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Colonic replacement in cases of esophageal atresia

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Long-gap esophageal atresia;
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Replacement of the esophagus in children is still a challenging problem; one of the major indications is failed esophageal atresia repair or long-gap ones. The colon is one of the best alternatives for replacement; long-term follow up has shown satisfactory results. In cases of complicated repair receiving frequent dilation and multiple operations, colon could be an alternative choice for these children to achieve normal swallowing.
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The outcome of patients with esophageal atresia has changed tremendously over the last decades and survival is now reaching 100%, especially in low-risk groups.[1,2] There are still some groups who will eventually need esophageal replacement. The choice of the graft depends on the results of the team performing the surgery. Good results were achieved using the colon,[3,4] stomach,[5,6] and jejunum.[7,8] There are no true comparative studies between different substitutes; only one study favored colon over stomach on a long-term basis.[4] Although it is well known that the native esophagus is the best esophagus, some patients with complicated esophageal atresia don't achieve normal swallowing after surgery, dilation, antireflux techniques, or resection of strictures. So in these cases, when the motility of the esophagus doesn't allow for normal oral feeding, an esophageal replacement will be indicated. Quality of life after replacement is not well studied. However, there are a few studies that report the quality of life after stomach pull-up[9] and colonic replacement.[10,11] In this study, the results of patients who had colonic replacement of the esophagus for esophageal atresia in the last 20 years will be highlighted.

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Indications for replacement

The following are indications for replacement: all patients with wide-gap esophageal atresia (more than 4 vertebrae) with or without a fistula, patients with birth weight less than 1500 g and having associated major cardiac anomalies, patients with major leakage after repair or disruption of the anastomosis, recurrence of fistula, and in cases presenting late (after 5-7 days), presenting with sepsis and major chest problems (eg, pneumonia).

Preparation and timing

All patients were subjected to cervical esophagostomy (left sided) and a feeding gastrostomy. In cases of atresia with fistula and failed anastomosis due to wide gap, the fistula is divided during thoracotomy. In low-birth-weight and premature infants, the distal esophagus is approached through the abdomen, ligated, and divided before doing the gastrostomy.

In patients with associated anorectal anomalies and a colostomy is decided, right transverse colostomy is done and irrigation of the distal colon is done daily to improve the size of the colon.

Ligation of the middle colic artery could be done to improve the vascularity of the colon by increasing the flow

through the marginal vessel. Care should be taken not to injure the marginal vessel, otherwise colonic atrophy will occur.

Patients should start sham feeding immediately and continue until surgery for fear of feeding difficulty after replacement.

In cases with cardiac malformations, the colon should be put in the posterior mediastinal position as most of the cardiac surgical procedures are through sternotomy incisions.

Patients are fed through the gastrostomy until the age of 5 to 6 months (before that, the colonic vessels are very small and grafts could be endangered). Patients are operated on when their weight is around 4.5 to 5 kg. Colonic washes are started 24 hours before surgery and are done through the gastrostomy by saline 20 c.c./kg BW.

All patients were given intestinal antiseptics orally 3 days before surgery (metronidazole and colimycin). On the day of surgery, intravenous cephalosporin and metronidazole were given 3 hours before the operation.

Technique

In patients with previous failed anastomosis and esophageal stricture, a trans-hiatal resection of the esophagus is done and posterior mediastinal position of the colon is chosen. In the other cases, no resection of esophageal remnant is done and the colon is placed either retrosternally or in the posterior mediastinum.

The technique of esophageal replacement has been previously described.[3,12] Once in the operating room, the patient is placed in the supine position with a small sand bag under the shoulder with the neck extended and turned to the right side. A tube is placed through the nose into the esophagus to allow easy dissection.

Traction sutures are placed at the esophagostomy, and careful dissection of the esophagus is done; division of the strap muscles makes dissection easier. Isolation of the esophagus is done after identification of the recurrent laryngeal nerve. Dissection of the esophagus should be minimal to avoid injury of the blood supply.

The abdomen is opened through a midline incision, mobilization of the colon is done, and the graft is chosen on the territory supplied by the upper left colic artery with the length measured from the site of the antrum to the esophagostomy site.

After choosing the colonic graft, inspection of the upper left colic artery pulsations is done (Figure 1). Then the middle colic (if it is not ligated before) and marginal vessels are clamped by bulldogs, and the colon is left inside the abdomen (to verify adequate circulation).

If a retrosternal procedure is performed, then a tunnel is made by blunt dissection dividing the endothoracic fascia very close to the sternum.

In cases of posterior mediastinal position, if the esophagus is present, trans-hiatal resection of the esophagus is done as previously described.[3] In the other cases, blunt dissection of the posterior mediastinum is done by finger dissection until the neck is reached.

