REVIEW OF LITERATURE
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Thermal injury presents a therapeutic challenge to the Surgeon due to its immediate altered anatomy & physiological derangement. It is a catastrophic illness causing overwhelming insult to the patient's psychological aspect and at the same time involves the family in a great financial loss.

Burns are caused by application of heat to the body. The depth of resulting burn injury will depend on intensity and duration of heat application and the conduction of tissue involved. Thermal injury causes no damage below 45°C of temperature. All gradations of cell injury occur between 45-50°C temperature and the denaturation of proteins become apparent above 50°C.

The management of burn patient comprises of two parts (1) General management comprising of maintenance of airway, intravenous resuscitation, sedation, tetanus prophylaxis and administration of systemic antibiotics. (2) Management of local wounds - the present day exercise is the outcome of ideas, observations and experiences of various workers. There are two main methods. Exposure method - The principle of this method is that drying the area of the burn inhibits the growth of bacteria and ultraviolet sunlight is hostile to bacterial
growth, eventually a dry surface is obtained and topical agents may be applied as a further deterrent to bacterial growth.

Close Method - The underlying principle of this method is the fact that the majority of burn are sterile or have no pathogenic organisms on their surface in the first few hours from the time of burn. If the area can be completely sealed off from its surroundings by means of sterile dressing.

There is wide range of dressing material and one finds it very difficult to choose ideal material. This leads to definition for good dressing as follows:

1. It must be readily available material.
2. It must have no antigenic properties.
3. It must be sufficiently strong and flexible.
4. It must be adequate to cover the wound and isolate it from the environment.
5. It must be capable of being sterilized.
6. It must have water vapor transmission rate which will allow the proper moisture balance in the repairing wound.

The Egyptians treated the burn by incin- tation and a mixture of gum, goat’s hair and milk of a mother who had given birth to a son, around 5th-6th
centuries B.C., Around 430 B.C., Chinese and Japanese used tinctures and extracts from tea leaves. Hippocrates, the father of Medicine, used resins and Bitumum mixed with melted swine suet, spread over a piece of cloth on the burn surface after warming it. He also used warm vinegar soaked dressing to relieve the pain. For the scar of burn he used solution of oak bark for tanning. In ancient Rome Calanus suggested mixture of honey and bran for local application. While Pliny and Eider advocated exposure method for the treatment of burn, Galen applied vinegar or wine locally over burn surface.

Paulus of Aegina (7th century A.D.) used various anesthetic preparations. The famous Arabian physician Rhazes used ice cold water locally in 9th century, Ambrose Pare (1517-1590) suggested ointments for the treatment of burn wound. Cloves (1991) used different complex preparations on the different parts of body area involved in burn. Edward Kentish (1797) advocated pressure bandage to relieve the pain and to prevent blister formation. Marjolin (1797) described that certain scars of burn wound changed to be malignant and they were termed after his name i.e., Marjolin ulcer. H.Earius (1799) suggested the use of ice cold water and described it as a good anesthetic.
father of German Surgery, described three degrees of burns according to depth. L. Heister (1682–1758) classified burn into 4 degrees. Beren Guillaume Depuytren (1832), a famous French Surgeon, classified depth of burn in 6 degrees and described four stages in the disease process of burn, (1) Period of irritation (2) Period of inflammation (3) Period of suppuration (4) Period of exhaustion. He also told about gastrointestinal haemorrhage in the cases of burn.

In the 19th century Syne (1827) suggested dry cotton wool dressing with firm pressure to cover the raw area. For gastrointestinal haemorrhage Garling (1842) recognized gastric and duodenal ulcers as a cause. Passawant suggested saline bath for burn area. Copeland (1877) advocated exposure method for burn area.

In the present century Edward Clark Davitson (1924–1933), at Henry Ford Hospital, suggested the use of tannic acid on burn surface in 1925. He claimed that these agents decrease the fluid loss, relieve pain and produce a clean scar. Later on McMurtry, of the same hospital, in 1944, described it as hepato-tropic and attributed many deaths to this toxicity. Aldridge (1933) advised the use of gentian violet as caustic agent on burn surface. Other caustic agents as 7% AgNO₃ and a long list came into light. The use of these agents persisted till the beginning of World War II.
Allen and Keck of Chicago (1942) suggested the use of petroleum gauze piece locally with strict immobilisation. These types of occlusive dressings were in use in army hospitals during World War II.

