to filaggrin, which acts as a glue to hold the keratin filaments together. A second type of granule forms near the top of the spinous layer. The lamellar granule contains free sterols, polar lipids, and several hydrolytic granules. This granule fuses with the keratinocyte cell membrane, discharging its contents into the intercellular space.

These granules establish a hydrophobic crystalline sheet within the intercellular space of the cornified layer, which is thought to give skin its impermeable quality.While the keratohylin and lamellar granules are forming, lysosomes are releasedinto the cell. It's thought that the enzymes effectively digest the intracellular organelles and nuclei. Tonofilaments and keratohylin are thought to be resistant to the lysosomal digestive enzymes and subsequently fill the mature corneocytes

Near the top of the granular layer, a thickening develops along the upper portionof the keratinocyte's plasma membrane. This thickening, called the marginal band or thecornified envelope, is formed from numerous disulfide bonds and other resistant chemical bonds between keratohylin and involucrin and multiple neutral

lipids. This marginal band provides the epidermis with an integrity that allows it to withstand the chemical and physical insults of the environment.The process of cornification is an orderly sequence of events. It starts at the basallayer where a cell begins producing tonofilaments. These are the precursors to α-keratin. As the cell ascends, it flattens out and loses the intracellular organelles and nuclei, which are replaced keratohylin granules. Hydrophobic lipids are released and form crystalline sheets in the stratum corneum that provide the epidermis its impermeable nature. Theoutermost layer of keratinocyte's plasma membrane thickness through a series of chemical bonds to construct an impermeable and resistant barrier to the environmental insults. The entire process takes about 19 days. The cornified layer is pliable and soft on normal skin; on the nail bed, the cornified layer is hard and thick to form the nail.

Melanocytes reside in the basal layer of the epidermis, in the ratio of 1 melanocyte every 10 keratinocytes. The primary function of melanocyte is to produce melanosomes. There are two types of melanin :eumelanin, with characterstic brown or black colour ; and pheomelanin, which accounts for lighter colour like blonde or reddish brown. The primary function of melanin is to protect skin from harmful effects of sunlight.

The Langerhans cell is a specialized cell that resides in the middle layers of epidermis. This cells provides the immune characteristics of skin and plays a larger role in contact dermatitis, allograft rejection and neoplasia surveillance.

Also within the epidermis are specialized cells called Merkel cells. Most of these cells are found in the epidermis of palms and soles, nail beds, and oral and genital epithelium. They act as mechanoreceptors and are able to transmit mechanical forces into action potentials along an association nerve.

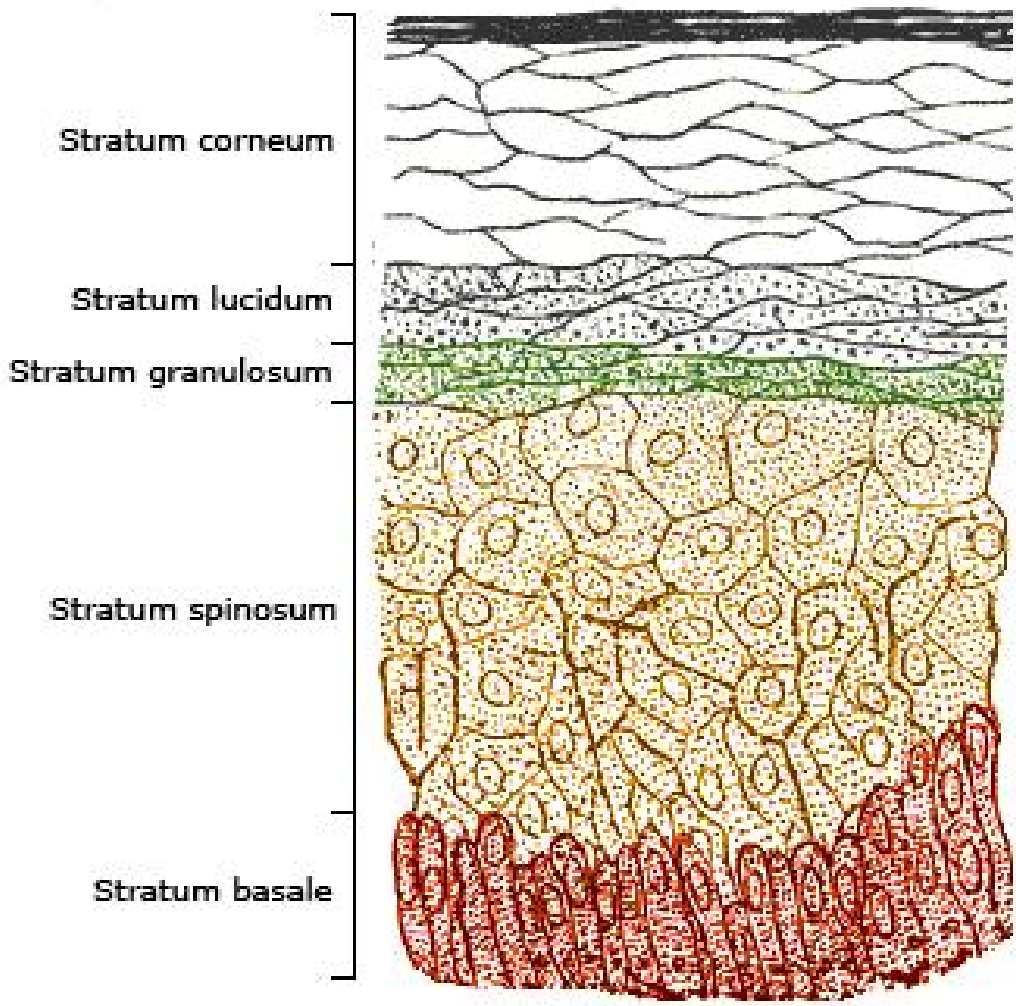


FIG.-2- LAYERS OF EPIDERMIS

2-The dermis, beneath the epidermis, is the vascular bed to the epidermis, contains tough connective tissue, hair follicles, and sweat glands. The capillaries present are able to regulate temperature by either vasodilatation or vasoconstriction. It is composed of collagen, elastic fibres and ground substance. It is relatively non cellular compared to epidermis. The dermis contains all nerves, vessels, and Lymphatics of skin and also the most glandular element of the skin. The dermis is 15-40 times thicker than epidermis.

The mature dermis can be divided into two layers, a superficial papillary layer and a deeper reticular layer. The papillary layer contains disorganised collagen bundles, elastic fibres, fibrocytes and ground substance and has a highly developed microcirculation. This microcirculation in the papillary dermis provides the blood supply for the metabolic activity epidermis. The reticular dermis is composed of thick bundles of coarse collagen arranged in orthogonal pattern. Coarse elastic fibres are interspersed between the collagen fibres.

The dermis immediately adjacent to hair follicles, apocrine glands, and eccrine glands resembles papillary dermis despite the deep nature of some of these glandular elements. This dermis is called periadnexal dermis and along with the papillary dermis can be referred to as adventitial dermis.

The ground substance found in the papillary dermis and to lesser degree in the reticular dermis is composed primarily of the mucopolysaccharides hyaluronic acid and chondritinsulfate. Ground substance tends to have a gel like consistency. Through the process of ageing, ground substance decreases and is replaced by fibrous tissue.

Dermal-Epidermal junction

The dermal- epidermal junction is the specialized site of attachment between the epidermis and papillary dermis. The most abundant cells in the dermo-epidermal junction are the basal keratinocytes. Other cells present include melanocytes and Merkel cells.

The dermal-epidermal junction provides the major functions for the skin. First, being the attachment between epidermis and the dermis. Second, the basement provides all support for the overlying dermis. Third, anionic proteoglycans such as

heparin sulfate rest on both the dermal and epidermal sides of the lamina densa. These proteoglycans provide a chemical barrier to the penetration of anionic macromolecules. The prime barrier to chemical penetration is the cornified epidermis, and the dermo-epidermal junction plays a minor role.

Blood supply

The cutaneous blood supply refers to the vascular arrangement superficial to deep fascia. After perforating the deep fascia, the arteries may run for various distances in the superficial fascia before sending branches towards the dermis. The subdermal arterial plexus is the major blood supply to the skin. Branches from the subdermal plexus supply the skin appendages and end in a plexus located in the superficial layer of papillary dermis. Capillary loops in the dermal papillae provide blood supply to the epidermis. Because of the interconnecting nature of the subdermal plexus, no portion of skin is directly dependent on the proximal cutaneous perforator.

The venous drainage of the skin mirrors the arterial supply. Efferent loop capillaries in the papillary dermis empty into a subdermal plexus. The venous subdermal plexus then drains into the segmental veins, which carry the venous return into the larger subcutaneous veins.

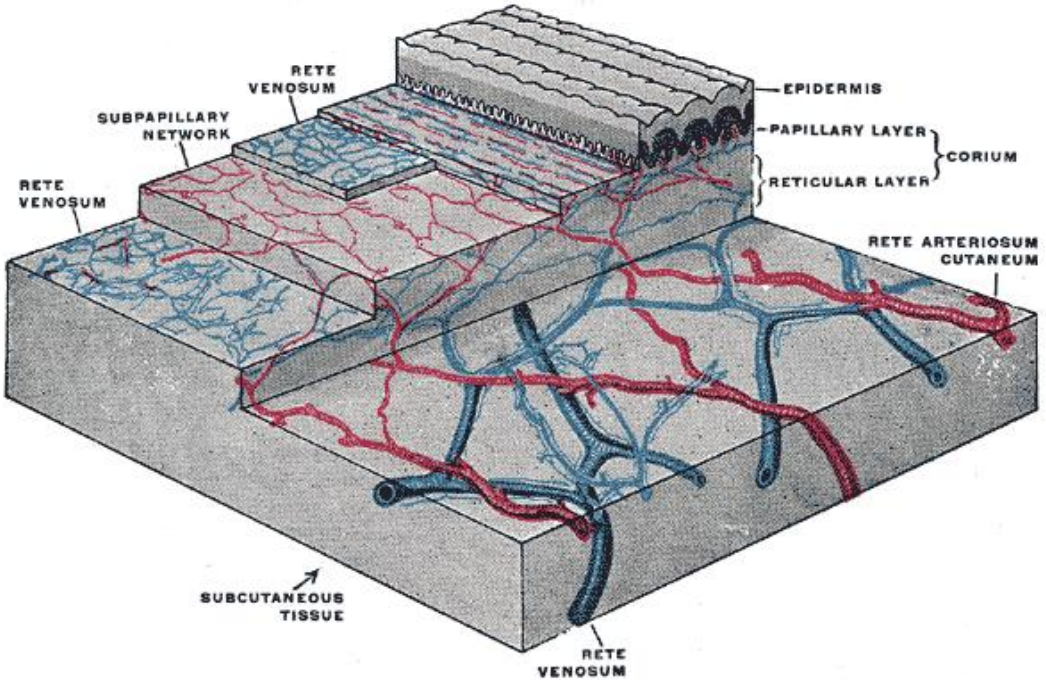


FIG.3- BLOOD SUPPLY OF SKIN

The blood supply the subdermal arterial plexus comes from two types of cutaneous perforators. First, the musculocutaneous perforators arise from vessels deep to the underlying muscle and pierce the fascia to terminate in the subdermal plexus. Second, the direct cutaneous arteries run parallel to the surface of the skin superficial to the muscle fascia. These arteries receive blood from segmental perforators that penetrate the muscle at various intervals. The direct cutaneous arteries terminate into the subdermal plexus.

Hair Follicles

Hair differentiation is first noted at 9 weeks of gestation as aggregates of mesenchyme beneath plaques of elongated epithelial cells. The process starts on the head and moves in the cranial-caudal direction. The mesenchyme begins to grow downward into the dermis as the epithelial cells proliferate upward through the epidermis, creating a canal called acrotrichia. On reaching the base of the developing

hair follicle, the epithelial plaque forms into a bulbous structure that encompasses the underlying mesenchyme. Once fully developed, hair follicle consists of a follicular matrix, derived from anunderlying follicular papilla, derived from mesoderm.

