

Effectiveness of Amniotic Membrane Dressing Compared to Banana Leaves Dressing in Management of Partial Thickness Burn Wounds

Pundlik T Jamdade¹, Rajesh Dnyaneshwar Jawale², Meghraj J Chawada³,
Sudhir B Deshmukh⁴

Author's Affiliation: ¹Professor and Head, ²Senior Resident, ³Associate Professor, ⁴Dean and Professor, Department of Surgery, Vilasrao Deshmukh Government Institute of Medical Sciences, Latur, Maharashtra 413512 India.

How to cite this article:

Pundlik T Jamdade, Rajesh Dnyaneshwar Jawale, Meghraj J Chawada et al./Effectiveness of amniotic membrane dressing compared to banana leaves dressing in management of partial thickness burn wounds./New Indian J Surg. 2021;12(2):21-27.

Abstract

Context: Morbidity and mortality are higher for burn injuries in low- and middle-income countries. The treatment should be effective and cost-effective also for patients from these countries.

Aims: To compare the outcome of Amniotic Membrane Dressing and Banana Leaves Dressing, in terms of pain during dressing change, comfort, recovery, hospital stay, complications and future need of skin grafting among partial thickness burn patients in Tertiary care centre

Settings and design: Hospital based comparative study was carried out at Burn care unit of Tertiary care hospital of Vilasrao Deshmukh Govt. Institute of Medical Sciences, Latur, Maharashtra, India.

Methods and material: Hospital based comparative study was conducted among 50 cases with partial thickness burns. They were assigned in equal number of 25 each. One group received amniotic membrane dressing (AMD) while the other received banana leaf dressing (BLD).

Statistical analysis: Mean scores of two group were compared with the help of independent t test. P value < 0.05 was considered as significant.

Results: Most common cause of partial thickness burn was scalds contributing (42%). Total burn surface (TBSA) area was 16%-30% in 60% of cases. Both groups were comparable for age, sex and TBSA. Patients in

AMD group had significantly less scores of pain during dressing removal, discomfort and significantly more scores for ease of dressing removal and less number of days for healing ($p < 0.05$). Signs of infection and need for skin grafting was comparable in two groups.

Conclusion: This study proved superiority of Amniotic Membrane Dressing (AMD) over Banana Leaves Dressing (BLD).

Key messages: Amniotic Membrane Dressing should be used among partial thickness burn patients for good results

Keywords: Effectiveness; Dressing; Amniotic membrane; Banana leaves; Burns.

Introduction

Burns are responsible for impacting the integrity of the skin.¹ Worldwide it is an important cause of trauma. It has been estimated that about 85% of burn injuries are from low and middle income countries. In these countries, the management standards of burn injuries are not up to the mark.²

India has an estimated 600,000–700,000 admission to burn units per year.³ Morbidity and mortality are higher for burn injuries in low- and middle-income countries. Currently, the burn size associated with a 50% case fatality in high-income countries is between 60% and 70% total body surface area (TBSA).⁴

Poor people are mainly affected by the burn injuries due to financial constraints. Burn injuries are leading cause of poor quality of life due to the intense pain associated with it and the cosmetic

Corresponding Author: Meghraj J Chawada, Associate Professor in General Surgery, Vilasrao Deshmukh Government Institute of Medical Sciences, Latur, Maharashtra 413512, India.

E-mail: dr.meghrajchawada@gmail.com

problems it cause among those who survive it. It is an important cause of burden on family and community. It affects the self confidence, capacity to work for an individual.⁵ They are classified depending upon the depth of the skin involved. If it is superficial, it is called as first degree burns. If the thickness of the skin is affected partially, then it is called as second degree burns and if the complete thickness of the skin is lost, it is called as third degree burns.⁶

Superficial partial-thickness skin burns as well as deep partial thickness skin burns are included in the category of partial thickness burns. They first one involves epidermis and extends to papillary layer of dermis. They are erythematous in nature. The later extends from papillary layer of dermis to reticular layer of dermis. They appear as mixed red or waxy white.⁶

Objective of burn wound management is to hasten the healing time or prevent the unlikely consequences like excessive scarring. Aim of partial-thickness burns management is minimize pain, prevent the infection, and promote healing and reduction in the occurrence of the disfigurement.⁷

For patients from developing countries, cost is a major factor. The therapy must be cost effective. Ideal dressing for burns should be long lasting, not irritable for the patients, protects from physical damage and infection, comfortable, and non toxic. It should also allow exchange of gases; topical therapeutic agents should not disturb the dressing and also helps in healing.⁹