Wallace of Edinburgh (1949) in England and Pusaki, Artz and Blocher (1950) in U.S.A. reintroduced exposure method for burn wound. Later on other surgeons accepted the same method with the view that development of crust provides physiological covering to burn wound, thus reducing the effect of raw area.

Leidbug, Poiss and Artz (1953) attributed primary cause of death of septicemia and staphylococci to be the main microbial. As antibiotics against Gram positive organism developed, the sepsis due to pseudomonas became very common and cause of death was attributed to it. It was because of Gram negative organism and other microbials that a great importance was laid on to develop the antimicrobial agents which can penetrate the burn surface and minimise the growth of such microbials. Various such antimicrobials, e.g. .5% silvernitrate (Meyer), Mafenide or sulfamylon (Moncrief), silver sulfadiazine (Fox, C.L, Jr., Kappelle N.W., Stanford W., 1969), Cerium nitrate (Williams, H., Hanafi, Sam H. Banden), Cerium nitrate and Silver Sulfadiazine (Fox, C.L, Jr., 1973) were tried and are
still in use. But these topical agents are effective merely in controlling microbial population. It is stated that from an average of \(10^7\) organism per gram of tissue it is reduced to \(10^4\) per gram of tissue by these agents (Artz C.P.).

**BIO-DRESSINGS**

Homografts, autografts, and heterografts have been tried for many centuries. In 1881 Girdner treated a lightening burn with skin from a suicide victim. In the same year Shede used skin from freshly amputated specimen as well as from cadaver to cover open wounds.

In the middle of the present century (1952) Dogo of Italy noted the usefulness of cadaver skin obtained in viable state. It was useful where it was possible to preserve the tissue till the time of application. He measured skin viability by determining the tissue oxygen uptake in the Warburg apparatus. The skin was preserved at 3°C in physiological solution. The oxygen consumption of cadaver skin was noted unaffected up to 16 hours after death.

The biological skin dressings as life saving measures in the treatment of extensively burnt patients were popularized by Brown in 1958. His work
was extended in 1953 in a report dealing with the use of postmortem allografts as biological dressing. Brown stated that skin may be recovered even days after death from cadaver if placed in cold storage. These grafts have been used for number of years and are still in used as life saving measures to cover extensive areas where autograft are not available and in emergencies.

Ende (1958) and Morris (1966) observed that the homografts had antibacterial property. They pointed out about the decrease in count of bacteria within 2 hours of homograft application. More recently homografts have been applied to prepare burn wound for autograft (Miller 1967).

In the 1960's skin from dogs and pigs came into use. Porcine heterografts are now popular as temporary coverage for granulating wound. Miller et al (1967) showed normal architecture with recognizable basal layer and normal collagen bundles in the dersmis, if healing had taken place under the coverage of homografts.

Sharma et al (1978) used the homografts in 25 cases of which 15 were superficial burns. These homografts were donated by voluntary donors. These grafts were preserved in a solution containing plasma, normal saline, antibiotics and placed on at the temperature of 0-4°C. The survival period of these grafts in the
cases of similar blood group to that of donor, was 11
days while it was 13 days where the blood of the patient
was not of the same group as that of the donor.

Allografts skin, have their limitations
though they fulfill most of the criteria for satisfa-
citory biological dressing. Baxter (1970) estimated
rise in physician hours and hospital cost of $225 per
patient as the cost for cadaver allografts.

Heterografts ( Xenografts )-

In 1960, canine skin had been used by
Svitser et al in the treatment of thermal injury. Porcine
skin is the material of choice for xenograft. Brodberg
et al and Elliott and Hoehn used pig skin as a temporary
bio-dressing. Salisbury et al reported poor results of
dressing of these xenograft on donor sites. Comparative
experiments were done of exposure treatment with
covering by fine mesh gauze.

Amniotic Membrane -

The amnion is the inner fetal membrane.
It's inner surface is in contact of amniotic fluid and
fetus. It's outer surface is separated from decidua of
uterus by chorion. It has following parts -

1) Placental amnion - lines the inner aspect of
placenta.