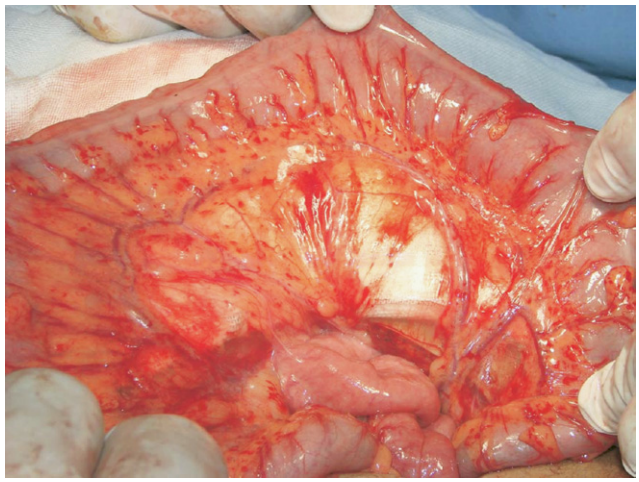

Figure 1 Barium swallow showing straight colon. (Color version of figure is available online.)

The colon is re-evaluated and resected after verification of its vascularity and length. The graft is washed with diluted povidine iodine solution and passed behind the stomach in an isoperistaltic manner.

To facilitate passage through the chest, a silk suture is applied to the proximal end of the colon and pulled through the cervical incision until the colon is in place, either in the tunnel retrosternally or in the posterior mediastinum. Redundant parts are resected. A single layer, end-to-side or end-to-end, esophago-colic anastomosis is done, and the colon is fixated to the neck muscles. The incision is closed after a drain is placed.

The gastro-colic anastomosis is performed at the cardia with 270° antireflux wrap of the stomach in cases of posterior position (Figure 2). In retrosternal cases, it is done to the anterior gastric wall with a wrap from the anterior gastric wall. Pyloroplasty is done in cases of esophagectomy.

The colon is fixed to the edge of the hiatus, the colo-colic anastomosis is performed, and the abdomen is closed with a mediastinal drain in posterior mediastinal cases. A chest x-ray is done, and, if an unrecognized pleural injury is found, a chest tube is inserted immediately.

How to avoid complications

- *Necrosis of the graft* could be avoided by careful identification of the blood supply and using a double blood supply from the left colic and the marginal paracolic arcade, as previously mentioned.[13]
- *Leakage and stenosis of the esophago-colic anastomosis* is avoided by careful dissection of the esophagus avoiding injury to the blood supply and wide anastomosis. The incidence of leakage should be extremely low as the proximal esophagus is healthy.

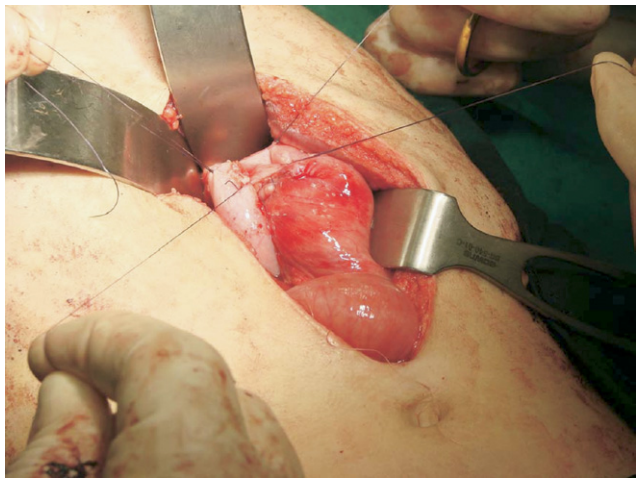

Figure 2 Vascularity of the colon. (Color version of figure is available online.)

- *Reflux in the graft* is easily avoided by doing an antireflux wrap on the colo-gastric anastomosis either 270° in transhiatal or wrapping the anterior wall in cases of retrosternal position.
- *Redundancy of the graft* is avoided by accurate measurement of the distance between the site of esophagostomy and the site of anastomosis. Usually redundancy is in the lower part of the graft and more common in retrosternal colon. Exerting slight tension on the graft with excision of excess length before doing the anastomosis usually prevents the redundancy.

Patients and methods

We studied cases of colon replacement for esophageal atresia at Ain-Shams University in Cairo over the last 20 years.

A total of 97 cases were found: 13 were referred from other units, 7 after failure of anastomosis and 6 with esophagostomy and gastrostomy. Indication of replacement is shown in Table 1.

Twelve patients had ligation of the middle colic during gastrostomy, and they were all from the wide-gap group.