There has been an agreement that prevention of trauma to the burn wounds helps healing faster. Hence occlusive non adherent dressing is recommended. For many years together and even now conventional gauze dressings is one which is commonly used. But the problem associated with gauze dressing is that they dry out easily and upon removal cause trauma thereby resulting in pain and affecting the healing of the wound. They also tend to leave the gauze fibers over the wound and thus may contribute to infection. The Human Amniotic Membrane is made using the fetal ectoderm. Hence it is like using another skin.⁹ It was first used by Davis in the year 1910 for transplantation of skin and afterwards it was used by Sabella and Stem in the year 1913 for the first time as a biological dressing of the burn.¹⁰ The aims and objectives of skin burn dressing are fulfilled by the Amniotic Membrane Dressing (AMD).¹¹

Banana Leaf Dressing (BLD) for the management of the skin burns is traditionally used. They are easily available.¹² They do not adhere to the wound,

effective in protecting the wound from any kind of trauma and also effective in preventing the dryness.¹³ It is very cost effective. "It is 11 times cheaper than (BPPB) Boiled Potato Peel Bandage, 160 times cheaper than Soframycin impregnated gauze, 1750 times cheaper than collagen sheet, and 5200 times cheaper than Skin temp biosynthetic dressing."¹⁴

Therefore in this study we sought to know the effectiveness of human placental Amniotic Membrane Dressing (AMD) over Banana Leaves Dressing (BLD) in partial thickness burn patients. Therefore this prospective study was conducted to compare the outcome of Amniotic Membrane Dressing and Banana Leaves Dressing, in terms of pain during dressing change, comfort, recovery, hospital stay, complications and future need of skin grafting among partial thickness burn patients in Tertiary care centre.

Materials and Methods

Study design: Hospital based comparative study.

Study settings: Burn care unit of Tertiary care hospital.

Study population: All the patients with partial thickness burns satisfying inclusion criteria admitted in Tertiary care centre.

Study period: 2 years & 3 Months (December 2018 to February 2021)

Sample size: 50

Sample size = $2 \times [Z\alpha + Z(1-\beta)]^2 \times P \times Q / (p1 - p2)^2$

Where P1 = clinically anticipated prevalence of complete recovery for Amniotic Membrane Dressing = 60 %

P2 = clinically anticipated prevalence of complete recovery for Banana Leaves Dressing = 22%

$P = p1 + p2 / 2 = 41\%$

$Q = 1 - P$

Level of significance (Alfa error) = 5% (0.05)

Power of test = 80% (0.84)

Sample size = 50

25 subjects were assigned in Amniotic Membrane Dressing (AMD) intervention group and 25 in Banana leaves dressing (BLD) intervention group.

Inclusion Criteria:

- Burn patients with partial thickness burns.
- Patients who got admitted with below 50% burns.

- Patients who are willing to participate in research study.
- All patients above the age of 18 year who can give consent for treatment.
- All patients above the age of 2 year whose parents can give consent for treatment.

Exclusion criteria:

- Burns patients who got admitted with co-morbid illness and wound complications.
- Patient who will not give consent for inclusion in the study.
- Burn patients with >50% burn area.
- Electric burns.
- Full thickness burn.

Methodology specified for data collection

Ethical Clearance: Ethical clearance was obtained from institutional ethics committee. Informed Consent was obtained from study subjects and was explained study procedure in local language. Permission from OBGY department HOD was obtained for getting Amniotic Membranes from mothers delivered normally or by LSCS. Also permission from local nursery Owner was obtained for getting fresh Banana Leaves for dressing.

Preparation of Amniotic Membranes: Before collecting the placenta in a sterile bowl it was ensured that it was from those who were not having any transmissible diseases like HIV and others. Placentas with conditions like toxemia of pregnancy, pre mature rupture of membranes, women with pelvic inflammatory diseases, women with endometritis, abnormal liquor or meconium stained liquor and other conditions were not used in this study. Separation of amniotic membrane was done using aseptic precautions. It was rinsed using sterile saline solution and care was taken to remove all clots. It was ensured that it is free from any bacteria by doing the culture. The material thus obtained was usable for next four days.

*Application of Membrane over Burn Wound:*¹⁵

Before applying the membrane to the wound, all aseptic precautions were taken and it was removed from container and allowed to drain in a kidney tray. This process helps make it less slippery. The burn wound was cleaned and debrided and the membrane were applied evenly with the glistening amniotic side in contact with the area of burn. It was inspected next day to ensure it was properly adherent. Non adherent part was removed and replaced by new

membrane and all these patients underwent regular examination on every alternate day.