2) Umbilical amnion - lines part of the chorion.

3) Dependent amnion - covers the internal os of
Histologically it has five layers:

1. Epithelium—It is composed of a single layer of apparently simple, non ciliated cuboidal cells. Recently it has been suggested that amniotic epithelium has a role in exchange of fluid and electrolytes between amniotic sac and mother.

2. Basement membrane—It is narrow band of reticular tissue below the epithelium and is firmly adhered to it.

3. Compact layer—It is dense, a-cellular layer, immediately below the basement membrane and is firmly adhered to it.

4. Fibroblast layer—It is composed of fibroblast network in the mesh of reticulum having fibroblast and Hoffleur cells (Macrophages).

5. Spongy layer—It is composed of extra embryonic coelomic reticulum. It is capable of great distension and contains masses.

The thickness of membrane is variable due to variable amount of mucin and fluid in spongy layer. Normally the thickness is 1/50 to 1/2 mm. which can increase as much as 3-5 mm.

Blood Supply—The amnion does not have any blood supply at any time of gestation.
Nerve Supply - The nerve supply to amnion has not been confirmed.

Lymphatic Drainage - Some workers gave the possibility of presence of lymphatic vessels in amnion. The many large spaces are present between the bundles of the reticular fibres of fibroblast and spongy layer but the presence of actual lymphatic vessels have not been confirmed.

Embryology - The development of amnion begins during transformation of embryo from morula to blastocyst stage about 7-8 days after fertilization. At the periphery of ectodermal layer of polyhedral cells, some cells are separated from inner cell mass. These cells are termed as amniogenic cells, and they form a slit like cavity with the appearance of primary extra embryonic mesoderm. The amniotic epithelium becomes separated from primitive trophoblast. Amniotic mesenchyme is derived from the primary extra embryonic mesoderm of the blastocyst.

Immunology - There are various studies reported to observe the facts concerning this aspect. It was observed that amnion was taken up as permanent graft when implanted to its own new born infant. The re-vascularisation was not seen. The nutrition of graft appeared to be by simple diffusion. When allograft amnion was implanted subcutaneously, the results were similar to that of autograft for first 4-17 days.
Later on these allografts were changed into hyalinated substances. Only mild round cell infiltration was observed after 20-30 days. Similar results have been observed of allografts and xenografts as surface bi-dressing. It was observed, when mesenchymal surface was placed towards the host, the 'take' or 'fixation' was superior and when amnion was placed towards the host, little fixation was noticed at the end of 72 hours. In any case neovascularization was not observed.

When allograft amniotic membrane was applied in pelvic cavity after pelvic exenteration, it was recovered after 3 weeks and was histologically viable. It was observed that fibroblastic activity was markedly inhibited as compared to that of control case.

In an experimental study amnion allografts, when implanted intra peritoneally, prevented adhesion formation and the gradual disintegration of graft without any host response. These evidences suggest the low antigenicity of amnion. No violent host reaction is noted yet.

Clinical and Experimental Application -
First person to report the attempts of grafting pieces of lining of amniotic sac on granulating wound, was John Staggs Davis in 1910 at Johns Hopkins University.
Sabella (1913) used amniotic membrane on raw surface caused by burn and ulceration. He suggested amnion side to be kept exteriorly because of its ectodermal origin. They observed reduced pain, rapid reepithelization and absence of infection.

Davis (1919) observed these dressings to be eventually rejected.

Brindeau (1935) and Burger (1937) reported the use of amnion graft in construction of artificial vagina. He later used amnion successfully in the repair of experimental defects in rabbits, dogs and cats. De Roth (1940) reported successfully that amnion was used in conjunctival repair.

Chao et al (1940) used amnioplastin prepared from amniotic membrane to prevent adhesions following the craniotomy. Amnioplastin was prepared by keeping the amniotic membrane in 70% alcohol. Then it was washed in water and was dried in air. He applied it over lacerated piamater. No adhesions were observed in any case. The amnioplastin gradually disappeared and mucoid material was observed as the remanent after 10th day and there was slight evidence of mucoid material after 20th day. There was no evidence after 30th day. Histologically no evidence of foreign body reaction and organised adhesion were observed after 10 days.
growth of fibroblast beneath and above the membrane was the only reaction to disintegrating foreign body. The remaining amnioplastin was as amorphous substance without cellular differentiation. There was no evidence of material after 30th day and defect in piameter was completely filled.

