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ORIGINAL ARTICLE

EXPERIMENTAL ASSESSMENT OF SMALL INTESTINAL SUBMUCOSA AS A BIOLOGICAL DRESSING

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Aim*: To demonstrate the effectiveness of the use of submucosal dressing for prompt healing of the wounds.*
Material and Method: *An experimental study was carried out by application of chicken small intestinal submucosa for dressing of clean surgical wounds carried out in the rabbits and compare it with similar wounds dressed by routine sterile surgical gauze.*
Results: *The two types of wounds were assessed clinically through necked eye observation and histologically through microscopical examination that shown a great evidence of proper healing in the wounds that were dressed by small intestinal submucosal dressing.*
Conclusion: *The uses of small intestinal submucosa as a biological dressing prompt healing of the surgical wound proved by clinical and histological evidences.*

Keywords: *Skin, cut wounds, submucosal dressing, light microscopy, rabbits.*

INTRODUCTION

Irrigation is often the easiest and the most effective means of wound care, not only by generation of correct H_2O pressure to remove bacteria and debris, but the patients can also remain in a comfortable independent position during treatment. In case of severe infection additives with normal saline solution can be included, but because these additives will also kill healthy tissue, it is limited to few days.(1) Our intestine gets injured every day, every time we got to a fast food place and get a virus or whatever; the body has to heal quickly.(2) A recent method for moisture-retentive dressings is a fibrous type that is used for different wounds, made as a biopolymer that liberates more hyaluronic acid to the moist wound-healing environment than would be biologically possible under normal healing condition. New in the market, there is a dray wound dressing which is made from the small intestine submucosa (SIS) of swine. This dressing creates a vital, moist healing setting by interacting with wound exudates.(3) The naturally occurring extracellular matrix from the middle layers of the small intestine provides a natural environment for wound management. The device is designed for the management of abrasions, lacerations and surgical wounds as well as it is suggested for using in partial and full thickness skin injures including diabetic, venous and pressure ulcers. The sheets are available in 10 or 20 cm lengths, fenestrated and non fenestrated configurations, intended for one-time use.(4)

Small intestinal submucosa (SIS) from porcine has been successfully used as a collagen scaffold for the repair of various tissues, including those of the human vascular, urogenital, and musculoskeletal systems.(5)

This study was designed to testify the healing effect of the small intestine submucosa of the so available chicken's intestine on clean surgical cut wounds made on skin of rabbits.

PATIENTS AND METHODS

Ten adult rabbits of both sexes were used in this study according to experimental standard approved by local ethics committees. The animals were kept in clean cages and fed ordinary food and free water supply. Two animals of them were used as control groups. The other eight animals were anesthetized with thiopental Na and a double (left and right) surgical clean cut wounds (Fig. 1a) were made on the dorsal surface of the animals after shaving their fur. After stitching of the cut wounds by non absorbable 5/0stitches (Fig. 1b) the left side wounds were dressed with routine sterile surgical gauze dressing while the right wounds side were dressed with intestinal segments of chickens after shaving their mucosa to expose the submucosal layers which were applied on the cut wounds and fixed with plaster (Fig 1c). Regular daily dressings of both wounds were done. After ten days, the wounds were photographed and the animals were anesthetized with thiopental Na. Skin samples were excised, and the rabbits were directly sacrificed with chloroform anaesthetic. The samples were fixed in formalin and processed up to paraffin blocks which were cut at[5] um micro thicknesses and stained with haematoxylin and Mallory stain. The sections were examined microscopically to detect histopathological signs including inflammatory cellular infiltrate and healing character of both epidermis and dermis.

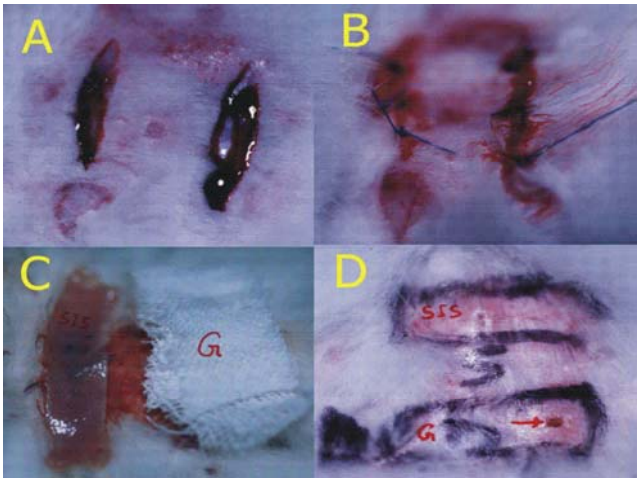

Fig 1.
A: The double surgical clean cut wounds after shaving the fur.
B: The cut wounds after stitching.
C: The left wound dressing with gauze (G) and the right wound dressing by small intestinal submucosa (SIS).
D: The wound dressed by gauze (G) is showing a non-healed spot (arrow) while the wound dressed by small intestinal submucosa (SIS),is showing complete healing ten days after incision.

