A SAFE SURGICAL SPONGE

EDWARD F. LEWISON, M.D., New York, New York

THE loss of a surgical sponge is a most deplorable accident. Yet the medical literature has shown an almost complete indifference toward this operative catastrophe. The development of operating room procedures to contend with this problem has been, for the most part, a measure of prophylaxis. The "sponge count," the use of "stick sponges," the metal-clipped or ringed laparotomy pads, the wire-threaded sponge, the "sponges on a string," and the continuous sponge are all important precautions primarily designed to prevent the losing of a surgical sponge. The meticulous regard with which the surgeon and his assistants are trained to convoy each free piece of gauze placed within the operative field is a tribute to the care and caution needed to preclude the possible inclusion of a tampon within the incisional closure. Despite these measures, some of which are inadequate and objectionable and others cumbersome, "lost" surgical sponges and laparotomy pads remain a rare but corrigible cause of grief after operation.

The problem of the missing sponge will continue to be a surgical hazard, regardless of the virtues of the many present plans of prophylaxis, as long as individual sponges are so used. Fundamentally, the safeness of a "lost" surgical sponge must exist in the ease and manner of its redemption and the facility with which it can be rapidly recognized, localized, and readily retrieved.

Interest in this problem was stimulated several years ago when a patient was admitted to the Johns Hopkins Hospital with a persistently draining sinus 1 year after an appendectomy. The diagnostic possibility of the presence of a gauze foreign body was naturally pre-eminent, yet the hazards of an operative exploration were considerable, thus making the problem a difficult one.

Of approximately 27,250 abdominal operations performed at the Mayo Clinic[1] over a 5 year period, 13 were for the removal of a gauze foreign body. As statistical accuracy is rather difficult to obtain, it may be reasonably assumed that a certain number of retained sponges may be compatible with good health, and similarly a certain number responsible for early death after operation.

These and similar experiences have prompted this investigation for a reliably redeemable surgical sponge. The character and extent of this research have resulted in the experimental use of all the known radio-opaque substances in the hope of producing a safe surgical sponge which might be readily detected on an x-ray film. Inasmuch as ordinary cotton gauze casts no x-ray shadow, it was not until the recent advent of glass fiber in the manufacture of fabrics that a practical and satisfactory solution to this problem was found. By incorporating into the gauze mesh a single strand of glass thread specially prepared with a predetermined lead content, a surgical sponge harmlessly inert and of marked radio-opacity was produced. Whether the introduction of lead glass thread will have an even more extensive use in the future field of surgery is at present difficult to say. However, further study along such lines is now in progress.

MATERIALS AND METHODS

Thus, with the objective well in mind—that of finding a safe and satisfactory tampon that would cast a permanent x-ray shadow—a systematic search to investigate each of the many well known radio-opaque contrast media was begun. Attention was first directed to the iodides because of their relatively high radio-opacity and the frequency with which they are so employed. Several small squares of sterile gauze mesh were first immersed in solutions of sodium iodide of various strengths, namely, 7½, 15, 25, 50 per cent, and a saturated solution. These squares were carefully sutured in sequence to the parietal peritoneum of a dog and x-ray films were taken at weekly intervals to determine the opacity of the shadows cast. It was found that all shadows disappeared in a period of 4 weeks, and the time of disappearance varied directly with the strength of the solution used. The factors responsible for this loss of radio-opacity in so short a span of time are speculative. However, it may be assumed that the sodium iodide entered into solution with the surrounding body fluids and was rapidly diffused throughout the body.

From the Division of Surgery, Northwestern Medical School and Passavant Memorial Hospital, and the Department of Pathology, Johns Hopkins Hospital.

Dr. Lewison was located formerly in Chicago.

[1] MASSON, J. C. An extra tag on the abdominal sponge. J. Am. M. Ass., 1919, 72:22.

Fig. 1.

Fig. 2.

Fig. 3.

Fig. 1. Film taken February, 1938, 1 month after placing a lead glass-threaded sponge within the peritoneal cavity of a dog. The arrow points to the single strand of lead glass fiber in the left upper quadrant. The gauze mesh of the sponge casts no x-ray shadow.

Fig. 2. Film taken May, 1938, 4 months after placing the sponge. The arrow points to the lead glass fiber.

Fig. 3. Film taken September, 1938, 8 months after placing the sponge. The arrow again points to the lead glass fiber. The 2 additional strands of lead glass thread which are visible in this film are being used to determine tissue reaction.

Further studies of a similar nature, making use of barium, bismuth, thorium, iodized oils, and lead-weighted silk, in a series of 4 experiments using 2 dogs, were made but with disappointing results. Characteristics of the undesirable effects of these materials were: (1) rapid loss of radio-opacity; (2) marked tissue reaction; (3) loss of absorption quality of the gauze mesh; and (4) difficulties relating to the physical properties of the contrast media used. These serious objections were sufficient to make their use inadvisable.