Kubanyi (1941-48) reported the use of amnion in burn, traumatic skin loss and to prevent intra abdominal adhesions. He also tried amnion successfully in the repair of enterocutaneous fistulas in one case. He suggested the further use of amnion in prevention of adhesions.

Pinkerton (1942) reported the use of amnioplastin to prevent the adhesions between flexor tendons and their sheaths. He found amnioplastin as gelatous transparent membrane after 3 months of application.

Hensen (1950) used amniotic membrane in the management of non healing ulcer of skin. He compared the granulation tissue beneath amniotic membrane to that of other methods as plaster of Paris coverage.

Douglas (1952-54) used homografts of fetal membrane as bio-dressings over burn area in 1952. He showed the effect of use of hetero-homograft membranes and homograft skin in an experimental study
in 1934. He also used human placental membrane on chorionicallantoic membrane of cheek. He observed the mean survival time of chorion allograft to be 13 days. He noticed the time taken for reepithelialization to be 14 days in chorion covered wound areas. He showed the neovascularization in grafted chorion as a sign of graft take up. He stated human chorion as graft to be better than alloplastic skin grafts. By tissue chamber technique he observed that plasma and haemic circulation remained active. The fissures were developed at surface but cells remained actively growing in perimeter of membrane transplant.

Jullian A. Sterling (1956) successfully used the amniotic membrane over old infected flame burns. He advocated it's dressing as emergency measure in trauma.

Pigeon (1960) observed following effects in burn cases dressed with amniotic membrane:

(A) Immediate Effects –
1. Pain relieved at once after application and no further analgesics were required.
2. Antibiotics were used only after development of complication.
3. The dressings were generally found dry.
4. Healing of wound was rapid and complete.

(B) Delayed Effects –
1. No discolouration was observed in amniotic treated cases.
2. Minimal scar tissue formation.
3. No contracture was observed in amnion treated cases.

He also stated that amniotic membrane undergoes changes similar to that in cornified cells.

Nasser and colleagues (1962) in an experimental study in dogs, used foetal membrane to replace parietal peritonium after pelvic exentration. After 59 days very few adhesions and dense scar tissue were found. Human trials failed at that time.

Dino (1965) used the amniotic membrane in burn cases and favoured it in comparison to control cases on following points –
(1) It is homograft, closely resembling the skin being a direct continuation of foetal integument along the umbilical cord,
(2) It is easily available with negligible cost.
(3) It is fairly strong and stretchable to cover a side area.
(4) It has minimal contact with maternal blood.

Dino (1966) found the best preservative for amniotic membrane. He preserved amniotic membrane in following solutions:– 1. Sterile normal saline solution. 2. Benzal potassium chloride (1:1000 dilution) in sterile saline. 3. Sodium hypochloride (1:40 dilution) in sterile saline. 4. Saline solution (400 cc) with 500000 units of
benzyl penicillin and 1 gram of streptomycin sulphate.

5. Saline solution (400 cc) with 1 gram kanamycin sulphate. The preserved grafts were kept in refrigerator at 4°C of temperature. He studied the preserved membrane bacteriologically at regular intervals i.e. 1st, 3rd, 7th, 14th and 30th days to test the efficiency of different solutions. He used the grafts upto one month of preservation. He concluded solution 3rd, 4th and 5th to be best. He showed cellular necrosis started from 2nd day. However according to Kirschbain and Henneudon (1963) cellular elements survived even after 45-50 days.

Trelford and associates (1972) reported preliminary results after using amnion alone as autograft and allograft from sheep. They also observed the mesenchymal side application towards the host, to be more consistent 'take'.

Martin (1972) compared the phagocytic activity of different bio-dressings in an experimental study. He produced 20% full thickness scald on back of 50 Aprague delay rats and 10^6 pseudomonas aerugamena were inoculated in each wound. After 5 days eschar tissue from each of surviving 38 animals were biopsied for quantitative and qualitative bacteriological studies. Then the wounds were dressed with human skin or amniotic membrane while some were left open as control cases. The
dressings were changed after every 48 hours. The wounds biopsied and bacteriological count were performed after 96 hours or after two changes in the biological dressing. The bacterial count was markedly decreased in all the animals treated with biodressings. Only 40% of control cases showed decrease in bacterial count. The degree of decrease was a thousand time greater by amniotic membrane than skin.