Banana leaves were brought from local nursery with prior permission of owner. 40x60 cm size was used after cleaning them. They were kept in paper bags for autoclaving at 135°C for 20 minutes. These autoclaved banana leaves were used for Burn Wound dressing.

Data on pain of the wound, dressing removal pain, discomfort, ease of dressing removal among patients was collected with the help of Visual Analogue scale.¹⁶

Data collection: Informed consent was obtained from study subjects. Predesigned and pretested case record form was used as tool for data collection. Data regarding socio-demographic characteristics like age, sex, education status, occupation was collected. Also data regarding source of burn was obtained. Burns were classified according to depth of burn as partial thickness and full thickness burns. Patients with full thickness burns were excluded. Socioeconomic class of study subjects was decided by estimating per capita income as per modified BG Prasad classification.¹⁷

Data regarding clinical features, history of present illness, time for complete healing (Days) and other co-morbid conditions like diabetes, hypertension, immuno-suppression therapy was recorded. Also record of cases of partial thickness burns that undergone conventional dressing was obtained. All the enrolled subjects were in two intervention group. Subjects with even MRD number as per hospital records were allocated in Group 1 and age and sex matched subjects with odd MRD number were allocated in Group 2.

Group 1: Amniotic Membrane Dressing intervention group.

Group 2: Banana Leaves Dressing intervention group.

Data analysis: All the data collected was entered in Microsoft excel software. Descriptive variables like mean, standard deviation and percentages were estimated. Mean scores for pain during dressing removal, comfort and ease of dressing removal were estimated. Mean scores of two group were compared with the help of independent t test. P value <0.05 was considered as significant. For qualitative data association between independent factor and dependent factor was studied with chi square test. P< 0.05 was considered as significant.

Results

Table 1: Distribution of study participants according to Etiology of Burns (N=50).

Cause	Frequency	Percentage
Scalds	21	42 %
Flame	13	26 %
Flash	09	18 %
Contact	04	08 %
Others	03	06 %
Total	50	100

As shown in table 1, most common cause of partial thickness burn was scalds contributing 21 cases (42%) followed by flame burns 13 (26%), flash burns 9 (18%), contact burns 4 (8%) and others like chemical burns 3 (6%) respectively.

Table 2: Distribution of study participants as per Total Body Surface Area (TBSA) involved (N=50).

TBSA	Frequency	percentage
< 15 %	02	4 %
16%-- 30%	30	60 %
31%-- 45%	18	36 %
> 45 %	00	00 %

As shown in table 2 TBSA involved in majority of subjects was 16%-30% contributing 30 cases (60%) followed by 31% - 45 % in 18 (36%), < 15% in 02 (2%) of cases.

Table 3: Comparison of quantitative study variable among study groups (N=50).

Variable	AMD group		BLD group		p value
	Mean	SD	Mean	SD	
Age	36.04	14.38	36.72	14.18	0.86
TBSA	27.80	9.25	26.82	10.27	0.72

There was no statistical significant difference in two groups for age and TBSA involved when means of two samples were compared with independent samples t test. ($p > 0.05$) for both variables. (Table 3)

Table 4: Comparison of qualitative variable among study groups (N=50).

Sex	No. of subjects	AMD group	BLD group	P value
Male	27	14	13	0.7766
Female	23	11	12	
Total	50	25	25	

There was no statistical significant difference between sex compositions of subjects among two groups. ($p > 0.05$) (Table 4)

Table 5: Comparison between amniotic membrane dressing and banana leaves dressing groups in relation to outcome criteria (N=50).

Outcome criteria	AMD group		BLD group		t value	p value
	Mean	SD	Mean	SD		
Pain at dressing removal score	2.2	0.64	4.24	1.26	7.2118	< 0.0001
Discomfort score	2.28	1.24	4.0	1.47	4.472	< 0.001
Ease of dressing removal score	3.56	1.68	5.0	1.76	2.959	0.004
Healing time (Days)	8.48	1.29	9.28	1.20	2.270	0.027

There was significant statistical difference between outcome of AMD dressing and BLD dressing in terms of pain during dressing removal ($p < 0.0001$), discomfort score ($p < 0.001$), ease of dressing removal ($p = 0.004$) and complete healing time in days ($p = 0.0270$). (Table 5)

Table 6: Comparison between AMD dressing and BLD among study participants with relation to outcome criteria in qualitative variables (N=50).

