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CURRENT CONTROVERSIES IN THE SURGICAL TREATMENT OF ESOPHAGEAL ATRESIA

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ABSTRACT

Background and Aims: **Esophageal atresia (EA) with or without tracheo-esophageal fistula (TEF) is a rare condition that can be nowadays succesfully treated. The current interest therefore is focused on the management of the difficult cases, on thoracoscopic approach, and on some aspects of the long-term results.**

Methods: **The current strategies for the difficult or impossible anastomoses in pure and long-gap EA, the introduction of thoracoscopic repair and the causes, mechanisms and management of post-operative gastro-esophageal reflux (GER) are reviewed.**

Results: **Methods of esophageal elongation and multi-staged repair of pure and long-gap EA allow anastomosis but with functional results that are often poor. Esophageal replacement with colon or stomach achieves at least similar results and often requires less procedures. Thoracoscopic repair is a promising adjunct, but the difficulties for setting it as a gold-standard are pointed out. GER is a part of the disease and its surgical treatment, that is often required, is burdened by high failure rates.**

Conclusions: **EA with or without TEF can be successfully treated in most cases, but a number of unsolved issues remain and the current approach to difficult cases will certainly evolve in the future.**

Key Words: Esophageal atresia; tracheo-esophageal fistula; long-gap; elongation; thoracoscopy; esophageal replacement; gastro-esophageal reflux; fundoplication

INTRODUCTION

Esophageal atresia (EA) with or without tracheo-esophageal fistula (TEF) is a star condition in Pediatric Surgery because the results of its treatment accurately portrait the standards of care provided by any individual institution. The first successful repair was achieved about sixty years ago (1) and progress in neonatal surgery and intensive care allowed rapid improvement of the results. Since current mortality is minimal (2) in spite of the frequent association with other malformations, the focus of interest shifted in the last few years to the more difficult cases (premature infants and difficult anastomoses) and in sequelae and quality of life.

The purpose of the present review is to recall the main controversies in the surgical treatment of this condition and in particular, the approach to difficult or impossible anastomoses, the role of minimally invasive repair and the management of the frequently associated gastro-esophageal reflux (GER).

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THE DIFFICULT OR IMPOSSIBLE ANASTOMOSIS: PURE AND "LONG-GAP" EA

Pure EA with an interruption of the upper esophagus and a more or less short nubbin of the lower end without fistula is rare (about 10% of all cases or less)

and represents a particular therapeutic problem. The vast majority of cases of EA have an interrupted upper end and a lower end replaced by a fistula that communicates the carina with the stomach. Both ends are therefore more or less distant but only in some cases they are so far apart that anastomosis may be impossible. These are defined as "long gap" EAs.

In both cases the primary aim is to join both ends by performing an anastomosis under acceptable tension. This is possible in most patients with EA+TEF and also in many with pure EA but in both situations with some limitations and risks that should be taken into account at the time of choosing the surgical strategy.

Pure EA has been treated for many years in several stages. Elongation of the distant ends of the esophagus was attempted by serial dilatation with bougies (3), circular myotomies (4), staged operations (suturing both ends for subsequent dilatation of the spontaneously formed fistula) (5, 6, 7, 8), installation of devices on both ends for magnetic elongation (9, 10), external elongation of the upper end (11)) or simply deferral of the repair until swallowing and GER made both ends grow and approach (12, 13). An anastomosis under acceptable tension was possible in many cases and anatomical reconstruction of the esophageal continuity was considered a success. More recently, progressive lengthening of both ends has been achieved by external traction of some sutures attached to them and exteriorized through the thoracic wall (the Foker method (14)). Whether anatomical elongation or real growth of the ends occurs is not clear but this operation has been adopted by a number of surgeons (15, 16). Esophageal replacement has also been used for re-establishing digestive tract continuity either primarily or after failure of the previously mentioned procedures. Unfortunately, once again, the scarcity of cases of these rare forms of an already rare condition makes establishment of solid evidence-based attitudes impossible and personal preferences tailored after individual experiences largely determine surgical strategies in this field.

In the vast majority of cases of EA + TEF, regardless of the apparent distance between both ends, a more or less tight anastomosis, eventually with extensive dissection of the distal end (17, 18), is possible with all the risks involved (19, 20). Prolonged post-operative mechanical ventilation may be of some help in these cases (21). However, there are a few real "long-gap" cases that require staged repair following the lines described for pure EA cases. Definition of "long-gap" is difficult and personal (22, 23): 1, 2 or 3 cm (24), 4 or 5 vertebral bodies (22) or impossible anastomosis (25) have been used. Once again, the limited number of cases and the subjective decision-making make any solidly based strategy impossible.

