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PREVENTION OF REFLUX ESOPHAGITIS WITH TISSUE VALVE

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A condition of reflux esophagitis following an excision of the esophago-gastric junction seemed to be a common complication as its percentage of incidence is fairly high according to various authors.^{1)~6)} It has been known that it is one of the most undesirable complications in esophago-gastric surgery. To prevent reflux esophagitis, the following operative procedures have been attempted besides conservative corrective methods which were known. 1) Decreasing of acidity of the gastric juice,^{7)~10)} 2) accelerating discharge of gastric contents,⁸⁾¹⁰⁾¹¹⁾ 3) isolation of the esophagus from digestive juice or interposition of the bowels,^{12)~18)} 4) utilization of a valve, such as an ileocecal valve, as a substitute for the cardia,^{19)~22)} and 5) surgical construction of a valve to replace the cardiac sphincter.^{23)~26)}

Recently, with the progress of various diagnostic technics, diagnosis of the cardiac malignancy of the stomach is possible even in early stage, and radical surgical operation of the lesion has been made. From physiological consideration of digestion and absorption,^{27)~31)} the choice of approach would be that unaffected stomach should be preserved as much as possible after resection of the cardia to make reconstruction in a condition much closes to physiological function. Of these methods, Dillard's valve is most famous, but whatever may be the case in the animal experiments, there are some difficulties according to the reports, and the valve failed to function completely because of utilizing an esophageal wall as a part of the valve.³²⁾ We have tried to study by making various valves experimentally in esophago-gastric anastomosis and were able to prevent reflux and which were confirmed by means of postoperative X-ray examination, measuring pH of digestive juice and avoidance of valve pressure, and proved to check occurrence of reflux esophagitis, substantiated by autopsy and microscopical findings.

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METHODS AND RESULTS

Adult mongrel dogs, weighing between 8~12 Kg., were used without regard to sex. To empty the stomach completely neither food nor water was given from the day before surgery. For anesthesia 0.125~0.25 gm. of hexobarbital or pentothal sodium was used intravenously for induction 20~30 minutes after subcutaneous application of 2 % morphine hydrochloride as a premedication. An endotracheal tube had been intubated and a closed circuit anesthesia was maintained with ether. Blood transfusion was performed in proportion to blood loss, with liquid transfusion. Chemotherapy was made intramuscularly for four days, and physiological saline solution and polytamine (amino acid preparation) were taken subcutaneously twice a day for three days and then liquid food was taken perorally, changing gradually to solid food.

The following five methods were used.

Method I: As a preliminary experiment, after the cardiac end of stomach was removed and the lower end of esophagus was made to protrude into the gastric lumen and followed with an esophago-gastrostomy and incorporated with a pyloroplasty. (Fig. 1)

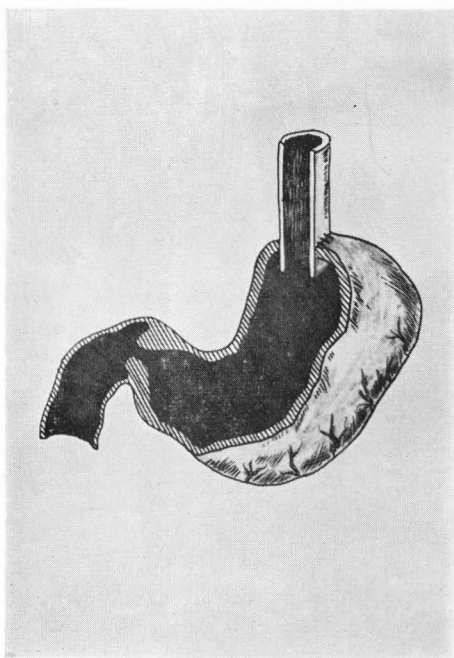


Fig. 1. Method I; showing that the lower portion of esophagus was made protrude into the gastric lumen.

Four dogs were used in this method. The autopsy revealed that macroscopically the protruded esophageal end had been invaded by gastric juice, and stenosis developed or the valve had thickened. In long-term survival dogs, the valves were constricted cicatricially and inverted to the oral side, acting as an opposite valve function. Because of shortening of the protruded esophageal end regurgitation into the esophagus was quite marked and the results seemed to be unsatisfactory. Microscopical finding revealed advanced inflammatory changes of the esophageal end which was protruded into the gastric lumen.

