

## UTILITY OF COLLAGEN SHEET AS SKIN SUBSTITUTE

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Certain categories of wounds, in particular such as those caused by burns, pose formidable problems. One of the most common complication of raw areas is secondary infection and considerable fluid loss from the exposed areas. A deep dermal burn with many of the deep epithelial cells preserved, has the potential for good spontaneous healing within 2-3 weeks. Onset of infection, however, may interfere and delay the normal healing process, resulting in deformities, contractures and scars.

The early and rapid skin coverage of large cutaneous defects has long been a problem, especially when adequate donor sites are not available. Once the wound is covered, the primary goal in skin loss is achieved, then an anabolic phase of recuperation begins, it is reflected in an acceleration of overall convalescence and a feeling of wellbeing.

The problems encountered in providing a cover for raw areas, has compelled researchers to evolve synthetic substances to serve the purpose, to minimise infection, and promote wound healing.

This study was done in 2nd phase of the project. Earlier experimental work was done on dogs (Krishnan et al.).

### Material and Methods

Clinical study was conducted on patients admitted to Gandhi Memorial and Associated Hospital, with burns, surface malignancies and trauma with skin loss. In superficial burn, a part of the raw area was covered with collagen sheet and part treated by conventional ointment dressings. In deep burns, operative wounds and traumatic wounds, skin grafting was done, in a part of the raw area and remaining part of the wound was covered with collagen sheet.

Observations regarding comparative evaluation of different modalities of treatment; photographic record; bacteriological culture of wounds before and after application of sheet, graft or dressing and histological examination findings at weekly intervals were recorded :

### Observations

Fifty cases were included in this study. Twenty had superficial burns, 10 had deep burns, 15 operative raw areas and 5 post traumatic raw areas (Table I).

### Bacteriology

#### *Burn wound (Graph I)*

Swab culture taken from superficial burn raw area on admission was sterile in 18

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Table I

S. No.	Wound	Time		Clinically		Total No.	+ve Culture	Sterile
		< 6 Hrs Old >	6 Hrs Old	Clean	Contaminated			
1.	Burns							
	(a) Superficial	16	4	11	9	20	2	18
	(b) Deep	7	3	6	4	10	4	6
2.	Traumatic raw area	3	2	2	3	5	3	2
3.	Operative raw area	15	—	11	4	15	4	11
	Total	41	9	30	20	50		

cases and infected in 2 cases. In 1 case the collagen sheet sloughed out due to gross infection, while 9 cases treated by conventional ointment dressing developed gross infection during the course of treatment.

Four cases of deep burn showed evidence of infection (swab culture positive) at the time of admission. In these sheet and the graft sloughed out during the course of treatment. Clean cases remained un-infected after application of collagen sheet or skin graft.

#### *Operative Raw Area (Graph II)*

Swab culture taken from operative raw area, intra-operatively, was positive in 4 cases. These cases were of either fungating skin malignancy or fungating breast carcinoma with gross infection. Rest of the 11 cases were sterile.

There was gross infection in 6 cases treated by collagen sheet application, Rest of the 9 were sterile.

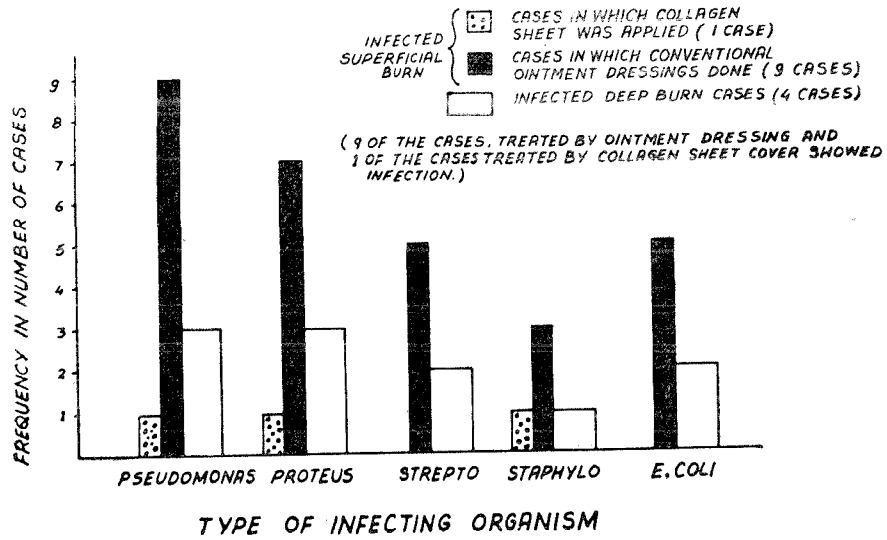
Of the 12 cases treated by simultaneous primary skin graft, 4 culture positive cases showed evidence of infection during the course of treatment and collagen sheet too, sloughed out in them.

