THE USE OF DRY OXIDIZED CELLULOSE AS A PRIMARY HEMOSTATIC AGENT IN NEUROSURGERY

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Oxidized cellulose was first described by Yackel and Kenyon\(^{11}\) of the Eastman Kodak Laboratories in 1941. This material consists of cellulose in the form of cotton, gauze, or paper, which has been subjected to oxidation by nitrous dioxide; as a result of this, carboxyl groups are formed, which render the material soluble in dilute alkali.

In 1943, Dr. Virginia Kneeland Frantz,\(^2\) College of Physicians and Surgeons, Columbia University, published a description of experiments in which oxidized cellulose had been implanted in the abdominal muscles, brain, dura, joint cavities, and peritoneal cavity of dogs and cats. Dr. Frantz reported that in all but one of the experiments, the oxidized material had been completely absorbed within 4 weeks. Whether the disappearance was due to solution, or to digestion by phagocytes, she could not say. Tissue reaction at all stages was negligible. Proliferation of connective tissue and glia was minimal; no adhesions were found between dura and brain or within joint cavities.

Dr. Frantz and her associates\(^6\) then reported further experiments in which they introduced packings of oxidized cellulose into surgical wounds in experimental animals. The second part of that paper included a report of 17 clinical cases contributed by various surgeons, in which control of bleeding had been achieved by the use of oxidized cotton.

In all of these experimental and clinical cases, the oxidized cellulose was used in the form of a surgical pack; its hemostatic effect was attributed entirely to the pressure exerted by the pack against the oozing surfaces.

A specific hemostatic property of oxidized cellulose was first cautiously suggested in a report by Frantz\(^3\) in April of 1945, in which she stated, “in handling the soluble gauze it became apparent that it had *unexpected hemostatic action in its own right.*” This specific hemostatic property was repeatedly described in subsequent communications by these authors.\(^4,5,7\) In all of these reports, they emphasized that this action was most effective when the material was used dry; when moistened, even with thrombin, its effectiveness was reduced.

It is important to distinguish between the use of oxidized cellulose as a primary hemostatic agent, and its use as an inert absorbable carrier for other recognized hemostatic agents such as thrombin. The use of oxidized cellulose as a mechanical carrier was first reported by Putnam\(^8\) and subsequently by

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Cronkite et al.\textsuperscript{1} and by Uihlein et al.\textsuperscript{9,10} None of these men was aware of the specific hemostatic properties of the oxidized cellulose.

Dry oxidized cellulose as a primary hemostatic agent in neurosurgery was first used at the Neurological Institute in April, 1944, by one of the authors (B.S.). Since that time, it has been used in approximately 2000 neurosurgical operations at this hospital. In none of these cases has the oxidized cellulose been used as accessory to another hemostatic agent.

Oxidized cellulose is available in two forms, cotton and gauze. The cotton is better adapted to neurosurgical technics. This material is packaged in such a way that secondary sterilization is unnecessary, rendering it immediately available to the surgeon at the operating table.

The greatest usefulness for this agent lies in the control of persistent oozing from broad surfaces. A thin layer of oxidized cellulose may be pressed against the under surface of bone in an osteoplastic flap to supplement waxing. Oozing from dural surfaces may be effectively controlled by placing small, thin pledgets of the oxidized cellulose directly over the bleeding point and holding it temporarily in place with a strip of dry cottonoid. Hemostatic action usually takes place within 30 seconds. Bleeding from Pacchionian granulations is effectively dealt with in this same manner. Small tears in the dural sinuses can likewise be controlled this way, although the texture of the material and its early absorbability render it unsatisfactory for the permanent repair of larger tears.

Small flat pledgets of oxidized cellulose may be applied directly to the brain itself to control bleeding from small vessels, either on the pial surface or from the raw surfaces remaining after cortical incisions. The method of application here is identical with that described for the dura.

In the sub-total removal of gliomata, intracapsular enucleation of tumors, and even in simple cavities left after the removal of encapsulated neoplasms, there often remain surfaces from which considerable oozing persists. Oxidized cellulose is particularly valuable in these situations. In many instances, the mere application of a thin sheet of the material against the oozing surface will suffice. In other cases where the bleeding is more brisk, the oxidized cellulose may be used as a surgical pack, in which the hemostatic effect of pressure is added to the specific hemostatic action of the cellulose. In this use, it has great advantage over other packs in that the bulk of the packing may be removed from the cavity after a few minutes, leaving a thin film affixed to the surface of the tissues to continue hemostasis. The removal of this type of pack does not cause fresh bleeding. The bleeding from hemangiomata affords a field of especial usefulness for this material.

In spinal surgery, oxidized cellulose is useful in controlling oozing from the lateral veins of the extradural plexus. Bleeding from small vessels on the surface of the spinal cord itself can be quickly controlled with small pledgets of the cellulose.

Bleeding from the stumps of peripheral nerves which have been resected and prepared for suture may be stopped by the application of small pledgets of the oxidized cellulose.