EXPERIENCES IN OESOPHAGEAL RECONSTRUCTION*

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Oesophageal reconstruction is a procedure which has received increasing interest, as surgery and especially paediatric surgery have developed. Today every paediatric surgeon can be confronted by patients who require such reconstructions. The cases are, however, so few that no one acquires any large experience. We must, therefore, learn from each other, and this is my modest contribution to our combined experiences.

My earliest memory of a patient who was the object of oesophageal reconstruction goes back to 1925, when I was an intern at the Surgical Clinic of the University of Lund. The patient was a poor, pale boy who suffered stricture after having swallowed a lye solution. He had a stomach fistula and a salivary fistula on the neck. There was only time to treat him during the longer holidays, and I remember that every time he was operated on it all broke down again and one had to start from the beginning with increasingly poor prerequisites.

The method of operation was the same as that published by Bircher in 1907. Bircher, who can be considered to be a pioneer in oesophageal reconstruction, described two cases where he performed an antethoracic reconstruction using a skin tube. This skin tube was covered by pulling over adjacent skin. None of Bircher's cases survived, and I believe no one else either has succeeded with this method because the tension in the suture rows placed over each other becomes too great.

My next experience in this field dates from the beginning of the thirties, when I was Assistant to Dr. Lundblad who was the head of a hospital in the country in western Sweden. He was one of the best doctors and surgeons I have ever seen (Fig. 1), idolized by his patients, adored by his staff, and respected by his colleagues. During 40 years he got up and was present at every night operation. He spent his vacations in Berlin, Vienna and Paris, visiting the larger surgical clinics. He educated and trained himself in this way until he was one of Sweden's foremost surgeons.

When I was with Dr. Lundblad I had the opportunity of seeing a case he had operated on in 1921, when the patient was 3 years old. This was again a patient who had swallowed lye and suffered from oesophageal stricture. The patient was operated on in one stage. Using an incision in the neck, Dr. Lundblad went down to the thoracic aperture and divided the oesophagus at the place of stricture. After this he made a resection of the transverse colon preserving its connexion with the middle colic artery. The right colon and left colon were anastomosed, after which the transverse colon was pushed up subcutaneously and anastomosed above to the oesophagus and below to the ventral side of

FIG. 1.—Dr. O. Lundblad. Sketch by the author, 1932.

* A paper read at a meeting of the British Association of Paediatric Surgeons in Stockholm, September 1961.

FIG. 2.—Antethoracic oesophageal reconstruction.

the stomach. When I saw the patient he was then 15 years old and in good health. He did not have any trouble at all with his colon/ventricle anastomosis.

Incidentally, I can also tell you a little more about how life proceeded for this patient. One day a few years ago I sat reading a newspaper report of a car accident in which a church caretaker had been killed. The interesting part was that the paper also said that he had at one time been a well-known surgical case operated on by Dr. Lundblad. Consequently the patient had lived without trouble for 40 years after the operation.

In the early 1940's there was increased interest in antethoracic oesophageal reconstructions. In the United States at the Children's Hospital in Boston, a number of antethoracic reconstructions on children were performed, commonly with the use of jejunum or using a combination of skin tube and jejunum. What was new was that these patients had congenital oesophageal atresia, and they were operated on when they were very young. As this had been taking place during the war, we knew little about what was happening on the other side of the Atlantic.

In Europe, at least in Sweden, oesophageal reconstructions were performed using plastic surgery and employing skin tubes and tubed pedicle grafts. This was the method I chose, and the following

is a case from the early war years. The patient was an 8-year-old Finnish boy who had a stricture after having swallowed lye. Our Finnish colleagues had their hands full of work with their wounded soldiers from the front and, therefore, sent him to Sweden, together with several other patients. What complicated this case was that someone had tried to make tube transplants in several places on the ventral side of the body, but had not succeeded and, therefore, the skin here could not be used. I was forced to make the big tube pedicle graft on his back and then swing it in front (Fig. 2).

In this figure we see the transplantation and we also see how the incisions were placed for the planned skin oesophagus. The edges of the skin were lifted and then placed back again to ensure nutrition in the future skin tube. When the reconstruction was finished the upper part of the transplantation was removed. The patient is now 27 years old and works as a radio assembler in Finland.

It can be said that antethoracic reconstructions are unaesthetic, partly on account of the ugly deformations of the chest wall, and partly because of the visible peristalsis often accompanied by borborygmus. However, fluids and solid foods can be transported in a fairly efficient way. Where skin has been employed the patient must sometimes assist the passage of the food into the stomach by stroking the outside of his chest wall. At times strictures develop at one or several of their anastomotic lines, requiring surgical dilatation, a feat which is sometimes difficult because of the devious course of the pathway.

Technically, this procedure is time consuming. On the other hand the operative risk is not particularly great.

Today antethoracic reconstructions are only a memory, but with the development of anaesthesiology and thoracic surgery it became possible to perform intrathoracic reconstructions. The development of paediatric surgery, particularly the treatment of oesophageal atresias, increased interest in this kind of case. There is, as all paediatric surgeons know, a group of congenital atresias (usually without a tracheal fistula) where one cannot consider making a primary anastomosis, but must plan a primary or secondary reconstruction. In the latter operation a gastrostomy is first performed, followed by a marsupialization of the upper pouch of the oesophagus. In intrathoracic reconstructions there are three different organs to choose as a substitute for the oesophagus.

