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ASPECTS OF TREATMENT*

Burn wound dressing with human amniotic membrane

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Summary

The use of amniotic membrane as a biological dressing for thermal injury is simple and cheap and has been found to be superior to allograft and xenograft. The membrane prevents heat and water loss from the wound surface and acts as a barrier against bacterial contamination, thus aiding the healing process and reducing morbidity. Another clinically significant and important property of the membrane is its ability to offer marked relief from pain.

Over a period of 30 months amniotic membrane was used to treat 15 cases of burn in a small hospital, with uniformly satisfactory results. The practical aspects of this method of treatment can easily be adopted by any hospital regardless of its available facilities.

Introduction

The past two decades have witnessed more progress in our knowledge of the pathophysiology of thermal injury, with concomitant improvement in its management, than all the preceding years combined[1]. In terms of final results the initial care of the burn wound is as important as the treatment of the accompanying shock.

Bacterial invasion is the commonest obstacle to the healing process in a burn wound. It can be overcome in the majority of cases by strict environmental control maintained in a burn unit, early excision of dead skin, and the use of an effective topical antimicrobial agent. Another less appreciated factor which impairs healing of any burn wound is the passive evaporative water and heat loss, the rate of loss being proportional to the surface area and depth of the burn[2-5]. Prevention of evaporative water and heat loss will therefore aid the healing process and can be achieved by immediate cover of the burn wound with allograft or xenograft[5-7]. Human amniotic membrane is admirably suited for this purpose and has many advantages[8-11].

This paper is based on my experience in the use of human amniotic membrane as a physiological dressing in 15 cases of burn treated in a small hospital. The method is simple, effective, and inexpensive.

Materials and methods

COLLECTION AND STORAGE OF AMNIOTIC MEMBRANE

Placentas from clean vaginal deliveries, emergency and elective caesarean sections of seronegative (syphilis and hepatitis B surface antigen) mothers are collected in a sterile bowl. Placentas from mothers with the following conditions are rejected: (1) premature rupture of membranes; (2) history of venereal disease; (3) history of endometritis or pelvic inflammatory disease; (4) toxaemia; and (5) meconium-stained or abnormal-appearing liquor, both in vaginal and caesarean section deliveries.

Using sterile technique, the membrane is separated from the placenta and rinsed three times in sterile physiological saline solution. In order to dislodge the clots the membrane is agitated thoroughly during rinsing and occasionally a gauze is used to remove the clots between rinses. Next the membrane is rinsed once in modified Dakin's solution† followed by three more rinses with saline. According to Robson[8], the antiseptic nature of Dakin's solution does not cause any chemical damage to the membrane, thereby allowing it to retain its biological properties. After a surface culture has been taken for initial bacteriological monitoring the membrane is transferred to a wide-mouthed sterile bottle containing physiological saline, labelled, and stored in a refrigerator at

†Dissolve 45 g sodium bicarbonate in 1 l 12% sodium hypochlorite solution. Add water to make 24 l. Dilute 1 in 32 for washing.

The Editor would welcome any observations on this paper from readers.
*Fellows and Members interested in submitting papers for consideration with a view to publication in this series should first write to the Editor.

4°C. The membranes are cultured at weekly intervals and those remaining sterile are stored for a maximum period of 6 weeks. With a delivery rate of 250/year, 3–4 membranes are available at all times.

APPLICATION OF MEMBRANE

Using sterile technique, the membrane is removed from its container and put in a kidney basin for 5 min to allow drainage of the saline solution, thereby making it less slippery to handle. It is often advantageous to have an assistant hold the membrane while it is being cut and applied. No attempt is made to separate its two layers and instead it is applied evenly with the glistening amniotic side in contact with the area of burn previously cleaned and debrided. The application of both amniotic and chorionic layers instead of the amniotic layer alone prevents desiccation and affords better protection[8]. All air and fluid blebs are smoothed out to ensure total contact and excess membrane is trimmed. No dressing is applied on those patients admitted to hospital unless the burn is circumferential. However, burns on the backs of legs and arms may require a dressing. Strict bed rest for 6 h prevents dislodgement of the membrane. In adult patients with less than 5% limb burns, except hands and feet, a wet dressing and bandage is applied over the membrane and the treatment continued on an outpatient basis.

