A Comparative Study of Hydrocolloid(Duoderm®) and Hydrogel(Nu-Gel®) Occlusive Dressing Materials in the Treatment of Full-Thickness Skin Wound in Dogs

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Abstract: This study was performed to compare the effects of hydrocolloid(Duoderm®, HC in this study) and hydrogel (Nu-Gel®, HG in this study) occlusive dressing materials on degree of exudate, wound contraction, epithelialization, and healing of full-thickness skin wounds in dogs. Three wounds measuring 2×2 cm in size were created bilaterally(6 wounds/dog) on the dorsolateral aspect of the trunk of 12 dogs. In each dog, the wounds were treated with HC, HG, and normal saline, respectively. For a 4 week period, the wounds were evaluated gross aspects and histopathological aspects. There were no statistically significant differences between treatment groups in percentage of wound contraction, percentage of epithelialization, and percentage of wound total healing during the first week. Significant differences were first detected on day 14. On day 14(P<0.01) and 21(P<0.05), mean percentage of epithelialization of HG-treated wound was significantly greater than those in HC- and normal saline-treated wound. Mean percentage of wound contraction of HG-treated wound was significantly greater than that in HC- and normal saline-treated wound. On day 21, mean percentage of wound healing of HG-treated wound was significantly greater than that in HC- and control wounds(P<0.02). On day 1, 4, and 7 after wound creation, although severe infiltration of PMN (polymorphonuclear leukocyte) cells in HC- and control wounds were observed in the subcutis and moderate infiltration of PMN cells in HG-treated wound were observed in the subcutis, we did not detect significant differences. On day 14 after wounding creation, in the wounds treated with HG dressing, epithelial cells were found over the surface, and edema further decreased in the tissue under the wounds, and the granulation tissue was replaced with collagen fibers. On day 21 after wound creation, in HG-treated wound compared with other experimental material-treated wounds, regenerated epidermis covered most of the wound surface, and the granulation tissue was more replaced with collagen fibers than that on day 14. Overall results indicated that the use of hydrogel dressing materials(Nu-Gel®) as hydrocolloid dressing (Duoderm®) materials and normal saline treatment on full-thickness skin wounds in dogs increased the rate of healing at repair stage.

Key words: hydrocolloid, hydrogel, full-thickness wound, wound healing, dog

Introduction

Wound dressing has been reported to play an important role in the different phases of the process of wound healing in the moist or dry environment1,11,14. This process is characterized by an orderly sequence of events involving infiltration of specific cells into the wound site. The combined actions and interactions of these cells result in the closure of the wound. The process of wound healing can be divided into four stages: firstly, hemostasis and inflammation stage; secondly, debridement stage; thirdly, repair stage with fibroblasts/capillary ingrowth, wound contraction, and epithelialization; fourthly, maturation stage. This process is continuous, and overlapping of the various stages2.

In veterinary practice, most wounds in dogs are traumatic in origin, and are contaminated or infected at the time of referral for treatment3. In these wounds are managed as open wounds, and are healed by contraction and epithelialization. It has been suggested that healing of an open wound will occur more quickly if it is covered with a dressing materials. Until now, advantage of occlusive dressings for treatment of open wound has been emphasized2,3,12-14,20,24,26,27,34-36. Although many topically applied agents have been used to treat open wounds, selection of the proper dressing material may affect the rate of wound healing. Occlusive dressings prevent exudate loss from the surface of the wound, are act as a physical barrier to inhibit infection by bacterial pathogens, accelerate the inflammation, and increase the rate of epithelialization3,27. They are permeable to atmospheric oxygen, but do not allow bacteria or exogenous fluid to reach the wound3,27. Since their introduction in 1962, occlusive dressings have been documented to decrease the total healing time of full-thickness wounds in human beings by promoting moist wound healing20,44.

Occlusive dressing materials are broadly classified as biological or synthetic. Although synthetic occlusive dressings have several beneficial properties that enhance wound healing, their overall performance has been reported to be inferior to that of biological occlusive dressings2. Biological occlusive dressings, such as porcine xenografts and cadaver allografts, are frequently used in human beings, but are infrequently used in veterinary medicine principally because of their exorbitant cost and lack of availability18.

Hydrocolloid dressing is an occlusive nonadherent hydrocolloid bandage material with a polyurethane backing. These
bandages are indicated for covering wounds in the repair stage of wound healing—that is, wounds with an established granulation tissue bed, stimulated contraction, decreased fluid production, and the beginning of epithelialization\(^9\).

Hydrogel dressing (Nu-Gel\(^8\), Johnson and Johnson Medical, Division of Ethicon Inc., HG in this study) is an occlusive hydrogel bandage material. These bandages are indicated for covering wounds in the repair stage of wound healing, when they have a healthy bed of granulation tissue and decreased fluid production, and are beginning to epithelialize. Hydrogels have also been described for use over noninfected eschars to soften and aid in their removal\(^9\).

Although these occlusive dressings have been shown to be effective in wound healing, there has been few study performed about comparison of these two occlusive dressing materials.