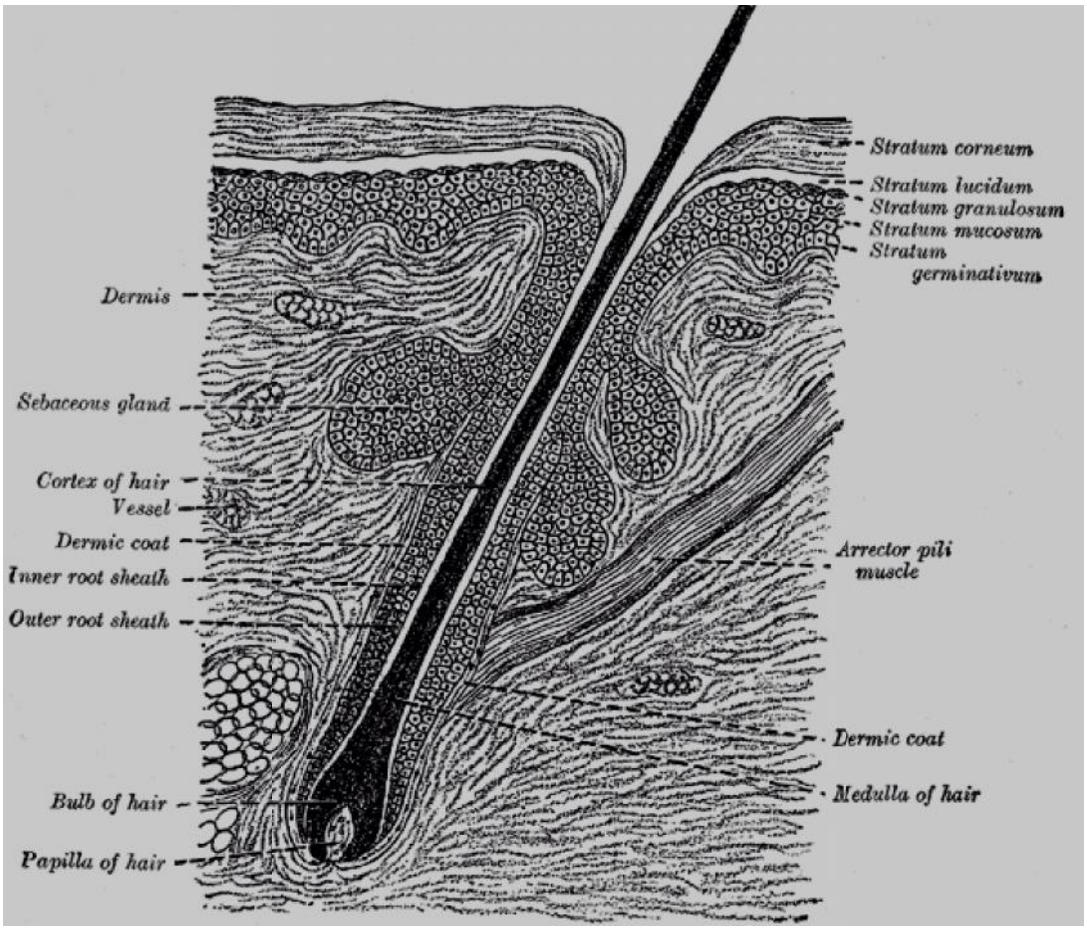


FIG.4 - LONGITUDINAL SECTION OF SKIN WITH HAIR FOLLICLE

As the hair follicle is developing, three bulges form on its sidewalls. The deepest bulge is the site of attachment of the hair follicle to the erector pilae muscle. The middle bulge forms into the sebaceous gland. The most superficial one develops into an apocrine unit, consisting of subcutaneous fat and the apocrine duct, which connects the gland to the hair follicle. As these structures are developing, the follicular matrix forms an inner and outer sheath, eventually creating embryonal hair.

The hair follicle can be straight spiral, helical, or wavy. The morphologic character of the hair follicle varies with race; blacks have spiral hair, whereas Asians frequently have straight hair follicles.

The hair follicle can be divided into 4 histological layers or zones. The infundibulum extends from the skin to the entrance of the apocrine gland. The isthmus resides between the apocrine gland Ostia and the sebaceous gland Ostia. The stem of the hair follicle is between the sabecous gland entrance and the attachment of erector pilae muscle. The portion of the follicle deep the erector pilae insertion is the bulb. The bulb contains the follicular matrix and the follicular papilla and is principally responsible for the hair development.

Hair development goes through three distinct phases in an adult. Active growth takes place during the anagen phase Involution of the hair follicle occurs during the catagen phase. The resting cycle of the hair growth is the telogen phase.

The characteristics of hair growth in a skin graft resemble those of the donor site. This must be considered in choosing a donor site. Hair follicles often grow in a slanted direction through the dermis. Incisions in the hair bearing areas should be beveled in the direction of hair growth to prevent undue destruction of the hair follicles.

Sebaceous Glands

Most sebaceous glands develop in the fourth week of gestation and arise from a maturing hair follicle. They are fond in the greatest concentration on the forehead, back, and nose. They almost always are associated with a hair follicle. However in the

oral mucosa, lip vermilion, internal fold of prepuce, labia minora and eyelids, the association is only of an infundibulum. No follicular stem or bulb is present.

Sebogenesis begins at the base of the sebaceous gland lobule. A germ layer exists at the periphery of the sebaceous lobule. As the cells mature, they fill with lipid and eventually lyse, releasing their contents into the sebaceous duct. As the cell and itscontents are released in toto, it's called as a holocrine gland. The content of sebaceousducts is called sebum. It contains multiple lipid components, including triglycerides, wax esters, squalene, cholesterol esters and cholesterol. Bacteria (propionobacterium) in the infundibulum of the associated hair follicle break down some of the lipids to free fatty acids. It has been suggested that these free fatty acids lead to inflammation associated with the acne-vulgaris.

Sebum production is a continuous process that does not rely on the nervous system. Sebaceous glands are active during infancy but quickly involute. At the age of 8 to 10 yrs, they become active again, coinciding with the onset of puberty. It appears that androgenic steroids control the sebum production. The exact function of the sebaceous gland is still uncertain.

Apocrine Glands

Apocrine glands are found in the axillae, areola, scalp, periumbilical region, perianal and circumanal areas, prepuce, mons pubis, labia minora, external auditory meatus and eyelids. The gland itself typically rests in the dermis or subcutaneous tissue and is attached to an associated hair follicle, where it inserts just above the entrance of the sebaceous gland. The apocrine gland is a coiled gland whose cells continuously secrete its contents into the apocrine duct through a decapitation process.

Apocrine secretion is controlled by the autonomic nervous system. Both unmylelinated adrenergic and cholinergic nerves innervate myoepithelial cells surrounding the secretory cells. Catecholamines can also stimulate apocrine secretion. Bacteria in the follicular infundibula and on the skin surface act on the apocrine secretion to produce sort –chain fatty acids, ammonia, and other malodorous products.

The exact content of apocrine secretion is currently unknown. Apocrine secretion in some primates acts as a sexual attractant or pheromone. Some believe it serves this function in humans; however there is no proven function for apocrine glands in humans at this time. Inflammation and obstruction of apocrine gland leads to a clinical condition called hidradenitissuppurativa.

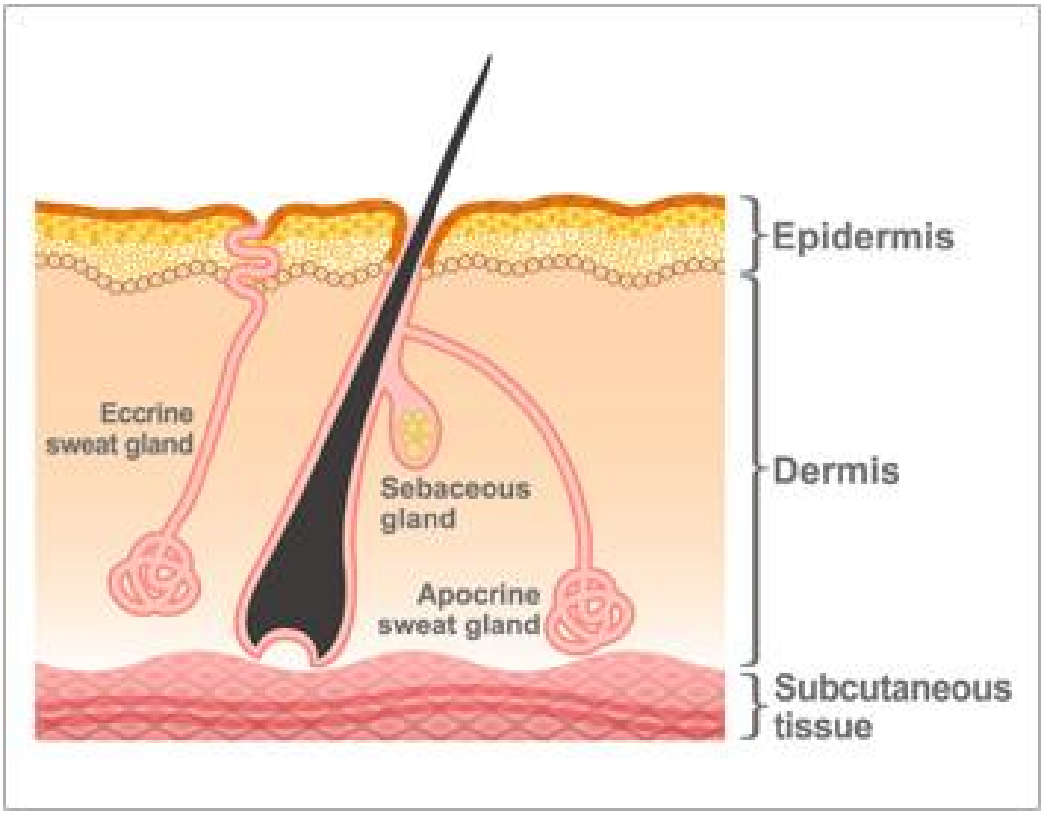


FIG.- 5-SKIN GLANDS

Eccrine Glands

The eccrine gland is the only true sweat gland in humans. They are present over the entire surface of the skin except the lips, clitoris, labia minora, and external auditory canal. The glands are typically tubular and are located at the base of the dermis and empty into the skin. They develop independently into folliculosebaceous apocrine unit and are of epidermal origin. An infant is born with approximately 3 million eccrine sweat glands from after birth.

The eccrine gland is a coiled secretor gland, with a coiled dermal duct, a straight duct that passes through the dermis, and a spiraled duct called the acrosyringium. The secretary gland releases isotonic solution that is a precursor of sweat. The duct absorbs sodium in partial exchange for potassium, resulting in a hypotonic sweat consisting of sodium, chloride, potassium, urea, lactate, bicarbonate, ammonia, calcium, phosphorous, magnesium, iodide, sulfate, iron, zinc, amino acids, proteins, and immunoglobulins. The pH of the sweat is between 4.5 and 5.5 and generally increases as the amount of sweat increases. Eccrine glands are innervated b both adrenergic and cholinergic fibers from the sympathetic nervous system.

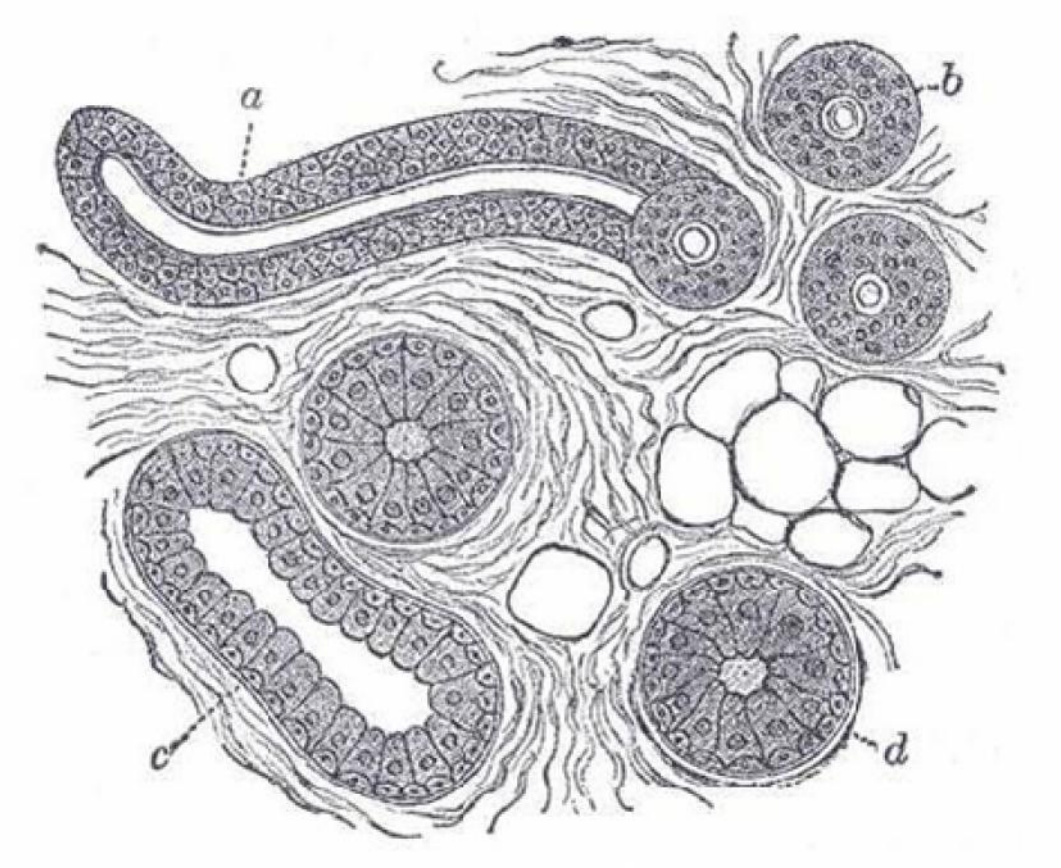


FIG.-6 -LONGITUDINAL AND TRANSVERSE SECTION OF SKIN

Body of a sudoriferous gland cut in various directions. a. Longitudinal section of the proximal part of the coiled tube. b. Transverse section of the same. c. Longitudinal section of the distal part of the coiled tube. d. Transverse section of the same.

The principal function of the eccrine gland is to control body temperature throughthe process of evaporation. An increase in the body temperature of 0.010 C will activate the hypothalamic system. This will activate the sympathetic nervous system, causing the number of eccrine glands actively secreting toincrease. In extreme temperature exposures, 2 to 3 liters of sweat can be produced in an hour. During prolonged exposure to high temperatures, eccrine glands become acclimatized and are

able to secrete larger amounts of sweat at a greater rate in response to a relatively smaller elevation in body temperature. Eccrine glands on palms, soles axillae, and forehead tend to respond to emotional stimuli as opposed to heat. This explains the familiar “cold clammy hands” that develop during particularly stressful situations.

