



Original article

Supercharged ileocoloplasty: an option for complex oesophageal reconstructions

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Introduction: Oesophageal reconstruction in a second time is a complex surgical operation which, in some cases, requires combining microvascular techniques to increase vascular flow to the conduit. «Supercharged» ileocoloplasty allows creation of a longer conduit that makes it possible to replace the entire oesophagus. We describe our initial experience with this technique for the total reconstruction of the oesophagus.

Material and methods: A retrospective review of the period from October 2007 to December 2009 identified 4 patients on whom a deferred oesophageal reconstruction was performed with a “supercharged” ileocoloplasty. The indications of this technique, morbidity and mortality, as well as functional results during follow up were evaluated.

Results: The indications of this technique were: previous failure of a left colon interposition (1), oesophageal disconnection due to a gastro-pleural fistula (1), total oesophagogastrectomy (1) and partial oesophagogastrectomy (1) due to the ingestion of caustic substances, respectively. Gastrointestinal complications were the most frequent. Two cervical fistulas were diagnosed which were resolved with an absolute diet, antibiotic therapy and enteral nutrition. There was no mortality. After a median follow up of 14.7 months, two patients were nourished exclusively by mouth, one by a mixed route (oral-enteral) and another exclusively by the enteral route due to an oesophageal stenosis 11 centimetres from the dental arch; this patient required dilations and is awaiting a jejunal graft.

Conclusions: “Supercharged” ileocoloplasty is a complex treatment option for the total reconstruction of the oesophagus when no other alternatives are available. Postoperative morbidity is significant but the functional results are good.

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Ileocoloplastia supercharged: una opción para reconstrucciones esofágicas complejas

R E S U M E N

Palabras clave:

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Supercharged

Reconstrucción esofágica

Introducción: La reconstrucción esofágica en un segundo tiempo es una intervención quirúrgica compleja que, en algunos casos, requiere asociar técnicas microvasculares para aumentar el flujo vascular a la plastia (supercharged). La ileocoloplastia supercharged permite crear una plastia larga que hace posible sustituir la totalidad del esófago. Describimos nuestra experiencia inicial con esta técnica para la reconstrucción de todo el esófago.

Material y métodos: La revisión retrospectiva del periodo octubre de 2007 a diciembre de 2009 identificó a 4 pacientes a los que se les realizó una reconstrucción esofágica diferida con una ileocoloplastia supercharged. Se evaluaron las indicaciones de esta técnica, la morbilidad y mortalidad, así como los resultados funcionales durante el seguimiento.

Resultados: Las indicaciones de esta técnica fueron: fracaso previo de una interposición de colon izquierdo (1), desconexión esofágica por fístula gastropleural (1), esofagogastrectomía total (1) y esofagogastrectomía parcial (1) por ingesta de cáusticos, respectivamente. Las complicaciones digestivas fueron las más frecuentes. Se diagnosticaron dos fístulas cervicales que se resolvieron con dieta absoluta, antibioticoterapia y nutrición enteral. No hubo mortalidad. Tras una mediana de seguimiento de 14,7 meses, dos pacientes se nutrían exclusivamente por vía oral, uno por vía mixta (oral-ental) y otro exclusivamente por vía enteral debido a una estenosis esofágica a 11 centímetros de arcada dentaria; este paciente ha precisado dilataciones y está pendiente de un injerto de yeyuno.

Conclusiones: La ileocoloplastia supercharged es una opción técnica compleja para reconstruir todo el esófago cuando no se dispone de otras alternativas. La morbilidad postoperatoria es significativa pero los resultados funcionales son buenos.

