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Study of clinical value based on 25 single-center. Centre experience



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Maja Milickovic*, Djordje Savic*, Blagoje Grujic**, Aleksandar Vlahovic***, Miroslav Vukadin*,
Mila Stajevic°, Vladimir Kojovic°°

Institute for Mother and Child Health Care of Republic Serbia, Dr Vukan Cupic, New Belgrade, Republic Serbia

**Department of Abdominal Surgery*

***Department of Neonatal Surgery*

****Department of Plastic Surgery and Burns*

°Department of Cardiothoracic Surgery

°°Department of Urology

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AIM: The aim of this study was estimation of clinical value of gastric tube esophagoplasty in children based on one single center experience.

METHODS: Forty-nine patients with diagnosis of EA (n=22) and caustic esophageal injury (n=27) had undergone reverse gastric tube esophagoplasty during 25 years at our institution. Almost all EA patients received initially gastrostomy and cervical esophagostomy. Majority of CS patients had initially repeated dilatation therapy. Demographics, preoperative features (initial condition, initial treatment and nutritional status) and postoperative features (leakage, stenosis, nutritional status and disease-specific symptoms) were retrospectively reviewed and analyzed. Mean follow up time was 8.2 years.

RESULTS: Of 49 patients, 2 patients died and gastric tube failed in one patient. The most common complications were anastomotic leak (52%) and anastomotic stricture (47,8%). Disease-specific symptoms (dysphagia and reflux symptoms) with important clinical manifestations were observed in 10.87% of patients. Preoperatively, all patients were eutrophic. One year after operation 96% of patients stayed eutrophic and two EA patients were malnourished.

CONCLUSION: The most common complications such as anastomotic leak and anastomotic stricture may be considered benign. Postoperative nutrition, as good indicator of the procedure's adequacy, for the majority of patients is satisfactory. Gastric tube esophagoplasty is an appropriate alternative for esophageal replacement in children.

KEY WORDS: Children, Gastric tube, Esophagoplasty

Introduction

The main indication for esophageal replacement in the pediatric population is esophageal atresia (EA) after

failure to achieve primary or delayed primary end-to-end anastomosis. Caustic stenoses (CS) are the most frequent indication for esophageal replacement in less developed countries. Esophageal replacement is possible with right or left colon, pedicle or free jejunal graft, gastric tube or whole stomach. There is lack of evidence to demonstrate that one method is clearly superior to others¹⁻³. In this paper we analyzed 49 reverse gastric tube interventions performed over 25 years at our institution.

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Correspondence to: Aleksandar Vlahovic, Department of plastic surgery and burns, Borivoja Stevanovica 10 v street, Belgrade, Serbia (e-mail: aleksandarvlahovic@yahoo.com)

Methods

Between 1990 and 2015, 22 EA patients and 27 CS patients underwent gastric tube esophagoplasty at Institute for Mother and Child Health Care of Republic Serbia. At the time of operation, the median age of EA patients was 14,4 months (range 4 - 25 months) and for CS patients 60,4 months (range 39 - 82 months). Follow up was from 1,5 to 20 years, with the mean follow up time of 8,2 years. Some of patients were lost during long-term follow up because of their foreign origin.

OPERATIVE TECHNIQUE

After taking down of previous gastrostomy, the reverse gastric tube was formed from the greater gastric curve with preservation of the left gastroepiploic arcade. GIA stapler was used for this purpose. Suture line was manually over sewn. To achieve appropriately sized gastric tube, an 18 to 24 French chest tube were used as a guide. Spleen was preserved. Pyloroplasty was done to everyone. The tube was introduced into posterior mediastinum via dilated hiatus. All patients, except two, have undergone thoracotomy to enabling a direct control of making space in posterior mediastinum for gastric tube and its positioning. The esophagus with caustic injury was removed before positioning of the gastric tube in mediastinum.

The patients with cervical esophagostomy (n=24) received esophagogastric anastomosis in the neck, and the patients without cervical esophagostomy (n=25) received esophagogastric anastomosis in the chest. The upper esophagus was manually anastomosed to the gastric tube with interrupted absorbable suture material.

Patient demographics, preoperative and postoperative clinical features were retrospectively reviewed. The preoperative clinical features were: initial condition, previous treatment and nutritional status. Postoperative clinical features were leakage and stenosis at the site of the anastomosis, nutritional status and disease-specific symptoms.