SKIN GRAFTS

Skin grafts are used in a variety of clinical situations. The essential indication for skin grafting being wound closure. In general full thickness grafts are applied to the areas of face, ears and hands. Split skin grafts are placed on trunk and genitalia. Skin grafts are an option for many wounds which cannot be closed primarily. Grafting offers the simplest method of wound closure in the reconstructive ladder, assuming that primary closure is not possible or would lead to undue tension. Various forms of skin grafts are also useful in releasing contractures, in certain forms of vitiligo, during syndactyly release, and in treating hair loss. Skin grafts are generally avoided in the management of more complex wounds. Conditions with deep spaces and exposed bones, such as sternal wounds, pressure sores, and open fractures, normally require the use of muscle flaps for stable wound coverage. Skin grafts have limited success in wounds with a compromised blood supply, such as irradiated wounds and ischemic ulcers.

Split Versus Full Thickness

Skin grafts can include either a portion of dermis or the entire dermis. When a graft includes only a portion of the dermis, it is referred to as split thickness skin graft. When the graft contains the entire dermis, it is called a full thicknessskin graft. The amount of dermis included in the graft determines both the survival and the amount of

contracture. Split thickness grafts can tolerate less vascularity but have greater amount of contracture. Full thickness skin grafts require better vascular bed for survival but undergo less contracture. Sensory recovery of the full thickness graft is superior to that of the split thickness graft.

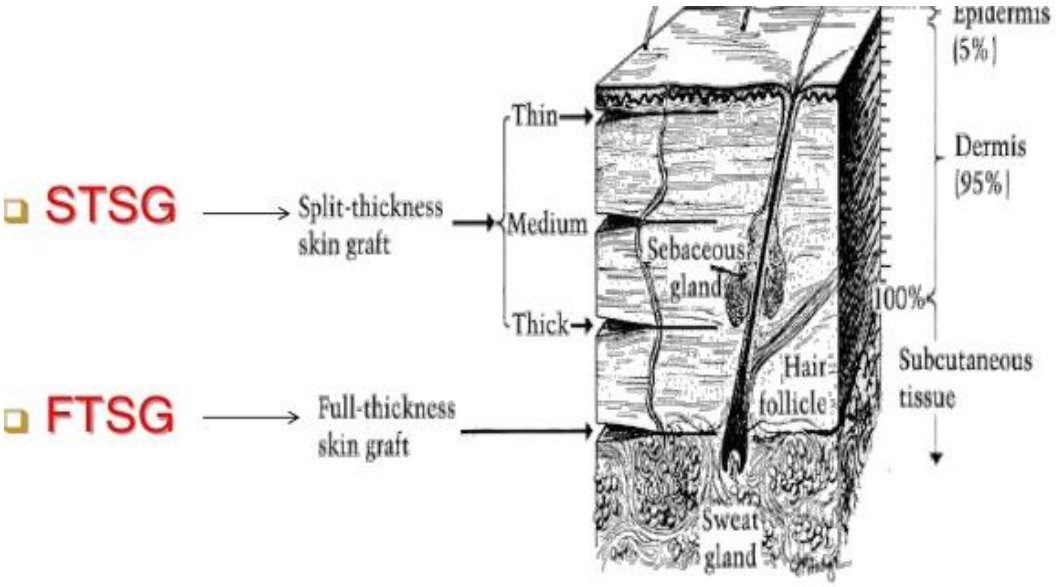


FIG.- 7-TYPES OF SKIN GRAFTING

A typical split thickness skin graft is 0.30 to 0.45 mm (0.012- 0.018 inch). Blood vessels are present throughout the dermis; thus the cut vessels on the undersurface of the graft can easily absorb nourishment for the survival. Therefore, when a skin graft is applied to close a wound with a tenuous vascularised bed, such as over periosteum, peritenon, or perineurium, split thickness grafts are less likely to survive. After a split thickness graft is harvested, the donor site generally heals spontaneously. Epithelial cells deep in the hair follicles and sweat glands generally cover a typical split graft site in 7 to 21 days, depending on the thickness of the graft. If necessary, the donor of the split thickness graft can be harvested again after the

wound epithelialization. This is often necessary in treatment of patients with large surface area burns.

Full thickness grafts contain both epidermis and the full thickness of dermis. Unlike in split thickness graft donor sites, there are no residual epithelial cells to resurface the donor area. Full thickness graft donor sites must be closed primarily. Thus, full thickness grafts are not normally used for large wounds. The degree of vascularity in the full thickness graft is greater than for thinner split thickness graft.

Donor Sites

Split thickness skin grafts can be taken from any area on the body, including the scalp. Despite the ability to heal spontaneously donor site is frequently scarred or discolored. Donor sites are frequently in areas hidden by modern day clothing. Popular areas for split thickness graft harvest include thigh, trunk, and buttocks. Donor sites containing suspicious lesions are avoided to prevent transfer of a malignant neoplasm with the skin graft.

Defects on the face are frequently closed with either local flaps or full thickness grafts. On occasion, a split thickness graft can be used. When placing a split thicknessgraft on the face, one should use a donor site from the “blush zone”. This gives a graft with the best color match. The blush zone is above the shoulders and consists of the scalp, neck, and the supraclavicular area. In taking a graft from a hair bearing area, it is important to take a thin graft because thicker grafts will contain undesired hair follicles and eventually lead to hair in the graft.

In choosing a harvest site, it is important to keep in mind the thickness of the donor site. Skin is typically thin in infants and the elderly. Men typically have thicker

skin than women do regardless of anatomic location. Skin is typically thicker on the trunks and the thighs and thinner on the eyelids and post auricular areas.

A frequently overlooked source of skin grafts in the trauma situation is avulsed skin. This skin can be harvested in either a full or split thickness fashion and can be applied to the resulting wound primarily or stored used later. In patients with combined polydactyly and syndactyly, the removed accessory digit may also be a source of skin for syndactyly release.

The donor site of a split thickness skin graft generally heals in 7 to 21 days. The most common treatment of a split thickness graft donor site is fine mesh gauze impregnated with a lubricant and, possibly an antibiotic. The gauze is applied immediately after harvesting of the graft and is left on the donor site until it falls off. The gauze provides a protective layer over the donor site and helps with pain control during the healing process. Re-epithelialization reliably occurs in 12 days with this method of treatment.

The optimal treatment of the donor site is auto grafting. When excess skin is available after grafting, it can be placed onto the donor site rather than discarded. It is possible to mesh a skin graft so that there is available skin for both the defect and the donor site. A variety of donor site dressings are available for the management of the donor site in a split thickness skin donor area.

Harvesting Split Thickness Grafts

Freehand dermatomes used for obtaining split skin:-

The process of harvesting a split thickness skin graft entails cutting the skin at some point through the dermis. This can accomplished with two different types of instruments, freehand and power driven dermatomes.

Freehand dermatomes include the Weck blade, the Humby knife, the Blair knife, and a simple scalpel. A freehand dermatome offers a quick method of harvesting a skin graft that does not depend on electricity or pneumatic power. However, with freehand dermatomes, one has difficulty in controlling the exact thickness and depth of the graft.

FIG.- 8 -HUMBY'S KNIFE

FIG. 9 -SILVERS SKIN GRAFTING KNIFE

Once the donor site has been identified, the area can be anaesthetized with local anaesthetic with or without adrenaline. Adrenaline can help control the bleeding and lengthen the duration of the local anaesthetic. Donor sites can also be anaesthetized with regional nerve blocks, general anaesthesia, or frost induced anaesthesia. A template can be used to help identify the amount of skin needed for the graft. If a larger template is used, the graft should be cut to 5% larger than the template to account for the skin contraction that occurs after the graft is harvested. The Weck blade, the Humby knife, and the Blair knife are equipped with a guard, which limits the depth of the skin graft. Typically, the guard is set at 0.30 to 0.45 mm for a split thickness skin graft harvest. This should be verified by passing the beveled end of a no.15 blade scalpel between the guard and the knife. If the guard is set 0.3mm, the beveled end of the blade will snugly fit between the guard and the knife. An assistant applies tension to the donor site, and the area is lubricated with mineral oil or saline. The surgeon then passes the knife parallel to the epidermis in back and forth direction, much like a musician playing a violin. The assistant gently withdraws the resulting graft from the dermatome as the surgeon continues the harvest.

Power driven Dermatome:-

In 1940, James Barret Brown introduced the first electrically driven dermatome. Because of the simplicity and reliability, the motorized dermatome has largely replaced the freehand dermatome for large split thickness skin harvests. A power driven dermatome uses a rapidly vibrating blade and works like a wood planar. The air Zimmer dermatome, powered by compressed water pumped nitrogen, produces uniform grafts of predetermined depth and width. It is the most commonly used motorized dermatome today.

FIG.-10 - POWER DRIVEN DERMATOME

In using a motorized dermatome, the first step is to assemble the dermatome. In general, a disposable blade must be attached to the dermatome, followed by a guard of predetermined width. The depth of the harvest is set and can be assessed by passing a no.15 blade between the guard and the blade. The dermatome is connected to a power source, unless the dermatome is battery driven. The dermatome is then checked to ensure that the instrument is receiving adequate power before the actual harvest begins.

In general, when a power driven dermatome is being used to harvest a split thickness skin graft, the patient is under general anesthesia. However, regional blocks, and local anesthesia with or without adrenaline can also be used with a power dermatome. The donor site is shaved and prepared with a standard operative scrub.

The area is then lubricated with saline or mineral oil. An assistant may apply traction to provide a taught donor site. The dermatome is then brought in contact with the donor site at a 30 to 45 degree angle, and the throttle is pressed, initiating a cut.

Gentle downwardpressure is applied to the dermatome as the machine is advanced flat to the skin. An assistant may lift the graft from the pocket area of the dermatome during the harvest so that the surgeon can assess the depth of the cut Once the harvest is complete, the surgeon angles the dermatome upward and lifts off the donor site while continuing to advance to cut the graft. This technique provides reliable grafts of a predetermined depth and width, especially in flat donor sites like the thigh. Some modifications must be made in harvesting over a bone prominence like the iliac crest or scalp to ensure a uniform graft.

TUMESCENT TECHNIQUE:-

Subcutaneous tissue infiltration with Ringer lactate solution can facilitate skin harvest over a bone prominence. One or 2 liters of fluid can be infiltrated beneath the donor site. The infiltrate will stiffen the skin and make for an easier and more predictable harvest. Adrenaline (2ml of 1:1000 adrenaline per liter of ringer lactate solution) can be added to the tumescent fluid. This will significantly limit the blood loss from the donor site after the harvest. This technique is particularly useful in burn surgery.

During the harvest, the surgeon should inspect the graft to ensure appropriate depth. Graft thickness can be determined by observing the graft and the donor site. An ideal split thickness graft should be slightly translucent. An opaque graft indicates a deep split thickness or possibly a full thickness harvest. The donor site will also give clues to the depth of the graft. Thinner harvests leave behind a multitude of small bleeding points because the blood vessels arborize as they travel through the dermis. Deeper harvests leave relatively fewer and larger bleeding points in the remaining

dermis. If the donor site contains areas of exposed fat, the harvest is full thickness in those areas.

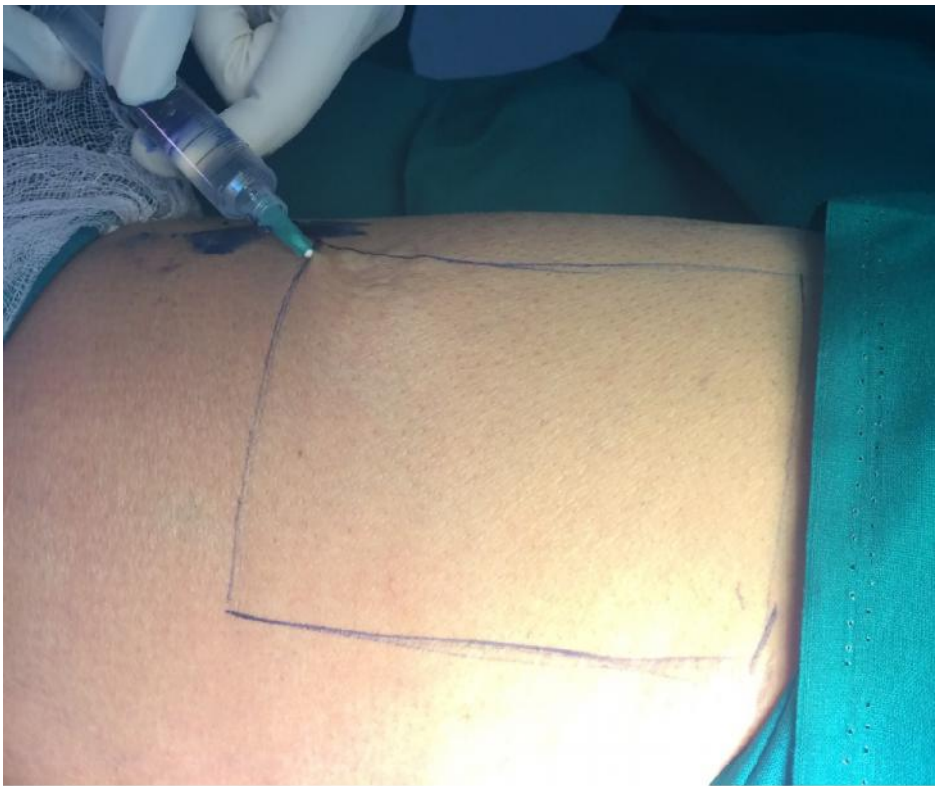


FIG.- 11-TUMESCENT TECHNIQUE

There is no standard depth setting used in harvesting of a split thickness skin graft. This is because each patient's skin thickness varies. Infants and elderly typically have a thin skin. The thickness of the skin also varies according to the anatomic location on the same individual. In certain patients, disease or medication causes significant tinning of dermis, example, patients taking corticosteroids generally have a thin dermis. It is important to assess the donor site during the harvest to prevent an unexpected full thickness defect.