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Introduction

The perforation or spontaneous rupture of the oesophagus, chemical traumatism (caustication) and complications following a previous oesophageal intervention are the main causes of disconnection of the oesophageal conduit. Deferred or second-stage reconstruction has classically entailed gastric or colon surgery,^{1,2} followed by jejunum interposition. These techniques are associated with high morbidity, which is linked to the high incidence of dehiscence of the anastomosis.^{3,4} Distal ischaemia is the most important factor in determining the appearance of dehiscence.^{5,6} An anastomosis at the cervical level and the route used for inserting the graft (anterior or pre-sternal mediastinum) mean that the digestive segment destined to be used for oesophageal reconstruction needs to be longer; this all complicates intramural microcirculation and encourages ischaemia.^{7,8}

Many techniques have been developed to minimize this problem. Akiyama described gastric conditioning (*delay phenomenon*), which involved embolization of the left gastric, right gastric and splenic artery by angiography and obtained good results⁹; other authors prefer to perform the conditioning procedure by laparoscopy.¹⁰ Microsurgical procedures which increase vascularization (*supercharged techniques*) and oxygenation of the gastric tube using the splenic vessels¹¹ or the left gastroepiploic and short vessels have also been described.¹²

With respect to colonic interposition, techniques to achieve anti-peristaltic revascularisation of the left colon, with anastomosis between the sigmoid and superior thyroid or facial artery,¹³ and of the right colon, with the anastomosis between the ileocolic and internal mammary vessels,¹⁴ have been described.

The third group of surgical procedures used in-direct or deferred oesophageal reconstruction corresponds to jejunal procedures. The interposition of a free jejunal segment was performed to reconstruct short oesophageal defects at the cervical level,¹⁵ while for the reconstruction of a subtotal oesophagectomy long *supercharged* jejunal segments have been used with anastomosis of the first jejunal branch to the internal mammary artery.¹⁶

A subgroup of patients who are candidates for deferred oesophageal reconstruction may have an oesophageal remnant which is too short to allow an optimal anastomosis to be performed, given that the conduit has to be longer and, consequently, the risk of ischaemia is increased. It is in this group of patients-with extensive caustication or in whom a prior reconstructive surgical intervention has failed-that *supercharged* or conditioning procedures should be considered to minimise this risk.¹⁷

Our group uses stomach interposition and prior conditioning, as described by Akiyama,⁹ in deferred oesophageal reconstructions, whenever this organ can be used. In cases in which coloplasty is required our first

option is the right colon. But in some cases the oesophageal segment for the cervical anastomosis is very short so a longer ileum segment is required. With the aim of avoiding distal ischaemia of the conduit in this patient subgroup, and in collaboration with the Plastic Surgery Department, we proposed the inclusion of *supercharged* ileocoloplasty, as part of the treatment of candidates for deferred reconstruction with a short oesophageal remnant, when gastropasty was not an option.

Patients and methods

A retrospective study of patients who underwent deferred oesophageal reconstruction with ileocoloplasty, associated with increased vascularisation (*supercharged* ileocoloplasty) and a microvascular anastomosis between the ileocolic and internal mammary vessels. The clinical features of the patients, surgical technique, post-operative complications and functional results are described.

From October 2007 to December 2009 four *supercharged* ileocolic interventions were performed at the Oesophagogastric Surgery Unit of the Hospital Universitari de Bellvitge.

Patients

Four candidate patients underwent complex deferred oesophageal reconstruction surgery. The clinical details of the patients are shown in Table.

Patient 1

A 51-year-old male with a history of gastric ulcer, for which he was receiving medical treatment. In March 2005 the patient developed Boerhaave syndrome and required a

transhiatal oesophagectomy, oesophagostomy and feeding jejunostomy. In November 2005 the digestive conduit was reconstructed by means of a left coloplasty. On the fifth day following surgery distal ischaemia of the reconstructed oesophagus was diagnosed so it was partially resected, and a new oesophagostomy and jejunostomy were performed. He was transferred to our centre in October 2007, where *supercharged* ileocoloplasty with end-to-side oesophago-ileal anastomosis was performed.

