INVESTIGATION OF DRESSING MATERIALS BY SCANNING ELECTRON MICROSCOPY

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Dressings must perform protective and therapeutic functions and, at the same time, they must possess certain essential properties: they must be atraumatic, must have some degree of absorptive capacity, must be airtight, must prevent the entry of infection into the wound, and must facilitate wound healing. These properties depend both on the type of material, the type of adhesive and its distribution, porosity, and the character of interaction between the wound and the apposed surface of the dressing. Various methods are used to investigate the characteristics of dressing materials: bacteriological, autoradiographic, physicochemical [1]. Scanning electron microscopy (SEM) is becoming increasingly popular as a method of studying synthetic polymers for use in medicine [2, 4, 5]. However, no published data on the use of SEM to study the properties of dressing materials could be found.

The aim of this investigation was to determine the value of SEM as a method of studying the properties of dressing materials, their behavior on wounds, and the state of wounds after a period of time beneath dressings.

EXPERIMENTAL METHOD

The following dressing materials were studied by SEM: Soviet adhesive nonwoven dressings with adhesives consisting of acrylic emulsion No. 25 and Primal E-358 (from Rohm and Haas, USA) the surface of which was covered with aluminum, and also Alu-tex dressing, from Ortmann Verbandstoff, 1195 Vienna, Austria, a Soviet nontraumatic, nonwoven two-layered material, and an imported dressing Cederroths Beogstoppare (Sweden) made of similar material, bactericidal Kapron gauze, and a dressing made from Kombutek K-2.

Specimens for investigation were prepared as follows: the original samples were dried and the test surface sprayed with silver. Samples of dressings after wound treatment and pieces of wound tissue were fixed in 3% glutaraldehyde solution in phosphate buffer (0.1 M, pH 7.4), dehydrated in alcohols of increasing strength, dried, and sprayed with a layer of silver. Contact surfaces between dressings and wounds and, if necessary, transverse sections through the dressings,* were examined in the ISM-2 scanning electron microscope (from "Jeol," Japan).

The type of distribution of the adhesive, the state of the dressing after application to the wound, and the wound surface were investigated. The functional properties of the dressings were judged on the basis of these results.

EXPERIMENTAL RESULTS

Examination of the original samples of dressing materials revealed structural differences between the dressings and the type of distribution of the adhesive. For instance, differences were found in the type of distribution of the adhesive on Soviet metallized nonwoven material and its imported counterpart. Imported specimens mainly had what is described as a point structure, in which most of the binding material is distributed at point zones, where the cemented fibers intersect. In Soviet dressings the adhesive envelops the fibers and is distributed mainly in the form of segments in the spaces formed by the intersecting fibers [1].

*The photographs were taken by engineer S. G. Prutchenko (L. Ya. Karpov Institute of Physical Chemistry).

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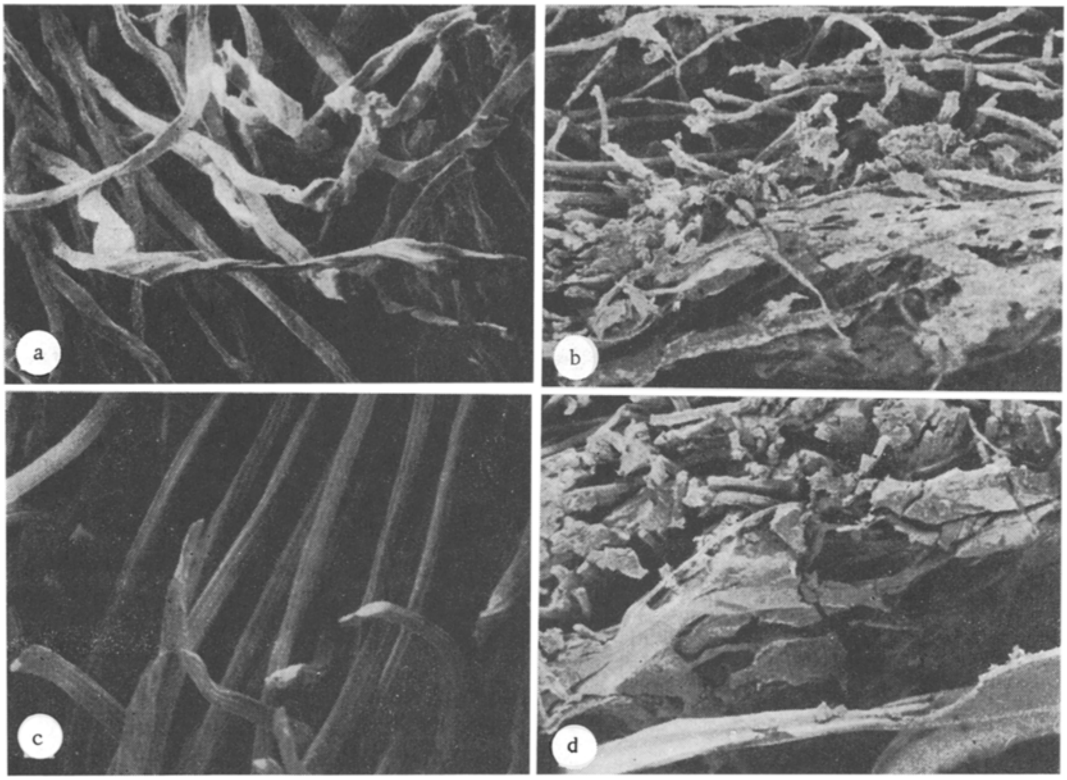