Motorized and freehand dermatomes can also be used for debridement of the eschar of full thickness burns. It has been shown that tangential excision of the burns

eschar allows the surgeon to remove the eschar to a level of normal bleeding tissue. Dermatomes also have been used to remove hypertropnhic scar to prepare for overgrafting.

Drum dermatome-:

A third type of dermatome for harvesting split thickness skin grafts is the drum dermatome. The Reese and Padgett-Hood dermatomes are the two best known examples of drum dermatomes. Drum dermatomes use a set of finely calibrated shims for harvesting split thickness skin grafts. The drum dermatomes are more difficult to modify the depth of the cut during the skin graft harvest. Drum dermatomes can be useful in harvesting of split thickness grafts from difficult areas, such as the back of the neck or the buttocks. Because the drum dermatome is more difficult to use and to adjust, it has largely been replaced by motorized dermatomes.

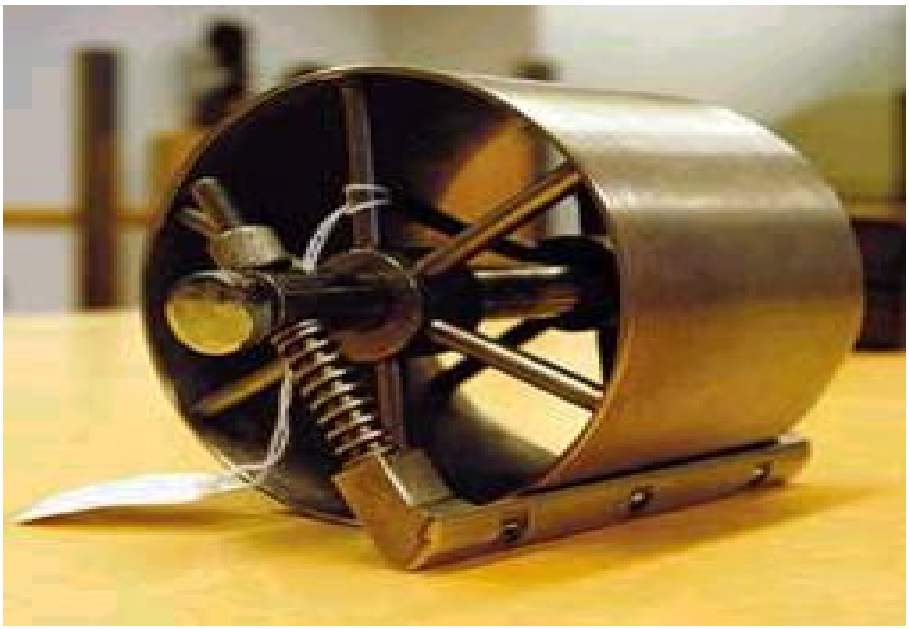


FIG.- 12-DRUM DERMATOME

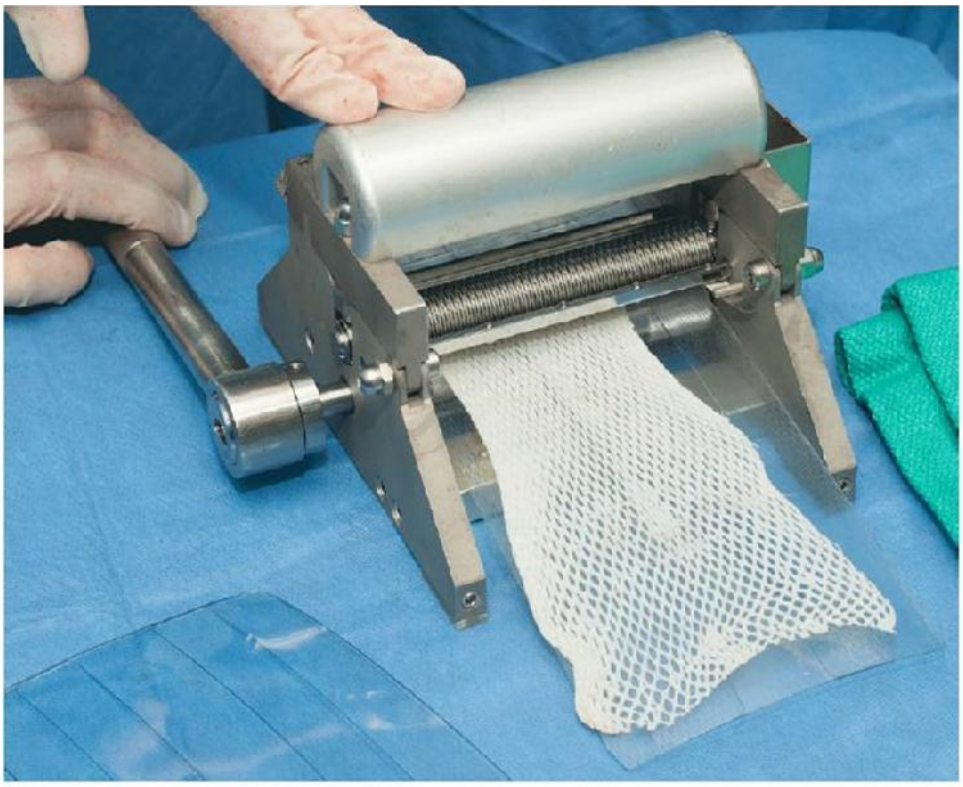


FIG.- 13-MESHER MACHINE

This is very important machine to create meshing in grafts and which is mostly helpful in excretion of the recipient site secretions. This machine is very useful in doing meshing of long grafts. This very time consuming and energy saving

Postoperative Care

Good postoperative care begins with the dressing. The first step is to apply a no adherent dressing over the graft. Adaptic, Telfa, Xenoform, petrolatum gauze is applied directly over the graft. The non-adherent properties of these types of dressing s prevent the skin graft from being debrided off the wound at the time of the first dressing change. The reminder of the dressing should apply gentle pressure on the graft to promote adherence without causing pressure necrosis. Cotton balls or fluffed

gauze is then pressed onto the wound to conform on the underlying bed. On an extremity, a circumferential wrap can be applied snugly across the wound to ensure contact between the graft and thehost bed. The extremity may then be immobilized with a splint, although early mobilization has not shown to delay wound healing.

For the grafts to the trunk and neck, a bolus tie-over dressing can be used. To use a bolus dressing, the graft must be fixated with a permanent suture, which is intentionally cut long. This leaves strands of suture that will be used to hold the dressing on. Once the sutures are placed, petrolatum gauze is applied on top of the graft. Fluffed gauze or cotton balls are gently pressed onto the graft. The suture strands are then tied together so that they hold the dressing firmly onto the graft. The bolus dressing minimizes the risk of hematoma or seroma formation and also prevents shearing forces from disrupting the graft.

A bolus dressing can be left in place for 7 to 14 days. If there is great concern about the graft, then additional sutures can be placed at the time of surgery and preserved for the next dressing change. This allows the tie overdressing to be changed and reapplied with the extra or spare sutures. Alternatively, the original bolster dressing can be applied by use of one of the two strands of each suture. The second strand can be saved to reapply the bolus dressing after the first dressing change. When the bolster dressing is removed, the gauze should be gently peeled from the wound to prevent disruption of the graft from the host bed.

The first dressing change is important for the graft survival. The timing of the first dressing change varies. In heavily colonized wounds, early dressing changes are preferred (1-3 days). Once the dressing is carefully removed, the graft is examined. At 2-3 days, the graft may still appear pale. However, vascular in growth has already

begun, and the grafts obtain a pink hue around the third or fourth post operative day. Seromas and hematomas are expressed through nicks in the skin graft. It is better to cut a small hole in the graft over the hematoma than to dislodge surrounding adherent graft to express the fluid through the graft periphery. Eschar is debrided because it offers an excellent medium for the bacteria. Once all seromas and hematomas have been evacuated, a new dressing is applied in a fashion similar to the original dressing. If a bolus dressing is being removed at 10 or 14 days, a second dressing may not be necessary and the graft may be treated with moisturizing cream.

In general, grafts should be covered and immobilized for at least 5 to 7 days. Graft adherence occurs rapidly during the first 8 hours after surgery and continues until the fourth postoperative day. After a minimum of 5 to 7 days, the extremity splints can be removed, and the patient may be allowed to bathe, assuming the patient is cooperative.

In infants or in sedated or immobile patients, grafts can be treated open. This allows early and frequent examination of the graft. Arm splints may be necessary in small children to prevent them from manipulating the graft. Fibrin glue can be used to fix the graft to the underlying bed, preventing the need for suture removal. This is an attractive alternative in young children. This is a relatively simple manner of treating a skin graft because there is no need for dressing changes.

Storage

When excess graft is harvested, it may be prudent to store the excess graft for a later operation. The easiest method of preserving a graft is to replace it on the donor

site. This will preserve the graft up to 5 days. The graft will ultimately take and will become difficult to elevate after 5 days.

If the graft needs to be preserved for more than 5 days, it can be placed in a saline solution at 4^0C. Antibiotics can be added to the solution, and this method of storage will preserve a graft for around 21 days. Under normal circumstances, freezing should be avoided. Various solutions are being studied to lengthen graft preservation without refrigeration. A solution containing a combination of growth factors, steroids, insulin, and adenine called ready mix currently achieves 60% keratinocyte viability at 30 days of incubation. Long term storage and allograft storage depend on freezing techniques. Glycerol or dimethyl sulfoxide is added to the solution to prevent tissue destruction by the freezing process, and the grafts are rapidly frozen with liquid nitrogen. When the grafts are needed, they can be thawed and easily applied.

Graft survival

A skin graft is essentially skin transplantation. The graft is completely severed from its blood supply, drainage system, and sensory innervations. The graft is placed onto a vascular bed so that the graft will become vascularized and sensate. The process of graft survival has been well studied during the past century. Immediately after grafting, the graft is dependent on the serous exudates from the recipient site for survival in a process called serum imbibitions. Ultimately, however, how the graft becomes vascularized is still unclear. Hübscher and Goldmann were the first physicians to recognize the importance of serum nourishment for graft survival. They termed this process “plasmatic circulation” of the graft. Subsequently, numerous

studies have been performed that demonstrate how a skin graft survives during the first 48 hours after transplantation.

Immediately after a graft is placed onto the recipient site, it begins to gain weight and appears edematous. It is thought that plasma leaks from recipient venules and, to a lesser extent, from capillaries and arterioles. This plasma then fills the space between the graft and the underlying host bed. The fibrinogen, within the plasma, settles out and forms glue like substance anchoring the graft to the bed. The remaining plasma is absorbed by the graft and provides temporary nourishment for the graft. Studies of this serum have revealed that it also contains erythrocytes and polymorphonuclear leukocytes. Because the fliud taken up by the graft is free of fibrin, it is technically termed serum. Thus, Converse, Ulschmid, and Ballantyne's proposed terminology "phase of serum imbibitions"has largely replaced Hübscher and Goldmann's original plasmatic circulation.

MATERIALS & METHODS

SOURCE OF DATA

All patients requiring SKIN GRAFTING admitted in KLES Dr. Prabhakar Kore Hospital and MRC from 1st January 2016 to 31st December 2016 will be eligible for the study. Consent will be taken for participation in the study.

Inclusion criteria :

- Patients admitted in KLES Prabhakar Kore Hospital And MRC, Belagavi.
- Patients between 18-60 years of age
- Patients undergoing skin grafting for clean surgical wounds
- Only thigh site donor area

Exclusion criteria:

- Patients who refuse to give consent.
- History of blood or coagulation disorder.
- Patients with comorbid conditions like Diabetes Mellitus,
- Hypertension, Ischemic heart disease and other cardiac
- Disorders, renal failure and immune-compromised states.

METHOD OF COLLECTION OF DATA

STUDY DESIGN :-

TYPE OF STUDY: Randomized Controlled trial

STUDY PERIOD: 1st January, 2016 to 31st December, 2016

SAMPLE SIZE AND SAMPLE SIZE CALCULATION:

Sample size = 90 (45 in each group)

It is calculated based on the following equation,

$$n = \frac{2(Z\alpha+Z\beta)^2 pq}{(P_0-P_1)^2} = 45 \qquad q = 100 - P$$

$$P = \frac{P_0 + P_1}{2}$$

where,

n = sample size $Z\alpha = 1.96$ $Z\beta = 0.84$ $P_0 = 30$ $P_1 = 70$ $q = 50$

Effective size $P_1 - P_0 = 70 - 30 = 40$

SAMPLING PROCEDURE:-

All consecutive patients fulfilling the criteria and who give informed consent during the period of study will be the sample of this study.

METHOD :-

The patients that fit the criteria will be randomly divided into 2 groups of 45 each by an 'Opaque envelope method':-

- Group A is TUMESCENT TECHNIQUE group
- Group B is NON-TUMESCENT TECHNIQUE group

Group A patients would undergo sub-dermal infiltration of skin graft donor site with a solution formula of 1 mg (1:1000) adrenaline added to 500 ml of saline.

Both groups will be monitored for donor site healing by inspection on 10^{th} post-operative day.