Method II: After removing the cardia and followed by an esophago-gastrostomy, the anterior wall of stomach was sutured and folded wrinkled in the direction of right angle to the longitudinal axis, and a lingual valve consisted of double whole gastric layers was protruded into the gastric lumen and finished with pyloroplasty. (Fig. 2) Four dogs were used. An autopsy showed that there was a stenosis developed in the area

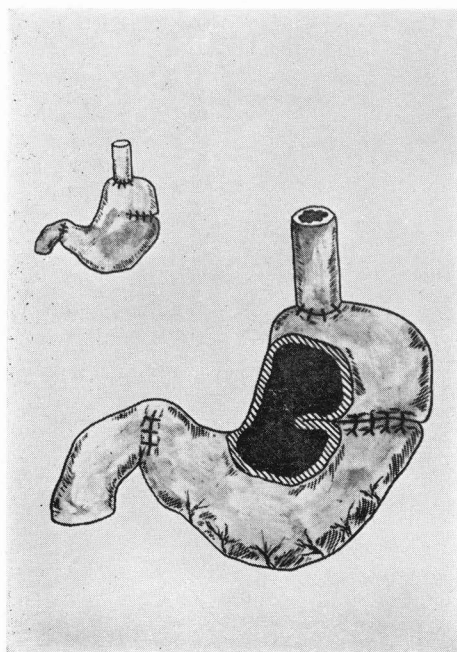


Fig. 2. Illustrating Method II. A valve was made with the anterior wall of stomach and folded wrinkled in the direction of right angle to the longitudinal axis.

of valve or with marked thickened lingual valve. In a long-term survival case, the valve was shrunken due to cicatric formation which seemed to present like a part of gastric folds. (Fig. 2)

X-ray examination of these cases which survived longer than 2 weeks were made and especially to make note of presence of reflux by test making the head low inclined to 30° or by pressing gastric portion by the palm of hand. Food passed the anastomotic portion with no difficulty though stenosis had developed in the valve portion. Dilatation of the esophagus and a part of stomach above the valve was seen. Reflux of the barium from the upper cardiac end was most noticeable, but when barium reached the pyloric side it seemed to stay. With a long-term survived dog, regurgitation appeared to be quite marked. Gross examination showed defect of the epithelial layer of the lower esophagus. (Fig. 3)

Postoperative esophagoscopy and measurement of pH in the content of gastric canal as well as X-ray examination were carried out, and no difference was found in the values of pH in both esophagus and stomach. Measurement of the maximum pressure which would prevent reflux was taken by inserting a catheter into the lower portion of stomach from the valve after the laparotomy. Although one case showed fairly high value of the maximum pressure which was possible to prevent reflux, but this was due to insertion of a catheter from the valvular portion down to the pylorus. In normal state it is natural to assume that gastric content regurgitates into the esophagus. The remaining cases failed to prevent regurgitation was due to atrophy of the valve which

had lost its function.



Fig. 3. Macroscopic finding showed defect of the epithelial layer of the lower esophagus. (Method II)

used. The cause of death in most instances was general weakness, but survival period

Method III : After having removed the cardia of stomach the anterior wall of the corpus ventriculi including the serosa and muscle layers was incised longitudinally in the middle of the anterior surface almost 5 cm long from the sectioned cardia. At the lower end of incision an esophago-gastrostomy was performed having the lower esophagus covered by the whole layers of the stomach like a Witzel's gastrostomy. (Fig. 4) While we were engaged in the experiment, Watkins et al. reported a similar method.²⁴⁾ The difference from Watkins' method is that an incision involves the serosa and muscle layers, because of this reason propagation of the gastric internal pressure may be more effective ; and slight or cicatritial stenosis following adhesion may develop in mucosa alone than in whole layers as Watkins' method. Fourteen dogs were

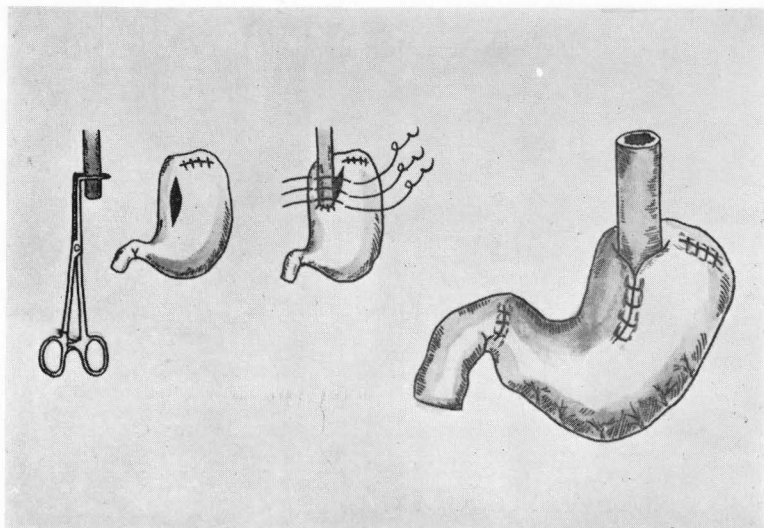


Fig. 4. Method III ; showing that the lower portion of esophagus was covered by the whole layers of the stomach.