Variable	AMD group	BLD group	Chi square	p value
Sign of infection	Yes 5 (20%)	7 (28%)	0.4386	0.5078
	No 20 (80%)	18 (72%)		
Need for skin graft	Yes 1 (4%)	4 (16%)	0.8889	0.345
	No 24 (96%)	21 (84%)		

There was no statistical significant difference between AMD dressing and BLD group in relation to outcome of signs of infection (Bad odor or pus) and need for skin grafting. ($p > 0.05$) (Table 6)

Discussion

Age distribution of study participants was studied. In present study it was observed that majority of study subjects belongs to age group 19-36 yrs contributing 40% followed by age group 37-54 yrs 18 cases (36%).

Mean age among Amniotic group was 36.04 with SD of 14.38 and mean age among BLD group was 36.72 with SD of 14.18. A similar study was done by Ali WG et al 15 in which it was seen that mean age of study participants was 27.6 years with SD of 8.53. Also it was seen that age of subjects was in the range of 18-55 years. These findings are consistent with present study.

Sex distribution of study subjects in this study revealed that majority of study participants were males contributing 27 cases (54%) and female contributing 23 cases (46%). Male to Female ratio

was 1.17: 1. In study by Bose B 18 it was observed that 84.62% were males and 15.38% were females.

In this study it was observed that burns are more common in lower socioeconomic classes. Most commonly class III contributed 23 cases (46%) followed by class IV (22%), class II (20%), Class V (8%) and class I (4%) respectively.

Etiology of partial thickness burns among patients admitted at tertiary care hospital was studied in present study. It was seen that most common cause of partial thickness burn was scalds contributing 21 cases (42%) followed by flame burns 13(26%), flash burns 9(18%), contact burns 4(8%) and others like chemical burns 3(6%) respectively. A study by Mohmmadi AA et al¹⁹ had shown contrasting results in which mechanism of burns was flame (63%), scald (18.5%) and flash (18.5%) A study by Ali WG et al¹⁵ had shown dry heat as most common cause of burn contributing 63.2% followed by moist heat 36.8%.

Total body surface area involved in partial thickness burn was estimated with the help of Wallace's Rule of Nine in this study. We found that TBSA involved in majority of subjects was 16%-30% contributing 30 cases (60%) followed by 31% - 45% in 18 (36%), < 15% in 02 (2%) of cases. In low-resource settings, oral rehydration therapy is routinely used for burns of less than 20% TBSA and has been successful in treating burns up to 40% TBSA.²⁰⁻²²

In present study it was seen that the two groups were comparable for age, TSBA, and gender. Outcome of this RCT was measured in relation to variables like pain during removal of dressing, discomfort felt by patients, ease of dressing removal with respect to adherence of dressing and mean healing time in days.

It was seen that mean pain score for BLD (4.24) was higher than AMD dressing. This difference was statistically significant ($p < 0.0001$). This proves superiority of amniotic membrane dressing over BLD. A study by Ali WG et al¹⁵ shown that the average dressing removal pain score was 2.3 ± 1.2 with BLD while that with ordinary it was 5.9 ± 1.2 .

Human Amniotic epithelial cells do not express HLA-A, B, C and DR or beta 2 microglobulin on their surface.²³ This could contribute to the lower inflammatory responses and less inflammatory mediators in the burn area and less pain sensation.

Saraswathy G et al²⁴ reported in their study that Amniotic Membrane was superior, from the standpoint of pain reduction during dressing changes, over the Tegaderm. Pain was described as

a primary endpoint and a visual pain analog scale was used for quantification. The majority of the patients tolerated the procedure very well.

Mean scores for discomfort between AMD dressing and BLD were 2.28 and 4.0 with SD of 1.24 and 1.47 respectively. In present study it was seen that mean discomfort score for BLD group was higher as compared to AMD dressing group.

This difference was statistically significant as $p < 0.001$. This indicates superiority of AMD dressing. A study by Ali WG et al¹⁵ stated that average discomfort score with BLD was 2.1 ± 1.3 while that with ordinary was 6 ± 1.5 .

Ease of dressing removal mean scores for both groups were estimated. Mean scores for AMD group and BLD groups were 3.56 and 5.0 with SD of 1.68 and 1.76 respectively. This difference was statistically significant ($p=0.004$) BLD groups shown more adherence of dressing to burn wound as compared to AMD dressing group.

