Use of Occlusive Dressings in Wound Management

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As a consequence of being the largest and outermost organ of the body, the skin is often subjected to a variety of forces during sports participation. Traumatic skin lesions are a common condition faced by sports medicine clinicians. Yet, wound management is an often overlooked area of sports medicine.

Traditional intervention in wound healing left wounds exposed to the air or covered with a textile based wound dressing such as a cotton or paraffin gauze (Szycher & Lee, 1992). Wounds left to heal in this way develop a hard eschar (scab). The rationale for this approach was to protect the wound from the outside environment and thereby prevent infection (Falanga, 1988; Szycher & Lee, 1992).

Unfortunately, a dry environment that discourages infection also inhibits the cellular processes involved in healing. This approach to wound healing was the only standard available until several researchers reported that wounds covered with an occlusive material had shortened healing times. An occlusive wound dressing is one that maintains a moist interface with the wound surface.

The positive results from these studies were published several decades ago, yet occlusive dressings did not become available in the U.S. until 1980. Today, even with more than 30 of these dressings available, their use remains limited in the sports medicine arena. This may be due to the lack of education and training available to students in allied health fields, which leads to confusion about the rationale, unique features, and indications for each type of occlusive dressing (Eaglestein, 1993; Falanga, 1988; Feedar, 1995).

This paper introduces the 4 types of occlusive dressings available to sports medicine practitioners. It also gives a brief overview on the rationale, mechanisms, and benefits offered by occlusive wound management.

The Role of Dressings in Wound Healing

During healing, wounds progress through a specific chronology of events that ultimately lead to the resolution of the injured tissue to a normal or semi-normal preinjury status (Kirsner & Eaglestein, 1993; Szycher & Lee, 1992; Wokalek & Ruh, 1991). The entire healing process is divided into 3 phases: inflammatory, proliferative, and maturation. The events occurring during each phase of healing differ, therefore each phase requires a unique microenvironment.

The purpose of a wound dressing is to provide an appropriate microenvironment. At this time, a single wound dressing with the ability to accomplish this remains a manufacturing challenge. Therefore clinicians must choose between the different dressings available, matching the environmental demands of the wound with the environment created by the dressings.

The initial goals of wound healing are to limit further external damage, prevent microorganism invasion into the wound site, promote hemostasis and the clotting cascade, remove necrotic debris and exudate, and keep the wound warm. Best suited for early wound healing are the traditional textile based dressings, as they are effective in absorbing exudate and removing necrotic debris from the wound site as well as being convenient for field use. They can also be readily secured over a wound, preventing outside contact with blood or body fluids.

Unfortunately, prolonged application of these dressings may be detrimental to timely progression toward later stages of healing. These dressings will begin to adhere to the wound site, especially...
as a scab forms (Feedar, 1995). A scab forces epithelial cells, which will only migrate over a moist tissue bed, to burrow under the scab to move over the wound site, delaying reepithelialization of the wound (Szycher & Lee, 1992).

In addition, the textile fibers of the dressing often become incorporated into the scab, causing further irritation of the wound site. The continued absorption of the fluid released by the wound may cause dehydration and desiccation of the wound site. These dressings often become permeable to microorganisms (Feedar, 1995; Hulten, 1994; Hutchinson & McGuckin, 1990), resulting in infection.

All of these events will further delay healing, therefore the strategy for managing a wound must change after the initial goals are met.

The next phase of wound management requires a shift from protection, isolation, and debridement to the creation and sustainment of a microenvironment that is conducive to the proliferative phase of healing (Wiseman et al., 1992). Occlusive dressings are optimal for creating this environment.

By creating and maintaining a sealed microenvironment and a moist interface with the wound surface, occlusive dressings provide a number of advantages over traditional ones. Healing wounds produce throughout the entire healing process an exudate (Kirsner & Eaglestein, 1993; Szycher & Lee, 1992; Wiseman et al., 1992) containing growth factors that enhance the rate of healing.

Infection rates also appear to be suppressed with occlusive dressings. After reviewing the rates of infection reported under both traditional and occlusive dressings, Hutchinson and McGuckin (1990) found that the infection rate of nonoccluded wounds was 7% compared to 2.6% for occluded wounds.

Additionally, several studies have reported a reduction in pain from the use of occlusive dressings (Barnett et al., 1983; Kannon & Garrett, 1995; Madden et al., 1989). This might be attributed to the moist interface protecting the nerve endings from drying and from fewer traumatic dressing changes (Field & Kerstein, 1994).

Patients also report that occlusive dressings are more comfortable and convenient to wear (Moshakis et al., 1983). For example, since occlusive dressings are waterproof, patients can bathe with the dressings in place and not have to change them afterward.