Stomach, jejunum and colon have all been used

in reconstruction of the oesophagus within the thorax.

Stomach. When reconstructing the oesophagus from the stomach it means that an organ which undergoes increasing distension is now placed in a pleural cavity where its space-occupying effects are significant. In addition, an intrathoracic stomach may have difficulty in emptying. The end result of such an operation is reminiscent of the condition of congenital hiatus hernia with brachyoesophagus and a partial ectopic ventricle. I have seen how much trouble such patients have and I know also how difficult it is to free these patients from their trouble. I have, for that reason, never pulled up the stomach to bridge an oesophageal defect in children.

Jejunum. The proximal part of the jejunum can be employed in oesophageal reconstruction (Fig. 3). If the gut is divided a few centimetres distal to the duodeno-jejunal flexure and the segment distal to this is isolated, while preserving the continuity of the arterial arch, the long portion of gut obtained can be used in constructing an oesophagus to lie either through the pleural space or retrosternally. The remaining proximal end of the jejunum is anastomosed in the normal manner according to the Roux-en-Y method. This results in a by-pass of the stomach and duodenum.

It seems that it would be simpler to make an anastomosis between the jejunal transplantation and the stomach, but this is not possible because the jejunal mucosa is sensitive to stomach juice and there is the risk of peptic ulceration.

FIG. 3.—Proximal part of jejunum employed in oesophageal reconstruction. Stomach and duodenum by-passed. Anastomosis according to the Roux-en-Y method.

Potts (1959) has used this method in three patients, who are, as he says, still in good condition three, five and six years after operation. My own case, in which this procedure was used, has proved less satisfactory. The patient developed poorly and had frequent attacks of diarrhoea. I was at last forced to do a gastrostomy, after which his condition improved. He finds himself now in the delightful time of life for a boy when everything that tastes good, such as ice-cream and the like, he eats through the mouth, and less interesting food he accepts through the gastrostomy.

I think I will eventually be forced to operate upon him again; how, I have not yet decided. Gross (1953) earlier had the same poor experience of by-passing the stomach. He believes that the stomach plays an irreplaceable role in the digestive functions and that it is quite necessary during the period of growth of an individual.

Two parts of the colon can be used as a substitute for the oesophagus: colon transversum and colon ascendens. Waterston (1954) and Sherman and Waterston (1957) developed an operation technique in several stages. The transverse colon is led up through a special opening in the diaphragm and then through the left pleural cavity behind the hilus of the left lung. The advantage of this operation is that the cardiac mechanism is preserved, lessening the danger of oesophagitis and ulceration due to regurgitation. My own opinion is that the colonic mucosa is resistant to gastric juice and that this danger is probably quite slight.

In any case, in Mr. Waterston's skilled hands, the method is excellent. Waterston has operated upon 24 cases and there were only four deaths.

I have treated one patient according to Waterston's technique. She was discharged from the hospital in good condition. Two months later she had measles at home. She vomited, and her mother, who was a little bit low, supposed this was a symptom of the measles. The patient died at home as a result of a small bowel obstruction caused by a simple band.

Colon. The ascending colon graft has either been placed retrosternally or in the right pleural cavity, and its lower end anastomosed to the stomach's anterior wall. In this way the graft comes to lie in front of the stomach, the pyloric portion of which rides over the graft's nutritive vessels (Fig. 4).

I have used this method in some cases. Similar oesophageal reconstructions using the right colon have been carried out (Potts, 1959; R. E. Gross (personal communication); Koop (personal

FIG. 4.—Diagram of oesophageal reconstruction using the ascending colon graft.

FIG. 5.—Diagram of oesophageal reconstruction with secondary obstruction of the pylorus. Gastro-enterostomy and enterostomy saved the patient.

FIG. 6.—Diagram of oesophageal reconstruction. The right colon with its vessel is pushed up behind the stomach through the omentum minus.

communication); Battersby, 1953, and Sherman, Mahoney, Dale and Stabins, 1955).

I said that the pylorus may rub against the graft's nutritive vessels. In one of Potts's cases this led to necrosis of the colon. It also may lead to an obstruction of the pylorus. This happened in one of my cases.

I was forced to perform a gastro-enterostomy and an enterostomy. Here is a diagram of all the patient's anastomoses (Fig. 5). It is not a pretty picture. It looks like the wiring diagram for a transistor radio or the cords in an atomic submarine. But it functioned excellently.

Sherman *et al.* (1955) and Neville and Clowes (1960) have recently published cases where the right colon with its vessel was pushed up behind the stomach through the omentum minus after which it was anastomosed as usual. The use of this technique eliminated beyond doubt the risk of suspension of the pyloric region (Fig. 6).