in this group was longer than groups I and II.

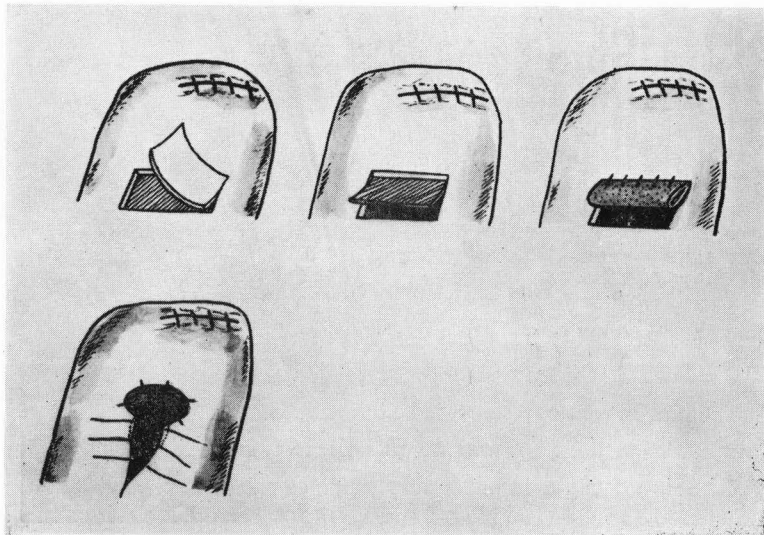
At autopsy, local finding showed better results, exclusive of two dogs of which one developed erosion in the anastomotic portion and while the other showed erosion and redness in the lower esophagus and reflux of the gastric contents into the esophagus. Microscopically in these two dogs, there were found inflammatory changes from the anastomotic portion to the lower esophagus.

X-ray examination showed generally finding of reflux prevention by making either head low or pressing stomach. However, one dog showed a temporary stagnation of barium in the anastomotic portion, and some showed little regurgitation of barium. This phenomenon presumably proves preventive mechanism by this valve. The values of pH in the esophagus and stomach were found to be identical as compared with the preoperative values. In two dogs the maximum pressure was measured and both showed the relative high values with fairly good results.

Methods IV and V : In the anterior wall of the stomach, an area of 7×4 cm. including the serosa and muscular layer was incised and a valvular structure was constructed with the exposed mucosa. Both right and left lateral borders of the exposed mucosa of the pyloric side were cut and replicated. The fold composed of double mucosa layers was made in pipe form by suturing right and left borders, thus, a valve composed exclusively of gastric mucosa was prepared. An esophago-gastrostomy was performed in the cardiac end of the valve and finished with pyloroplasty.

Postoperative examinations have revealed later that satisfactory functional results for preventing reflux have been obtained, and the similar valve was made in the cardiac stump of the stomach (method V.). (Fig. 5)

In group IV. there were ten dogs used and sixteen dogs in group V. The main



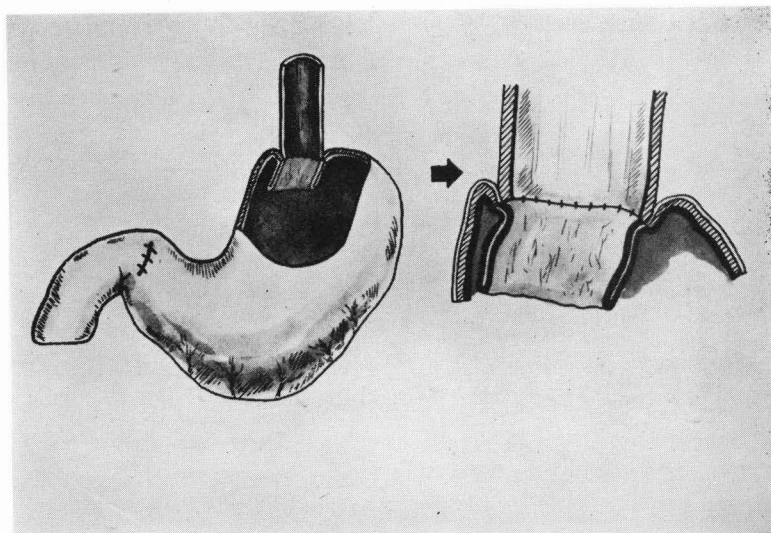


Fig. 5. Method IV & V. Illustrating the method of constructing the valve with the exposed mucosa.

cause of death was general weakness, but survival periods could be prolonged markedly than those of methods I.-III.