Nine patients had associated cardiac anomalies and they had colon placed in the posterior mediastinum. Six had colon replacement after cardiac operations and three before cardiac surgery.

Table 1 Indications of replacement

Indication	No. of cases (97)
Failed repair (no esophagostomy)	19
Wide gap	21
Small premature (with cardiac condition)	22 (9)
Late presenting with chest problems	35

Table 2 Early complications

Mortality	4 cases (3 cardiac)
Anastomotic leakage	5
Upper anastomosis stricture	3
Pneumothorax	15 (9 posterior mediastinal)

One patient had tracheotomy for congenital tracheal stenosis, three had limb anomalies, three had spine deformity, and three had high anorectal anomalies for which they had right transverse colostomy at the time of gastrostomy followed by correction of the anorectal anomaly. Then, as a third procedure, they had replacement of the esophagus and closure of colostomy.

Results

There were 40 girls and 57 boys. Age at surgery ranged from 5 to 20 months, average 8 months.

One patient died before replacement due to motility problem of the stomach with failure of feeding by the gastrostomy and sepsis.

A total of 27 cases had posterior mediastinal colon replacement, and 69 had colon in the retrosternal position.

Follow-up ranged from 1 year to 20 years; 58 cases had follow-up at more than 10 years. Early complications are shown in Table 2.

Feeding started in all patients from the 7th day after surgery and stopped in cases of leakage (5 cases), which healed spontaneously in all cases.

A total of 86 cases achieved normal swallowing after 1 month of surgery, 5 cases needed 2 months to reach normal swallowing, and 6 cases needed from 3 to 6 months.

Late complications included two cases requiring redo of the upper anastomosis due to persistent stricture and two with redundancy (one of them needed surgery).

All patients after 10 years of follow-up are within the standard Egyptian weight and height curves; all have normal feeding and show no clinical symptoms.

Motility studies done for 12 of these cases showed no peristaltic waves and that bolus propagation is by gravity mainly. Although some reports have stated that stomach replacement showed some peristaltic activities,[14] our stomach pull-up patients after corrosive injuries failed to show the same results.

Technetium meal scan performed for 29 cases showed absence of gastro-colic reflux in all patients with posterior mediastinal position of the colon and very good evacuation of the colon, which was also evident on Barium swallow (Figure 3). Mild reflux in the graft with slight delay in evacuation was found in the retrosternal group, but without clinical manifestations.

Endoscopic biopsies were taken from 17 of these cases, and they showed normal colonic mucosa with no dysplasia or mucosal atrophy.

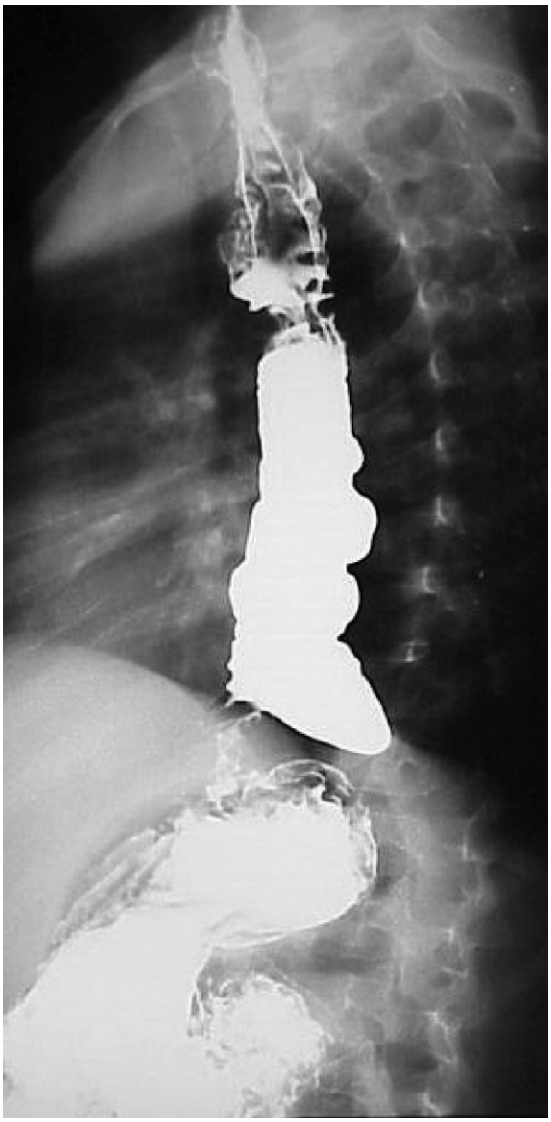

Figure 3 Valve around the colo-gastric anastomosis.