Patient 2

A 60-year-old male who had undergone a transthoracic oesophagectomy (Ivor Lewis) in 2001, owing to a pT3N0M0 oesophageal adenocarcinoma, after receiving neoadjuvant chemo-radiotherapy. In February 2008 he was diagnosed with adenocarcinoma of the upper lobe of the right lung so a lobectomy was performed. In the post-operative period he developed a gastropleural fistula and underwent surgery, which entailed primary suturing of a perforation of the gastropasty. Due to the persistence of the fistula, the patient had to have a second operation, which involved a terminal cervical oesophagostomy, mechanical closure of the pylorus and a feeding jejunostomy. After the latter intervention the gastropleural fistula persisted and the patient was transferred to another centre, where right thoracotomy was performed to remove the gastropasty. The patient was referred to our hospital for oesophageal reconstruction. In October 2008 *supercharged* ileocoloplasty with side-to-end oesophagoileal anastomosis was performed.

Patient 3

A 74-year-old male patient with a history of hypertension and diabetes mellitus. In June 2007 he ingested caustic substances

Table 1 – Characteristics of the patients and post-surgery morbidity

	Patient 1	Patient 2	Patient 3	Patient 4
Sex/age	Male, 51 years	Male, 60 years	Male, 74 years	Female, 56 years
Disconnection aetiology	Spontaneous oesophageal perforation	Gastropleural fistula	Ingestion of caustic substances	Ingestion of caustic substances
Surgical history	Oesophagectomy, left coloplasty	Transthoracic oesophagectomy, superior right lobectomy, exclusion gastropasty, resection transthoracic gastropasty	Oesophagogastrectomy	Total gastrectomy
Oesophagoileal anastomosis	End-to-side	Side-to-end	End-to-side	Side-to-side
Transfusion during the first 24 h	0	2 units erythrocyte concentrate	2 units erythrocyte concentrate	0
Stay in ICU	3 days	9 days	4 days	3 days
Morbidity	Cervical fistula on the 4 th day after surgery	Pneumonia caused by multi-resistant <i>Pseudomona aeruginosa</i>	Ileocolic fistula, pleural leakage	Cervical fistula on the 12 th day after surgery, pleural leakage
Treatment	Absolute diet, enteral nutrition	Mechanical ventilation, broad-spectrum antibiotic therapy	Absolute diet, parenteral nutrition, thoracic drainage	Absolute diet, enteral nutrition, thoracic drainage

ICU indicates Intensive Care Unit.

with the intention of committing suicide so he had to undergo a oesophagogastrrectomy, cervical oesophagostomy and feeding jejunostomy. 2 weeks after caustication, he developed sialorrhoea with suppression of saliva output as a result of the oesophagostomy. Oesophagoscopy revealed caustic stenosis 15cm from the dental arch. In February 2009 a *supercharged* end-to-side ileocoloplasty with anastomosis was performed.

Patient 4

A 56-year-old woman, who was admitted to another centre in June 2008 because she had tried to commit suicide by ingesting caustic substances and was discharged after 20 days of conservative treatment. She was readmitted 5 days later as a result of a massive upper digestive tract haemorrhage, which required urgent surgical intervention, involving total gastrectomy without excision of the oesophagus, the insertion of a Nelaton catheter at the distal end of the oesophagus for drainage purposes and a feeding jejunostomy. Cervical oesophagostomy was not performed. The patient developed aphagia and spontaneous closure of the abdominal oesophagocutaneous fistula. Follow-up endoscopy showed caustic stenosis 18cm from the dental arch. In November 2009 we performed a *supercharged* ileocoloplasty with side-to-side oesophageal anastomosis.

