A Method of Transplanting Gastric Mucosa to the Anterior Abdominal Wall of the Rat for the Local Application of Carcinogens*

EDNA W. TOOVEY, LEON HELLER, and D. R. WEBSTER

(Experimental Surgical Laboratories, McGill University, Montreal, Canada)

INTRODUCTION

The incidence of spontaneous gastric adenocarcinoma in experimental animals is extremely low (1, 2, 8, 10, 13), and it is difficult to produce this neoplasm experimentally with carcinogens (4, 5, 11, 12). Technics for transplanting gastric mucosa to the anterior abdominal wall of cats and dogs for the study of gastric physiology have been described (3, 6, 7). No study has been published, however, on the use of this procedure for gastric cancer. A simple method for exteriorizing a portion of the glandular stomach of the rat onto the anterior abdominal wall for the local application of carcinogens is described, with some observations on the changes in the gastric mucosa caused by this exposure.

METHOD

Piebald male rats of the Royal Victoria Hospital Colony, weighing 150-200 gm., were used for the operations. They were all 2-3 months of age, but were chosen on the basis of weight rather than age, because it was found that the stomachs of rats weighing less than 150 gm. were too small to handle easily, and rats weighing more than 200 gm. had so much fat in the mesentery that the right gastro-epiploic artery could not be seen clearly at the operation. On the day before operation the rats were weighed, and the food was removed from the cages, but water was allowed ad libitum up to the time of the operation.

The instruments, sutures, sponges, and drapes were all sterilized for 15 minutes in an autoclave at 15-lb. pressure just before the operations were started but were not sterilized again during a session of 3 or 4 operations. No sterile gowns, masks, or gloves were used, since a brief hand scrub was found sufficient to prevent peritonitis.

The rat was anesthetized lightly with ether in a glass jar, removed, and tied to the operating board. The ether anesthesia was continued intermittently by the use of a 50-cc. beaker as an ether cone. A layer of cotton was placed in the bottom of this beaker and moistened with ether. The hair was shaved off the left side of the abdomen, tincture of merthiolate was applied, and a small sterile drape sheet was placed over the rat, with the edges tucked under the operating board.

A left rectus muscle-splitting incision, starting just below the costal margin, was extended downward for 3 cm. The stomach was delivered into the incision with a smooth forceps, and the mesentery along the greater curvature was held up to the light. The arcades of the right gastro-epiploic artery were then seen clearly, so that a clear space near the pylorus could be perforated with a fine, pointed forceps (Fig. 1). The tip of one blade of a curved Halstead hemostat was then inserted through this hole, and the blades were closed tightly, thereby crushing together a very narrow strip of the anterior and posterior walls of the stomach. This procedure left the blood supply via the right gastro-epiploic artery intact to the greater curvature, which constituted the flap, and, by crushing the tissue, provided hemostasis on the cut edges. The blades of the curved Halstead hemostat used in this operation were filed down to 1 mm. in width, so that only a small amount of tissue was lost by crushing. When placing the hemostat on the greater curvature, care was always taken to include an adequate segment of glandular tissue without any squamous forestomach, but, at the same time, not to impinge on the pylorus. Four No. 60 black cotton sutures, with the ends left 8 cm. long, were then placed on the greater curvature close to the hemostat to serve as stay sutures in the four corners of the future flap (Fig. 2). A scalpel was used to sever the greater curvature from the stomach, while the stay sutures were held taut so that the arterial supply in the mesentery was not damaged with the scalpel. Then this detached portion of the stomach was laid to
PYLORUS
DUODENUM
RT. GASTRO-EPIPLOIC ARTERY, SHOWING ARCADE
MESENTERY
FORESTOMACH (RUMEN)
STOMACH
BLACK SILK ARTERY SUTURE
STAY SUTURES
HALSTEAD
FREE END OF SUTURE
PEDICLE
PARKER-KERR CLOSURE OF STOMACH
MESENTERY
STAY SUTURES
SMOOTH FORCEPS
STAY SUTURES THROUGH FLAP AND LT. RECTUS MUSCLE
MUCOSAL SURFACE OF FLAP
Fig. 1.—Rat’s stomach, showing the right gastro-epiploic artery with the arcades to the glandular stomach.
Fig. 2.—Greater curvature crushed with the Halstead hemostat, showing the four stay sutures.
Fig. 3.—Parker-Kerr closure of the stomach over hemostat.
Fig. 4.—Identification of structures in Figure 3.
Fig. 5.—Stomach closed by Parker-Kerr suture, with reinforcing sutures in place.
Fig. 6.—Left rectus incision closed with interrupted sutures above and below the pedicle to the flap.
Fig. 7.—Flap anchored to left rectus muscle by four stay sutures.
Fig. 8.—Skin edges sutured snugly around the flap.
the right of the incision on the abdominal wall and covered with a sponge moistened in warm saline solution.

A Parker-Kerr method of closure (9) over the hemostat on the cut edge of the stomach was then done with a five-zero black silk artery suture on a curved atraumatic needle (Figs. 3, 4). Several interrupted reinforcing sutures of the same material were placed along the line of closure (Fig. 5), and the stomach was dropped back into the abdominal cavity. The split left rectus muscle was closed with interrupted sutures of No. 60 black cotton by catching the muscle wall beneath them (Fig. 8). The operating time for this procedure, without an assistant, was usually 30 minutes.

There was very little blood lost during the operation, and the rats were active and drank water within a few minutes. No food was given until 24 hours after the operation.

Skin sutures were removed on the seventh postoperative day, because stitch abscesses developed if the sutures were left in place. By the tenth day, the flaps were well established, and treatment with carcinogens could be started.

RESULTS

More than 300 operations have been done by the use of this technic. Of these animals, 67.5 per cent had good flaps. In 27 per cent the flaps dried up or sloughed off, usually within 10 days after operation. The operative mortality was 5.5 per cent, pyloric obstruction being the major cause of death.

DISCUSSION

After operation, the rats have remained sleek and have gained 3–5 gm. each week, but it has been impossible as yet to tell whether the operation has shortened their life span. A dozen rats with good flaps, from the first series of operations done 15 months ago, are still alive and in good health. Two animals have always been kept in each cage and have never been known to damage each other’s flaps.

The skin has always grown closely around the flaps without overgrowing them or ulcerating from the gastric secretion. In 2–3 months after the operation, the flaps have grown thicker and have secreted copiously. Microscopic examination of the flaps has shown that the gastric glands remain, but all the gland cells contain mucin granules when stained with Southgate’s mucicarminic stain.

SUMMARY

A simple operating technic for exteriorizing a portion of the glandular stomach of the rat onto the anterior abdominal wall has been described. Good flaps have been obtained in 67.5 per cent of the operations. The rats have remained in good health after operation. Microscopic examination of the flaps has shown that the gastric glands remain, but that all the gland cells contain mucin granules.

REFERENCES

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