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Original Article

Modified distal anastomosis between colon and thoracic esophagus for hypopharynx reconstruction using free colon flap: A comparison study



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ABSTRACT

Background: Free colon flap is the preferred method of hypopharynx reconstruction when the defect is substantial, or simultaneous voice reconstruction is planned. Most of the complications in free colon flaps are located at the anastomosis between colon and thoracic esophagus due to size mismatch of the lumen. We present our experience comparing a modified anastomosis technique and a conventional anastomosis technique at the distal end of interposed colonic segment.

Methods: In this retrospective review, 94 patients, divided into two groups, underwent hypopharynx reconstruction. Group A (18 patients), conventional anastomoses between colon and thoracic esophagus was performed, while in Group B (76 patients), underwent the modified method of anastomosis.

Results: The average follow-up period was 46 months in group A and 54 months in group B. Fistula formation was found in 2 patients from Group A, and 1 patient from Group B. Strictures were observed in 4 patients from Group A, and 1 patient from Group B. Difference between both groups regarding complications of leakage and stricture formation was statistically significant ($p < 0.05$).

Conclusion: Modified method for anastomosis between colon and thoracic esophagus was found to be effective in the reduction of complications associated with the use of a free colon flap for hypopharyngeal reconstruction. Further advances of this technique could gain momentum in the future.

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1. Introduction

Reconstruction after the resection of hypopharyngeal cancer is a major challenge for reconstructive microsurgeons, particularly in light of the complex nature of the defects associated with operations involving the esophagus and larynx.¹ However, in recent years, thanks to advances in reconstructive microsurgery, reconstruction of these complex defects is now carried out in a single

stage procedure with minimal complications.^{2–4} The ultimate goal of contemporary reconstruction is to give patients maximal functional benefits in terms of their capacity to eat without choking, to nourish themselves through oral intake, and to provide them with the capacity to produce intelligible speech through one of the available mechanisms.⁵

A variety of methods for the reconstruction of the pharyngo-esophagus tract (hypopharynx and cervical esophagus) have been described in the literature, most notably the gastric pull up procedure,^{6–13} skin flaps^{14–19} and intestinal flaps (jejunum, colon or ileo-colon).^{20–26}

In recent years, free jejunal flaps have begun to be widely used for cervical esophageal reconstruction.^{27–30} However, free colon or ileo-colon intestinal flaps are believed to be better alternatives to

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the jejunum flap when defects are located more superiorly, or a simultaneous voice reconstruction is planned.

This is due to the fact that the free colon flap provides a proper size match at the proximal anastomosis, unlike the jejunum flap. However, at the distal anastomosis, a site mismatch in caliber is more obvious with a colonic flap than a jejunal one,⁵ leading to an increased incidence of complications, most notably leakage, dysphagia and stricture formation.

In this article, we discuss our experiences with the modified method of utilizing an interposed colonic segment to reconstruct the hypopharynx, and its efficacy in the reduction of the above-mentioned complications present with the conventional method of a free colon flap.

2. Materials and methods

2.1. Patients

This paper is a retrospective review of 94 patients who suffered from hypopharyngeal cancer, and all of whom underwent surgical ablation and reconstruction using a free colon or ileo-colon flap from January 1994 to December 2012.

The inclusion criteria for the study was as follows: a free colon or ileo-colon flap for cervical esophageal reconstruction, with or without voice reconstruction. The exclusion criteria comprised of patients who had undergone other types of flap reconstructions, or were not followed up for a minimum of 3 years.

Data pertaining the patient demographics, type of cancer, type of reconstruction, peri- and postoperative course, adjuvant therapies and complications were taken note of from the hospital records.

Informed consent had been obtained from all the patients included in this survey. The study was performed according to the ethical standards of the 1964 Declaration of Helsinki as revised in 2000.

Patients have been placed into two groups, which can be seen below:

- Group A – 18 patients (13 male, 5 female) that underwent a conventional method of anastomosis
- Group B – 76 patients (63 male, 13 female) that received the modified method of anastomosis

2.2. Surgical technique

To initiate the procedure, a midline laparotomy incision was performed and the flap was harvested in the classic manner.³¹ The

flap was positioned in the neck defect in an isoperistaltic fashion, and a nasogastric tube was inserted through the nose, the interposed colonic segment and the distal esophagus to reach the stomach. The flap was positioned in the defect with anchoring sutures, and then vessel anastomosis was performed in order to minimize the ischemia time. Following this, the proximal anastomosis between colon and remnant of the oropharynx was carried out in two layers.