Grafting of either jejunum or colon has usually

not been performed until a considerable time after birth. Potts (1959) has suggested 2 years of age as the optimal time, and blames his one failure on the fact that this patient was only 18 months old at the time of operation. Waterston has usually done this operation at about 6 months. As a preliminary to the final reconstruction in these cases, a gastrostomy is done to permit feeding, and the proximal oesophageal stump led out and opened through the neck for drainage of saliva. After this the patient can be cared for at home until the time is suitable for the final operation.

The present régime of management has, however, serious shortcomings, of which the greatest is the interval between the child's birth and the final operation. During this period the child becomes a part of the family, and his next of kin suffer all the fearful anxiety with which an inevitable, serious operation must be anticipated.

Another disadvantage is the necessity for repeated operations, which in infants may sometimes cause widespread adhesions, which, in turn, lead to alarming situations. Both these disadvantages could be eliminated by a technique which permitted immediate, primary reconstruction, without the need for gastrostomy.

In the autumn of 1959 I had completed a plan for such an operation. Then the question was *when* such a patient would come who required a new oesophagus.

Autumn passed, but not until Christmas Eve did such a patient appear. He was a 1-day-old premature boy who weighed 2,300 g.

He had a high oesophageal atresia. No gas in the stomach or bowel. Diagnosis was atresia of the oesophagus without fistulous connexion with the trachea.

Thoracotomy on the right side was performed first of all and a good proximal oesophagus was discovered, ending blindly in the usual way. The distal portion of the oesophagus proved also to end blindly, but there was a gap of 4 to 5 cm. between the two ends. There was no tracheal fistula. Direct anastomosis was precluded unless the stomach could be drawn up into the pleural cavity. This was not considered desirable, and the operation was proceeded with as planned. The distal oesophageal stump was dissected free as far down as the hiatus oesophagus (Fig. 7). The upper abdomen was then entered through a horizontal incision, and a typical microcolon no thicker than a lead pencil was discovered. The thread-like arteries were easily identified in the fat-free mesentery. The transverse colon was resected, preserving its connexion with the medial colic artery, and the

FIG. 7.—Schematic drawing of the operation.

remaining ends of the colon were anastomosed.

The distal part of the oesophagus, dissected free earlier, was now pulled down into the abdominal cavity and held in position under the diaphragm. Continuing through the omental bursa, behind the stomach, an opening was made in the bursa up through the hiatus oesophagus, and the fine transverse colon was drawn up through the hiatus. No sutures were placed between the diaphragmatic crura and the graft. The colon was stretched up to the proximal oesophageal stump. This was opened and anastomosis carried out between this structure and the transverse colon. Anastomosis was done with a double row of sutures. Just before it was completed, a thin duodenal tube of polythene (outer diameter 2 mm.) was passed through the oesophagus and transverse colon until it appeared in the abdomen. The next step was an anastomosis between the distal end of the colon graft and the stomach. This was made on the posterior wall of the stomach, within the omental bursa. The duodenal catheter was again pulled through and passed on through the small stomach, pylorus and duodenum. The

FIG. 8.—Left, the patient at the age of 4 months. Right, radiograph of the oesophagus.

gastrocolic anastomosis was then completed. The duodenal catheter now lay through the nose, pharynx, upper oesophagus, transverse colon, stomach, pylorus and duodenum, down to the jejunum. In this way it was possible to nourish the child without a gastrostomy, which would in any case be difficult to effect in the tiny stomach. The abdominal wound was closed, and after insertion of a fluted drain in the thorax, this wound was also closed.

The patient tolerated the operation well.

During the following weeks, especially the first week after operation, there was a copious effusion from the right pleural cavity, probably the result of obstruction to venous return from the graft, until adequate venous anastomoses developed. During this period, when peristalsis in the transplanted colon was certainly absent, it was possible to feed the child through the catheter which lay in the jejunum. This tube was left in position for three weeks, after which the child himself withdrew it. A radiological examination at this time showed a narrow, tube-like oesophagus. There was no fistula at the site of the anastomosis. The typical colonic haustration was absent. Oral feeding was now commenced and progressed without complication. Seven weeks after operation a further radiological examination showed that the colon graft

had increased appreciably in diameter and showed active peristalsis (Fig. 8).

This operation serves to show that it is technically possible to reconstruct the oesophagus in a single stage. My experience to date is limited to a single case, which has progressed surprisingly free from complications in spite of prematurity. The great importance of adequate postoperative care must, however, be emphasized. Without this asset the operative risk would undoubtedly be much greater, but this applies equally to operation and anastomosis in the usual oesophageal atresia case, as well as to every intrathoracic procedure.

If I were to summarize this new technique the main points would be as follows:

- (1) Primary reconstruction, no waiting time.
- (2) Anatomically correct placement of the upper anastomosis.
- (3) No gastrostomy.
- (4) No intestinal clamps are necessary, the bowel is sterile.
- (5) Minimal risk for adhesions.
- (6) No disturbance of the function of the diaphragm.

Finally, a few words about the patient. Together with his mother he visited me one year after the operation. When I asked the mother how he felt, she answered: 'Now he is just as normal as his brothers'. This was a good testimonial and I believe that as paediatric surgeons our goal should be to strive toward this end when we work with surgery of malformations—to try to make these malformed children as normal as their brothers.

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