So, the purpose of this study was to compare the effects of an occlusive hydrocolloid dressing and an occlusive hydrogel dressing on the healing of full-thickness skin wound in dogs.

**Materials and Methods**

For four week adaptation period, all dogs were exterminated by anthelmintics (Rintal\(^8\) tabs, Bayer Korea Ltd., Korea) and were vaccinated with DHPL (Vanguard puppy\(^8\) Pfizer Inc.). All dogs were maintained in water and solid-feed by free feeding, and discontinued before one day of laboratory work. Throughout the study all dogs had a good appetite, nor did they show signs of discomfort.

**Experimental Set-up and Wound Creation**

Twelve healthy adult mixed breed dogs (9 female, 3 male, mean body weight 3.50±0.5 kg) were used. Nine dogs were assigned for gross aspects, and three dogs were assigned for histopathological aspects. On day 0, dogs were administrated atropine sulfate (Atropine\(^8\), Dai Han Pharm. Co., Korea, 0.05 mg/kg, SC). After ten minutes, anesthesia was induced with xylazine hydrochloride (Rompun\(^8\), Bayer Korea Ltd., Korea, 1.1-2.2 mg/kg, IM) and maintained with ketamine (ketamin\(^6\), Yuhan Co., Korea, 11 mg/kg, IM). Each dog was positioned in sternal recumbency. Hair over the dorsal aspects of the trunk, from the caudal borders of the scapula to the folds of the flanks and half way to the ventral midline, was removed by use of electric clippers, and was prepared circumferentially for aseptic surgery. A plastic film template was constructed so that 2×2 cm wounds creation. Three 2×2 cm square full-thickness skin defects including the underlying cutaneous trunci muscle were created bilaterally, using a No. 15 scalpel blade. The defects on each side were centered between the caudal border of the scapula and the tuber coxae, with 4 cm between defects and each being 6 cm ventrolateral to the dorsal midline. The skin defects were designated by their location as left cranial, left middle, left caudal, right cranial, right middle and right caudal. Immediately after surgery, the wounds were filled with autoclaved gauze to absorb free blood and stop bleeding.

**Wound Treatment**

Treatment was randomly assigned. In each dog, two wounds were treated with hydrocolloid dressing (Duoderm\(^6\), Conva-Tec, A Bristol-Mayer Squibb Company, HC in this study), hydrogel dressing (Nu-Gel\(^8\), Johnson and Johnson Medical, Division of Ethicon Inc., HG in this study), and normal saline (0.9% NaCl Inj., Dai Han Pharm. Co., Korea, control), respectively. Three treatment groups were established immediately after the wounds were created (day 0). All wound dressing materials were nonadherent, so covered with flexible dressing fixation fabric sheet (Mefix\(^8\), Mohlycke Health Care LTD). The occlusive dressings were changed every 4 to 7 days according to the manufacture's criteria, or sooner if wound fluid was noted penetrating the bandage. If not, bandage changes also were performed in association with wound tracing schedule. Bandage changes followed the outlined protocol in which a bandage was soiled, had slipped, or was partially removed by individual dog. In such cases, the dogs were restrained and the bandages were repaired and the dressings were replaced if necessary. Crisscross bandage strips were placed between the forelimbs and attached to the body bandage to prevent the bandage from slipping caudally. Elizabethan collars were used to keep the dogs from damaging the bandages. Cotton-padded casting material was placed as a neck brace on each dog to prevent self-inflicted bandage or wound disruption. To avoid infection, the animals were injected twice with Bytril\(^8\) (Bayer Korea Ltd., Korea, 2-4 mg/kg, IM) on the day of surgery and two days after.

**Wound Evaluation**

Generally, the wounds were evaluated over a 4-week period. For this study, the results are given only for the first 4 weeks because all treated-wounds were healed after this period except control wounds. Postsurgical gross aspects evaluations were done on day 0, 7, 14, 21 and 28. All wounds were constructed by OHP film (PC82-T1\(^8\), SKC), and were analysed by Color Image Analyser Q520 (Meta morph, Cambridge Instrument, UK). On each evaluation day, the dogs were sedated with xylazine hydrochloride (Rompun\(^8\)) and ketamine (ketamin\(^6\)) using the previously noted doses. The dressings were removed and excessive debris was cleaned from each wound with a sterile gauze pad.

The initial wound area (W\(_0\)), wound area on the day measured (W\(_i\)), and area of unepithelialized granulation tissue (U\(_i\)) were measured (Fig. 1). Mean percentages of wound contraction, epithelialization, total healing (percentage of contraction plus percentage of epithelialization) were calculated, using the follow formulas:

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\text{Percentage of wound contraction}= 100 \times \left[ \frac{(W_0 - W_i)/W_0}{W_o} \right] \\
\text{Percentage of epithelialization}= 100 \times \left[ \frac{(W_i - U_i)/W_0}{W_o} \right] \\
\text{Percentage of wound healing}= 100 \times \left[ \frac{(W_o - U_i)/W_o}{W_0} \right]
\]