Percentage of wound healing by epithelialization will be calculated by using wound tracing by transparent sheet technique that is the sterile transparent sheet is placed over donor site wound and healed epithelialized area is marked by marker and then this sheet is placed over calibrated paper to count the area of percentage of healing in both the groups.

STATISTICAL ANALYSIS:

To evaluate the healing of donor site on day 10^{th} between tumescent and non-tumescent group, the unpaired t test will be used to compare healing in both groups, a P – value of less than 0.05 will be considered statistically significant.

INVESTIGATIONS: Routine investigations (Hb, TC, DC, Platelet count, BT, CT, LFTs, Urine Routine, S. Urea, S. Creatinine, HIV, HbSAg)

INTERVENTION: Subcutaneous infiltration of adrenaline solution (1 in 500000) at donor site.

RESULTS

The total sample size in our study is 90. The group A is tumescent technique and Group B is non tumescent technique. Each group sample size is 45. This is a randomized control study with all the 90 patients fulfilling the inclusion criteria and who have given informed consent during period of study and are included in the study. The patients who fit the criteria are randomly divided into 2 groups of 45 each by an opaque envelope technique. In our study we analyzed the healing of donor site on 10^{th}post operative day. All the data was analyzed using Chi-square test.

The study consisted of total 90 patients who meet the inclusion criteria. 64 (71.11%) are male patients and 26(28.89%) are female patients. The sex distribution in individual group is as follows, in group A out of 45 patients 30 (66.66%) are male and 15(33.34%) are females. In group B 34(75.55%) are males and 11(24.45%) are females. The sex distribution of the patients has been summarized in TABLE NO. 1 and TABLE NO. 2

TABLE NO. 1:- SEX WISE DISTRIBUTION IN STUDY POPULATION

SEX	NUMBER	PERCENTAGE%
MALE	64	71.11
FEMALE	26	28.89

GRAPH-NO.1:- SEX WISE DISTRIBUTION IN STUDY POPULATION

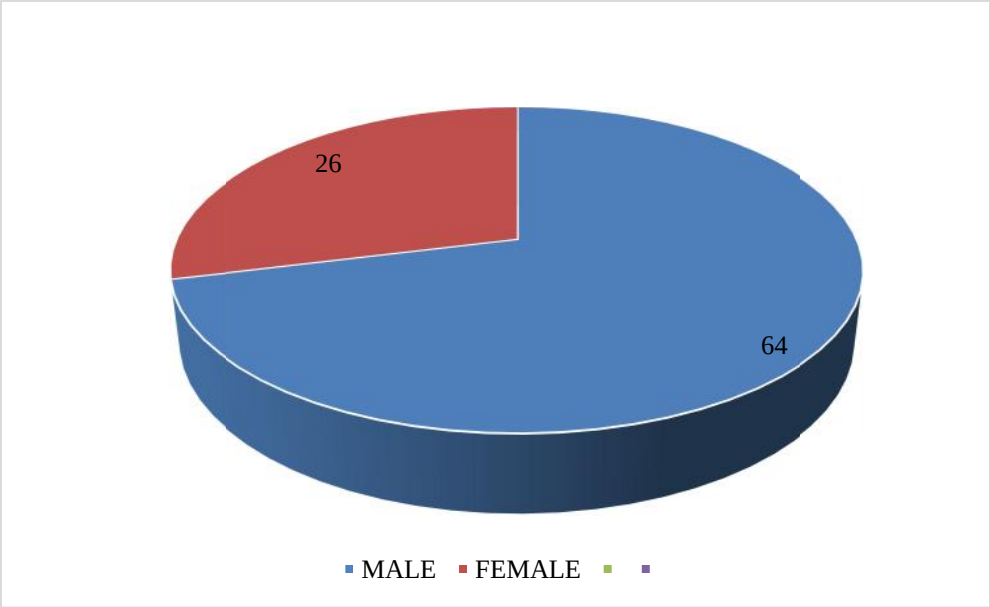
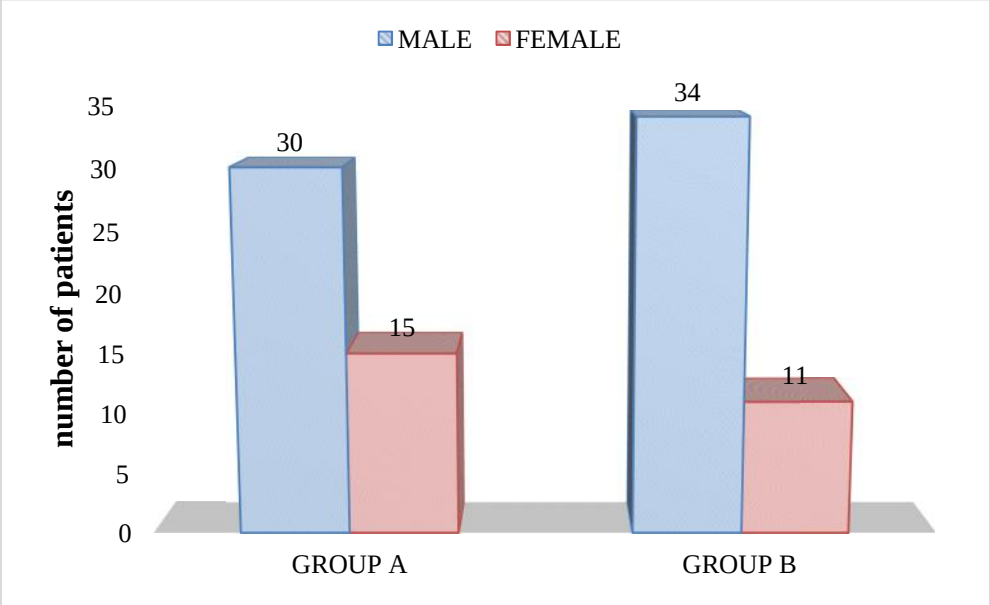


TABLE NO. 2:- SEX WISE DISTRIBUTION IN INDIVUDUAL GROUP

	MALE	FEMALE	TOTAL
GROUP A N=45 (%)	30(66.66%)	15(33.34%)	45
GROUP B N=45 (%)	34(75.55%)	11(24.45%)	45
TOTAL	64(71.11%)	26(28.89%)	90

GRAPH NO.2:-SEX WISE DISTRIBUTION IN INDIVUDUAL GROUP

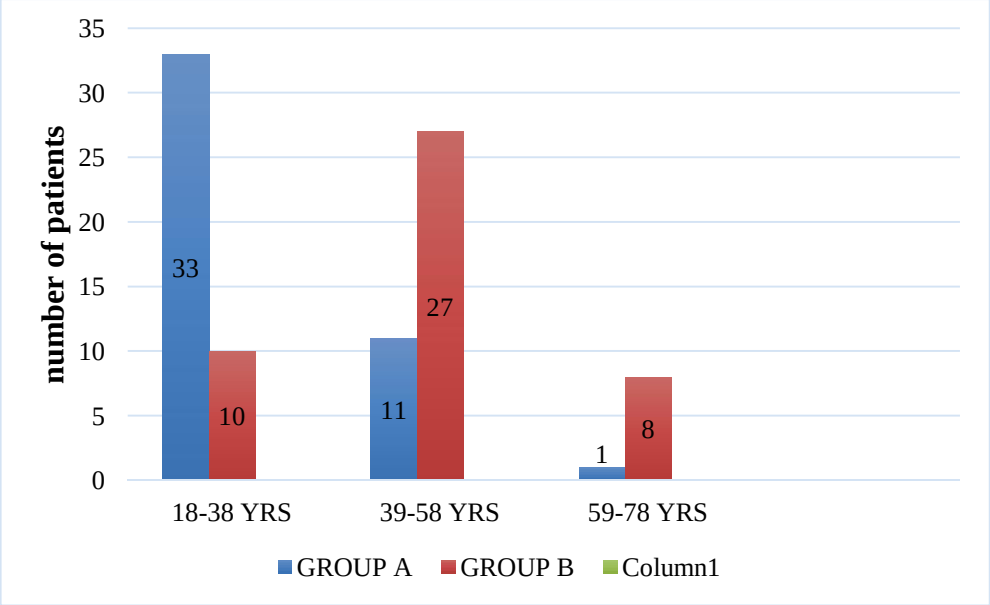


The mean age of the study population is 29.98+/-12.6years for GROUP A and 45.36+/-10.23years for GROUP B. The age distribution of the study population is concentrated in the age group between 18-38 years. The numberof patients between 18-38 years are 33(73.33%) in group A and 10(22.22%) in group B out of 45 patients of each group. Out of 45 patients in each group the number of patients between 39-58 years are 11(24.44%) in group A and 27(60%) in group B. And 1(2.33%) from Group A and 8(17.78%) from group B are in 59-78 years age group. All the data is summarized in TABLE NO. 3

TABLE NO. 3:-AGE WISE DISTRIBUTION IN INDIVIDUAL GROUP

AGE(YRS)	GROUP A N = 45 (%)	GROUP B N = 45 (%)	Total
18-38	33(73.33%)	10(22.22%)	44
39-58	11(24.44%)	27(60%)	38
59-78	1(2.33%)	8(17.78%)	9
total	45	45	90

GRAPH-NO.3:- AGE WISE DISTRIBUTION IN INDIVIDUAL GROUP



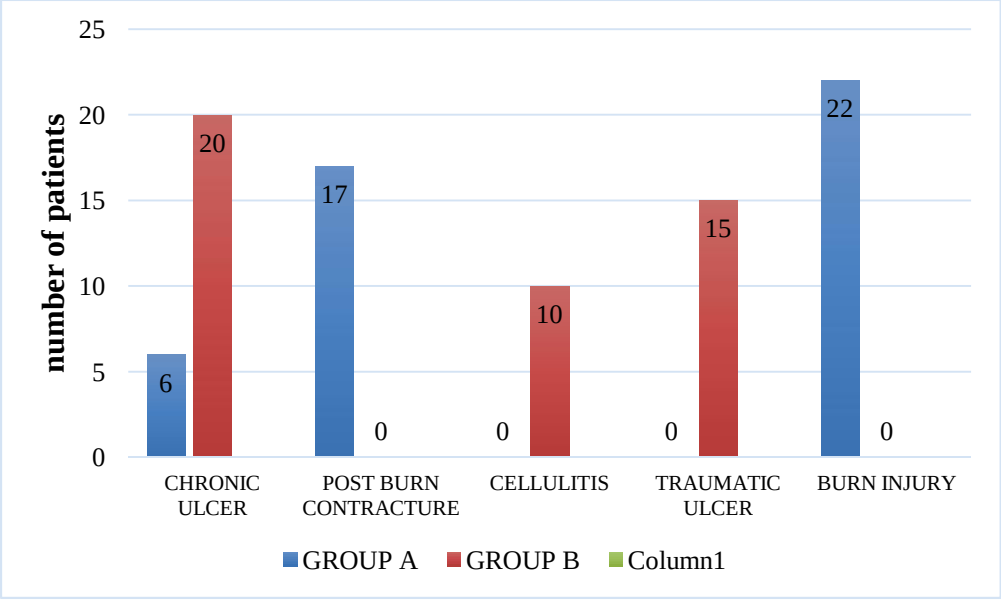
The patients who required skin grafting have a different diagnosis and the most common diagnosis in the group A is burn injury 22 patients (48.90%) and followed by post burn contracture in 17 patients (37.77%) patients and rest 6 patients (13.33%) are diagnosed as chronic ulcer.

In group B most common diagnosis is chronic ulcer 20 patients (44.45%)and after that traumatic ulcer 15 patients (33.33%). Rest 10 patients (22.22%) come under cellulitis. This has been summarized in TABLE NO. 4

TABLE- 4- DIAGNOSISWISE DISTRIBUTION IN BOTH GROUPS

DIAGNOSIS	GROUP A -N = 45 (%)	GROUP B –N = 45 (%)
CHRONIC ULCER	6 (13.33%)	20(44.45%)
POST BURN CONTRACTURE	17(37.77%)	0(0%)
CELLULITIS	0(0%)	10(22.22%)
TRAUMATIC ULCER	0(0%)	15(33.33%)
BURN INJURY	22(48.90%)	0(0%)

GRAPH NO.4:- DIAGNOSISWISE DISTRIBUTION IN BOTH GROUPS



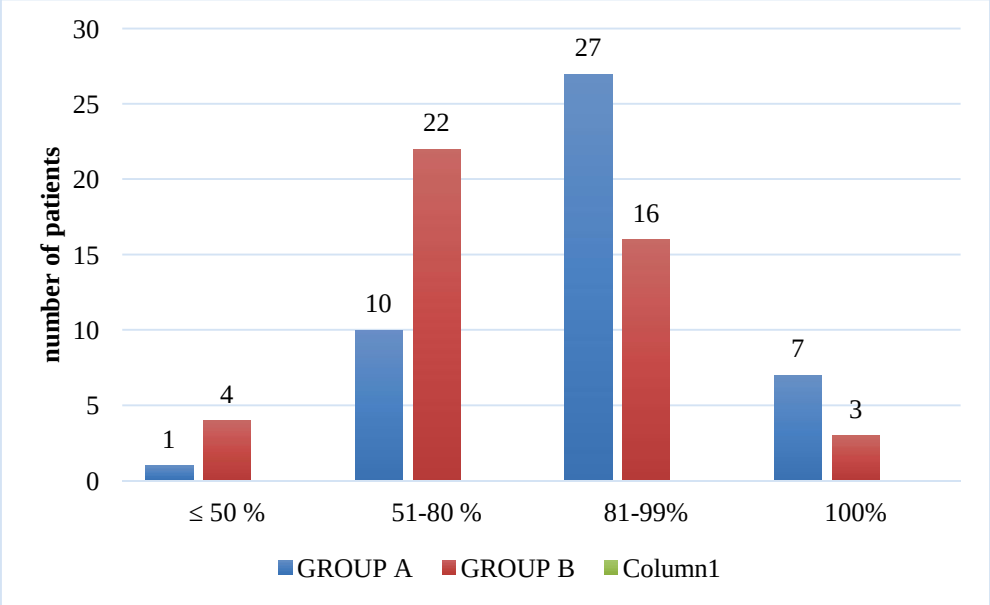
The number of donor areas that achieved complete (100%) epithelialization on the 10th post operative day by TUMESCENT technique was seen in 7 patients (15.56%), whereas in NON-TUMSCENT technique it was only seen in 3 patients (6.66%) donor sites.