Conclusion

Although most of the patients with esophageal atresia will reach primary anastomosis with no complications, approximately 5% of these patients will have multiple procedures and half of them will eventually end up in replacement.[15,16] Choosing the patient who needs replacement at birth is usually based on length of the gap or condition of the neonate.[17-19] Although new procedures for esophageal lengthening are promising,[20] there will always be cases that will need replacement. Colon has been used over the years with variable results.[4,21] In this series over the last 20 years, colon has proven to be a valuable substitute for the esophagus in cases of wide gap or failure to achieve primary anastomosis. Sham feeding seemed to be important to improve feeding in cases of esophagostomy. The age of correction should be early but not less than 4 months to have good vascularity of the colon. The colon in the posterior mediastinum has better function than the retrosternal position, and on long-term follow-up, patients are experiencing normal swallowing and no sequel of replacement.

References

1. Lopes PJ, Keys C, Pierro A, et al. Oesophageal atresia: improved outcome in high risk groups? J Pediatr Surg 2006;41:331-4.
2. Spitz L, Kiely EM, Morecroft JA, et al. Esophageal atresia: at-risk groups for the 1990s. J Pediatr Surg 1994;29:723-5.
3. Hamza AF, Abdelhay S, Sherif H, et al. Caustic oesophageal strictures in children: 30 years' experience. J Pediatr Surg 2003;38:828-33.
4. Tannuri U, Maksoud-Filho JG, Maksoud G, et al. Which is better for esophageal substitution in children, esophagocoloplasty or gastric transposition? A 27-year experience of a single center. J Pediatr Surg 2007;42:500-4.
5. Spitz L, Kiely E, Pierro A. Gastric transposition for esophageal substitution in children: a 21-year experience. J Pediatr Surg 2004;39: 276-81.
6. Hirschl RB, Yardeni D, Oldham K, et al. gastric transposition for esophageal replacement in children experience with 41 consecutive cases with special emphasis on esophageal atresia. Ann Surg 2002; 236:531-41.
7. Bax NMA, Van der Zee D. Jejunal pedicle grafts for reconstruction of the esophagus in children. J Pediatr Surg 2007;42:363-9.
8. Cauchi JA, Buick RG, Gornall P, et al. Oesophageal substitution with free and pedicled jejunum: short- and long-term outcomes. Pediatr Surg Int 2007;23:11-19.
9. Ludman L, Spitz L. Quality of life after gastric transposition for oesophageal atresia. J Pediatr Surg 2003;38:53-7.
10. Burgos L, Martínez L, Suárez O, et al. Pediatric patient in adult age. Long-terms results of esophageal replacement. Cir Pediatr 2007;20: 169-74.
11. Ure BM, Slany E, Eypasch EP, et al. Quality of life more than 20 years after repair of esophageal atresia. J Pediatr Surg 1998;33:511-15.
12. Hamza A. Colonic replacement of the oesophagus. In: Puri P, Hollwarth M, eds. Pediatric Surgery. Heidelberg: Springer, 2006:67-76.
13. Tannuri U, Maksoud-Filho JG, Maksoud JG. Esophagocoloplasty in children: surgical technique, with special emphasis to the double blood supply to the interposed colon and results. J Pediatr Surg 1994;29: 1434-8.
14. Gupta DK, Charles AR, Srinivas M, et al. Manometric evaluation of the intrathoracic stomach after gastric transposition in children. Pediatr Surg Int 2004;20:415-8.
15. Orford J, Cass DT, Glasson MJ. Advances in the treatment of esophageal atresia over three decades: the 1970s and the 1990s. Pediatr Surg Int 2004;20:402-7.
16. Spitz L. Esophageal atresia: lessons I have learned in a 40-year experience. J Pediatr Surg 2006;41:1635-40.
17. Al-Shanafey S, Harvey J. Long gap esophageal atresia: an Australian experience. J Pediatr Surg 2008;43:597-601.
18. Poenaru D, Laberge JM, Neilson IR, et al. A new prognostic classification for esophageal atresia. Surgery 1993;113:426-32.
19. Maksoud-Filho JG, Ernesto M, Tannuri U, et al. An exclusively intraabdominal distal esophageal segment prevents primary delayed anastomosis in children with pure esophageal atresia. J Pediatr Surg 2002;37:1521-5.
20. Till H, Oliver J, Muensterer J, et al. Staged esophageal lengthening with internal and subsequent external traction sutures leads to primary repair of an ultra long gap esophageal atresia with upper pouch tracheoesophagel fistula. J Pediatr Surg 2008;43:E33-5.
21. Erdogan E, Emir E, Eroglu E, et al. Esophageal replacement using the colon: a 15 years review. Pediatr Surg Int 2000;16:546-9.