#### *Traumatic Raw Area (Graph III)*

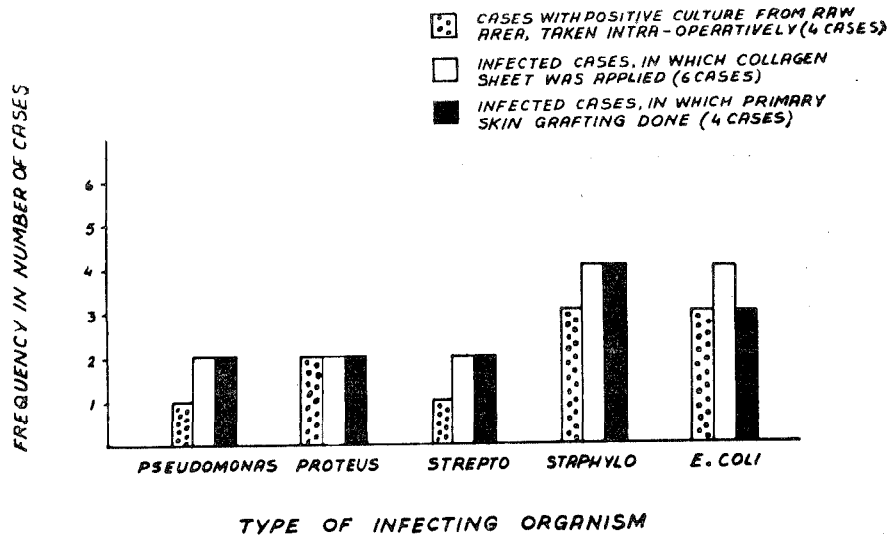
Three clinically contaminated and culture positive cases were the ones in which sheet sloughed out with complete or near complete failure of the graft to take up.

In 19 out of 20 cases of superficial burns the sheet was cast off in 14-21 days, with complete epithelization of the raw area (fig. 1-4). In 1 grossly contaminated case sheet did not adhere. Frequent excision of blebs and repatching of sheet became imperative due to pus collection. The sheet ultimately sloughed out and conventional dressing was resorted after 14th day.

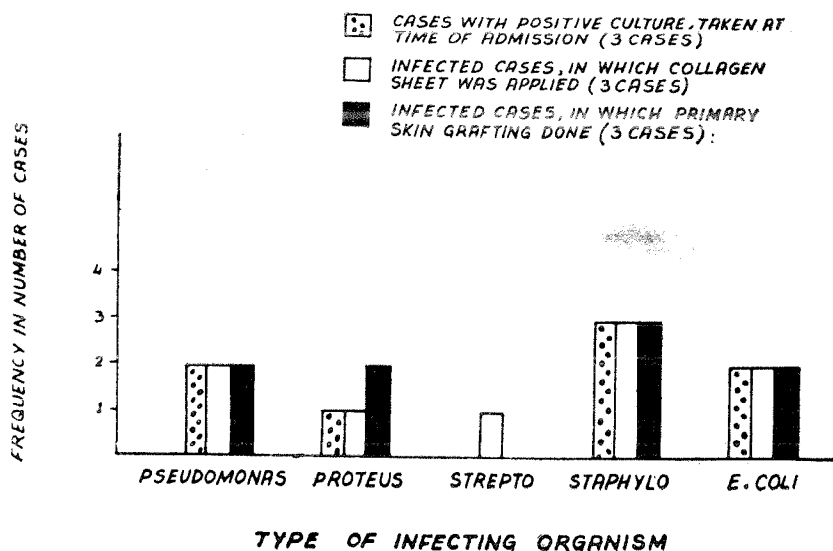
Out of the 20 cases treated by conventional dressings (furazolidine ointment), 5 cases on 3rd day and 9 cases on 7th day, showed signs of gross infection. The number of grossly infected cases came down to 4 on the 14th day and 1 on the 21st day. Four cases showed complete epithelization on the 14th day, 6 more on the 21st day and 9 on the 28th day. Only 1 case which was grossly infected, epithelized completely on the 37th day. In 4 cases, scarring at a few places was noticed after healing was complete.