Surgical technique

The patients were admitted 24 hours before the surgical intervention for antegrade preparation of the colon with

polyethylene glycol. When the patients were anaesthetised, antibiotic prophylaxis using 1g de ceftriaxone/24 hours and 500mg of metronidazole/8 hours was initiated, this regime being maintained for 48 hours. Patients were placed face upwards with their head to the right and fully stretched. Three simultaneous surgical fields were prepared: an abdominal (3 surgeons), anterior thoracic (2 surgeons) and left cervical field (2 surgeons). The intervention was initiated simultaneously at the abdominal and cervical levels. The intervention is presented schematically in Figure 1.

Abdominal time

A midline laparotomy, with the release of adhesences and movilisation of the terminal ileum, and the right and transverse colon as far as the middle colon vessels, is performed. The right ileocolic and colic vessels are dissected as close as possible to the mesenteric vessels; special care has to be taken in the ileocolic vessel section, heparinising the distal end and keeping it occluded with *microclamps*. Then, the distal ileum is sectioned about 15-20 cm from the Bahuin valve and the transverse colon close to the middle colic vessels. The tunnel is created from presternal space by blunt dissection and reaches as far as the neck. The time spent on abdominal surgery is completed by performing a Roux-en-y end-to-side colojejunoanastomosis and an end-to-side or side-to-side ileocolostomy: we performed both anastomoses using manual discontinuous absorbable 3/0 sutures. We completed the intervention with a distal jejunostomy at the foot of the loop.

Cervical time

Left cervicotomy and dissection of the cervical oesophagus; the latter is easier to identify after orally inserting a digestive probe. Once the oesophagus has been dissected, the subcutaneous insertion of the graft is completed and we perform an end-to-side or side-to-side oesophagoileal anastomosis using manual discontinuous absorbable 3/0 sutures.

Thoracic time

An incision is made parallel to the rib arch into the 2nd right costosternal space and the internal mammary vessels are identified and dissected; once the conduit has been put in place, the ileocolic artery and vein are positioned at this level. The venous microanastomosis is performed first, using manual end-to-end continuous non-absorbable 9/0 sutures, and discontinuous suturing is used for the arterial microanastomosis. A $\times 3.5$ magnifying glass is used to amplify the surgical field.

Post-operative care

Care must be taken to ensure that the bandages in the thoracic area do not compress the microvascular anastomosis. We keep a digestive probe in place with intermittent aspiration until a gastrografen-labelled transit rules out the presence



Figure 1 – Contrast-labelled transit of a supercharged ileocoloplasty.

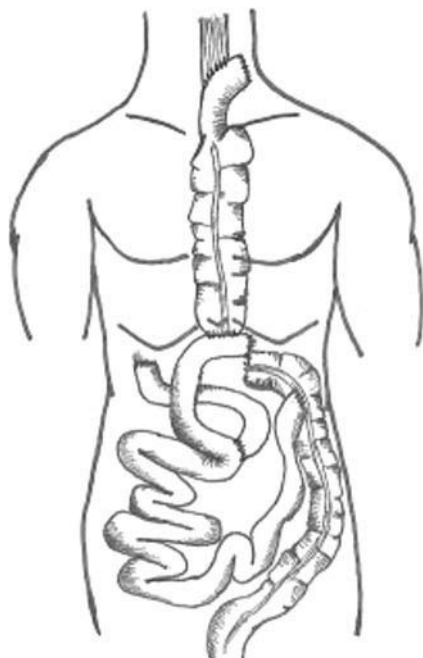


Figure 2 – Diagram of a supercharged ileocoloplasty.

of fistulas (Figure 2). We apply intrabdominal aspiration drainage at the subxiphoid level and maintain low molecular weight heparin treatment for one month.

Functional results

All the patients were monitored on an outpatient basis. The functional result of reconstruction was classified as follows: good, if the patient was exclusively nourished by mouth; discrete, if the patient required mixed oral-enteral nutrition; and deficient if calorie intake was exclusively enteral.