In vitro, he denied the presence of any specific antibacterial agent in amniotic membrane homografts. In vivo, the antibacterial effect is due to host's own defence mechanisms in biologically closed wounds obtained with bio-dressing.

Trelford and associates (1975) reported the use of amnion alone in full thickness fresh surgical wounds. They also suggested that the mesenchymal surface provides better 'take'. He observed decrease in pain, fluid loss and secondary infection, and hence decrease in hospital stay.

In further studies Martin (1973) showed clear inhibitory effect of amniotic membrane on microbial growth. He also observed the autolysis and further disintegration of amniotic membrane in 48 hours if applied over deep grossly infected burn wound.
Guillermo Caleplo et al (1974) in their clinical and experimental studies applied amniotic membrane over open wounds (60 patients with full thickness donor sites and 42 patients with partial thickness burn) and in subcutaneous pockets in rats. He observed that amnion dessicated over partial thickness wound and reepithelialization of skin began on 3rd day and completed on 7th day. There was no evidence of allergy, rejection or neovascularization in any case. In the experimental study amnion retained its cellular integrity when buried beneath the flaps even after 5 days. None of the human donor site biopsy and India ink injection in experimental animal showed communication with the host.

C.V. Bapat and Premod M Kothari (1974) reported the successful restoration of floor of mouth with human amniotic membrane after radical total glossectomy.

Martin further observed in 1976 the use of amniotic membrane as most rapid way of reducing bacterial population in operative wounds. The relief in pain was similar to that after use of allograft skin. Amniotic membrane adhere better than xenograft.

Marilyn Tralford - Senior and others (1977) used amniotic membrane to cover raw area after
pelvic exenteration. They concluded following benefits—It is readily available tissue of low antigenecity, low intestinal complications because of absence of pelvic raw surface, reduced protein and fluid loss and reduced hospital stay. In 1978 they reported the use of allograft amniotic membrane to prevent intra abdominal adhesions.

Bose B (Nov. 79) recently reported the use of amniotic membrane over burn wound especially in developing country like ours.

**COLLAGEN SHEET**

Collagen is a connective tissue which is present in many of the animal tissues like skin, muscle, bone etc, in high concentration. It is well established that collagen in its pure form has minimal antigenic activity. This property of collagen makes it an ideally suited raw material for use in the preparation of a variety of biomaterials for use in surgery.

For more than a century collagen rich mammalian intestine are being used for the manufacture of absorbable surgical sutures. During the last 40 years another surgical product made out of gelatin (hydrolysed collagen) in the form of foam is also being successfully used by surgeons for arresting hemorrhage. In recent times there had been attempts at utilizing collagen for making gels, powders, tapes, sheets etc, for use in various surgical situations.
Collagen sheet and its processing -

Collagen sheet is a product made from animal tissues rich in collagen such as serosa and submucous layers of caecum and/or intestines, pericardium, amniotic membrane etc. This raw material is collected from slaughtered healthy animals. It is thoroughly cleaned by washing it repeatedly in warm water and chemically freed from the undesirable non-collagenous proteins, lipids and mucopolysaccharides etc., with successive treatment in baths of non-ionic detergent alkali and oxidising agents. To enhance the in-vivo time of digestion, the alkali free stock is crosslinked in a solution of a suitable cross linking agent such as chromium sulphate. The chronised stock is then washed well to make it free from soluble and processed into sheets of desired size. The sheets so produced are packed either in glass ampoules or polythylene packets with a preserving fluid containing ethylene oxide as sterilizing agent and hermetically sealed.

Clinical applications -

Pandey et al successfully used collagen sheet in the cases of excision orthoplasty, in prevention of ankylosis. Thukral used it in repair of hernia and other surgical defects. Gupta et al used it as coverage material in artificially produced raw area in
an experimental study. Bhargava et al showed it's usefulness in bridging abdominal wall defects. Kumar also used it to gap the abdominal defects. Ibrahim showed the use of collagen sheet in vestibuloplasty.