GRAPH I: SHOWING BACTERIOLOGY IN CASES OF BURNS WITH GROSS INFECTION.



GRAPH II: SHOWING BACTERIOLOGY IN CASES OF OPERATIVE RAW AREAS WITH INFECTION.



**GRAPH III: SHOWING BACTERIOLOGY IN CASES OF TRAUMATIC RAW AREAS WITH INFECTION.**

In 4 infected cases of deep burns the sheet sloughed out on the 7th day. These cases were treated by conventional dressings and later by skin grafting. In the remaining 6 cases, the sheet was firmly adherent to the underlying raw area, 2 of these were treated by removal of collagen sheet and immediate skin grafting on the 14th day (Fig. 5). The resultant raw area was much smaller and covered by healthy granulation tissue. Take up of the graft was 100%. On the 21st day, 3 sheets came off with the dressing due to liquification but wound was healthy which was covered with granulation tissue and was treated by skin grafting.

Out of 9 cases in which the collagen sheet was well adherent and there was no evidence of gross infection, in 4 the sheet was stripped off on the 14th day and immediate skin grafting was done. The take up was 100%. In 2 cases the sheet liquified and came off with the dressing on the 21st day. The resultant wound was grafted and take up

was 100%. in 3 cases the sheet completely disappeared (1 on the 28th day and 2 on the 35th day), the wound completely epithelised with a good supple scar (Fig. 6+7).

In only 12 of the above cases, part of the raw area was covered with simultaneous primary skin graft. 8 showed 80-100% take up, 4 showed a take up of between 10-40% and in 1 case the graft sloughed out completely. These 5 cases included patients with fungating lesion. Only in 1 such area, while the sheet had sloughed out, the graft take up was 100%.

Of the 15 cases in which collagen sheet was applied, 5 sloughed out on the 7th day and 1 on the 14th day. Of these 6, 4 cases in which the sheet sloughed out had been applied to raw areas created as a result of excision of grossly infected fungating skin malignancy or fungating carcinoma breast. In all these cases, the intra-operative swab culture was positive. In the other 2, the intra-operative culture was sterile.

Five cases of raw areas involving full thickness loss of skin as a result of trauma, were studied.

In 5 cases out of 5, the collagen sheet sloughed out on the 3rd and 7th day. In 2 cases, the sheet was well adherent (these cases had come within 6 hours and wound was not contaminated). In 1 of these, the sheet was stripped off the wound and immediate skin grafting was done. (Fig. 10). In 1, the sheet completely disappeared with complete epithelization and a good supple scar.

In 2 cases out of 5, the take up of the graft was 90-100%, in 2 it was 40-60% and in 1 case the graft sloughed out completely. These raw areas were dressed conventionally, till the wound was healthy and subsequently grafted.

#### **Histopathological Examination of wounds with collagen sheet cover**

The 5 cases in which the collagen sheet was completely absorbed, were biopsied at weekly intervals, to study the changes in the wound, the sheet and the state of epithelization. The time taken for healing varied slightly from case to case.

There was no invasion of any type of cells in collagen sheets during first and second week. Inflammatory response and fibroblasts were in abundance around the sheets. Invasion of fibroblasts and chronic inflammatory cells started in 3rd week which became more marked in 4th week. There was complete replacement of sheet due to fibroblasts by the 6th week.

#### **Discussion**

The role of collagen sheet as a temporary cover was observed in 50 cases. The wounds were grouped into 3 groups :—

- (i) Burn Group—(i) Superficial (ii) Deep.
- (ii) Operative Wounds Group.
- (iii) Traumatic Wounds Group.

#### **Superficial Burns**

In 20 patients with superficial burn dressed with collagen sheet, the raw area in 70% of cases completely epithalized by the 14th day and the sheet was cast off. 25% cases took 21 days to epithelize completely. The results are in confirmity with the study of Gupta, et al. (1978).

Repeated dressings are not required with the use of collagen sheet. When once applied to the surface of the raw area, it adheres firmly and stays in place until epithelization causes it to be cast off gradually and completely. No covering dressing is required. In the series studied by Gupta, et al, (1978), a covering dressing was used, because the collagen sheets were perforated before application.

The healing time is much shorter in cases covered with collagen sheet as compared to cases treated by conventional dressings. 70% of cases covered with collagen sheet epithelized in 14 days, while only 20% of cases treated by conventional dressing did so, in the same period of time.