A similar findings were seen in study by Ali WG et al¹⁵ in which it was observed that ease of dressing removal score average was 3.5 ± 1.9 with BLD while it was 7.4 ± 1.2 with ordinary.

Time for complete healing was observed. Mean time for complete healing in AMD group was 8.18 days with SD of 1.29 whereas mean healing time in BLD group was 9.28 with SD of 1.28. There was statistically significant difference between means of two groups ($p=0.027$). Partial thickness burn wound heals faster with AMD dressing as compared to BLD. Amniotic Membrane adheres to the wound immediately.

Several studies have shown that it is accompanied by rapid re-epithelialization and promotion of wound healing. 25-27 Amnion does not vascularize, however it stimulates angiogenesis through an unknown mechanism. It has also been suggested that the mechanism responsible for the rapid healing and developing granulation tissue is inhibition of the protease activity, thus reducing the infiltration of polymorph nuclear leukocytes.

These mechanisms explain the more rapid wound healing in the Amnion group. Signs of acute infection like bad odor and pus in partial thickness burn wound were studied. Among AMD group, 20% of subjects shown signs of infection and in BLD group 28% patients had infected wound.

Proportion of burn wound infection was higher in BLD group as compared to AMD group. However this difference was not statistically significant ($p > 0.05$). Anatasov W et al²⁶ found a similar result.

The intimate adherent property of the Amniotic Membrane Dressing to an open wound in some way suppressed bacterial proliferation and helped to eliminate existing bacteria.

A number of factors may contribute to this effect. In a clean surgical wound, the collagen of the graft or biological dressing, via its haemostatic properties, will help to stop bleeding and thus prevent subsequent hematomas, which would provide opportunities for bacterial proliferation.³⁵

Branski L et al²⁸ found highly statistically significant low incidence of infection 2.6% under amniotic dressings compared with 7.1% with Tegaderm dressings ($P < 0.001$). Additional benefits of Amniotic Membrane Dressing therapy include pain reduction and improved cosmetic outcome of wounds healed by both primary and secondary intention.

Need of skin grafting was observed among study groups. Among AMD group 1 patient (4%) needed skin grafting whereas in BLD group 4 patients (16%) needed skin grafting. AMD dressing reduced the need of skin grafting in this study.

Amniotic Membrane Dressing needs less frequent dressing change (every 2-3 days) and does not traumatize the wound because Amniotic Membrane completely adheres to wound and does not need to be removed before a new Amniotic Membrane will be applied over it.

This prevention of repeated dramatization and deepening of the wound seems to be the cause of decreasing the need for skin graft in amnion group.

Conclusions

Amniotic Membrane has physical barrier effect, pluripotency, rapid epithelialization, anti-inflammatory, anti-microbial, anti-scarring, anti-adhesive, non-immunogenic, low antigenicity, analgesic & anti-angiogenic effects and it was found to be cost effective as it accelerates wound healing, decreased pain, decreased usage of analgesia, has less frequent dressing change, decreased liability to infections and reduces hospital stay. Banana Leaves has waxy, non-adherent surface, cooling property, antioxidant property, reduce inflammation & fever, its polyphenol & allantoin has soothing effect, boost immunity, accelerates healing. Banana Leaves Dressing has significant outcome on burn wound healing process. Patients suffer less discomfort and less pain during dressing removal and removal of dressing was easier with BLD than with ordinary dressing. It is clear that BLD is cheaper, easy to prepare and make use in

Burn wounds, completely non-adherent, relatively painless, promotes healing, and reduces hospital stay. This study proved superiority of Amniotic Membrane Dressing (AMD) over Banana Leaves Dressing (BLD).

Limitation of the study: As only 50 study subjects were included in study with involvement of TBSA less than 50%, further studies are recommended to evaluate amnion efficacy in larger burned surface areas.