In the absence of evidence-based strategies, "eminence-based" ones are legitimate. We herein discuss this issue on the basis of a critical review of the literature and also on our own experience.

After many years of working at a large referral center for complex pediatric surgical problems and treating a large number of complications of esophageal reconstructive techniques, we became reluctant to accept that anastomosis of the own esophagus at any price is the best functional option. Perhaps, as Oktay Mutaf, from Izmir, Turkey, stated, …"conservation of the own esophagus is the best option…. whenever there is one available"… (Personal communication in 1998), and this is not the case for many of these patients.

The quality of the esophagus obtained after more or less heroic anastomoses or lengthening procedures is often poor. All children have GER and dysphagia, most have stenoses, many have chronic respiratory disease and, whenever physiologic studies are performed, the quality of esophageal motility is poor (26, 27). Fundoplications (that often fail and have to be repeated), are almost always necessary and resections of the stenoses are occasionally required (28, 29). Whether this staged, multiple operation strategy can be considered a success or not is difficult to ascertain since most series are collected along long periods of time, involve many surgeons and are not the result of controlled studies. Failures and mortality remain usually unreported whereas long-term results are rarely reported.

The available alternative is esophageal replacement. This can be achieved with colon (30–32), stomach (35, 36) or jejunal grafts (37–38) at the expense of major surgery not devoid of complications and risks that are again judged on the basis of single-centre experiences collected along prolonged periods of time and therefore lacking uniformity and study design. However, the standard against which replacement should be compared is staged repair of pure or "long-gap" EA that involves generally several operations, including one or more thoracotomies, one or more fundoplications and even sometimes one or more resections of stenoses…. to obtain esophageal patency with bad esophageal function. Esophageal replacements in turn have frequent complications like salivary fistulas, anastomotic stenoses, reflux, graft redundancy and, of course, some mortality (32, 38, 39). However, after using for many years most of these procedures, we found esophageal replacement the preferable option after failure of the first operation or when the anatomic variety of the malformation makes primary anastomosis impossible. Colonic grafts or gastric pull-ups (we do not have experience with the jejunum) achieved in our own patients equally good oral intake, growth and quality of life and they do not require as many operations as the other "esophagus-saving" procedures. But still, we acknowledge that this can be considered as another example of "eminence-based" strategies not proven by evidence-based methods.

THE ROLE OF MINIMALLY INVASIVE SURGERY (MIS) IN THE REPAIR OF EA-TEF

Like in other surgical specialties, rapid progress in MIS took place in Pediatric Surgery in the last few years and this approach has been successfully attempted in many conditions including congenital malformations. Thoracoscopic division of TEF and end-to-end esophageal anastomosis were shown to

be possible by the pioneers of pediatric MIS (40–42) and this evidence generated a new challenge for pediatric surgical community. There is little doubt about the benefits of MIS over thoracotomy for reducing pain, scars and musculoskeletal sequelae into the hands of experienced surgeons (43–45). However, adoption of this approach as a gold-standard is unlikely for the coming years. Only a handful of cases of this particularly rare condition are treated every year in most large centers and it is obviously difficult to acquire the necessary skills for this particular operation in small babies with tiny thoracic spaces (23). How to achieve this goal when not so many consultants operate upon more than one or two cases per year? Moreover, how to familiarize the trainees with this approach, when they need to prove that they are successful in the repair of this paradigmatic condition during their residency years? There is no doubt that the results achieved with MIS by institutions in which EA repair is concentrated into the hands of one or two individuals are comparable to those of the best centers that use conventional thoracotomy but it is probably wise not to forget that the gold standard remains a good anastomosis with survival, limited sequelae and good quality of life rather than a successful minimally invasive repair. It is obvious that these goals are yet to be proven in large populations treated by MIS by multiple surgeons. Unfortunately, the results of any treatment in conditions with an incidence of 1:3000 births are difficult to assess objectively. Randomized clinical trials are badly needed to create good quality evidence of the possible benefits of MIS over conventional repair, and this is a difficult task.

In addition, the limited number of physiologic studies about neonatal thoracoscopy published so far demonstrate that gas exchange and brain oxygenation could be impaired for some time after the operation as a consequence of CO_2 reabsorption and perhaps prolonged increased superior vena cava pressure (46).