RESULTS

Necked Eye Observation: Macroscopic observation of the wounds revealed a progressive wound healing in both gauze and SIS-dressed wounds. However, in case of SIS-dressed wounds the healing was marvelous and more precise until the last day of the experiment (Fig. 1d), the right wound marked by liters SIS. The wounds dressed with the sterile surgical gauze; there was incomplete healing where a granulomatous non-healed spot appeared at the side of wound (Fig.1d), the left wound marked by liter G.

Microscopic Observation: a. Low power magnification (HX and EX100):

In the wounds dressed with the sterile surgical gauze showing the skin appeared with different zones, the zone of normal skin (N) with prominent normal dermal papillae and hair follicles, the zone of the wound (W) showing loss of dermal papillae and hair follicles and the zone of the transition (T) which exhibit irregular dermal papillae and loss of hair follicles (Fig. 2a). However the wounds dressed by SIS, showing approximate normal thickness of epidermis with a thin layer of zona granuloza covered with a thin layer of keratin. The hair follicles appeared in the dermis and normal dermal papillae (Fig. 2b).

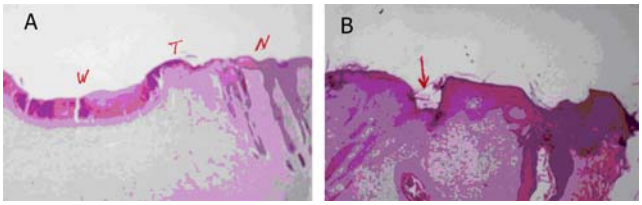

Fig 2.
A low power magnification (HX and EX100) ten days after incision showing: A. The wound dressed by gauze, shows a zone of normal skin (N) with prominent dermal papillae and hair follicles, zone of the wound (W) with loss of dermal papillae and hair follicles and the zone of the transition (T) which exhibit irregular dermal papillae and loss of hair follicles.
B. The wound dressed by SIS, shows normal skin structure. The site of the cut wound is indicated by a notch (arrow) at the surface).

b. High power magnification (HX and EX250) & ((HX and EX400) :

The wounds dressed with sterile surgical gauze showing the keratin was lost and hypertrophies of the granular cell layer at the transition zone (T) and thinner irregular dermal papillae, absence of the hair follicles, and proliferation of zona granuloza with flat basophilic nuclei which appeared darker than the deeper nuclei of the stratum spongiosum and a gradient of cellular infiltrate at the site of wound

zone (W) (Fig. 3a). However the wounds dressed by SIS showing ,the epidermis has a normal structure covered with a thin layer of keratin and there is proliferating branches of normal epidermal down growth separated by thin layers of vascular connective tissue appeared under the wounds (Fig. 3b). A more high power magnification at the site of the wounds (W) dressed by sterile surgical gauze are showing granulomtous tissue with loss of epidermis and gradient of cellular infiltrate from the dermis (Fig. 4a). The wounds dressed by SIS with the same magnification showing normal epidermal keratinocytes and appearance of intraepidermal capillaries lined with flat endothelial cells (Fig. 4b) and small amount of collagen fibers in wounds dressed by sterile surgical gauze (Fig. 5a) compared by heavy collagen (blue colored) fibers separating by the branched epidermal down growth in wounds dressed by SIS after healing (Fig. 5b).

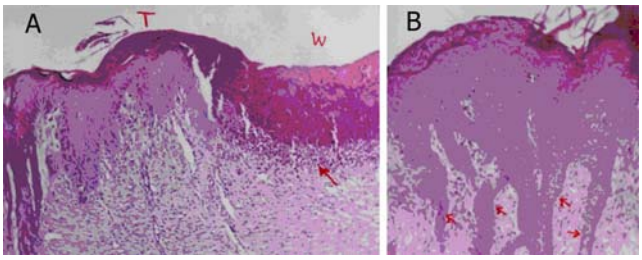

Fig. 3:
A high power magnification (HX and EX250) is showing: A. The wound dressed by gauze shows hypertrophy of the granular cell layer at the transition zone (T) and a gradient of cellular infiltrate (arrow) at the site of wound zone (W). B. the wound dressed by SIS shows proliferating grown branches of the epidermis (arrows).