Results

The characteristics of the surgical intervention and the post-operative complications are provided in Table. The average duration of the surgical intervention was 355 minutes (315-400 minutes). One patient required 2 units of red blood cell concentrate during surgery and another during the first 48 hours after surgery. The average length of stay in the Intensive Care Unit (ICU) was 4.75 days (3-9) and the average hospital stay lasted 45 days (21-69); there were no fatalities.

Complications and functional results

After an average follow-up period of 14.75 months (7-30), the functional result of the intervention was as follows:

Patient 1

On the fourth day after the surgical intervention the patient developed a cervical fistula, which was successfully treated with absolute diet, enteral feeding and antibiotic therapy. He was

clinically monitored when he attended the centre three months after surgery and by telephone 30 months after his operation. The patient feeds himself exclusively by mouth and has had no episodes of dysphagia or bronchoaspiration, or clinical symptoms which are compatible with dumping syndrome.

Patient 2

During the post-operative period the patient suffered various episodes of pneumonia caused by multi-resistant *Pseudomonas aeruginosa*, which led to respiratory failure. He was discharged from hospital after 69 days on a mixed oral/ enteral diet. Oesophagoscopy prior to his discharge identified an anastomosis at 16cm with a healthy mucosa. During telephone follow-up 3 and 12 months after the surgical intervention the patient continued to follow the mixed diet he had been prescribed and reported no dysphagia or dumping syndrome, although occasionally, he experienced choking episodes.

Patient 3

On the seventh day after surgery, the patient developed an ileocolic fistula, which was successfully treated with absolute diet, total parenteral nutrition and antibiotic therapy. Oesophagoscopy performed after the surgical intervention revealed an anastomosis at 13cm with a normal mucosa; however, the patient suffered occasional episodes of regurgitation and bronchoaspiration so he was discharged 57 days after surgery on an enteral diet. During outpatient follow-up he reported rapidly progressive dysphagia and sialorrhoea. A new oesophagoscopy detected complete stenosis 11cm from the dental arch. Currently and, after the failure of a programme of endoscopic dilations, he is waiting for reconstructive surgery using a free jejunum graft.

Patient 4

In this case an oesophagectomy was not previously performed and, during reconstructive surgery, we did not resect the oesophagus. A cervical fistula was diagnosed twelve days after surgery and was resolved by the same treatment described for patient 1. At the two follow-up visits at 3 and 7 months the patient was being nourished exclusively by mouth with no episodes of dysphagia or bronchoaspiration; neither did she report any clinical symptoms which were compatible with dumping syndrome. A control oesophagoscopy revealed an oesophagoileal anastomosis 17cm from the dental arch.

Discussion

Second-stage reconstruction of the oesophageal conduit is a complex technique which is associated with high morbidity and mortality. The most feared complication in this type of surgery is anastomotic dehiscence; in a review made by our group the rate of anastomotic dehiscence was higher than 30%.⁴

There is a subgroup of these patients in whom the length of the oesophageal remnant is very short due, essentially, to

the failure of previous reconstructive techniques, extensive caustications or poor planning of the initial disconnection.¹⁴ In these cases, and in order to achieve a technically correct anastomosis, a longer reconstruction than usual is required. In the case of right coloplasty, sometimes an ileal segment longer than 10 cm, which is vascularised exclusively by the middle colic vessels, is required and this increases the possibility of ischaemia of the distal segment. To minimize this problem, many techniques designed to increase the vascularization of the reconstructed region have been described; we can classify them into two groups: "conditioning" and "addition" techniques. In the gastric tube Akiyama⁹ described gastric conditioning (*delay phenomenon*), by means of percutaneous embolisation of the gastric vessels, for the immediate reconstruction of an oesophagectomy. There are also colon conditioning techniques for paediatric patients.¹⁸

Numerous techniques for increasing vascularisation (*supercharging*) have been described in cases of surgery, owing, in particular, to the popularisation of microvascular anastomosis techniques. In gastropasty microvascular anastomosis has been performed between the short or left gastroepiploic vessels and the thyroid or facial vessels.¹² In right and left coloplasties anastomosis has primarily involved using the ileocolic or sigmoid—in left anti-peristaltic coloplasty—and the internal mammary vessel.¹³