Fig. 1. Contact surface and transverse section through samples of Soviet nonwoven two-layered dressing material (a, b) and imported dressing from Cedarroths Beogstoppare (c, d). a, c) Original, 300 ×; b, d) after application to wound, 100 ×.

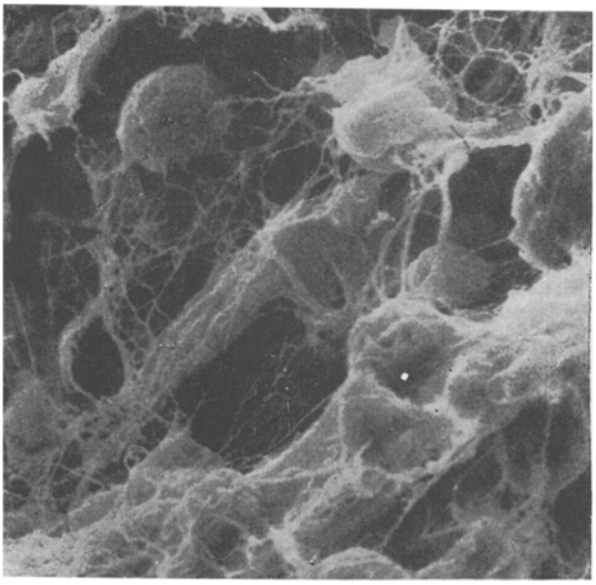

Fig. 2. State of wound surface on 8th day after treatment with dressing made from Kombutek K-2. 3000 ×.

Structural differences between the original dressing materials also were reflected in their interaction with the wound. After application to models of a wound surface the structure of the imported metallized dressing remained virtually unchanged. Fibrin clots formed in the spaces between the fibers. Cracking and detachment of the adhesive were observed on the dressing of Soviet manufacture [1]. The surface became nonhomogeneous and loose, evidence of differences in the degree of adhesion of the dressing to the wound surface. These findings correlate well with results obtained by laboratory investigations of the degree of adhesion of the dressings [1].

Investigations of a dressing in which the layer in contact with the wound consisted of bactericidal Kapron gauze showed, after application to a wound, that the areas of deposition of fibrin clots on the surface next to the wound were very small. Most of the surfaces remained for practical purposes clean [3]. This fact is evidence that this dressing is nontraumatic. The absence of deposition of fibrin in the interspaces of bactericidal gauze also ensures that the absorptive layer of the two-layer dressing lying above it can work well.

To study the properties of nonwoven two-layer dressing materials by SEM the contact surface and a transverse section through a Soviet product and its imported counterpart were investigated. The absorptive part of the Soviet material consisted of cotton and viscose fibers (Fig. 1a). After application to a wound on an animal, dense deposition of clots of wound exudate was observed in the lower layers adjacent to the wound (Fig. 1b). By contrast with the Soviet two-layer material, the absorptive layer of the imported product consisted of more regularly oriented viscose fibers (Fig. 1c). Absorption and deposition of fibrin clots took place more regularly in this product throughout the thickness of the layer (Fig. 1d). These distinctive features of the behavior of dressings on wounds also enabled functional properties of the dressings such as differences in the rate of absorption of wound exudate to be estimated qualitatively.

The dynamics of wound healing after application of various dressings can also be studied by SEM (Fig. 2). Fibroblasts and a network of collagen fibers could be found on the wound surface after treatment for 8 days with dressing made from Kombutek K-2, evidence that this dressing has a beneficial effect on regenerative processes in the wound [3].

SEM can thus be used to detect the effect of structural differences between dressings on their atraumatic qualities, to evaluate the absorptive power of dressings, and to study the dynamics of wound healing under dressings.

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