The first wound inspection is carried out after 24 h, when new blisters are removed and adherence of the membrane is ascertained. The non-adherent portion of the membrane is removed and replaced by new membrane after surface cultures have been obtained from the wound. Thereafter wound inspection with dressing change is carried out on alternate days. The membrane as a rule does not adhere to areas of full-thickness or deep partial-thickness burn, thereby helping to identify those areas which may require tangential excision and grafting. The membrane is reapplied to areas of tangential excision and changed every 48 h. The removal of adherent membrane helps to debride the wound to prepare it for grafting, as evidenced by the appearance of punctate bleeding points on the wound surface.

After 4–6 days it is usually easy to assess the areas requiring grafting. Those areas in which grafting is deemed unnecessary are covered with membrane and left undisturbed until they separate spontaneously. In areas where infection is responsible for the failure of the membrane to take, its use is abandoned and instead treatment is continued with topical silver sulphadiazine. When skin grafting is carried out the membrane is also used to cover the donor site, thus allowing quicker healing and reharvesting within as little as 8–10 days[9].

Patients and results

Physiological dressing with human amniotic membrane was used on 15 burn patients over a period of 30 months. Their ages ranged from 6 to 54 years, 2 being children aged 6 and 12 years. Two patients were female. Hot liquids caused the burns in 5 cases, explosions in 2 cases, and hot tar in 1. One patient sustained full-thickness electrical burns to both hands and a paraplegic suffered 12% full-thickness burn to the anterior abdominal wall from a hair dryer. The sites of the burns were the hands in 3 cases, the trunk in 2, and the limbs in the remaining 10. The surface area of burn ranged from 2–15%. Of the 2 explosion victims, 1 had facial burns, but the membrane was not used on the face. Of the 7 patients admitted to hospital, 2 required skin grafting. Minor tangential excision was carried out in 4 cases. In the earlier part of this series gross infection in a case of leg burn precluded the use of the membrane after 3 days and instead treatment was continued with mafenide (Sulfamylon) cream. The results in the other 14 cases were uniformly satisfactory. The pain relief after application of the membrane was impressive and in 2 cases dramatic.

Discussion

The concept of physiological or biological dressing dates back to 1869, when the French surgeon Reverdin used split-thickness skin from his own arm to cover part of the wound of a patient with an extensive burn[12]. Except for sporadic use, no progress was made during the next century until Miller *et al*[6] in 1967 demonstrated in a clinical trial that partial-thickness burn wound protected by immediate allografting healed faster than controls, the healing time being shorter by an average of 14 days. However, routine use of allograft skin in

the past decade has been limited to special burn units as it requires a well-organised skin bank. This led to the use of xenograft (porcine skin) as a substitute, but, apart from being inferior to allograft, it is expensive and not easily available in most countries[8,12,13].

Human amniotic membrane was first used as a physiological burn dressing by Sabella[14] in 1913, but his report failed to attract the attention it deserved, as evidenced by the absence of any publication on the subject in the next few decades. Subsequent reports[15-18] also failed to popularise the use of the membrane. Recently a few units have evaluated the membrane and reported its use[8-10]. One suspects that this renewed interest in its use has resulted from a search for an alternative to allograft and xenograft skin. Clinical trials and animal experiments have documented that the membrane is superior to both allograft and xenograft skin[8,9], and its use has recently been extended to surgical wounds and ulcers[11,19,20].