Finally, the distal end of the flap was anastomosed to the thoracic esophagus. The anastomosis at this site was carried out by one of two different methods, and, as mentioned previously, the patients were divided into two groups accordingly.

In Group A (conventional method), the direct anastomosis between the distal colon flap and thoracic esophagus was performed in two layers. Normally, the diameter of the colonic lumen is twice that of the esophageal lumen, which usually results in an excess of lumen from distal colon flap at the end of the anastomosis. This excess lumen was closed in two layers, as shown in Fig. 1 A.

In Group B (modified method), the distal anastomosis was performed only after a full thickness trimming of the colon end which was carried out in a conical fashion, with the apex of the cone towards the mesenteric end, a vertical myotomy of 2–3 cm of the thoracic end of the esophagus was performed. The conical portion of the cut colon was then interposed to the vertical myotomy, and sutured in two layers, as shown in Figs. 1B and 2.

After hemostasis and the insertion of a drain, the wound was closed without tension, with either the advancement of local flaps, or the addition of skin grafting if necessary (Fig. 3 A and B).

All patients were initially kept in the intensive care unit for three days with careful monitoring of the flap. An esophagography with a barium meal was carried out on all patients at the end of 2–3 weeks; if their imaging was normal, swallowing training was commenced on the patient.

Post-operative radiotherapy was started within 3–4 weeks after the completion surgery. Two-dimensional, conventionally fractionated, post-operative radiotherapy was administered. The nasogastric tube was removed one month after surgery. A semi-solid diet was advised to patients one and a half to two months following the surgery. Patients with voice tube reconstruction were started with speech rehabilitation, along with swallowing training, one month after their surgery.

All operations were performed by the senior author (HCC). The patients within Group A were operated on in the initial period of the study, from 1994 to 2002. On the other hand, operations on patients present in Group B, in other words those who underwent the modified method, were performed from 2002 to 2012. All patients were followed-up at 6 monthly intervals for the first two years following the surgery, and yearly thereafter.

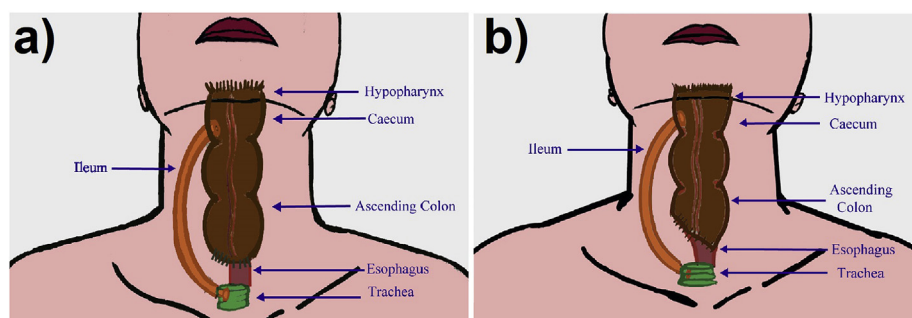


Fig. 1. Diagram showing the conventional (A) and modified (B) methods of anastomosis between colon and thoracic esophagus. In Fig. 1 A, the proximal end of the ileum is anastomosed on the lateral wall of the tracheal stump for future voice reconstruction function. In Fig. 1 B, it is shown the anastomosis with conical excision of the colon and vertical myotomy of the esophagus.

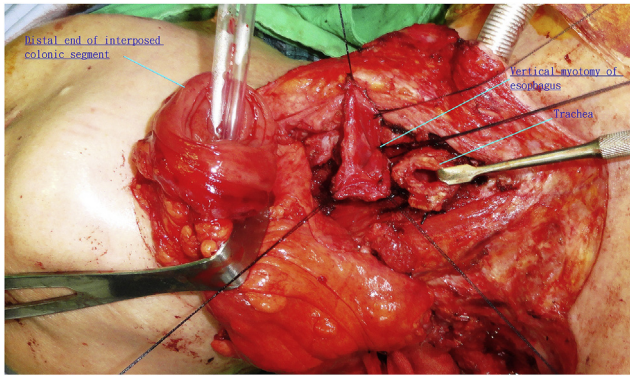


Fig. 2. Intra-operative image showing vertical myotomy of esophageal lumen.