Furthermore, several studies have reported a better cosmetic appearance of wounds treated with occlusive dressings (Hein et al., 1988; Moshakis et al., 1983). The reasons for these results are probably related to the quicker and more complete epithelialization that occurs under the occlusive dressings.

Therefore occlusive dressings keep the wound fluid, which contains various growth factors, in contact with the healing tissues. Textile based dressings, on the other hand, absorb the fluid, thereby starving the healing tissues of the growth factors that are essential to the healing process.

### Types of Occlusive Dressings

#### Transparent Films

The category of transparent films includes sterile dressings consisting of a thin polymeric sheet with one side coated with a pressure-sensitive adhesive. Transparent films are also referred to as semipermeable films, moisture-vapor-permeable dressings, vapor-permeables, synthetic-adhesive moisture-vapor-permeable dressings, and polyurethane films.

The best material for the manufacturing of these dressings is polyurethane, which is semipermeable, allowing both gases (O<sub>2</sub> and CO<sub>2</sub>) and water vapor to pass while blocking the passage of wound fluid. The transparent films currently available “breathe”...
Table 2

<table>
<thead>
<tr>
<th>Dressing Type</th>
<th>Indications</th>
<th>Special Characteristics/Considerations</th>
</tr>
</thead>
<tbody>
<tr>
<td>Transparent films (change in 3–5 days, once new epithelial tissue forms)</td>
<td>Superficial &amp; minor wounds, Blisters</td>
<td>Transparent—allows continual wound inspection, Adhesive side readily sticks to itself, Limited wound-exudate control, Easily displaced with frictional forces, May not maintain optimal wound temp., No part of dressing dissolves into wound</td>
</tr>
<tr>
<td>Hydrocolloids (change in 3–7 days)</td>
<td>Partial &amp; full thickness wounds, Surgical sutures</td>
<td>More exudate handling capacities, Develops “gel &amp; smell” phenomenon, Thicker &amp; less conformable, Can be used w/additional hydrocolloid formations for more exudate capacity, Maintains wound temperature, Minimal transparency</td>
</tr>
<tr>
<td>Hydrogels (change in 1–2 days)</td>
<td>Partial &amp; full thickness wounds, Dry wounds</td>
<td>Allows for hydration of dry wound &amp; absorption of excess wound exudate, Completely nonadherent, requiring secondary bandaging, Daily inspection needed to check hydration &amp; security status of dressing, Good conformability, Semitransparent</td>
</tr>
<tr>
<td>Spyrosorbsents (change in 5–7 days)</td>
<td>Partial &amp; full thickness wounds, Wound closure</td>
<td>Combines characteristics of transparent films &amp; hydrocolloids, Nonadherent to moist wound bed, Good conformability &amp; elasticity, Adjusts exudate control to amount present</td>
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Indications and Characteristics of the 4 Types of Occlusive Dressings

The aqueous portion of the wound exudate that forms under the dressing "migrates" through transparent films into the atmosphere. The rate at which migration occurs depends on the molecular structure of the film and its thickness. Once the aqueous portion of the exudate evaporates, a protein substance is left under the dressing. It is questionable whether this residue is detrimental to wound healing (Szycher & Lee, 1992).

The timing of removal of transparent films is critical. The dressing should be removed once epithelial tissue has formed under the dressing. Otherwise the newly epithelialized tissue will be damaged during a later removal. Other concerns with these dressings are listed in Table 2.

Hydrocolloids

Hydrocolloids are a family of occlusive dressings manufactured from a gel adhered to a polyurethane film or foam. The gel generally consists of gelatin, pectin, and carboxymethylcellulose. Mineral oil, elastomers, and a rubber hypoallergic adhesive are added to the gel mixture to help the dressing conform and adhere to intact skin (Rheinecker, 1995; Szycher & Lee, 1992). The major brands of hydrocolloids are listed in Table 1. These dressings are impermeable to gases and water vapor.

These dressings rely solely on the hydrocolloid layer for exudate control. Upon contact with a wound, the hydrocolloid component of the dressing begins to absorb the wound fluid. The fluid is then dispersed throughout the dressing, where it interacts with the molecules in the hydrocolloid, forming a gel that fills the wound and provides a controlled absorption gradient for the rest of the wound.

wounds. Once large amounts of exudate gather under the dressing, the bacterial barrier offered by these dressings becomes compromised. Two-way channels may develop, allowing the excess exudate to leak out from under the dressing while at the same time creating an entrance for microorganism invasion.
The maximum amount of exudate a hydrocolloid can absorb depends on the quantity of hydrocolloid present. Once saturated, the dressing will not absorb additional exudate. Several manufacturers make hydrocolloids available in two thicknesses; the thicker hydrocolloids can handle more exudate. Unfortunately, the increased thickness decreases the amount of comfort and conformity. Additional hydrocolloid formations such as pastes or granules can be used in conjunction with the hydrocolloid dressing to provide additional exudate control.