The initial condition was defined either „favorable”, or „unfavorable”. In EA patients unfavorable initial condition included: prematurity, low birth weight, associated anomalies, or other severe neonatal conditions. In CS patients, unfavorable initial condition indicated weight loss and /or other severe complications of caustic ingestion. The favorable initial condition in EA and CS patients, assumed absence of noted unfavourable entities. Preoperative nutritional status was determined right before esophageal replacement, and postoperative nutritional status was determined one year after surgery. It was expressed in number of standard deviations (SD) from median value of the body mass index of the World Health Organization (WHO) international reference

population (BMI z-score). Rate of subjects were calculated in three categories: 1. BMI z-score greater than -1 SD, 2. between -2 SD and -1 SD, and 3. less than -2 SD and more than -3 SD, even though eutrophic category, by the standards of WHO, is within the limits of the BMI z-score from -2 SD to + 2 SD.

Anastomotic leakage was defined as any leakage of saliva and was proved by x-ray with water-soluble contrast medium. Patients were classified on 3 severity grades with respect to the occurrence of anastomotic leakage and related respiratory complications. Grade A was defined as no anastomotic leakage. Grade B was defined as anastomotic leakage with or without moderate respiratory complications (pneumonia, pneumothorax, pleural effusion). Grade C was defined as anastomotic leakage associated with the life threatening complications as mediastinitis and/or sepsis.

Anastomotic stenosis requiring endoscopic dilatation was defined as any narrowing of the suture line at barium swallow study that was responsible for dysphagia. Classification of stenosis was made depending on number of required endoscopic dilatations at 2 years follow up which is required time for maturation of anastomotic scar. The classification was as follows: Grade I - dilatations were not required; Grade II - 1 to 3 dilatations were required; Grade III - 4 to 6 dilatations were required and Grade IV - more than 6 dilatations were required. Three patients with grade IV of stenosis underwent periodic dilatations up to 5 years after replacement. Dysphagia (stenosis was excluded as a cause of dysphagia) and reflux symptoms were accepted as disease - specific symptoms. These symptoms were considered as either “present” or “absent” two years after esophageal replacement.

Long-term results were estimated based on nutritional status and satisfaction with their own health related quality of life.

Statistics: Fisher exact test and logistic regression were used for statistic analysis.

Results

Among 49 children with gastric tube esophagoplasty, two patients died (overall mortality 4,08%): a boy with Dross type A EA who had accidental injury of aorta while space for gastric tube in posterior mediastinum was created without thoracotomy and a girl with severe form of cerebral palsy and two recurrences of tracheoesophageal fistula (TEF) after unsuccessful primary esophageal reconstruction. Boy died at 20th postoperative day because of multiorgan dysfunction caused by massive hemorrhage and reanimation, and girl died from mediastinitis, pneumonia and sepsis on postoperative day 24th. One patient with Gross type A EA had ischemia and necrosis of the proximal third of the gastric tube. This patient underwent right colon interposition six

Table I - Staged. Treatment in EA patients who received gastric tube esophagoplasty.

| Staged treatment | Gross type (course of disease) | No |
|---------------------------------------------------------------------------|------------------------------------------------------------------------------|----|
| - Primary anastomosis | Gross type A (dehiscence of primary anastomosis) | 2 |
| - Gastrostomy and cervical esophagostomy | Gross type C (dehiscence of primary anastomosis) | 2 |
| - Reverse gastric tube esophagoplasty when they reached the age of 1 year | Gross type C (two recurrence of TEF) | 1 |
| | Gross type B (dehiscence of primary anastomosis and overlooked proximal TEF) | 1 |
| - Gastrostomy and continuous pharyngeal aspiration | Gross type A | 1 |
| - Reverse gastric tube esophagoplasty in the 4 th month | | |
| - Gastrostomy and cervical esophagostomy | Gross type A (blind upper pouch ended in neck) | 11 |
| - Reverse gastric tube esophagoplasty when they reached the age of 1 year | | |
| - Gastrostomy and continuous pharyngeal aspiration | Gross type A (dehiscence of primary delayed anastomosis) | 4 |
| - Primary delayed anastomosis | | |
| - Gastrostomy and cervical esophagostomy | | |
| - Reverse gastric tube esophagoplasty when they reached the age of 1 year | | |

Table II - EA patients' disorders which influenced on initial condition.

| | |
|---------------------------|---|
| Congenital anomalies | 8 |
| - heart disease | 3 |
| - VATER* syndrome | 1 |
| - cerebral palsy | 1 |
| - trisomy 21 | 1 |
| - vesicouretral reflux | 1 |
| Preterm gestational age | 9 |
| - < 32 weeks | 1 |
| - 32 - 36 weeks | 8 |
| Low birth weight | 9 |
| - < 1500gr | 1 |
| - 1500 - 2500gr | 8 |
| Various serious disorders | 8 |
| - respiratory distress | 6 |
| - intracranial hemorrhage | 1 |
| - neonatal sepsis | 1 |

VATER = vertebral anomalies, anal atresia, tracheoesophageal fistula and /or esophageal atresia, renal and radical anomalies.

months later. Because of two deaths in early postoperative period and one conduit loss, 49 patients were reviewed for demographics and preoperative clinical features, 48 patients were reviewed for leakage and 46 patients were reviewed for stenosis, disease-specific symptoms and postoperative nutritional status.