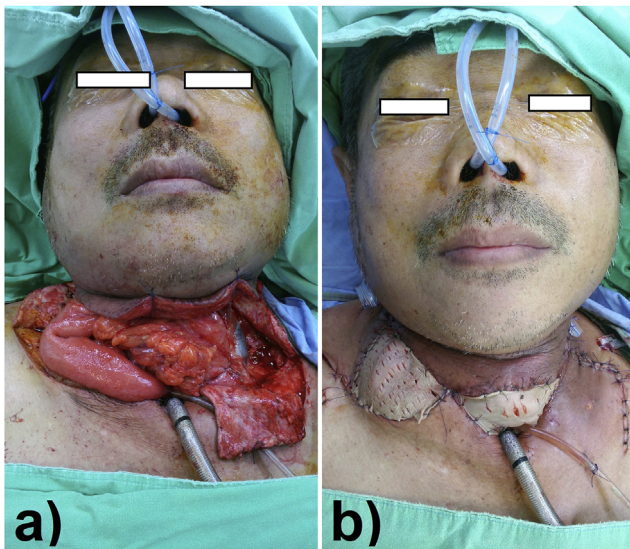


Fig. 3. Intra-operative picture showing the inset of ileo-colon flap (A) and closure of the wound using local flaps and skin grafts (B).

Post-operative leakage or fistula formation at the site of anastomosis of the colon and distal esophagus was diagnosed if one of the following criteria was met¹: evidence of cervical wound infection with excessive discharge requiring antibiotics or drainage,² radiological evidence of free anastomotic leakage or³ radiological evidence of anastomotic leakage significant enough to delay the resumption of oral feeding.³²

Stricture formation at the site of anastomosis was diagnosed if patients complained of difficulty in taking solid or semi-solid food, as well as if the diameter at the anastomotic site was found to be < 1 cm on endoscopic examination, and further confirmed by a barium study.

2.3. Statistical analysis

Fisher's exact test was utilized for the statistical analysis of both leakage and stricture formation in both groups respectively. The statistical calculations were carried out with the aid of Minitab®. A *p* value of <0.05 was defined to be statistically significant.

3. Results

The average length of follow-up was 46 months (ranging from

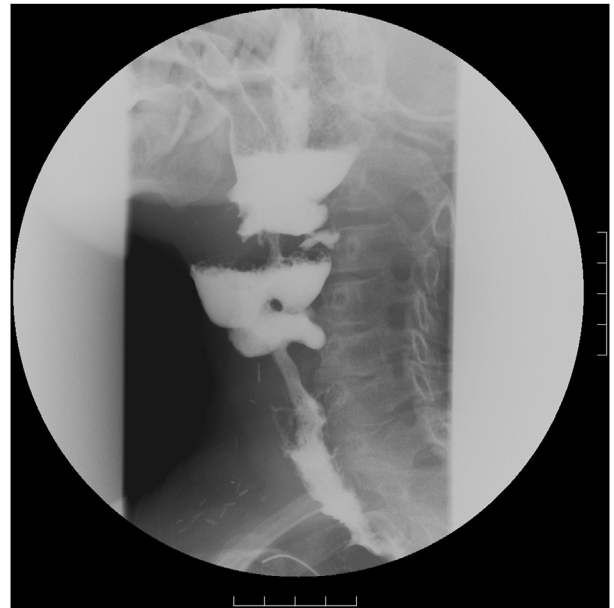


Fig. 4. Barium study showing collection of contrast proximal to the distal anastomosis in the conventional method of anastomosis.



Fig. 5. Barium study of modified method showing improved passage of contrast medium without excessive collection proximal to distal anastomosis.

38 to 60 months) in Group A, and 54 months (ranging from 36 to 74 months) in Group B. All patients underwent clinical examinations and a barium study (Figs. 4 and 5) in follow-up visits.

The most relevant and specific parameters were placed into Table 1 for ease of comparison. The overall average operative time for the conventional anastomosis of the distal end was 30 mins, whereas with the modified method the average duration was 45 mins.

The competency of anastomosis was evaluated by the criteria mentioned above. Leakage from the distal anastomotic site was observed in two patients in group A, and one patient from group B. These were all detected within the first two weeks following the

surgery. One of the Group A patients was found to have a minor leak, which was managed conservatively, while the other suffered from a major leak, which required exploration and refashioning of the anastomosis. The leakage in the single Group B patient was minor, and did not necessitate surgery. There was no recurrence of leakage in any of the patients. No leakage was present at the proximal anastomotic site between colon and pharynx in any of the patients in this study's cohort. Although the reduction in number of leakages from group A to B was not deemed statistically significant ($p = 0.093$), it is important to note the qualitative improvement in the leakage observed in group B, and its minimal deleterious effect on patient morbidity.