Collagen sheet completely fails to adhere to the underlying raw areas, if the whole wound is already the seat of gross infection. In such circumstances, the collagen sheet is useless. Such patients are benefited most by daily dressings with suitable agents.

#### **Deep Burns**

In 10 patients with deep burns the collagen sheet sloughed out in four cases by the 7th day and the wound was grossly infected. In the remaining six the sheet was well adherent to the raw area and there was no evidence of gross infection.

In the series of cases studied by Gupta, et al. (1978), in 58.3% the sheet liquified and came away along with the dressing on the 28th day, revealing healthy granulation tissue which was subjected to skin grafting. In their series collagen sheet was absorbed and the wound completely epithelialized in 41.7% cases, by the 35th day.

In our series, this was achieved in only 10% cases, the time taken being the same. The size of the raw area in which this could be achieved was approximately 40 sq. cms. Our observation regarding this is in conformity with those of Gupta et al. (1978).

These observations reveal the following advantages of collagen sheet as compared to primary skin grafting in the treatment of this conditions.

Collagen sheet may prevent loss of fluid from body through the burn wound. This aspect needs further investigation.

In our study, cases in which collagen sheet was applied on deep burns without infection, only a weekly change of dressing was required, to inspect the wound and excise small blebs and put new patches. It has been our observation that in clean wounds, dressing could be delayed as late as fortnightly. The advantage is obvious.

The collagen sheet preventing infection facilitates development of healthy granulation tissue, thereby preparing an ideal bed for subsequent skin grafting.

In 60% of cases in which primary skin grafting was done, the graft take was 90-100% and by the 10th day, complete healing had occurred with graft firmly in place. Considering this observation, we can conclude that though autograft is the best method for the closure of deep burn, it is not always

possible—if patient is having extensive burns, is in a critical condition and not able to withstand the effects of anaesthesia and operation (Arts & Monocrief, 1960). In such cases, use of skin homografts and heterografts has been suggested by many workers (Arts, et al 1965) ; Haynos, 1963 ;). The collagen sheet, while serving all the purpose of a skin homograft, does not have the problem of availability, storage and frequent change of dressing.

#### **Operative Wounds**

It can be used to cover the wound intra-operatively and does not restrict post-operative ambulation.

Complete absorption of sheet, with epithelization and supple scar formation occurred (20%) in 4-5 weeks, but the raw area size was maximum 6 sq. inches only.

Collagen sheet can be applied instead of doing a primary skin graft in raw areas, where a secondary tumor deposit or recurrence is expected. The patient can be subjected to radiotherapy, with the sheet covering the raw area.

#### **Traumatic Raw Areas**

In traumatic raw areas, the use of collagen sheet are extremely limited.

Collagen sheet is of use only when primary closure with skin graft is not possible, or there is gross contamination.

#### **Conclusion**

Conclusions derived from the study are :

1. Collagen sheet is very useful in preventing exogenous infection.
2. It promotes rapid epithelization in partial thickness raw areas, by protecting it from infection and the sheet is ultimately cast off.

3. Split thickness skin graft do not take up in cases of partial thickness skin loss. The wound epithelizes under the graft and it is cast off.
4. Ointment dressings are prone to infection (57%) and they need frequent changes, unlike collagen sheet.
5. Small, clean, full thickness raw areas covered with collagen sheet, take lesser time to heal completely (28 days), compared to those treated with conventional dressings (35-45 days).
6. The sheet is invaded by fibroblasts, capillaries and ultimately complete epithelization occurs, incorporating the sheet into the raw area. Fibrosis is more marked in cases treated with ointment dressings.

In the final analysis, collagen sheet is very effective in the treatment of partial thickness raw areas and in some cases of operative raw areas. It is only of limited use in deep burn and traumatic raw areas.



Fig. 1. *On admission* : Showing appearance of raw area after cleaning.



Fig. 2. *Immediate* : Showing appearance after collagen sheet application.



Fig. 3. *First Week* : Sheet greyish yellow, no collection, healing at periphery of wound evident, sheet casted off there.