There were EA 22 patients: 11 males and 11 females. Staged treatment in these patients is shown in Table I Esophageal atresia patients disorders which influenced

initial condition is shown in Table II. Based on them, 10 of EA patients were in favourable, and 12 were in unfavourable initial condition. Preoperative BMI z - score SD in 5 EA patients were in category -2SD to -1 SD, and 17 in category > -1SD.

Out of the 27 CS patients who had undergone gastric tube esophagoplasty, 16 were males and 11 were females. Indications for esophageal replacement were inability to save esophagus, or failed dilatations. Staged treatment in these patients is shown in Table III.

Unfavorable initial condition in CS patients was estimated in 9 of them: 3 with esophageal perforation, 3 with extensive caustic injury to the upper aerodigestive system and 3 with malnutrition. Favorable initial condition in CS patients was estimated in 18 of them. Preoperative BMI z - score SD of in 5 CS patients were in category -2SD to -1SD and in 22 in category > -1SD.

None of the patients had a leak from long suture line on gastric tube. Esophagogastric anastomosis leakage rate in this study was 52% (57% in patients with EA, 52% in patients with CS). Twenty-one patients (43.7%) were in grade B and four patients (8,3%) were in grade C of leakage. All anastomotic leakages in survivors were managed conservatively and stopped spontaneously after a period varying from 8 to 40 days. Among the 48 patients available for the analysis of anastomosis leakage, favorable initial condition was estimated in 28 and unfavorable initial condition was estimated in 20 of them. Eighteen patients of 20 with unfavorable initial condition suffered from anastomotic leakage, whereas only 8 of 28 with favorable initial condition had anastomotic leakage. Binary logistic regression assessed that initial condition impacted of the occurrence of leak (OR=28,08, 95% CI = 3.82 to 206, 35, p <0.01).

Table III - Staged treatment in CS patients who received gastric tube esophagoplasty.

| Staged treatment | Course of disease | No |
|----------------------------------------------------------------|------------------------------------------------------------------------------|----|
| - Esophageal exclusion, gastrostomy and cervical esophagostomy | Delayed recognition of esophageal perforation during ballon dilatation | 2 |
| - Gastric tube esophagoplasty | Delayed perforation of esophageal perforation following diagnostic endoscopy | 1 |
| - Gastrostomy and repeated dilatations | | |
| - Gastric tube esophagoplasty | Severe disphagia and swallowing problems | 7 |
| - Repeated dilatations | | |
| - Gatsric tube esophagoplasty | Unyielding stricture and inability to establish an esophageal lumen | 17 |

Stenosis rate was 47,83% (47.4% in EA patients, 48,28% in CS patients). Among the 46 patients available for analysis of anastomotic stenosis, significantly higher incidence of stenosis occurred in 23 patients who had previously suffered from leakage than in the 23 patients without leakage ($= 31.451$, $df = 1$, $p < 0.001$). All of these strictures resolved with balloon dilatations, and none of the anastomoses were revised: in 59.1% of stenosis resolved with one to three balloon dilatations, 23,3% of stenosis resolved with four to six balloon dilatations and 13.6% required more than six dilatations. Patients underwent on average 5 dilatations (range 2 - 11 dilatations). Disease-specific symptoms with important clinical manifestations were observed in 5 patients (10.87%). None of the patients had need for surgical intervention. Two patients had coughing and regurgitation after meals as well as 1 or 2 episodes of aspiration pneumonia, one patient had.