Stricture formation was observed in a total 5 patients, 4 from Group A and one from Group B. The average duration for diagnosis of a stricture formation after surgery was 14 months. All patients complaining of dysphagia for both solid and semi-solid food were subjected to endoscopic examination. If the internal diameter at the anastomotic site was found to be more than 1 cm, then endoscopic dilatation of stricture was undertaken; however, when the diameter was less than 1 cm, surgical refashioning of anastomosis was performed without prior trial for endoscopic dilatation. Out of the 4 patients from Group A, 3 were found to have strictures of <1 cm, who all underwent surgical refashioning of their anastomoses. In the remaining single patient from group A, the stricture was >1 cm, and was managed with endoscopic dilatation. However, after 3 consecutive attempts of failed dilatations, refashioning of the anastomosis through surgical intervention had to be carried out. The patient from Group B, who was the same patient who suffered from a minor leak from their anastomotic site, had a stricture with an internal diameter of <1 cm, and therefore underwent surgical refashioning of anastomosis without attempts for endoscopic dilatation. No recurrence was observed in any of the patients who underwent surgical correction of their strictures. Furthermore, the quantitative difference in stricture formations was found to be statistically significant between the two groups ($p = 0.0044$).

4. Discussion

With advances in microsurgery, the results of free intestinal flaps are becoming more predictable, especially with an increasing number of plastic surgeons opting for free flaps in hypopharyngeal reconstruction. Radial forearm and anterolateral thigh flaps were commonly used in the past, and are still widely made use of in the reconstruction of the cervical esophagus^{33,34}; despite this, intestinal flaps are considered to be the gold-standard way to reconstruct the cervical esophagus. Currently, free fasciocutaneous and jejunum flaps are the most prevalent means for cervical esophageal reconstruction. However, we utilized free colon or ileo-colon flaps for patients with higher defects in their pharynx, as well as in those patients who needed simultaneous voice tube reconstruction.⁵

A free jejunum flap for hypopharyngeal reconstruction was first used by Seidenberg and Hurwitz³⁵ in 1958, after which several series of free jejunal transfers were described in the literature, suggesting it as a standard method for circumferential defects of

hypopharynx.^{36,37}

Ozkan et al. described an interesting case report of recurrent laryngeal cancer in a 59-year-old patient. They used a pedicled colon segment and a free jejunum flap, both tunneled subcutaneously for interposition to the esophagus, in order to create a diversion loop for the passage of food from the pharynx to new inlet at bucco-gingival sulcus, thus keeping the native esophagus untouched. This is a novel solution to a difficult reconstruction, using traditional pedicled and advanced microsurgical flaps.³⁸ The use of a free ileo-colon flap for hypopharyngeal reconstruction was first reported by Kawahar et al.³⁹

Free jejunal flaps are regarded to be ideal for hypopharyngeal reconstruction due to the size of their lumen size and therefore caliber match with the esophagus, as well as the thinness of its wall. However, colon flaps are a better alternative to the jejunum in situations where the defect is higher up in the pharynx, as well as in patients who need simultaneous voice reconstruction, since the colon shows an even better caliber match.^{25,40}

Dantas and Mamede⁴¹ used a manometric evaluation of the motility of the transverse colon when used for an esophageal reconstruction in a study group of ten patients. According to their evaluation, there was delay in transit time from mouth to stomach, which was most evident across the reconstructed portion of esophagus. They further observed that the interposed colonic segment did not usually show contraction after a water swallow, but if the stimulus was sufficient, contractions occurred. They therefore concluded that this could be a possible explanation for the dysphagia observed in half of the patients in their study.

Moerman et al.,⁴² in their video fluoroscopic study, observed that there was absent contraction across the interposed colon and temporal stagnation of food proximal to the anastomosis.

Similar findings were observed by Nakayama et al.⁴³ In their study, after 21 free transplants of intestine for esophagus reconstruction, dysphagia was found in 5 patients. This could be because of absence of contraction despite of sufficient stimulus in the colon as well as stagnation of food proximal to distal anastomosis. They have also hypothesized that could be cause by the crowding of mucosa just proximal to distal anastomosis which was accentuated by mismatch of caliber of lumen.