Our group uses the gastric tube with percutaneous conditioning as the first option in oesophageal reconstruction, albeit immediate or deferred, with cervical anastomosis. We could only use the stomach in one of the four patients in this series, but this option was considered inviable, owing to the patient's history of gastric ulcer.⁹ When this option is not possible, our preference is interposition of the right colon, as it shows less vascular variation and is longer.³ This is why, when we decided to start using *supercharged* techniques, we chose a model we were familiar with. If the right colon cannot be used, our option would be the interposition of the *supercharged* left anti-peristaltic colon with a microvascular anastomosis between the sigmoid and internal mammary arteries. In our opinion, the choice of one or other colon segment depends more on the experience of the group than on objective advantages.

Basically, candidates for this type of surgery are patients with extensive caustications or previous reconstructions which have been unsuccessful. The shorter the viable oesophageal remnant, the longer the graft segment needs to be and the greater the risk of ischaemia. It also needs to be taken into account that the anterior or presternal mediastinal route "shortens" the length of the reconstructed conduit. For our group all the patients with an oesophageal remnant less than 18cm from the dental arch are potential candidates for this reconstructive technique.

To perform the procedure the availability of surgeons with extensive experience in microsurgical techniques is indispensable. In our hospital the Plastic Surgery Department has over 20 years' experience in microvascular procedures so its contribution has been very important. We always use the presternal route. The anatomical position of the internal mammary vessels and the final localisation of the ileocolic vessels after ascending the colon favours this

option. Other groups employ the mediastinal route¹⁷; in these cases the sternal manubrium, head of the collar bone and first rib are removed in order to perform the microvascular anastomosis. In two of the four patients in our series the anterior mediastinum was blocked: in patient 1 as the result of a previous reconstruction attempt by means of left coloplasty and, in patient 2, owing to the neoadjuvant radiotherapy he received as part of his treatment for oesophageal neoplasia.

We always perform anastomosis of the cervical oesophagus using manual discontinuous sutures made of absorbable material. If the oesophagostoma is terminal, after its dissection we perform an end-to-side oesophagoileostomy. In situations where a terminal oesophagostoma is lacking, we dissect the anterior side of the oesophagus using a guide probe and the anastomosis is performed side-to-end or side-to-side.

Post-operative morbidity in these patients is high and this determines their hospital stay. Their previous clinical state and the aggressive nature of the technique are the factors which most affect morbidity, respiratory pathology being the most common complication. 50% of our cases developed a cervical fistula (patients 1 and 4) on the fourth and twelfth day following the surgical intervention. Conservative treatment consisting of absolute diet, enteral nutrition and broad-spectrum antibiotic therapy was prescribed and both cases remitted without any sequelae of stenosis in the medium term.

Two of the four patients presented extensive caustications. Our group believes that in this type of case, when surgical intervention is necessary, an oesophagogastrrectomy and a terminal cervical oesophagostomy should be performed, conserving as much of the oesophagus with viable mucosa as possible, and a feeding jejunostomy whenever it is practicable. The aggressive nature, haste and execution of surgical treatment are the factors which will determine the immediate survival of the patient and facilitate subsequent reconstruction.

We think that *supercharged* ileocoloplasty is a technique which should be considered as a last option in patients in whom, for whatever reason, the oesophageal remnant is very short and the risk of ischaemia is high. The final objective is to achieve the functional reconstruction of the oesophageal tract. There are few surgical options and both the planning and the execution of the surgical process are important. The small number of patients—which makes proper training for implementing this type of surgery difficult—and the need for considerable experience in oesophageal surgery and the use of complex surgical techniques, such as microsurgery, limits the number of centres which can offer these procedures.

Conflict of interest

The authors declare that they have no conflict of interest.

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