

EXPERIMENTAL INTRATHORACIC OESOPHAGOPLASTY WITH SKIN TUBE

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During the past decade, thoracic surgery has been advancing at enormous strides. VISHNEVSKY's vagosympathetic blockade, intratracheal anaesthesia, the extensive use of transfusions and antibiotics have greatly reduced the hazards of opening the chest. In oesophageal surgery intrathoracic techniques are common and transpleural methods are employed in an increasing number for oesophageal repair approaching best the aims to be attained. Oesophagoplasty performed in this way is physiologically and cosmetically adequate and the functional results are by far superior to those obtained by antethoracic repair. However, the present techniques of intrathoracic surgery still leave much to be desired and research must continue to develop efficient and reliable techniques.

Experimental

Dogs weighing 12 to 18 kg were used. Under ether anaesthesia an oblong full-thickness piece of abdominal skin was cut to make a skin tube 80 to 100 mm long and 15 to 20 mm in diameter. With the epithelium inward, the graft was united by knotted sutures to form a tube and was transplanted into the lower portion of the omentum maius of dogs, covering it completely with omentum, fixing it by few knotted sutures then placing it into the abdominal cavity. Three to six weeks later the transplant was pulled out from the abdomen, opened up at the two ends and the omentum was prepared up from the margins in a width of a few mm, to facilitate anastomosis (*Fig. 1*). The omentum maius was pedicled to facilitate pulling up into the thorax, taking care for the pedicle's adequate blood supply. Under intratracheal anaesthesia thoracotomy was performed in the left 7th intercostal space. The mediastinum, vagus nerve and phrenic nerve were infiltrated with procaine and below the aortic arch a piece of oesophagus, 4 to 6 cm long, was resected. The diaphragm was cut near the oesophageal hiatus, the skin tube prepared for anastomosis hanging on the pedicled omentum was pulled up into the anterior thorax to the stomach and was anastomosed in place of the resected part of the oesophagus (*Fig. 2*). Anastomosis was performed in three layers, separating the oesophageal muscle layer from the layer of mucosa. In the first layer the mucosa was united with skin, by interrupted sutures. As the second layer, the first line of sutures was so covered by the detached muscle layer, that the muscle was sutured to the subcutis. In the third layer the detached part of the omentum was sutured circularly onto the oesophagus (*Fig. 3*). The diaphragm wound was narrowed and the omental pedicle was fixed to its margins with a few sutures. After administering penicillin and streptomycin into the thoracic cavity, the wounds were closed by layers. The survivors were fed a liquid diet for one week, and a light, mixed diet until death.

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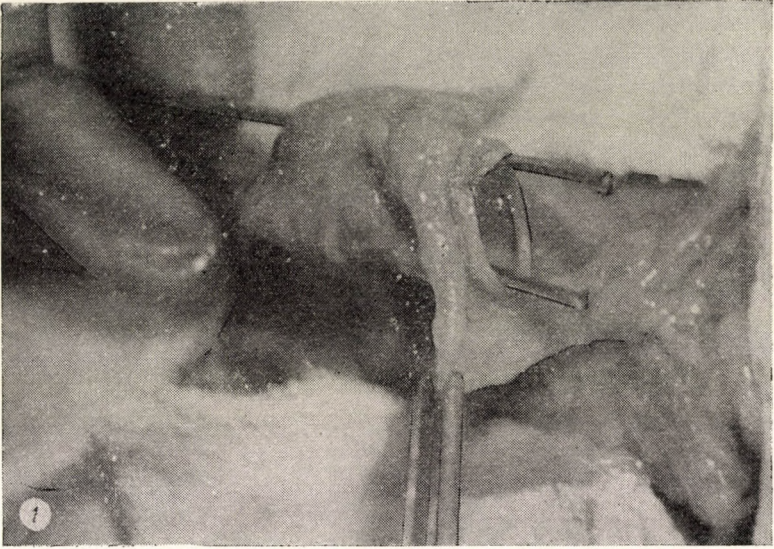


Fig. 1. Skin tube in the lower portion of the great omentum, six weeks after transplantation. The two ends are prepared, ready for anastomosis



Fig. 2. Skin tube attached to omental pedicle, pulled into thorax, to repair resected oesophagus

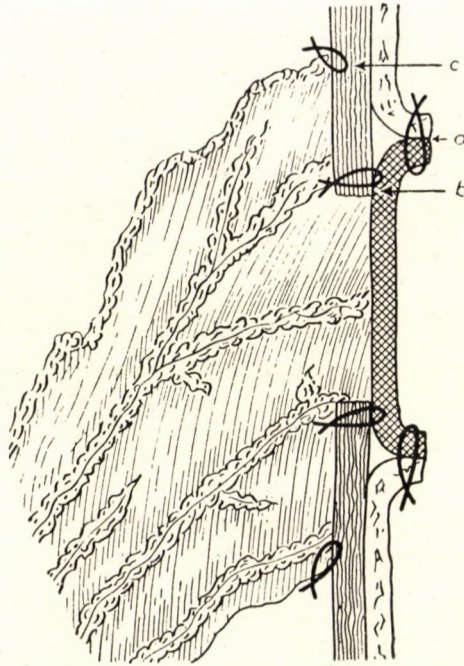


Fig. 3. Diagrammatic representation of oesophageal-skin tube anastomosis by three layers. (a : skin to mucosa, b : skin to muscle, c : omentum to oesophagus)