The indications for hydrocolloid use are listed in Table 2. Their increased exudate control allows them to be used for deeper and larger wounds compared to transparent films. In addition to wounds, hydrocolloids can be used over surgical sutures (Hulten, 1994).

The removal of a hydrocolloid dressing after a regular interval is associated with the "gel and smell" phenomenon described by Gilchrist (Rheinecker, 1995). The gel that is formed as the hydrocolloid particles interact with the wound exudate takes on a yellow-brown color with a disagreeable odor. This yellowish gel fluid does not indicate infection—unless the odor persists after cleansing or other clinical signs of infection are present.

Patients should be warned of this phenomenon before removal to avoid unnecessary apprehension about the status of wound healing. Sycher and Lee (1992) advocate removal of this gelatinous material from the wound site before placing a new dressing over the wound, but the manufacturer claims it is not necessary to remove the gel.

### Hydrogels

Hydrogels consist of networks of hydrophilic polymers in a colloidal suspension on a polyethylene mesh support between two polyethylene films. The gels are usually composed of 96% water and 4% polyethylene oxide.

Hydrogels are semipermeable to gases and water vapor. They are usually packaged in a partially hydrated form, allowing for both hydration of a dry wound and absorption of excess wound exudate. In addition, this hydration evokes a cooling and cushioning sensation upon dressing application. No part of these dressings will dissolve into the wound site.

Hydrogels rely on the colloidal suspension to control exudate. Upon contact with a wound, exudate is absorbed and dispersed throughout the dressing. Similar to hydrocolloids, once a hydrogel becomes saturated, its ability to maintain an optimal wound environment is diminished.

As a hydrogel absorbs wound exudate, it swells and may begin to move away from the wound. Some manufacturers have suggested removing the impermeable backing sheet when this occurs. Unfortunately, this may result in complete dehydration of the dressing, causing damage to the underlying wound upon removal.

Indications and contraindications for hydrogel use are similar to hydrocolloids (Table 2). Hydrogels are also indicated for use over wounds with a dry surface.

### Spyrosorbents

Spyrosorbent wound dressings are considered second-generation occlusive dressings because they combine the characteristics of both transparent films and hydrocolloids. Constructed as a bilaminar structure consisting of a microporous polyurethane membrane, they are coated with a pressure-sensitive adhesive applied in a dot matrix pattern.
The outer surface of the dressing is composed of a nanoporous skin that is impermeable to bacteria. The inside surface of the dressing consists of large conical voids coated with an acrylic pressure-sensitive adhesive that allows 50% of the dressing’s pores to be exposed directly to the wound. Currently the only spyrosorbent dressing available is Spyroflex (PolyMedica, Woburn, MA).

The surface of spyrosorbents when hydrated with wound exudate becomes nonadherent, allowing the dressing to remain in place for longer periods than transparent films without damaging new epithelial tissue. The conformability offered by these dressings approaches that of the semitransparent films. An additional unique characteristic is their astringent property, which stimulates platelet aggregation and stops the bleeding more quickly.

Spyrosorbent dressings control exudate by combining the absorptive characteristics of hydrocolloids with the aqueous transportation of transparent films. When the dressing comes into contact with a wound, exudate is absorbed into the pores of the polyurethane membrane.

Within the membrane are thousands of molecular coils which, when dry, are limp and overlap each other. However, when exudate is absorbed, these coils begin to stiffen according to the quantity of exudate present. In the stiffened state, vapor from exudate has a more direct route through the coils to the outer membrane where evaporation can take place. By utilizing this exudate-control mechanism, the dressings can adjust to the amount of exudate present, therefore preventing the dressing from drying out or allowing pools of exudate to form.

Indications for the use of spyrosorbents are similar to those of hydrocolloids (Table 2). An additional application of spyrosorbents is in wound closure (Ives et al., 1992; Szycher & Lee, 1992), since the dressing possesses enough conformability and elasticity to be used as a wound closure tape. Contraindications for the use of spyrosorbents are also similar to those of hydrocolloids.

Summary

Occlusive dressings create and maintain an optimal wound healing environment at a wound site by keeping it moist with the wound exudate. Many studies have demonstrated enhanced healing under occlusive dressings due to their provision of an optimal healing environment. Unfortunately, their use remains limited, especially in the field of sports medicine.

For many athletes, occlusive dressings represent a new approach to wound healing that may contradict their notions about how to treat wounds. The sports medicine clinician must educate athletes as to the rationale of occlusive dressings to ensure compliance. Athletes must be fully educated about leaving the dressings intact for the treatment time, and about the symptoms that are normal and abnormal in the wound site. It is especially important that they be told to inspect the dressing and wound daily for displacement, disruption, or infection.

References


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