Preoperative mean BMI z-score for all patients was $0,05 \pm 0,71$ (for EA patients: $-0,26 \pm 0,83$ and for CS patients: $0,015 \pm 0,59$), and postoperatively it was $-0,24 \pm 0,78$ (for EA patients: $-0,5 \pm 0,91$ and for CS patients: $0,02 \pm 0,61$). We were not able to find correlation between worsening of nutritional status and the presence of stenosis, or between the worsening of nutritional status and the presence of disease-specific symptoms. However, comparing worsening of nutritional status in EA patients and in CS patients, we found significant difference. Namely, of 27 CS patients 26 stayed postoperatively within the same category or rose into a higher one, whereas it happened in the 13 of 19 EA patients available for postoperative BMI z-score (96.3% vs 68.4%, Fisher test: to a lower BMI z-score category in comparison with preoperative nutritional status, whereas this happened in 1 of 10 (10%) EA patients with favorable initial condition (55.55% vs 10%, Fisher test: $P = 0.046$).

Long-term follow up (at least 10 years and up to 20 years) was available for 20 patients. Normal nutritional status and satisfaction with own health related quality of life were presented in 17 (85%) of them. All patients underwent upper gastrointestinal endoscopy: Barrett's esophagus was not found, but

ulcer was seen in the second third of gastric tube in one patient. This patient responded well to proton pump inhibitors.

Discussion

Among actual conduits for esophageal replacement, gastric tube has lost popularity because of high rate of anastomotic leakage and stenosis⁴⁻⁷ and late complications such as peptic ulceration and Barrett's esophagus⁸⁻¹⁰. At present, this opinion might be deemed unjustified because the majority of the leaks and stenosis are successfully treated with conservative manner. Also, serious late complications are sporadic, and the published studies of children with gastric tube esophagoplasty present satisfactory long-term results^{5,6,11}.

We had two deaths and one conduit necrosis. They happened at the time of generational change in surgical team. It supports the idea that good outcome of complex intervention requires experienced surgeon⁴.

Furthermore, posterior mediastinum was route for placing the tube in all patients. It is natural esophageal bad, the most direct route and allow for better swallowing^{6,12}.

Until ten years ago, at our institution, initial treatment for Gross type A EA consisted of gastrostomy and cervical esophagostomy. In recent years, our first treatment choice for Gross type A EA was delay primary anastomosis with previous gastrostomy and continuous pharyngeal aspiration. Failure of this procedure as well as failure of primary procedures in patients with other EA types was treated with gastrostomy, if it did not exist previously, and cervical esophagostomy. Gastrostomy and cervical esophagostomy allowed for sham feeding and care at home without fear of aspiration¹³. Esophageal replacement was delayed till the baby's age of 1 year, or when baby weighted more than 10kg. Only 1 patient (4,5%) did not receive cervical esophagostomy and esophageal replacement was successfully performed in 4th month of life with respect to the published experience with early replacement of esophagus¹⁴.

The majority of our CS patients (88.9%) had multiple dilatations before esophageal replacement of witch seven

needed gastrostomy for adequate feeding. Three life threatening iatrogenic complication during endoscopic therapeutic or diagnostic procedures were treated with esophageal exclusion, cervical esophagostomy and gastrostomy. Difficult excision of damaged esophagus was performed in all patients in the moment of esophageal replacement, in order to avoid mucocele, distal esophageal ulceration and bleeding, Barrett's esophagus and carcinoma in long life expectancy of young patient^{5,15,16}.

The most common early postoperative complication was anastomotic leakage with rate of 52%, which is similar to the rate of leakage in some published series, while there are also series with much lower leakage rate^{14,17,18}.

Effective drainage, nutritional support and antibiotics were sufficient for successfully conservative treatment. One death was associated with mediastinitis, among many other health issues. Initial patient's condition was a sufficient predictor of occurrence of leakages. This means that an increased risk of anastomotic leakage exists in EA patients with low birth weight, prematurity, associated anomalies and other serious neonatal condition as well as CS patients with initial weight loss or severe early complications of caustic ingestion. This can be explained by the fact that most of the factors that determine unfavorable initial conditions become chronic and generally predispose to poor tissue healing. There was never a leak from long suture line on gastric tube. We believe that is because of using stapler for suturing gastric tube and outer reinforcing of suture line⁶.

Anastomotic stenosis was the most common long-term complication in our series. High rate of stenosis was also reported by authors who reported high rate of leakage. All stenosis in our patients resolved with dilatations varying from 2 months to 2 years. Only 13.6% required more than 6 dilatations. Lee HQ reported that up to 64% of his EA patients required 10 dilatations in the first years of life probably because he performed dilatations prophylactically while we performed them for symptomatic strictures⁷.