81-99% of epithelialization was seen in 27 patients (60%) donor areas, treated with tumescent technique, whereas the donor areas treated with non tumescent technique are 16 patients (35.56%) . 51-80 % epithelialization was seen in 10 patients (22.22%) in group A donor area and in 22 patients (48.89%) with non-tumescent technique. Less than 50% of healing is seen in only 1 patient (2.22%) in tumescent group and 4 patients (8.89%) in non-tumescent group. The p value is **0.0134** and is significant. These results have been depicted in TABLE NO.5 below.

TABLE NO. 5 - HEALING % IN BOTH GROUPSP VALUE = 0.0134

Healing %	Group A N = 45 (%)	Group B N = 45(%)	TOTAL
≤ 50 %	1 (2.22%)	4 (8.89%)	5
51-80 %	10(22.22%)	22(48.89%)	32
81-99%	27(60%)	16(35.56%)	43
100%	7(15.56%)	3(6.66%)	10
TOTAL	45(100%)	45(100%)	90

GRAPH NO. 5 - HEALING % IN BOTH GROUPS



There was no clinical evidence of donor site infection in any of the groups, as judged by surrounding erythema or purulent exudate. Difference was found between tumescent and non tumescent technique in exudate secretion, skin maceration, or haemorrhage from the donor site. The healing rate in tumescent technique is more than non tumescent technique.

DISCUSSION

Skin is an organ designed to protect the body from the harmful external environment. When injured, the skin must consistently and rapidly repair itself in order to maintain this external defense system. The donor site too is a superficial wound on the body and needs to be treated in lines with any other superficial wound, like a graze or an abrasion. After donating split thickness skin graft to the recipient area it loses full thickness of epidermis and a part of the dermis depending on the graft thickness obtained.[4]

The challenge in managing the donor site is to promote healing as quickly as possible while minimizing adverse effects and complications. If complicated by infection, split-thickness defect may convert to a full-thickness loss, analogous to a third-degree burn. Although numerous techniques have been devised for the treatment of the donor site there is no clear agreement as to which is the best.[3]

For the STSG the tumescent technique is very good choice of modality to prevent excess blood loss at donor site and as compared to non-tumescent technique the healing is much faster in tumescent technique.[1]

In this study we compared the donor site healing percentage in tumescent and non-tumescent technique. 90 patients are studied for donor site healing. The study population consisted of 64 males and 26 females. The sex distribution in individual group is as follows, in group A out of 45 patients 30 males (66.66%) and 15 females (33.34%). In group B 34 males (75.55%) and 11 females (24.45%).

The mean age of the study population was (29.98+/-12.6yrs for GROUP A and 45.36+/-10.23yrs for GROUP B). The age distribution of the study population

was concentrated in the age group between 18-38 yrs. The numbers of patients between 18-38 yrs were 33(73.33%) in group A and 10(22.22%) in group B out of 45 patients in each group In each group the numbers of patients between 39-58 yrs were 11(24.44%) in group A and 27(60%) in group B. And 1(2.33%) from Group A and 8(17.78%) from group B are in 59-78 yrs age group.

In this study the patient who underwent tumescent technique are mostly having burn injury or post burn contractures. In group A; 22 patients (48.90%) had burn injury and 17 patients (37.77%) had post burn contracture and the rest 6 patients (13.33%) had chronic ulcer.

In group B most common diagnosis is chronic ulcer that is 20 patients (44.45%) and second most common is traumatic ulcer that is 15 patients (33.33%). Rest 10 patients (22.22%) had cellulitis.

The number of donor areas that achieved complete (100%) epithelialization on the 10th post-operative day by TUMESCENT technique was seen in 7 patients (15.56%), whereas in NON-TUMSCENT technique achieved complete epithelialization was seen in only 3 patients(6.66%).

81-99% of epithelialization was seen in 27 patients (60%) where donor sites were treated with tumescent technique, whereas the donor sites treated with non tumescent technique that is in 16 patients (35.56%) shows similar percentage ofepithelialization. 51-80 % epithelialization was seen in 10 patients (22.22%) in group A donor sites and 22patients(48.89%) in non-tumescent technique. Less than 50% of healing is seen only in 1 patient (2.22%) in tumescent group and 4 (8.89%) patients in non-tumescent group. The p value is **0.0134** and it is significant.

According to Dr. Nawaz Shariff A; study held in Mangalore; tumescent fluid safely reduces blood loss, postoperative pain and results in faster healing[9].

According to Dr. Kenya Fujita, MD PhD, in Nagano , red cross hospital, Japan; tumescent technique reduces incidence of serious bleeding and is helpful for excision of burn eschar.[14]

Dalatet al[3] found this technique useful in scar excision, which resulted in achieving hemostasis and pain free recovery.[16]

These are the points which are highlighted in our study and there are some similar studies conducted which show similar findings.

The studies related to tumescent technique started to establish the co-relation between the healing of donor site as compared to normal technique.There are other studies which compare the blood loss and also the post-operative pain at donor site.

In a study, done by Sherdan and Szyfelbein, showed that adrenaline clysis of burns and donor site significantly reduced intraoperative and perioperative blood loss among children with burns[2], which is also seen in our adult population.

There was one more study in burns patient by Kahalley et al who demonstrated that infiltration of donor sites and burn wounds with a saline-vasopressor solution could reduce intraoperative blood transfusion.

In a study of the surgical treatment of burns and post burn sequelae in paediatrics patients, Bussolin et al successfully utilized the tumescent infiltration and adrenaline under general anaesthesia, and assessed the intra and post operative course, post operative pain and requirement of analgesics. And the surgical advantages are

clearly mentioned in this study regarding the easy dissection and bloodless donor site[5].

The maximum safe dose of tumescent local anesthesia of 55mg/kg lidocaine, recommended by the American Society of Dermatological Surgery in 1997 seems to be safe in most of the patients[8].

Tumescent anesthesia technique has been reported to have antibacterial effects also, due to lidocaine bacteriostatic properties which are enhanced by the addition of sodium bicarbonate and the washout effect of the solution commonly used in tumescent local anesthesia[8].

Robetson et al did a case control study where tumescent technique significantly reduced blood loss during burn surgery[9].

A study done by Fujito et al showed successful excision of burn scar with no intra operative bleeding[9].

Gacto et al study showed reduced intra operative bleeding in donor site injected with tumescent fluid. This study also shows reduced post-operative pain and accelerated re-epithelisation at donor site injected with tumescent fluid [9].

All the above studies favourthe use of tumescent technique as compared to the non-tumescent technique and show a positive result. Based on the results of above study, it can be concluded that tumescent technique achieves faster epithelialization of the donor site and are hence preferable to the non-tumescent technique.

CONCLUSION

Tumescent technique by using adrenaline is more efficient than non-tumescent technique in the healing of donor site.

SUMMARY

Split thickness skin grafting (STSG) have an important place in many areas of plastic surgery. Though the technique of skin grafting is more or less standardized the treatment of donor site differs greatly and has been topic for debate. Thus it is not uncommon for patients to complain more about pain at the donor site than at the site of surgery. To overcome this the tumescent technique is used now a days. The tumescent technique is very useful in reducing post-operative complications at donor site

The primary objective of this study is to study the efficacy of tumescent technique over non tumescent technique by using adrenaline in healing of split thickness skin graft (STSG) donor site on 10^{th}post-operative day.

The study was conducted at KLES Dr.Prabhakar Kore Hospital and Medical Research centre, Belgaum, Karnataka, India. The study included 90 adult patients requiring STSG for various etiologies between1st January 2016 to 31st December 2016.

Half of this 90 patients underwent tumescent technique and the rest underwent non tumescent technique. Healing in both the groups are compared on10^{th} postoperative day.

The number of donor areas that achieved complete (100%) epithelialization on the 10th post-operative day by TUMESCENT technique was in 7 patients (15.56%), whereas NON-TUMESCENT technique achieved complete epithelialization in only 3 patients (6.66%).

81-99% of epithelialization was seen in 27 patients (60%) where donor sites were treated with tumescent technique , whereas the donor sites treated with non tumescent technique was 16 patients (35.56%). 51-80 % epithelialization was seen in 10 patients (22.22%) in group A donor sites and 22patients (48.89%) in non tumescent technique. Less than 50% of healing is seen only in 1 patient in tumescent group and 4 (8.89%) patients in non-tumescent group. The p value is **0.0134** and which is significant.

The healing rate of tumescent technique is better than non-tumescent technique with less pain and blood loss.

Hence it is concluded that Tumescent technique by using adrenaline is more efficient than non-tumescent technique in the healing of donor site..

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ANNEXURE -I

INFORMED CONSENT

***Title of Research Study*:**

"RANDOMIZED CONTROL TRIAL TO STUDY THE EFFICACY OF TUMESCENT TECHNIQUE OVER NON TUMESCENT TECHNIQUE BY USING ADRENALINE IN HEALING OF SPLIT THICKNESS SKIN GRAFT (STSG) DONOR SITE."

Principal Investigator: - *Co-investigator:*

Co-Guide:

INTRODUCTION AND PURPOSE:-

You are requested to participate in a study that is an attempt to find out the effectiveness of tumescent technique for taking skin graft from donor site.

Skin grafting is used to cover non healing wounds, post burn injury, clean wounds and while taking graft from the donor site it will cause bleeding and blood is the best medium to flourish the infection at donor site so it will lead to post-operative prolonged healing of donor site and may cause infection.

In an effort to avoid the above mentioned problems, this study has been undertaken to evaluate the efficacy of a new technique that is tumescent technique. This study is designed to study the efficacy of adrenaline infiltration in improving the rate of healing of donor site. By this technique bleeding is lesser and the operations are thus performed easily and rapidly.

This technique is simple, effective and safe which facilitates anesthesia in large area of body surface which leads to less bleeding and easy surgical dissection and hydrodissection allowing fast, easy surgery.

In this study, there will be comparison of the tumescent technique with non-tumescent technique. About 90 patients undergoing skin grafting will be enrolled in this study.

This study will be conducted by Dr. Vaibhav Avinash Patil, Post Graduate in Department of Surgery, under the direct supervision and guidance of Dr. V. M. Uppin, Professor, Department of Surgery, J. N. Medical College, BELAGAVI and co-guidance of Dr. RAJESH POWAR, Professor and Head of Department of Plastic Surgery, J. N. Medical College, BELAGAVI

You need to be eligible, meeting all the selection criteria to participate in this study. You should be willing to provide information about yourself. 90 subjects will be enrolled in this study who will then be randomized in either of 2 groups (details below).

PROCEDURE: - If you agree to participate in this study, you will be randomly allotted into a group (A or B) and accordingly receive either the TUMESCENT TECHNIQUE treatment or NON TUMESCENT TECHNIQUE treatment. And After 10 days of surgery, you will be assessed for percentage of wound healing by epithelialization which is calculated by using wound tracing by transparent sheet technique that is the sterile transparent sheet is placed over donor site wound and healed epithelialized area is marked by marker and then this sheet is placed over calibrated paper to count the area of percentage of healing in both the groups.

BENEFITS: - This tumescent technique causes less blood loss at the donor site, which will cause less accumulation blood and hence reduce the chances of infection and aide faster healing.

RISK INVOLVED:-The side effects of this technique will be minimal and may include acute and temporary cardiovascular effects like increased heart rate or arrhythmias.

COMPENSATION:-Taking part in the study will not affect the cost of treatment i.e. it will be similar to the cost of standard procedure. In the event that you become injured as a result of taking part in this study, treatment will be offered to you or you will be given information about where to receive medical care. But you/your insurance company will be responsible for the costs. However, no reimbursement, compensation or free medical care will be given.

CONFIDENTIALITY: - Every effort will be made to protect the confidentiality of the information you provide. This means that the researchers will not let anyone, not a part of the study, see the information you provide. Only Dr. Vaibhav Avinash Patil, Dr. V. M. Uppin and Dr. Rajesh Pawor will have access to the information collected. Results of this study may be published but your name will not be revealed.

VOLUNTARY PARTICIPATION / WITHDRAWAL: - Taking part in this study is voluntary; you may choose not to enroll in this study. Your decision will not change the present or future health care services offered to you at KLES Dr. Prabhakar Hospital, BELAGAVI. The alternative that you have is to undergo the traditional procedure that is carried out in KLES Hospital.

If you need any further information regarding your rights as a study participant, you may also contact Dr.Ganga S. Pilli (Mobile No.9480275601), Chairman of Institutional Ethics Committee, JNMC, and Belagavi-10

CONSENT TO PARTICIPATE IN THE STUDY

I Mr./Ms._____ have been explained about the research study, the need of the study, the intervention, their risks, benefits and alternatives available in my own vernacular language.

