Normal saline wound dressing - is it really normal?

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SUMMARY. Gauze swabs soaked in normal saline are frequently used as dressing on open wounds. Their exact mechanism of action is not known. This study was designed to assess the hypothesis that normal saline dressings act in part as an osmotic dressing. Ten patients had skin ulcers (n = 10) dressed with normal saline soaked sponges. A control group (n = 10) identical sponges were placed upon intact skin. The sponge fluid osmolarity and electrolyte concentrations were serially assayed to test our hypothesis. In the control group, the osmolarity, sodium and chloride concentrations increased with time as a result of evaporation, altering it from an isotonic to a hypertonic dressing. However, in the ulcer group, the osmolarity, sodium and chloride concentrations remained relatively isotonic with time. This result is statistically significant (P < 0.05). We postulate that, as a result of evaporation, the sponge dressing increases its tonicity. This draws fluid from the wound into the dressing so that a dynamic equilibrium occurs and the sponge dressing regains isotonicity. The dressing remains functional provided that the wound fluid is absorbed freely from the wound. This process is terminated when either the dressing completely absorbs the wound fluid or the dressing dries out. The latter often occurs prematurely in a contaminated wound or in a wound where exudate forms a non-permeable barrier which prevents osmosis and allows the remaining water in the dressing to evaporate completely. This correlates with the observation in clinical practice that for maximum efficacy the dressing should be changed regularly. © 2000 The British Association of Plastic Surgeons

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Normal (0.9%) saline wound dressings are a useful adjunct in the treatment of open wounds. They are commonly used in clinical practice with reputed success. The dressings are said to be physiologically normal and isotonic, providing a moist environment for wound healing. They are cheap and easy to apply. Despite their widespread use, there is no documentation in the English literature regarding their mechanism of action. Clinical practice may suggest that a form of mechanical debridement occurs with frequent wet to dry dressing changes. Yet again, this has not been documented.

The aim of this study was to investigate prospectively the hypothesis that normal saline dressings function in part as an osmotic dressing. With evaporation of water the dressing becomes hypertonic. The hypertonicity of the normal saline dressing provides an osmotic gradient for absorption of wound fluid, contributing to its effectiveness as a wound dressing.

Patients and methods

From July 1996 to January 1997, ten patients at our institution with full thickness skin ulcers were included in the study. Aetiology of the ulcers include chronic venous disease (5), diabetes (2), trauma (2) and arteriopathy (1). The mean size of the ulcers was 48 cm².

Although normal saline is usually applied to the wound with gauze dressing, we have used 10 mm thick sterile foam sponges to dress the wound, similar to foam sponges used for dressing split skin grafts. The foam sponges provided a uniform area of contact with the wound whilst retaining sufficient wound fluid to allow accurate fluid and electrolyte assaying. The porosity of the sponges also allows free diffusion of fluid at the wound/dressing interface so that a dynamic equilibrium can be reached, reflecting ionic changes at this interface.

The ulcers were initially cleansed with sterile water. Two foam sponges were cut to the exact size and shape of the ulcer. A radiograph template with premarked grids of 1.5 x 2.0 cm was used to trace the pattern onto the two sponges as shown in Figure 1. Using a pipette, equal volumes of normal saline were administered to each sponge until the sponges were fully saturated and would not hold any further saline. This is to eliminate the effect of capillary action of the sponge on the wound fluid. The sponges were also weighed to ensure that equal volumes of saline solution had been taken up. One sponge was placed on the ulcer with the outer aspect then covered with a non-absorbent sheet to enable the sponge to be secured gently to the wound with adhesive tape. This was done carefully to ensure that no saline was spilled during the process. If spillage occurred the procedure was repeated. The
second sponge, acting as a control, was placed on intact skin and again covered with a non-absorbent sheet (Fig. 2). The sponges were placed on the wounds in a horizontal plane to negate any effects of gravity and to prevent pooling of fluid within the sponge.

At 30-minute intervals, for a period of 6 h, a 1.5 x 2.0 cm piece of sponge was removed from an identical position from both the control and ulcer sponges, using the premarked grid (Fig. 3). Fluid from the sponges was then emptied into separate containers and assayed for osmolarity and sodium chloride concentration, using an automated multiple biochemical analyser. The patient remained in bed for the duration of the study.

Results

The results of the assays for the control and the ulcer groups are shown in Figures 4, 5 and 6 with respect to sodium and chloride concentrations and osmolarity.

The results were statistically analysed using generalised estimating equations analysis. Generalised estimating equations, an extension of quasi-likelihood analysis, are designed to guarantee consistency of the regression coefficient estimates under minimal assumptions about the time dependence. The quasi-likelihood approach is a Markov model in which the expected response at a given time depends not only on the associated covariates, but also on past outcomes. There was a significant difference ($P < 0.05$) in the osmolarity, sodium and chloride concentrations between the ulcer and the control groups. Figure 4 shows that at time zero, the mean sodium concentration of both groups was approximately 158 mmol/l (0.9% saline = 154 mmol/l). Over the 6-hour period of the study, there was a gradual increase in the sodium concentration of the control group to almost double the starting concentration. In contrast, the sodium concentration in the ulcer group remained relatively constant. We believe that the movement of wound fluid into the dressing via osmosis has a dilutional effect, maintaining the saline dressing near isotonicity.

Discussion

Normal saline dressings are used in wound healing as they are said to be physiologically normal, isotonic with plasma and provide a moist environment for the healing of wounds. This study shows that the fluid sampled from the ulcer sponges remains essentially isotonic with time. As the water in the foam evaporates, the dressing becomes hypertonic and draws fluid from the wound by osmosis. The wound fluid then dilutes the dressing to reach a dynamic equilibrium, whereby the foam fluid assayed will approach isotonicity, as shown in Figure 7. This movement of wound fluid into the sponge may contribute to its effectiveness as a dressing.

This osmotic effect is not observed in the control group. Fluid assayed from the control group sponges...
shows a rise in the osmolarity and sodium chloride concentration. Water evaporates from the dressing but intact skin acts as an impermeable membrane, preventing the movement of interstitial fluid into the dressing, thus explaining the increasing hypertonicity of the dressing with time. We calculated that the ionic and osmolarity changes that occur cannot be explained by pure capillary action of the sponge on the wound. If that were the case, the sodium and chloride concentrations and osmolarity would have to be much higher at the end of the 6-hour period than was demonstrated.

An interesting observation made in the study was that there was usually blood and dried exudate adherent to the ulcer dressing on removal. It is likely that these eventually form a non-permeable barrier that prevents further movement of fluid and electrolytes from the wound into the gauze dressing. With continued evaporation of water the dressing eventually dries out completely. This may explain why frequent dressing changes are required to maintain adequate tonicity and permeability for the dressing to be effective clinically.
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References

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Figure 6—Mean osmolarity.

Figure 7—Dynamic interaction between the sponge and the ulcer.

SALINE FOAM DRESSING

EVAPORATION

FOAM

OSMOSIS

WOUND

OSMOSIS