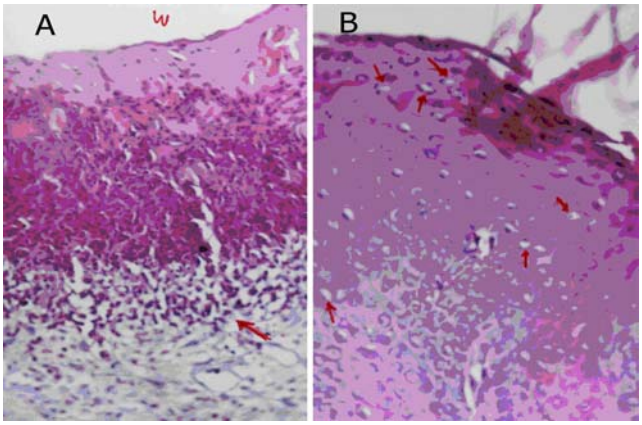

Fig. 4:
A higher power (HX and EX400) is showing:
A. The wound dressed by gauze (W) shows granulomtous tissue with loss of epidermis and a gradient of cellular infiltrate from the dermis (arrow).
B. The wound dressed by SIS shows normal epidermal keratinocytes including much capillaries (arrows) lined by flat endothelial cells

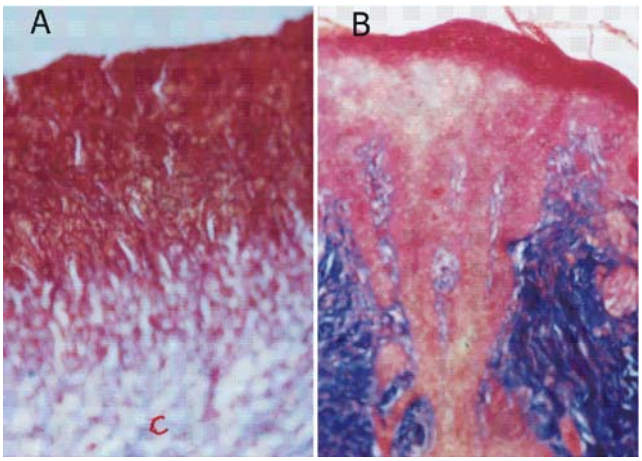

Fig. 5:
A. A more power magnification (Mallory trichomeX400) after healing is showing: A. the wound dressed by gauze shows a small amount of collagen (C). B. The wound dressed by SIS shows heavy collagen fibers (blue colored) separated by the branched epidermal down growth.

DISCUSSION

Clinical application of SIS grew out of animal research more than a decade ago using the material to repair blood vessels. Its efficacy in those experiments caused researchers to question whether it might be useful in other applications.

In the previous study, Gastel JA[6] observed intre-epidermal capillaries in the wound dressed with SIS. He added that SIS had shown an ability to spark a wound healing response that stimulates the growth of new blood vessels. It served as a "scaffold" around which the body healed, eventually replacing the material with new tissue. Also Badylak et. al.[7] mentioned that the submucosa of the porcine small intestine was a biocompatible collection of structural proteins and growth factors that served as a natural framework of repairing and growing tissue.

In this study, we notice a considerable amount of collagen fibers in the wounds dressed by SIS. This is explained by the good dermal healing specially when compared with small amount of collagen fibers appeared in the wounds dressed by the sterile surgical gauze. Abundance of nutrient resources contained in the matrix of the submucosal layer, enhances the host cells ingrown until epithelizing, which occurs at a speed depending on how deep the wound to be treated is.

Badylack[8] said that the conventional use of SIS will challenge physicians to rethink a long-standing practice, because the material actually responded to stress, building natural tissue more quickly.

The successful use of SIS- dressing was not a 100% agreed with, Dr. Suckow[9] who tested SIS in the joints of rabbits. He is concerned that the publics demand to get the fruits of research more quickly into clinical settings that may have prompted the FDA to act hasty in approving the clinical trials. Wang et. al[10] had been used SIS successfully. He reported that SIS looked like parchment paper and it had several uses. He used it to repair the injured skin on a hawk's elbow joint which was healed and looked like actual skin. He added that SIS provided a matrix into which the bodies own repair cells could grow. A biomaterial derived from the submucosal portion of porcine small intestine has been used successfully in pre-clinical studies of wound healing and in other surgical procedures where soft tissue reinforcement is indicated.[11] Plamar[12] expanding the use of porcine small intestinal submucosa (SIS) as a free biomaterial dressing for wound healing in humans that act as scaffold material for constructive remodeling of damaged or missing tissue.

The SIS biomaterial has now been developed into a wound care product that improves healing of full-thickness venous leg ulcers, compared to standard care, in clinical population. No allergy has evoked in any case since layer matrix is acellular. and significant cost-treatment economy is lower since the layer applications are performed as an outpatient procedure.[13] Recently the use of the SIS came in issue as dermal replacement in preventing secondary skin graft contraction that evaluated by MaCleod.[14] SIS is able to support an overlying skin graft but had no beneficial effect on skin graft contraction compared to skin grafts alone.

In this experimental study, SIS significantly enhances the healing of the cut wounds of the rabbits through improvement of mechanical properties and histological appearance of the wounds. Nonetheless, these promising results justify further evaluation of this biologic matrix for its effectiveness in the treatment of full thickness wounds.[15]

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