I voluntarily agree to participate in this study by signing up this form below. I understand that I may withdraw at any time from this study. I have been given adequate time to clarify my doubts about the study and my rights as a study participant.

My signature / thumb impression below indicates that I have read or information in the consent been read to me including the risks and benefits and have cleared my doubts.

Name of participant: Signature/LTI:

Name of legally authorized Signature/LTI:

Representative (if applicable):

Relationship with participant:

Name of witness: Signature:

Name of investigator: Signature:

Date:

Place:

ANNEXURE-II

PROFORMA / QUESTIONNAIRE TO BE USED FOR DATA COLLECION

The proposed proforma / questionnaire to be used for data collection for the study titled **"RANDOMIZED CONTROL TRIAL TO STUDY THE EFFICACY OF TUMESCENT TECHNIQUE OVER NON TUMESCENT TECHNIQUE BY USING ADRENALINE IN HEALING OF SPLIT THICKNESS SKIN GRAFT (STSG) DONOR SITE."** is as follows:-

1. PATIENT IDENFICIATION DATA

Group: Ward:

Name: IP No.:

Age: Sex: D.O.A:

Address: D.O.S:

D.O.D:

Education:

Religion: Marital Status:

Occupation: Socio-Economic Status:

CHIEF COMPLAINTS:

HISTORY OF PRESENTING COMPLAINTS:

Past History:

Personal History:

Family History:

GENERAL PHYSICAL EXAMINATION:

Built and Nourishment:

Weight:

Pallor / Icterus / Cyanosis / Clubbing / Edema / Lymphadenopathy

Vital Signs: PR: /min; BP: mmHg; RR: /min; Temp:

LOCAL EXAMINATION

Inspection of donor area on 10^{th} post-operative day and see the

Healthy granulation tissue (in percentage):-

SYSTEMIC EXAMINATION

Abdomen:

CNS:

CVS:

R S:

CLINICAL IMPRESSION:

INVESTIGATIONS:

OPERATION DETAILS: -

DATE OF SURGERY:

NAME OF SURGERY:

ANAESTHESIA: _____ ANAESTHESIA

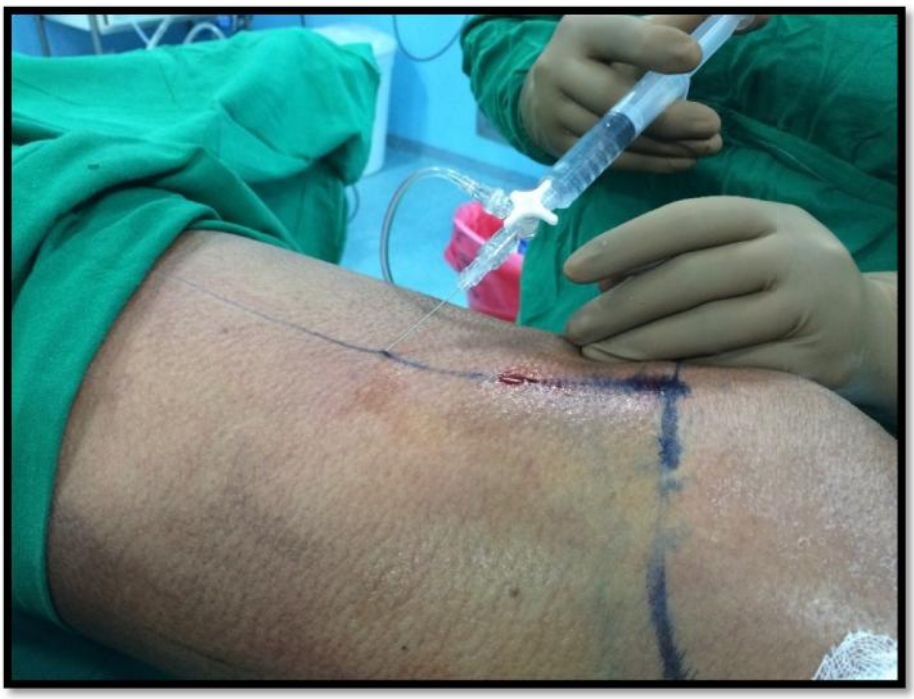
POST OPERATIVE (ON 10TH DAY) ANALYSIS OF WOUND HEALING AT DONOR SITE BY USING WOUND TRACING TECHNIQUE :

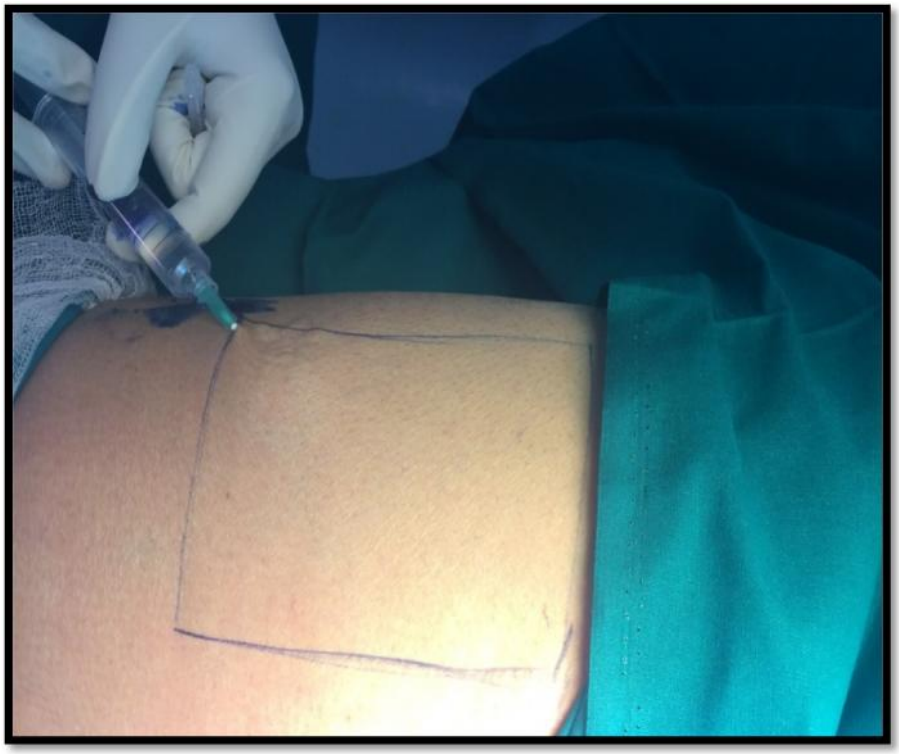
	AREA IN sq. cm	AREA IN sq. cm
Total donor site area(A)		
Area healed (B)		
Area not healed (C)		
Percentage of area healed: $\frac{B-C \times 100}{A}$		

Any complications after surgery-:

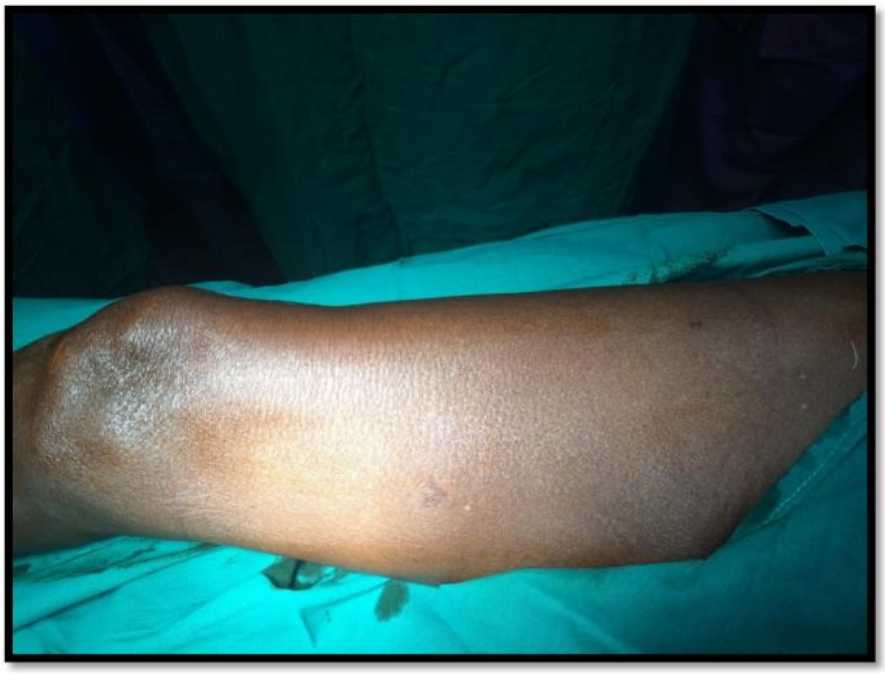
ANNEXURE III – PHOTOGRAPHS

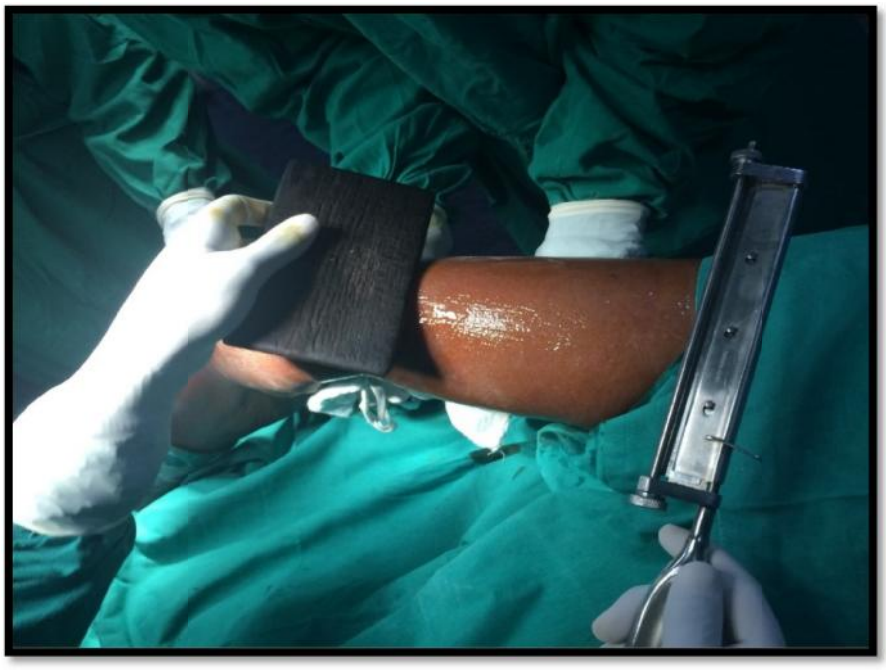
PHOTOGRAPH 1 TUMESCENT TECHNIQUE DONOR SITE



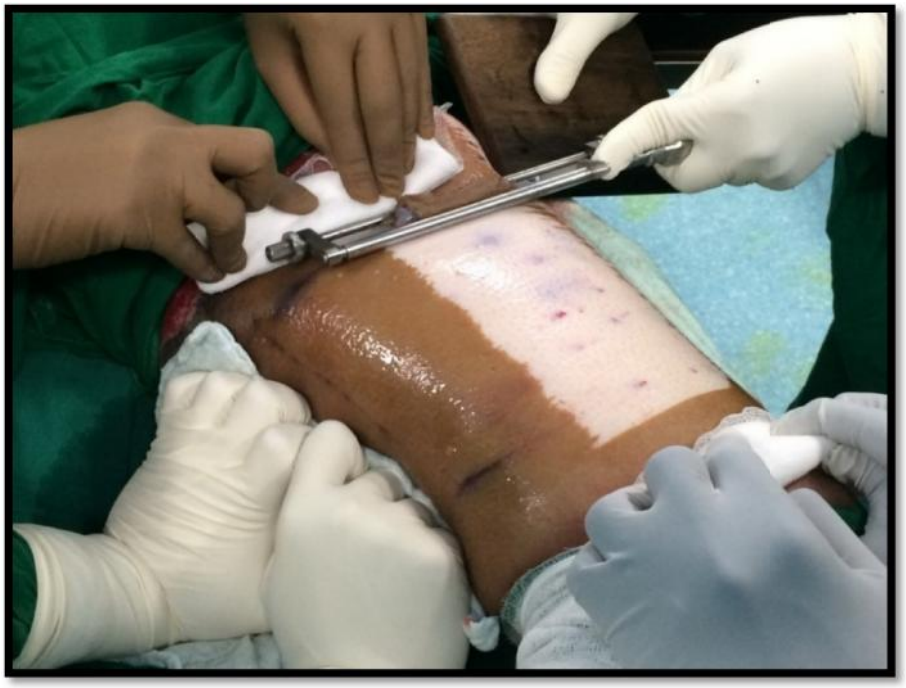


PHOTOGRAPH 2- NON TUMESCENT TECNIQUE DONOR SITE

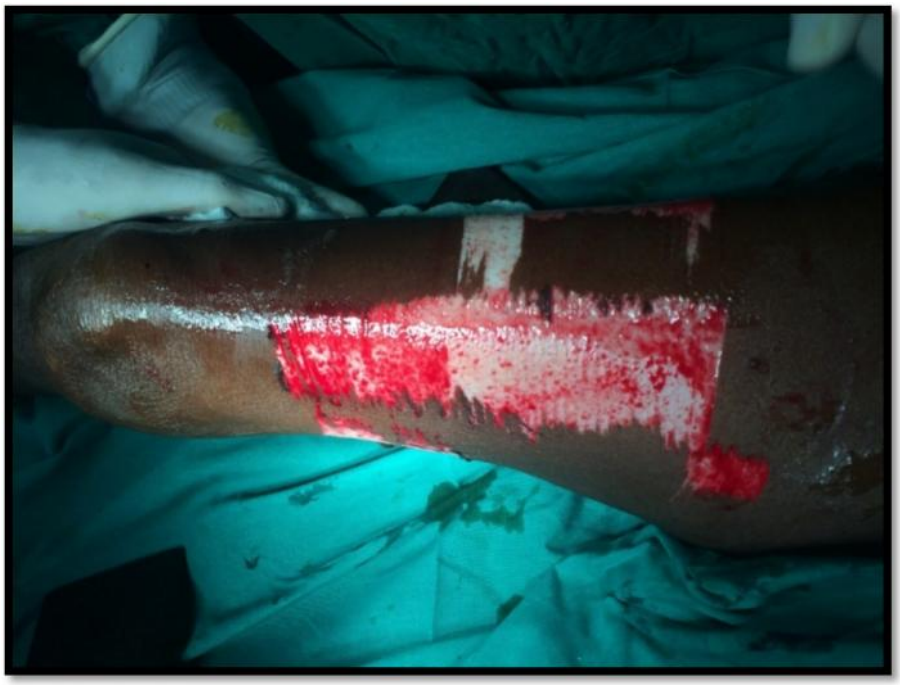




PHOTOGRAPH -3 INTRA-OPERATIVE PICTURE

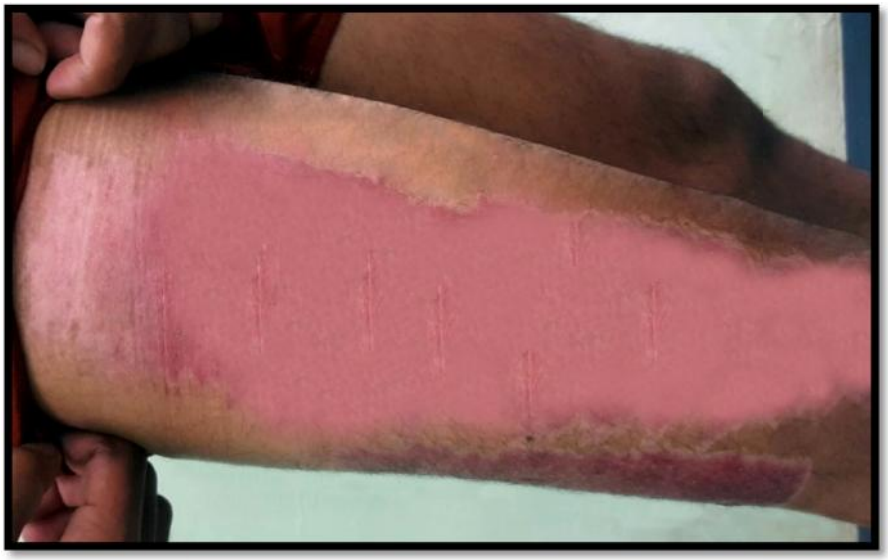


(TUMESCENT TECHNIQUE)

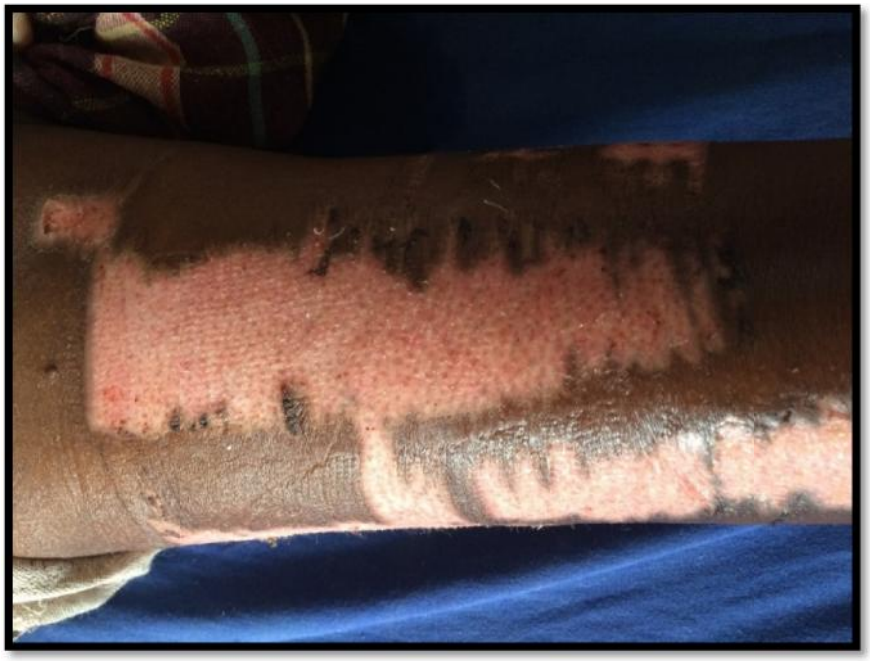


(NON TUMESCENT TECHNIQUE)

PHOTOGRAPH-4 POST OPERATIVE DAY 10TH



(TUMESCENT TECHNIQUE)



(NON TUMESCENT TECHNIQUE)

ANNEXURE-IV - MASTER CHART

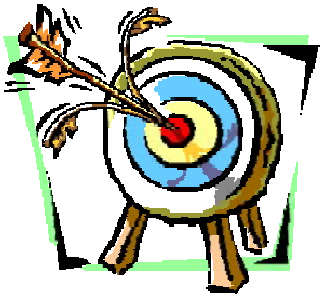
GROUP-A							
sl no	**NAME**	**IP NO.**	**AGE(YR)**	**SEX**	**GPE**	**DIAGNOSIS**	**% Of donor site healing on 10th post operative day**
1	KALLAPPA	201116	54	M	N	CHRONIC ULCER	80
2	SAGAR	712371	45	M	N	CHRONIC ULCER	60
3	SURAJ	715219	49	M	N	CHRONIC ULCER	100
4	SHARADHA	715432	40	F	N	POST BURN CONTRACTURE	70
5	SOMAPPA	712367	30	M	N	POST BURN CONTRACTURE	80
6	VIJAY	713421	25	M	N	CHRONIC ULCER	75
7	AISHWARYA	751139	20	F	N	BURN INJURY	50
8	AMIT	715973	19	M	N	BURN INJURY	70
9	BASAVRAJ	725484	23	M	N	POST BURN CONTRACTURE	80
10	BASAVRAJESHWARI	751113	33	F	N	BURN INJURY	60
11	CHANDRAKANT	709680	55	M	N	BURN INJURY	66
12	KISHOR	740560	31	M	N	BURN INJURY	70
13	GULFARAJ	695935	19	M	N	BURN INJURY	75
14	MAHANTESH	751145	18	M	N	BURN INJURY	100
15	MUTTAPA	755791	22	M	N	BURN INJURY	80
16	NAMEERA	973670	18	F	N	BURN INJURY	90
17	NIRMALA	721150	42	F	N	BURN INJURY	95
18	PARSHURAM	729577	30	M	N	BURN INJURY	90
19	RAMESH	728977	23	M	N	BURN INJURY	91
20	RAVICHANDRA	706862	18	M	N	BURN INJURY	85
21	SNEHA	781228	21	M	N	BURN INJURY	85
22	VIDYA	705885	22	F	N	BURN INJURY	100
23	AKKATAI	742225	36	F	N	POST BURN CONTRACTURE	90
24	ANIL	742121	40	M	N	CHRONIC ULCER	85

25	APPAYYA	762373	34	M	N	POST BURN CONTRACTURE	88
26	ARACHANA	752140	23	F	N	POST BURN CONTRACTURE	95
27	BHOURAO	753478	38	M	N	BURN INJURY	81
28	BISMILLA	769214	27	M	N	POST BURN CONTRACTURE	85
29	CHANDRAPPA	763662	43	M	N	BURN INJURY	100
30	DADAPFEER	755973	25	M	N	POST BURN CONTRACTURE	90
31	DEEPA	761079	22	F	N	POST BURN CONTRACTURE	95
32	FAKIRAVVA	743920	18	F	N	POST BURN CONTRACTURE	81
33	GANGPPA	767703	47	M	N	POST BURN CONTRACTURE	85
34	KHUTIJA	716654	24	F	N	POST BURN CONTRACTURE	86
35	LAXMI	731323	18	F	N	POST BURN CONTRACTURE	100
36	MAHANTESH	751653	20	M	N	BURN INJURY	88
37	MALLAVVA	743957	30	F	N	BURN INJURY	90
38	MAGAL	712924	23	F	N	POST BURN CONTRACTURE	95
39	NINGAPPA	712940	24	M	N	POST BURN CONTRACTURE	95
40	RAMANGOUDA	759897	50	M	N	BURN INJURY	100
41	SARASATI	722942	20	F	N	POST BURN CONTRACTURE	81
42	SHANKAR	769499	50	M	N	CHRONIC ULCER	85
43	YALLAPPA	742302	60	M	N	BURN INJURY	86
44	YAMANURAPPA	767161	20	M	N	POST BURN CONTRACTURE	100
45	SAGAR	767240	20	M	N	BURN INJURY	81

GROUP-B							
Sl no	**Name**	**Ip no.**	**Age(yr)**	**Sex**	**Gpe**	**Diagnosis**	**% of donor site healing on 10th post operative day**
1	GANGAVVA	718528	35	F	N	CHRONIC ULCER	50
2	KALMESH	719571	33	F	N	CHRONIC ULCER	70
3	SADASHIV	720302	61	M	N	CHRONIC ULCER	48
4	MAHESH	717396	32	M	N	CHRONIC ULCER	60
5	GEETA	720201	40	F	N	CHRONIC ULCER	70
6	SIDDHAPPA	729210	30	M	N	CELLULITIS	100
7	ANNAPPA	729222	45	M	N	CHRONIC ULCER	80
8	RADHIKA	729230	40	F	N	TRAUMATIC ULCER	50
9	VIJAYKUMAR	729231	45	M	N	CHRONIC ULCER	60
10	PRASHARAN	729240	40	M	N	CELLULITIS	70
11	MUSAMILL	729241	43	M	N	CHRONIC ULCER	50
12	PADARANGOUDA	729250	40	M	N	CHRONIC ULCER	80
13	PARAGOUDA	729300	41	M	N	CELLULITIS	55
14	GURAPPA	729348	30	M	N	CHRONIC ULCER	75
15	MARUTI	729421	50	M	N	TRAUMATIC ULCER	80
16	PARANGOUDA	729431	30	M	N	TRAUMATIC ULCER	80
17	PARAGOUDA	729440	50	M	N	CELLULITIS	50
18	KANTUBAI	729445	55	F	N	CHRONIC ULCER	75
19	BALAPPA	729551	40	M	N	CHRONIC ULCER	75
20	RATNAWWA	729554	40	F	N	TRAUMATIC ULCER	60
21	GOUJASAB	729559	30	M	N	CHRONIC ULCER	80
22	PARAMESHWAR	729661	40	M	N	TRAUMATIC ULCER	100
23	MALIKARJUN	730010	50	M	N	CELLULITIS	70
24	SHANTAVVA	720100	40	F	N	TRAUMATIC ULCER	60
25	LAXMAN	730250	45	M	N	CHRONIC ULCER	70

26	RUDRAYYA	730251	40	M	N	CHRONIC ULCER	60
27	MALLAPPA	734213	50	M	N	TRAUMATIC ULCER	70
28	SANJU	734312	45	M	N	TRAUMATIC ULCER	81
29	YALLAVVA	734400	47	F	N	CELLULITIS	100
30	RAJENDRA	734511	40	M	N	TRAUMATIC ULCER	85
31	RAMAPPA	734122	45	M	N	TRAUMATIC ULCER	90
32	VENKAPPA	734550	35	M	N	CHRONIC ULCER	85
33	RAMANGOUDA	734556	40	M	N	TRAUMATIC ULCER	81
34	MALLAPPA	734660	55	M	N	CELLULITIS	82
35	SHIVAJI	734670	60	M	N	TRAUMATIC ULCER	81
36	BABU	734568	55	M	N	CELLULITIS	50
37	SHIVALILA	734631	45	F	N	CHRONIC ULCER	85
38	SHIVPUTRA	734661	34	F	N	CHRONIC ULCER	90
39	SIDAPPA	734770	50	M	N	TRAUMATIC ULCER	95
40	SOMASHEKHAR	734778	60	M	N	TRAUMATIC ULCER	88
41	SWATI	734790	65	M	N	CELLULITIS	81
42	VIDYASHREE	734811	65	F	N	CELLULITIS	85
43	YALLAPPA	734850	60	M	N	CHRONIC ULCER	88
44	VIJAYKUMAR	734860	65	M	N	TRAUMATIC ULCER	86
45	YAMNAVVA	734999	60	M	N	CHRONIC ULCER	87

Introduction



Objectives

Review of Literature

Methodology

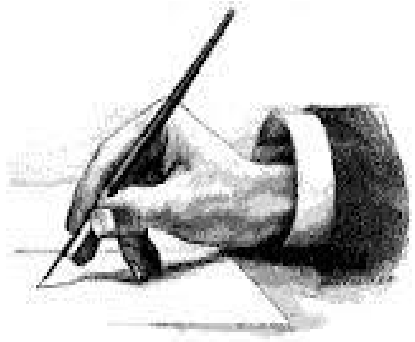
Results

Discussion

Conclusion

Summary

Bibliography



Annexure-I

Annexure-II

Annexure-III

Annexure-IV