References

1. Mike W. In: Walsh M, editor. *Watson's Clinical Nursing and Related Sciences*. 6th ed: Baillieres Tindall publications; 2002
2. Albertyn R, Bickler SW, Rode H. Paediatric burn injuries in sub Saharan Africa: an overview. *Burns* 2006;32: 605-612
3. Jaiswal AK, Aggarwal H, Solanki P et al. Epidemiological and socio-cultural study of burn patients in M.Y. Hospital Indore, India. *Indian J Plast Surg*. 2007;40:158-163
4. Taylor S, Curri T, Lawless M et al. Predicting resource utilization in burn treatment. *J Burn Care Res*. 2014;35(Suppl 2):S235- S2
5. Leach M. A critical review of natural therapies in wound management. *Ostomy Wound Manage* 2004; 50:36-46.
6. Dumville JC, Munson C. Negative pressure wound therapy for partial-thickness burns (Review). 2012. *The Cochrane Collaboration*. Published by John Wiley & Sons, Ltd
7. Demling R, DeSanti L. Management of partial-thickness facial burns comparison of topical antimicrobial and bioengineered skin substitute. *Burns*; 1999; 25(3):256-61
8. Pankhurst S, Pochkhanawala T. Wound Care. In: Bosworth Bousfield C, editor. *Burn Trauma Management & Nursing Care*, 2nd ed 2002, Whurr Publishers, London, pp 81-108
9. Coudray S, Lucas C, Bever H et al. Ornithine alphaketoglutarate improves wound healing in severe burn patients. A prospective randomized double-blind trial versus isonitrogenous controls. *Crit Care Med* 2000;28(6):1772-6
10. Barrow R, Jeschke M, Herndon D. Early fluid resuscitation improves outcomes in severely burned children. *Resuscitation* 2000;45(2):91-6
11. Ravishanker R, Bath AS, Roy R. Amnion Bank- the use of long term glycerol preserved amniotic membranes in the management of superficial and superficial partial thickness burns. *Burns* 2003; 29: 369-74.
12. Atiyeh B, Masellis A, Conte C. Optimizing Burn Treatment in Developing Low-and Middle-

- Income Countries with Limited Health Care Resources, *Ann Burns Fire Disasters*. 2009; 22(4): 189-195
13. Jurjus A, Atiyeh S, Inaya A et al. Pharmacological modulation of wound healing in experimental burns. *Burns* 2007; 33: 892-907.
 14. Cox N. Traditional Wound Dressings. *J Comm Dermatol* 2008; 5(7): 1-16
 15. Ali WG, Eazaym HA. The Effectiveness of Using Banana Leaf Dressing in Management of Partial Thickness Burns' Wound. *Int J Nursing Didactics* 2015; 5: 22-24
 16. Jamison R, Gracely R, Raymond S, et al. Comparative study of electronic vs. paper VAS ratings: A randomized, crossover trial using healthy volunteers. *Pain* 2002; 99: 341-347
 17. Pandey VK, Aggarwal P, Kakkar R. Modified BG Prasad Socio-economic Classification, Update - 2019. *Indian J Comm Health*; 2019; 31(1): 123-125
 18. Bose B. Aspects of Treatment. Burn wound dressing with human amniotic Membrane. *An nRCollSurgEngl* 1979; 61(6): 444-7
 19. Mohammadi AA, Sabet B, Riaz H et al. Human Amniotic Membrane Dressing: an Excellent Method for Outpatient Management of Burn Wounds. *Iran J Med Sci* 2009; 34(1): 61-64
 20. El-Sonbaty MA. Oral rehydration therapy in moderately burned children. *Annals of the MBC*. 1991; 4: 29-32
 21. Kramer GC, Michell MW, Oliveira H, et al. Oral and enteral resuscitation of burn shock - the historical record and implications for mass casualty care. *Eplasty*. 2010; 10:e56
 22. Vyas KS, Wong LK. Oral rehydration solutions for burn management in the field and underdeveloped regions: a review. *Int J Burn Trauma*. 2013; 3: 130-136
 23. Akle CA, Adinolfi M, Welsh KL, et al. Immunogenicity of human amniotic epithelial cells after transplantation to volunteers. *Lancet* 1981; 2: 1003-5.
 24. Saraswathy G, Noorjahan S, Krishnan S et al. Preparation of hydrogels using human amniotic membrane and their characterization. *Trends Biomater Artif Organs* 2004; 17(2): 31-6
 25. Moerman E, Middelkoop E, Mackie D et al. The temporary use of allograft for complicated wounds in plastic surgery. *Burns* 2002; 28: S13-5.
 26. Atanassov W, Mazgalova J, Todorov R, et al. Use of amniotic membranes as biological dressings in contemporary treatment of burns. *Ann Medit Burns Club* 1994; 7: 202-5
 27. Sawhney CP. Amniotic membrane as a biological dressing in the management of burns. *Burns* 1989; 15: 339-42
 28. Branski L, Herndon D, Celis M et al. Amnion in the treatment of pediatric partial thickness facial burns. *Burns* 2008; 34(3): 393-9
-
-