Rate of acid reflux in gastric tube esophagoplasty is high in some available papers^{6,7,12}. In the study of Gupta, scintigraphy showed reflux in 31% of patients, although there were no patients with symptoms of reflux¹¹. Occurrence of acid reflux is expected since gastric tube produces acid and gastric tube effective peristalsis is lacked. This does not mean that the reflux is always pathological. Also, it was not conspicuous problem in our patients. We believe that routine pyloroplasty, an adequate tube size and posterior mediastinum rout for tube placing were responsible for the inconspicuous reflux problem in our series of patients. Three of our patients suffered from dysphagia. It could be explained with poor peristalsis of the tube and lack of swallowing training.

Nutritional status is good indicator of the procedure's success. Initial treatment resulted in that all patients were preoperatively eutrophic. One year after esophageal replacement, 96% of patients stayed eutrophic, except two EA

patients with additional disorders. Furthermore, CS patients had satisfying catch-up phase in follow up period, whereas this was not clearly stated in EA patients. In this sense, we found that unfavorable initial condition in EA patients such as associated congenital anomalies, prematurity and low birth weight, influenced negatively on postoperative nutritional status. EA patients' tendency to remain in a low weight category after successful esophageal replacement was observed after various substitutional procedures and not exclusively linked to gastric tube esophagoplasty¹².

Satisfaction with our long-term results has limited value because of small number of available patients. Follow-up period was also shorter than in larger series of currently popular procedures for esophageal replacement, as gastric transposition and colon interposition^{12,19,21}.

However, one of rare current reports of gastric tube esophagoplasty showed excellent long-term results using anthropometry, barium swallow esophagography, manometry and 24-h pH monitoring of the neoesophagus, as well as, radionuclide scan¹¹.

Comparing the results of our series and larger series of gastric transposition and colonic interposition, there is noticeable higher rate of anastomotic leakage and stricture in our series of gastric tube esophagoplasty^{12,19,20}. Mortality rates were similar in mentioned series and our series: 0%-2,5% in series of gastric transpositions, 1%-9% in series of colonic interpositions and 4% in our series of gastric tube esophagoplasty^{12,18,20,21}. Considering conservative treatment of anastomotic leakage and stenosis, satisfied long-term results and low mortality rate, gastric tube esophagoplasty continues to be valid option for esophageal replacement.

Conclusion

The most common postoperative complications, anastomotic leakage and stenosis, may be considered benign because they were resolved with conservative treatment. Using stapler for suturing gastric tube and outer reinforcing of suture line, pyloroplasty and posterior mediastinal rout for tube placing certainly had a positive effect to the satisfactory results in terms of absence of leakages from suture line on gastric tube, as well as low rate of reflux and dysphagia. Finally, nutritional status was very satisfactory in patients of this series. Initial condition can partially predispose outcome. Consequently, the gastric tube is an appropriate alternative for esophageal replacement in children with complex and/or complicated esophageal atresia and children with intractable caustic strictures.

Riassunto

Lo scopo di questo studio è stato quello di valutare il valore clinico di questo metodo basato sull'esperienza di un singolo centro.

METODI: Quaranta nove pazienti con la diagnosi EA (n=22) e lesioni esofagee da caustici (n=27) sono stati sottoposti ad un'esofagoplastica con tubo gastrico inverso durante un periodo di 25 anni presso la nostra istituzione. Quasi tutti i pazienti EA hanno avuto inizialmente la gastrostomia e l'esofagostomia cervicale. La maggior parte dei pazienti CS ha inizialmente ripetuto la terapia dilatativa. La demografia, le caratteristiche preoperatorie (le condizioni iniziali, il trattamento iniziale e lo stato nutrizionale) e le caratteristiche postoperatorie (la dispersione, la stenosi, lo stato nutrizionale e sintomi specifici della malattia) sono state retrospettivamente riviste ed analizzate. Periodo medio di follow-up era 8,2 anni.

RISULTATI: Due su 49 pazienti sono morti e il tubo gastrico non è riuscito in un paziente. Le complicanze più comuni erano deiscenze anastomotiche (52%) e stenosi anastomotica (47,8%). I sintomi specifici della malattia (disfagia e sintomi di reflusso) con le manifestazioni cliniche significative sono state osservate nel 10,87% dei pazienti. Prima dell'intervento, tutti i pazienti erano eutrofici. Un anno dopo l'intervento il 96% dei pazienti sono rimasti eutrofici e due pazienti EA erano malnutriti.

CONCLUSIONI: Le complicanze più comuni come ad esempio la perdita e la stenosi anastomotiche possono essere considerate benigne. La nutrizione postoperatoria è soddisfacente per la maggior parte dei pazienti. Il tubo gastrico esofagoplasty rappresenta un'alternativa adatta alla sostituzione esofagea nei bambini.

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