Long-Gap Esophageal Atresia - How to Gain Length: An Experimental Study

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This experimental study was carried out on rabbits in order to evaluate the usefulness of circular myotomies, in bridging the esophageal gap. Thirty two rabbits were divided into 2 groups, each having 16 rabbits. Rabbits of first group underwent resections of 1cm, 2cm, 3cm and 4 cm of esophagus in subgroups of 4 rabbits each. Single circular myotomy of upper esophageal segment was followed by end to end anastomosis. Rabbits of second group had resection of similar lengths in each subgroups but double circular myotomies were performed followed by end to end esophageal anastomosis. There was no post operative anastomotic leak with resection of upto 2cm segments in case of single circular myotomy whereas 25% of animals with 3cm resection and 50% of 4cm resections showed leak after single circular myotomy. With double circular myotomies there was no leak upto 3 cm resection of esophagus whereas resection of 4 cm showed 25% leak. The authors conclude that upto 2 cm esophageal gap can be easily bridged with single circular myotomy whereas gaps of 3-4 cm should be repaired by double circular myotomies.

Key words: Circular myotomy, esophageal, atresia, esophageal anastomosis.

Treatment of long gap esophageal atresia (EA) is still a challenging problem. Because of a wide gap between atretic upper pouch and lower esophageal segment, it is usually not possible to perform a successful anastomosis without elongating the esophagus. The best conduit is the patient's own esophagus[1]. Direct anastomosis of esophageal segments is superior to any "interposition"[2,3,4]. To cope with the severe tension during primary repair of EA, different procedures have been performed in the past. Circular myotomies of the esophagus is one of the procedures adopted to elongate the proximal segment[5]. The authors have tried to determine the length of the esophageal gap which can be bridged satisfactorily by performing single or double circular myotomies on the proximal esophageal segments in rabbits. This experimental data may be directly applicable to human neonatal esophagus due to close similarities in gross texture and consistency between rabbits and human neonatal esophagus.

Material and Methods

The experimental study was carried out in the department of Paediatric surgery Mayo Hospital, Lahore. Research was conducted on experimental animals i.e., rabbits. A total number of 32 rabbits were included in the study. Animals were thoroughly examined to ascertain their health. Solid food and liquids were withheld 4-6 hours before surgery. The surgical site was thoroughly prepared for aseptic surgery.

Rabbits were divided into 2 main groups A and B each of which was further subdivided into 4 subgroups of 4 animals each. Animals of group A underwent single circular myotomy whereas double circular myotomies were performed on proximal esophageal segment of group B rabbits. End to end anastomosis was performed in both groups.

General anaesthesia was induced with ether using rabbit's mask. After induction, tracheostomy was performed because it was not possible to introduce endotracheal tube through oral cavity. The animals were manually ventilated throughout surgery. Right lateral thoracotomy was performed through 5th intercostal space[6]. Esophagus was identified and respective lengths of thoracic esophagus were excised in different groups of animals. Single or double circular myotomies were performed on the upper esophageal segment. Myotomies were performed free hand through both the layers of esophageal muscles down to submucosa[7]. Myotomies were performed over an inflated Foley's catheter introduced through proximal end. Myotomies started 2cm proximal to esophageal end. End to end anastomosis was achieved with single layer of interrupted sutures of 5/0 vicryl. After inserting an under water seal, thoracic cavity was closed. Post operatively, they were kept nothing by mouth for 24 hours, antibiotics, (Penicillin and streptomycin) were given for 5 days and were sacrified on 7th post operative day. Anastomotic leak, signs of mediastinitis or obstruction at the anastomotic site were observed at autopsy.

Results

The results of circular myotomies on esophageal anastomosis in both the groups have been shown in table I & II. Single circular myotomy had a success rate of 100% for repair of upto 2 cm gaps whereas success rate was 75% & 50% in cases of repair of 3 cm & 4 cm gaps respectively. With double circular myotomies success rate was 100% upto 3 cm gaps whereas it was 75% for a gap of 4cm.

Table 1: Results of single myotomy

Esophageal gap	n=	Anastomotic leak	%age
1 cm	4	-	-
2 cm	4	-	-
3 cm	4	1	25%
4 cm	4	2	50%

Table II:- Results of double myotomy

Esophageal gap	n=	Anastomotic leak	%age
1 cm	4	-	-
2 cm	4	-	-
3 cm	4	-	-
4 cm	4	1	25%

Discussion

The ideal goal in the management of long gap EA is to achieve a primary esophageal anastomosis without any tension. In the past manual bougienage[8], Rehbein's silver olive method[9] and electromagnetic bougienage[10] were used to elongate the esophagus. The atretic upper pouch of the esophagus has excellent longitudinal blood supply which runs in the submucosal layer[11], therefore extensive mobilization of upper pouch and circular myotomies are safe[12,13,14]. Myotomy reduces the force required to approximate the esophageal segments. Traction is mainly exerted on the submucosa which is predominantly made up of elastic connective tissue with loose attachment to over lying muscles allowing it to elongate and change its position in relation to muscular layer. Myotomy, therefore permits atraumatic mobilization of proximal esophagus without jeopardizing the viability of esophageal tissue and easy accomplishment of anastomosis[15].

Dissection of the lower esophageal segment often results in ischemia[16]. This is caused by insufficient vascular supply of lower esophageal segment. Myotomies obviate the need for wide mobilization of lower segment as both the esophageal segments can be brought together comfortably. During post operative period, straining efforts at swallowing induce upward retraction of proximal esophageal segment. Myotomy by interrupting the continuity of longitudinal muscle fibres reduces the anastomotic tension. Submucosa is nutritionally independent of surrounding musculature[13] with the result that the myotomy does not cause significant vascular insufficiency at the anastomotic site. Distal progression of esophageal peristalsis is not interrupted by myotomy[16]. The peristalsis distal to myotomy may be part of the primary peristaltic wave or released secondary to the local distension of gut from the bolus. In the present study there was no disturbance of esophageal functions secondary to myotomy.

Anastomotic leak is the most important immediate postoperative complication of esophageal anastomosis. The incidence of leak in long gap EA varies for 0% - 100% in some series[18,19]. In a study presented by Lai et al [15] it was 40% after circular myotomy in cases of gaps of 5– 6.5 cm. In the present series, there was anastomotic leak (37%) in those experimental rabbits where long esophageal gaps were repaired with single circular myotomy where as it was 12.5% in those where double myotomies, were performed. This is comparable to results shown by the study presented by Takada et al[20]. Mucosal out pouching at myotomy site is another abnormality found on esophagogram[21,22]. However it usually does not cause obstruction or foreign body retention.

Our experimental data may be directly applicable to human subjects due to close similarity in gross texture and consistency between rabbit's and human neonatal esophagus. Large segmental gaps in EA may be bridged by direct anastomosis obviating reconstructive procedures. Moreover, post anastomotic or other strictures may be resected and anastomosed without extensive mobilization.

The authors conclude that upto 2 cm esophageal gap can be bridged by single circular myotomy whereas gaps of more than 2 cm should be repaired with double circular myotomies. The technique has no deleterious effects on esophageal functions.

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