X-ray examination follows up with those dogs survived longer than two weeks were made. In early stage some showed a temporary stagnation of barium in the area of anastomosis presumably due to edema or hematoma. Most animals showed uninterrupted passage and no reflux had occurred even making the steep Trendelenburg position having inclined to 30° or in pressing the stomach by palm of hand. (Fig. 6) Postoperative pH of the stomach showed lower acidity probably due to pyloroplasty or vagotomy. While esophagus showed almost same values, comparing with preoperative ones. In measuring the maximum pressure of preventing reflux, most dogs indicated high values.

At autopsy, most dogs showed no pathological findings in the lower esophagus, and only few developed slight inflammatory changes microscopically, but there were no defect of epithelium or ulcer to be found. In the epithelium of the oral side of the

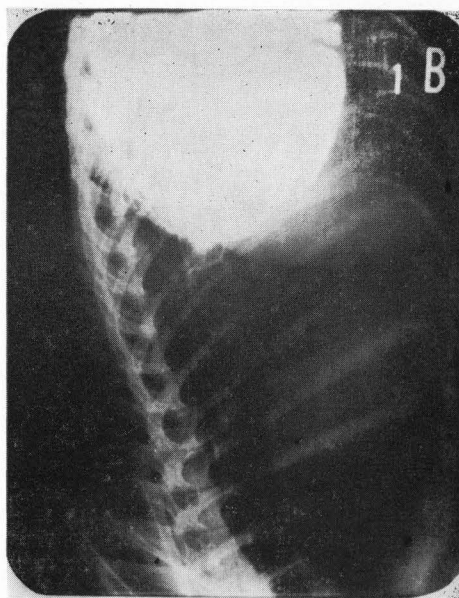


Fig. 6. No reflux with steep Trendelenburg position was proved by X-ray examination.



Fig. 7. Photo illustrates no pathological findings macroscopically in the lower esophagus. (Method IV)

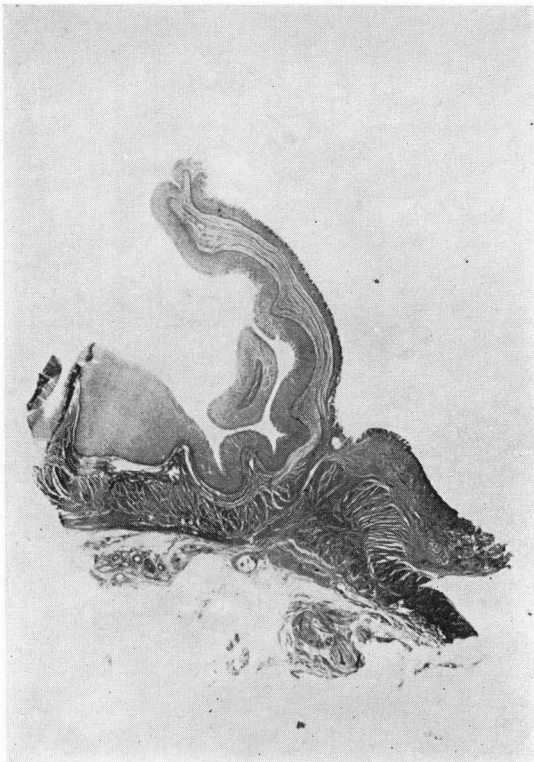


Fig. 8. Showing no microscopic findings on the valve made with gastric mucosa.

valve there occurred a metaplasia.

(Fig. 7 8). Few dogs showed slight inflammatory changes at the site of anastomosis and hematoma in the valve, but no dogs ever showed esophagitis clear cut.

DISCUSSION

To prevent reflux esophagitis we have tried ileocolic grafting including ileocecal valve. Experimental and clinical trials have given satisfactory functional results. It has been known, however, the method is commonly indicated in total gastrectomy when an lesion is localized in the lower esophagus or the cardia; it is the most satisfactory method to construct a surgical valve as substitute of the cardia.