When jejunal free flaps are carried out, fistulas are more prone to occur at the proximal site of anastomosis due to a mismatch in lumen size of the jejunum when compared to the pharynx. They are less common at the distal anastomosis site, between jejunum and esophagus, due to a more appropriate match in lumen size.^{44–46} On the other hand, when free colon flaps are employed, fistulas are more common at the distal site of anastomosis. This could be explained by a mismatch in caliber between the colon and esophagus.⁴⁷ A similar finding was evident when conducting our study: the incidence of leakage was more common in patients in Group A than those in Group B. The reason for the improved outcome in group B patients is hypothesized to be the elimination of the mismatch in lumen caliber, which was achieved by carrying out the reconstruction using the modified method.

Stricture formation at anastomotic sites is a widespread

Table 1
Demographic data and operation details.

Group	Patients (n)	Age (years)	Type of cancer	Reconstruction using free colon (no voice reconstruction)	Reconstruction using free ileocolon flap (voice reconstruction)	Post op radiotherapy	Anastomotic leakage	Anastomotic stricture	Follow up (months)
A	18 (13:5)	56 (41–74)	Squamous cancer ¹⁸	12	6	18	2	4	46
B	76 (63:13)	58 (36–77)	Squamous cancer (76)	56	20	76	1	1	54
Stat							$p = 0.093$	$p = 0.0044$	

problem and a possible explanation is the formation of fibrosis.⁴⁷ The colon mucosa has the capacity of water absorption and the conventional method may cause accumulation of food residue and inflammation with subsequent development of stricture. Our study found stricture formation to be more common in Group A than Group B.

The following steps were carried out when the distal anastomosis between the colon and esophagus were performed using the modified method¹: Smooth and gradual narrowing of the distal end of the colon performed by an oblique or conical full thickness excision of the distal end, with the apex of the cone facing the caudal side.² Dilatation of the esophageal lumen was performed by a full thickness vertical incision in the wall of the esophagus (a vertical myotomy) with a length of approximately 2–3 cm.³ Interposition of the apex of the obliquely trimmed colon to the incised wall of the esophagus, with an overall effect of dilating both the lumen of the esophagus and the anastomotic site.⁴ Care to avoid the formation of side pouch.⁵ Gradual narrowing of the lumen of the distal colon, with hope of early initiation of stimulus down the interposed colonic segment, for the propulsion of food distally through the anastomosis.^{40,42}

When using the modified technique, the calibers of the two ends were matched with a sufficient lumen width, hence the incidence of anastomotic leak, dysphagia and stricture formation were all less frequent when compared to the conventional method. There is a wealth of literature showing an increased incidence of the above-mentioned complications associated with the conventional method for anastomosis.^{45–47} Therefore, with the modified technique, there is an improvement in the functional outcome of the procedure, alongside a decrease in patient morbidity.

In view of the fact that we noticed an improvement in our results when using the modified method to carry out the anastomosis, this became the technique of choice. Over the course of the study period, the results obtained through the modified method were consistently superior, in addition to an improvement in suitability and ease of the operation. Moreover, it is worth to note that the average follow-up duration from group B was longer than that of group A (Table 1). This is primarily due to the premature death of certain patients, which had a more pronounced affect in group A due to the smaller sample size. We further hypothesize that, with the passage of time, the improvement in hospital facilities and available post-operative care programs were also contributing factors.

Lastly, patients who underwent the conventional method had, on average, little amelioration of their symptoms when the preventative measures of drinking plenty of water after each feed or avoiding sticky food were carried out, as these measures avoid stagnation of food particles proximal to anastomosis.

Patients with a defect at a level superior in the hypopharynx and requiring a simultaneous voice reconstruction are therefore deemed to be the ideal candidates for a free colon or ileo-colon flap. This is due to the fact that these flaps provide a better caliber match at the proximal site of anastomosis. At the distal end, modification of the anastomotic technique provides a more preferable outcome over the conventional method.

5. Conclusion

The modified anastomotic technique between the colon and the thoracic esophagus improves caliber match between the two lumens in a controlled fashion. The incidence of post-operative complications of leakage, dysphagia and stricture formation, which are all of concern, had been reduced, alongside an improvement in functional outcome. With further advances of this technique, the use of free colon flaps for hypopharyngeal reconstruction could gain

momentum in the future.

Declaration of competing interest

None of the authors has financial conflicts or interests to report in association with the contents of this paper.

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