As previously mentioned, the recently extended use of glass thread, made by forcing potassium silicate through many minute holes with high pressure steam jets in the field of textiles, has given added zest to the successful solution of this problem. Sample fibers of glass thread were obtained for experimental study. Ordinary glass thread, however, cast no x-ray shadow, yet it seemed that this material was admirably well suited for its intended purpose. Its pliancy, delicacy, and high tensile strength, in addition to its

Fig. 4.

Fig. 5.

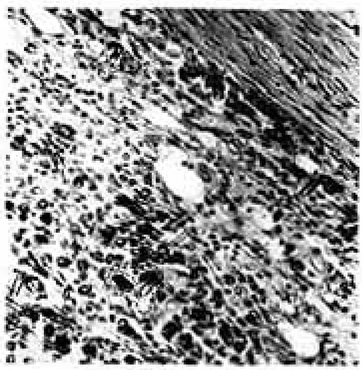

Fig. 6.

Fig. 4. Section of rectus muscle 48 hours after implanting a large thread of lead glass fiber. Oval space at top of section represents site at which thread was placed. Moderate leucocytic tissue reaction. ×80.

Fig. 5. Section of subcutaneous tissue 1 month after implanting a thread of lead glass fiber. Low-grade tissue reaction; marked connective tissue proliferation. ×190.

Fig. 6. High power magnification of section shown in Figure 5. Characteristic mononuclear cellular response. Fibroblastic activity indicates reparatory process. ×400.

Fig. 7. Roentgenogram of the right upper quadrant of an obese female. The lead glass thread is clearly defined between a gall stone and residual barium in the large bowel.

negligible cost of production, were factors of considerable importance. Further study found it possible to alter the chemical composition of the glass thread. By the addition of lead to the potash silicate, a strand of glass thread could be produced of such radio-opacity that the x-ray shadow cast was of a density equal to that of bone. It was then feasible to interweave a single strand of this lead glass thread, composed of innumerable minute fibers .0002 of an inch in diameter, into a small square of gauze mesh and place it within the abdominal cavity of an experimental animal. X-ray films were taken at bi-weekly and then monthly intervals over a period of 8 months to determine its permanence and opacity.

After 1 month (Fig. 1) the x-ray film showed clearly the presence of the lead glass-threaded sponge in the upper left quadrant of the dog's abdomen. Four months later (Fig. 2) the film revealed no appreciable change in the thread's radio-opacity, and from the shadow cast it could hardly be confused with any other structure in the body. At the end of 8 months a lateral film (Fig. 3) again confirmed the permanence of the opaque shadow and gave no evidence of its possible loss of contrast density. This gave rather conclusive proof that radio opaque lead glass thread retained a remarkable longevity and could be used expediently in this capacity, should its other properties prove desirable.

The 2 additional strands of lead glass thread that strikingly stand out in Figure 3 were placed within the abdominal wall to determine the tissue reaction of this thread. Blocks of rectus muscle and subcutaneous tissue were resected at intervals of 1, 2, 7, 14, 30, and 240 days. A section through the rectus muscle (Fig 4), 2 days after implanting a heavy piece of lead glass thread, reveals only a moderate leucocytic infiltration in the adjacent muscle. The tissue reaction seems well localized and no greater, considering the incident trauma, than that stirred up by catgut of a similar size. Glass thread, like glass, is a relatively inert substance and would be expected to cause a minimum amount of tissue reaction. After 30 days (Figs. 5 and 6) a section of abdominal subcutaneous tissue clearly illustrates the glass thread, fragmented in the preparation of the section, and the low-grade mononuclear cell infiltration that is present. New connective tissue proliferation is conspicuous and is an important part of the animal's reparatory process.

Figure 7 represents the radio-opacity of a lead glass-threaded sponge when filmed through the tissues of an obese female. The thread is clearly defined when contrasted with the opacity of a gall stone above and residual barium in the large bowel below.

SUMMARY

The "lost" surgical sponge is frequently a disastrous mishap. Because the present methods of sponge control are only partially satisfactory, this investigation was undertaken in the hope of providing a readily recognizable safe gauze tampon. All of the commonly known radio-opaque materials were exploited to this end and none found to be practically expedient. A specially prepared product, namely, lead glass thread, was found to embody these qualities: marked radio-opacity, permanent radio-opacity, minimum tissue reaction, negligible cost of production, chemical inertness, pliancy, delicacy, and appearance resembling white silk thread. As a result a single strand of lead glass thread may be interwoven in surgical gauze mesh and the *presence* and *location* of the "lost" sponge determined with facility.

Mr. H. P. Hood and Mr. G. V. McCauley, Corning Glass Co., were most helpful in preparation of lead glass thread.