Results

Of the 14 skin tubes 2 had partially necrosed and could not be used for anastomosis. In the other 12 cases oesophagoplasty was performed 3 to 6 weeks after grafting. At that time the skin tubes were moderately shrunk and filled with a soft mass composed of sebum, epithelial cells and hairs. The surface of the skin was covered by very fine hairs. Microscopically, the structure of the epithelium was intact, the stratum corneum slightly loosened. Many capillaries were present in the subcutaneous connective tissue. There were no considerable differences between the grafts transplanted after 3 and 6 weeks, except that in the latter the subcutaneous connective tissue was more richly vascularized.

Of the 8 animals lost immediately after transplantation 4 died of pneumonia and/or empyema, 3 of suture insufficiency and 1 as a result of vascular occlusion in the omental pedicle due to compression or thrombosis. The remaining animals survived for 27 to 115 days and died of intercurrent disease or inanition (*Table I*). In the dogs which had survived longer, necropsy revealed an intact graft in 3 animals; in 1 graft there was an ulcer about 2 cm in diameter. The grafts united well with the oesophagus, but shrank and the distal line of sutures was narrowed in every animal. The section of the oesophagus above the graft was dilated (*Fig. 4*). The histologic pattern of the section above

Table I

No.	Interval between omental transplantation and oesophagoplasty, days	Survival time, days	Cause of death, post-mortem findings
1.	24	1	Pneumonia, pleuritis, heart failure
2.	35	5	Empyema, insufficiency of suture
3.	35	5	The partially necrosed skin tube was unsuitable for use in oesophagoplasty
4.	41	27	Pneumonia, marasmus, the lower anastomosis blocked by a nut-sized ball of meat
5.	21	3	Empyema, suture insufficiency
6.	34	52	Pneumonia, inanition, lower anastomosis narrowed to pencil-thickness
7.	35	2	Pneumonia, empyema, suture insufficiency
8.	38	1	Pneumonia, pleuritis, heart failure
9.	26	3	Empyema, suture insufficiency
10.	26	3	Partial necrosis of skin tube, as in case 3.
11.	43	115	Inanition, distal anastomosis extremely narrowed
12.	36	2	Empyema, necrosis of graft, thrombosis of the blood vessels of the omental pedicle superior to the diaphragm
13.	30	98	Inanition, extremely severe stricture at the distal anastomosis, in the skin graft an ulcer, about 2 cm in diameter, bleeding and covered by fragile tissue
14.	32	1	Pneumonia, pleuritis, heart failure

the graft was normal. In the well-discernible upper portion of the graft a part measuring about 5 mm of the oesophageal muscle pulled down during operation was visible. Below that level the wall of the graft tube consisted of connective tissue. The oesophageal muscle surrounded the graft at the gastric end. The epithelium of the transplant was composed of 4 to 5 layers of flat epithelial cells. In the subepithelial connective tissue there were leucocytic and mainly lymphocytic infiltration, dilated capillaries and smaller arterioles.

Discussion

The afore-told experimental investigations have shown that the full thickness abdominal skin tube graft takes when transplanted into the great omentum and retains its histologic structure. Three to 6 weeks after transplantation the tube grafted on an omental pedicle may be pulled up through the diaphragm into the thorax and can replace a resected part of the oesophagus. The anastomosis by three layers remained firm in 75 per cent of the cases and this percentage may further be raised by improving the surgical technique. The omental pedicle pulled up into the thorax has a good blood supply. Only one of the grafts connected with it was necrosed, presumably as a result

of surgical error ; the diaphragmal wound had namely been sutured too tightly around the pedicle, compressing its blood vessels. Except in one case, the grafts remained intact, though shrunk. At the distal suture line a stricture developed so that the animals could not eat and died of inanition or from intercurrent



Fig. 4. X-ray appearance of oesophagus 3 months after operation. Stricture at lower anastomosis, dilatation of the proximal part of oesophagus

disease due to starvation. The stricture developed apparently because of the absence of sufficient peristaltic pressure to carry the food further across that area. Peristalsis pressed the food through the upper suture line, but below it there was no peristaltic activity. With antethoracic repair it is also usual that the patients help with their hands to forward the food in the skin tube, preventing thereby a congestion of food, and press it through the distal suture line.