A notable method of preparing a surgical valve is by Dillard's.²³⁾ This is done by using a part of the esophagus as the valve, but the human esophagus has thicker wall than that of dogs, hence, valvular function would be unsatisfactory. And relatively a longer part of esophagus had to be used which is likely to be invaded by gastric juice. From these reasons, this method may not be so effective clinically as Dillard's which has been pointed out by Ishikawa et al.³²⁾

While we were experimenting, Watkins et al. reported a similar method as our method III.²⁴⁾ While our result is not comparable to Watkins' report, it is necessary to have a long normal esophagus, as esophago-gastrostomy must be performed in the fairly lower part of the stomach the method is less suitable in clinical application.

Redo et al.²⁵⁾ reported a new method of using esophago-gastrostomy and to prevent reflux a submuscular tunnel was made in the stomach, but it is often required fairly longer normal esophagus and yet it is hardly possible after excision of the lesion.

Adler et al.²⁶⁾ attempted a new trial, by making a fundus tunnel with use of plastic sling tunnel and nylon diaphragm replacement with plastic crus. There may be some problems left in the method and valve function.

Our attempt was to construct a new surgical valve and to make postoperative follow up investigations. In the method I., the lower end of the esophagus was made to protrude simply into the stomach but esophageal end could be readily invaded by gastric juice; this resulted in either stenosis or shortening, or hypertrophy developed. Without fail regurgitation of the gastric contents into the esophagus had occurred.

With method II., the valve had to be constructed in the almost middle of the corpus ventriculi for technical reason. But the method creates detention of food in the upper part of the stomach which may contribute the lower end of esophagus to be attacked by gastric content though low in acidity. It is questionable that the thick valve composed of double whole gastric layers would serve a proper function. Postoperative X-ray examinations revealed unsatisfactory results as it was anticipated.

The method III. is practically identical with Watkins', except an attempt was made so that the gastric serosa and muscular layers were incised in the direction of the stomach having the esophagus placed on it to provide effective valve function. However, the result of our experiment was proved to be less satisfactory than Watkins' and X-ray examination showed some regurgitation until the content filled the gastric lumen.

It is assumed that the valvular mechanism begins to work when gastric content filling the stomach. As to the gastric wall covering the esophagus some differentiation had to be made from the normal condition. From our experience, it was experimentally possible, but as this method requires fairly long esophageal tissue, it is hardly possible to apply clinically.

We have tried to construct surgical valve as a substitute of the cardia with gastric wall, no attempt was made to use the esophagus for the valve. Newly devised methods IV. and V. are to improve above disadvantages. The serosa and muscular layers were removed as much as possible, and postoperative cicatricial constriction of mucosa would be much less. Exclusive of a long-term survived dog, most cases failed to develop stenosis. Postoperative X-ray examination showed temporary stagnation of barium due to edema or hematoma of the valve portion, but it disappeared gradually in a due course of time. Unlike Dillard's method the lower esophageal end especially its mucosa is always demarcated above the valve of gastric mucosa not to be invaded by gastric juice, and no esophagitis could be seen microscopically as well as macroscopically. Moreover, in proportion to the diameter of each esophagus, a valve, very soft and flexible, can be made. For bleeding from separating the serosa and muscle layers and hematoma-formation thrombin for local use seemed to have been effective.

The methods IV. and V. are identical in the valve construction, but the method V. showed slight tension in the anastomotic portion and lesser danger of incomplete suture due to valve construction at the stump of the stomach, comparing with the method IV. The method showed the best results in our series of valve construction after falling off the cardial function and may be applied for clinical use.

SUMMARY

To prevent reflux esophagitis following excision of the cardia, we have tried to study by constructing surgical valves in a space of the gastro-esophageal junction, using 48 dogs, followed by postoperative X-ray examination, esophagoscopy, measuring pH of esophageal and gastric contents, the maximum pressure to prevent reflux including macroscopic and microscopic tissue findings.

The methods I. and II. which were tried in an early period of this experimental series showed poor results. The method III., which was almost similar to Watkins' technique gave unsatisfactory results as Watkins et al. reported. The valve composed of gastric mucosa alone as methods IV. and V. showed fairly good results, that is, the valve is soft and flexible with suitable valve function and hardly any chemical invasion of gastric juice had occurred, and there was no case of reflux esophagitis developed as attested by examinations.

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