In partial-thickness thermal injury the initial loss of blood flow starts to return slowly after 24 h as patent vessels reappear. The delicate dynamic process of revascularisation for the purpose of repair is associated with local circulatory stasis. This 'zone of stasis' is therefore very vulnerable to desiccation and infection, and either one can trip the balance, converting it to a 'zone of necrosis' or full-thickness burn[1,7,21]. The water retention ability of the skin depends on its effective vapour pressure and the diffusion barrier offered by the keratin layers and the lipid content in the stratum corneum. This lipid is thermolabile and easily destroyed by heat[4]. When this barrier is removed by thermal injury the effective vapour pressure gradient is increased by 15–20 times (normal 1.5 ± 0.08 mm above atmospheric pressure), resulting in a large amount of evaporative water loss amounting to 3–10 times the normal rate of insensible loss of 40 ml/h. The deeper the burn, the greater is the amount and the longer the duration of the loss[2]. The recognition of this evaporative water loss has great therapeutic significance from the point of view of wound healing and water replacement in the post-24 h burn period.

The rationale behind the use of physiological dressing is mainly threefold[22]: (1) to prevent wound desiccation due to evaporative water loss; (2) to protect from bacterial invasion; and (3) to prepare and preserve the wound for future grafting.

The human amniotic membrane consists of two layers, the inner amnion and the outer non-glistening chorion. Embryologically, the membrane is derived from fetal ectoderm and hence can be considered analogous to fetal skin allograft[11]. Therefore it can be expected to fulfil some of the functions of the lost or damaged skin it replaces. However, unlike skin allograft, vascularisation and rejection of the membrane does not occur when its amnion side is placed in direct contact with the wound[9], and yet the membrane promotes healing by accelerating the migration of fibroblasts and development of collagen during the first 6–8 days of the repair process[19].

The ability of the membrane to combat infection and sterilise a wound has been documented in clinical and laboratory experiments[8]. The mechanism of this antibacterial property is unclear and is believed to be due to the lysozyme and progesterone content of the amniotic fluid[9]. Lysozyme is a powerful bactericidal protein and progesterone is bacteriostatic to many Gram-positive organisms[11], but whether these agents are retained by the membrane is as yet unknown[9]. Burleson and Eiseman[23] showed in animal models that a biological dressing which adhered to the wound prevented accumulation of pus on the surface of the granulation tissue, and sterilisation of this tissue preceded the disappearance of surface bacteria; in other words, wound biopsy cultures became negative before a surface culture. This adherence mechanism of a biological dressing is therefore of immense therapeutic importance and has been described as a 'fibrin–elastin biological bond'. Amniotic membrane is well known for its ability to adhere to the wound and this may explain some of its antibacterial properties in addition to the lysozyme concept. By providing a cover the membrane, like other biological dressings, protects the wound from the environment and reduces fluid and heat loss. Its ability to offer relief from pain in partial-thickness burn is well documented[8,9,11] and has been the experience in this series as previously mentioned.

The advantages of using amniotic membrane

as a biological dressing for burn wounds are as follows, and it is apparent that some of its properties complement each other: (1) readily available at no cost; (2) sterilisation, storage, and application are simple; (3) prevents fluid, protein, and energy loss; (4) combats infection; (5) promotes healing; and (6) relieves pain. The only disadvantage that I have encountered, and which has been confirmed by others (Marvin, J (1978) personal communication), is that the membrane adheres more firmly than other biological dressings and attempts to remove it even after soaking the area can cause considerable bleeding and pain to the patient. Therefore it is recommended that an adherent membrane should be left undisturbed except over areas of tangential excision where inspection becomes mandatory to assess the need for skin grafting.

The rising cost of health care delivery is universal and can be afforded only by a few. Therefore it is appropriate that any method of treatment which can reduce the cost without compromising standards should be seriously considered, and the use of amniotic membrane in burn wound dressing is one that deserves such consideration. It is felt that this report will stimulate interest in those concerned with the treatment of burn victims.

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