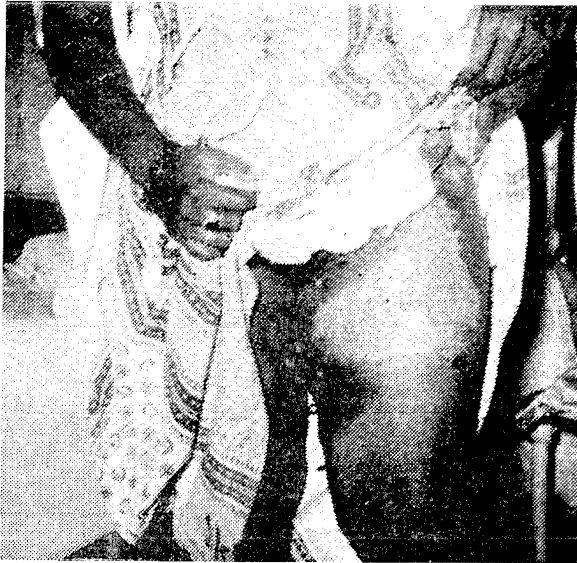


Fig. 4. *Second Week* : Showing wound completely epithelized, sheet cast off.



Fig. 6. *Second Week* : Showing collagen sheet firmly adherant to underlying raw area.



Fig. 5. *Second Week* : Showing sheet well adherant. Evidence of healing at edges of the raw area.

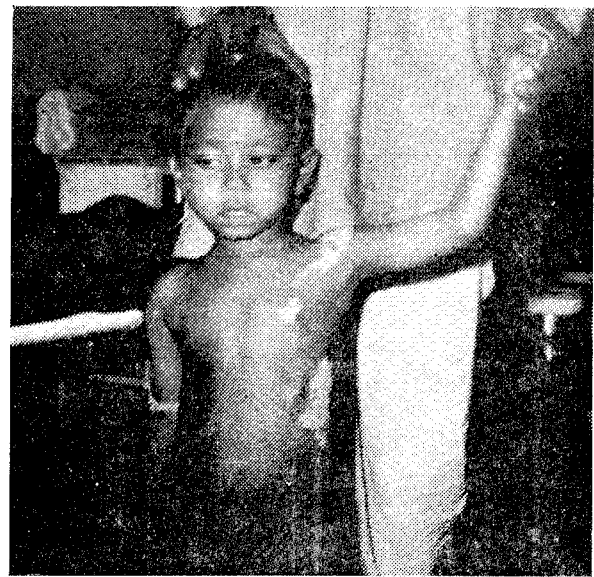


Fig. 7. *Fifth Week* : Collagen sheet absorbed completely into the raw area, resulting in a supple scar.





Fig. 8. *Third Week* : Showing collagen sheet well adherant to the raw area. The split thickness graft is by firmly taken up.

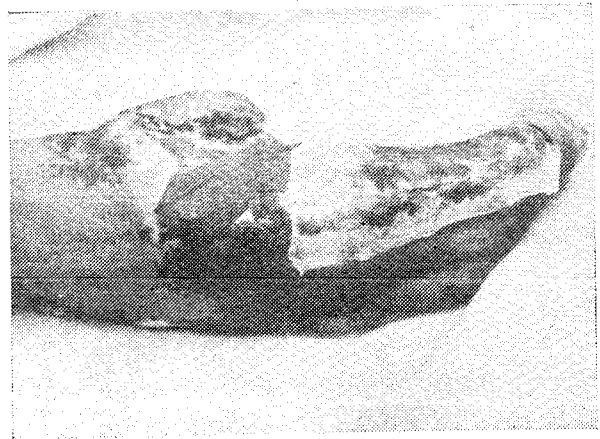


Fig. 10. *Intra Operative* : Showing raw area, as a result of debridement. Half the raw area is covered with a split thickness skin graft and the other half with collagen sheet.



Fig. 9. *Fifth Week* : Collagen sheet absorbed completely into the raw area, resulting in a supple scar.

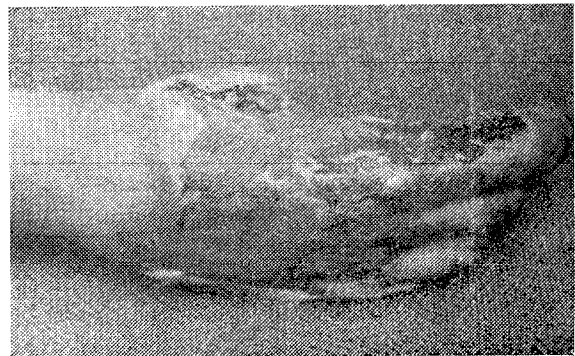


Fig. 11. *Second Week* : Showing nearly complete take up of skin graft. Sheet has been stripped off, revealing healthy granulation tissue.

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