In our experiments the mortality rate was very high immediately following intrathoracic surgery, greater than in clinical practice. This is easy to understand if we realize that it is difficult to institute shock-relieving measures, blood transfusions, infusions and parenteral alimentation in animals and

we had no possibility for employing such therapeutic interventions. Even so, refined surgical technique and adequate experience may considerably reduce the mortality rate. Our method may still prove superior in clinical practice to that involving the use of plastic tubes (BERMANN, RÓTH) or to those in which lyophilized specimens are transplanted (PATE, SAVAYER, PATAKY, MOLNÁR JAKAB, BORNEMISZA). Repair with a skin tube carried up into the thorax, complete with an omental pedicle with good vascular supply and anastomosed in three layers, seems to be a more reliable method than the transplantation of a free skin tube, as employed by EDGERTON, CONNER, and others; such tubes are not certain to take.

The method facilitates segmental repair of the oesophagus; the cardia may be retained and thus oesophagitis, ulceration due to regurgitation may be prevented. The procedure cannot be claimed to have solved the problem of segmental intrathoracic oesophageal repair, in view of the fact that the insufficient intraluminal pressure resulting from the lack of peristalsis caused the distal suture line to constrict, so that the animals that had survived the operation subsequently died of inanition. We think that for oesophagoplasty such an organ should be used which by its own peristaltic activity is capable of producing a sufficient intraluminal pressure and may thus forward food even through the distal suture line. Research should therefore be continued in this direction.

Summary

In animal experiments a full thickness abdominal skin tube flap was prepared which was then transplanted into the great omentum. Three to six weeks later the skin tube with its omental pedicle was pulled up through the diaphragm into the thorax to serve for repairing the oesophagus from which a section had been excised. The skin tube united with the oesophagus, but shrank. As a result of a lack of peristaltic activity and low intraluminal pressure the distal line of sutures became narrowed and a stricture developed.

The method seems to be superior to those involving the use of plastic tubes or lyophilized oesophagus for oesophagoplasty. It is more reliable than the use of a free skin tube, but it cannot be claimed to have solved the problem of segmental oesophagoplasty. To this end, an organ should be used which has a peristaltic activity of its own and is thus capable of passing the food across the line of distal anastomosis.

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ЭКСПЕРИМЕНТАЛЬНАЯ ВНУТРИГРУДНАЯ ЗАМЕНА ПИЩЕВОДА КОЖНОЙ ТРУБКОЙ

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Авторы в опытах на животных сшивали полную толстую кожу брюшной стенки в трубку, обращая эпителий во внутрь, и пересаживали ее в большой сальник. 3—6 недель после имплантации они прилившую кожную трубку подняли при помощи сальниковой ножки трансдиафрагмально в грудную полость и заменили таким образом иссеченную часть пищевода. Кожная трубка сrasлась с пищеводом, но она сморщивалась. Вследствие отсутствия перистальтики и давления внутри просвета дистальная линия шва суживалась. Методом авторов можно добиться лучших результатов, чем заменой пищевода трубкой из пластмассы или лиофилизированным пищеводом. Это более надежный метод, чем трансплантация свободной кожной трубки, однако, вопрос сегментарной замены пищевода при помощи этой методики еще не следует считать разрешенным. Авторы того мнения, что для внутригрудной замены пищевода пригоден только орган, который соответствующей перистальтикой своей мышечной стенки и надлежащим внутрипросветным давлением способен продвигать пищу также через нижнюю линию анастомоза.

EXPERIMENTELLE INTRATHORAKALE ÖSOPHAGUSPLASTIK MITTELS HAUTROHR

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In Tierversuchen wurde ein von der Bauchwand entnommener volldicke Hautrohrlappen — mit dem Epithel nach innen — in das grosse Netz implantiert. 3—6 Wochen nach der Implantation wurde das haftende Hautrohr am Netzstiel durch das Zwerchfell in die Brusthöhle hinaufgebracht und damit der herausgeschnittene Teil der Speiseröhre ersetzt. Das Hautrohr verheilte zwar mit der Speiseröhre, erlitt aber Schrumpfung. Infolge der fehlenden Peristaltik und des intraluminalen Druckes hatte sich die distale Nahtlinie verengt. Mit der beschriebenen Methode konnten zwar bessere Ergebnisse erzielt werden, als durch Ersetzung des fehlenden Teiles der Speiseröhre mit einem Kunststoffrohr, oder lyophilisierter Speiseröhre, und kann auch zuverlässiger durchgeführt werden, als die Transplantation eines freien Hautrohrs, doch kaum die segmentale Ösophagusplastik mit beschriebenen Methode noch nicht als gelöst betrachtet werden — zu diesem Zweck scheinen zu sein, nur solche Organe geeignet, die durch entsprechende Peristaltik ihrer muskulösen Wand und durch entsprechenden intraluminalen Druck imstande sind, die Nahrung über die untere Anastomose zu befördern.

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