It is likely that MIS will become the gold standard in the future but, for the moment, it should be kept in mind that the accumulation of multiple learning curves might impair for an unknown period of time the quality of the results currently achieved by conventional thoracotomy approach.

THE PROBLEM OF ASSOCIATED GASTRO-ESOPHAGEAL REFLUX (GER)

GER is recognized as a frequent eventuality in EA + TEF survivors. Many of the symptoms and sequelae that they bear later in life were linked to GER many years ago (47, 48). However, only the relatively recent refinements of functional esophageal studies and some experimental work allowed better understanding of why and how both conditions are so tightly related.

Suture of the esophageal ends under more or less tension explains some displacement of the gastro-esophageal junction upwards (49) compromising the anti-reflux barrier. This has been pointed out years ago and confirmed by several functional studies including stationary manometry (50–52). Recent studies with microcatheters demonstrated that deficient function of the sphincter is present (53), together with poor distal peristalsis (27) in babies with EA + TEF. On the other hand, surgical shortening of the esophagus in the rat abolished the lower esophageal sphincter function (54) and the junction itself has been demonstrated to be abnormal (shorter intra-abdominal esophagus and wider hiatus) in the rat model of EA + TEF (55). As regards the other main component of the anti-reflux barrier, the esophageal peristaltic pump, it was shown to be damaged in patients operated upon for EA+TEF by barium meal (56), stationary manometry (52, 57), and ambulatory manometry (26). More recently, combined pH-metering and impedance studies confirmed these findings (58, 59) and showed the relevance of non-acidic reflux in these cases. The reason for the incompetence of the peristaltic pump in these patients is certainly anatomical, since the arrangement of the muscle layers and innervation of the repaired esophagus are far from being normal (60). In addition, the extrinsic innervation, the vagus and laryngeal nerves and their branches (61) as well as the intrinsic innervation (62–64) are deficient in EA. This also happens in the rat and mouse models of the malformation (65–67).

The result is that, although progression of the alimentary bolus is possible in most patients after deglutition, dysphagia is probably present for life in survivors and that GER often becomes a component of this condition (68–71). Patients may suffer apneic spells (72, 73) or barking cough (74) during infancy and childhood, frequent vomiting (75), repeated pneumonia (69, 76, 77) and/or chronic respiratory tract disease (78) that are considered as sequelae of the esophageal malformation but that might be related directly to the GER. Recurrent anastomotic strictures are indeed related to GER and become manageable after effective anti-reflux treatment (79). Some of these patients acquire esophageal mucosal metaplasia and real Barrett's esophagus later in life (71, 80–82) and some cases of early esophageal carcinoma (83, 84) have been reported in them.

In contrast with regular refluxers, EA + TEF survivors totally lack the tendency to a favorable outcome of GER and therefore are less prone to respond to postural or dietary treatment. Prokinetic medication is not expected to be very useful because of the abnormal extrinsic and intrinsic esophageal innervations. Antacid treatment may alleviate symptoms (85) and even help to outgrow the reflux (86, 87) but it does not address non-acidic reflux that is more frequent in this condition.

The implication is that anti-reflux surgery is often necessary in EA + TEF and this has been recognized years ago (48, 88, 89). In most cases, surgical creation of a competent anti-reflux valve has rewarding effects in terms of alleviating symptoms but, unfortunately, these effects are transient in a proportion of operated patients ranging from 25 to 40% (90–92) due to the persistence of the anatomic and physiologic anomalies that account for the GER itself and also to the often imperfect fundoplications achieved in these in-

dividuals with open or absent angle of His, small gastric fundus and high-located cardia. Nissen fundoplication has been the preferred valve but, for the above-mentioned reasons, posterior (93) or anterior (94) hemi-valves have also been used with variable success rates. Laparoscopic approach is increasingly used for this purpose (95, 96). In our experience, abnormal motility is not a major obstacle for electing a complete wrap-around provided that it is floppy enough (this can be difficult with a small fundus) (97). It is our impression that a progressively higher proportion of patients operated for EA + TEF undergo fundoplication some time during their life but the proportion varies widely in different institutions.

Surgical treatment of GER is probably another component of the treatment of EA + TEF in a number of patients. Favorable outcomes should be expected in most of them but a high failure rate of the surgically-created valve should be expected as well and this should be known by patients and families before the indication is made.

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