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Original Article

Nutritional support via percutaneous endoscopic gastrostomy in children with cardiac disease experiencing difficulties with feeding

Giovanna Ciotti, Ralf Holzer, Marco Pozzi, Mark Dalzell

Royal Liverpool Children's National Health Service Trust, Alder Hey, Liverpool, UK

Abstract Adequate nutrition is crucial to the management of children and infants with cardiac disease. Difficulties with feeding are extremely common, and maintaining an adequate caloric intake, in order to achieve sustained growth, is often not possible without nutritional support. We retrospectively reviewed our experience between 1995 and 1999 in treating 37 children with cardiac disease who underwent percutaneous endoscopic construction of a gastrostomy to augment nutritional needs. We stratified the patients into those with cyanotic heart disease, when saturations of oxygen were less than 95%; those with non-cyanotic heart disease with saturations greater than 95%, and those with minor cardiac disease associated with a systemic disorder. Each group was compared to control children matched for age, sex, and diagnosis. We evaluated the variation in standard deviation score for body weight over a median period of follow-up of 295 days. Improvements in the standard deviation score for body weight occurred in each of the groups, whereas children in the control groups demonstrated a decrease in standard deviation score for body weight. The median change of the score for body weight was significantly higher in patients managed with gastrostomy compared to controls. We conclude that supplementation using a gastrostomy tube allows the safe delivery of the caloric intake needed to support malnourished children with cardiac disease.

Keywords: Endoscopic feeding; failure to thrive; score for body weight

Nutritional support is of fundamental importance in the treatment of infants and children with congenital and acquired cardiac diseases. Adequate growth not only contributes to the general well-being of patients, but supports surgical success and influences postoperative morbidity.[1] For example, an increase in body mass and weight by the time of surgical intervention may allow the surgeon to choose a larger size homograft or prosthetic material, with a subsequent prolongation of the interval prior to reintervention.

Children with cyanotic or clinically relevant non-cyanotic cardiac diseases have higher energy expenditure when compared to a healthy population, with a requirement of up to an additional half of the dietary reference value for energy.[2–4] This increased metabolic demand is not easily achievable when set against the background of cyanosis and congestive cardiac failure. Tachypnoea, exhaustion, and intolerance to food are limiting factors to adequate oral alimentation. The situation may become additionally complicated by malabsorption secondary to right heart failure or protein losing enteropathy.[5]

The conventional management of children suffering difficulty in feeding has involved the use of a nasogastric tube, pump feeding, and provision of caloric-dense feeds.[6] The results, however, are frequently unsatisfactory. Nasogastric alimentation often negatively interferes with the development of oromotor feeding skills. It also contributes to gastroesophageal reflux and oesophagitis as a result of the oesophageal splinting effect. The result is often a vicious circle of regurgitation, possible aspiration, and difficulties with fluid balance.

Correspondence to: Dr Giovanna Ciotti, Department of Paediatric Cardiology, Royal Liverpool Children's NHS Trust, Alder Hey, Eaton Road, Liverpool L12 2AP, UK. Tel: 0151 252 5633; Fax: 0151 252 5643; E-mail: giogio33@yahoo.com

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In contrast, provision of food through a gastrostomy constructed by percutaneous endoscopy encourages simultaneous oral feeding as tolerated, and avoids the specific problems of gastroesophageal reflux associated with feeding via a nasogastric tube. In addition the absence of the nasogastric tube allows the uninhibited development of oromotor skills, thus avoiding the very real complication of long-term aversive feeding behaviour. Percutaneous endoscopic placement of a gastrostomy tube is quick and easy, with few associated risks.[7,8] It allows a more controlled delivery of nutritional needs. Insertion of the gastrostomy tube can frequently be timed to accommodate other invasive and non-invasive procedures under general anaesthesia, such as cardiac catheterisation. So far, to the best of our knowledge, only one study has investigated the benefit of nutritional support by gastrostomy in children with cardiac disease,[5] although its benefit has been well documented for malnourished children with non-cardiac disease.[9,10]

With these considerations in mind, we reviewed retrospectively the nutritional status of our children with cardiac diseases who had nutritional support through a gastrostomy constructed by percutaneous endoscopy, comparing them with matched children who had received oral or nasogastric feeding.

Materials and methods

Between June 1995 and November 1999, 37 children, 22 female and 15 male, with congenital or acquired cardiac disease (Table 1) underwent percutaneous endoscopic construction of a gastrostomy for nutritional support. Of the children, 8 (21.9%) had associated chromosomal disorders, such as DiGeorge syndrome, Down's syndrome or Noonan's syndrome.

Two of the patients, with oesophageal atresia and tracheoesophageal fistula, required gastrostomy on the first day of life. The remaining 35 patients received conventional nutritional support such as nasogastric feeding, pump feeding, or provision of caloric-dense feeds, prior to construction of the gastrostomy. All patients were failing to thrive due to inadequate nutrition.

Based on their cardiac diagnosis, and transcutaneous saturations of oxygen at the time of the procedure, each patient was allocated to one of three groups (Table 1).

- In 14 patients with cyanotic heart disease, the saturation of oxygen was below 95%.
- In 18 patients with significant non-cyanotic cardiac malformations, the saturations of oxygen as measured transcutaneously were equal to or above 95%.

Table 1. The specific cardiac lesions of our patients in whom a gastrostomy was placed by percutaneous endoscopy.

Cyanotic disease	**14**
Tetralogy of Fallot and pulmonary Atresia	3
Pulmonary atresia with intact ventricular septum	1
Transposition with or without pulmonary stenosis	3
Hypoplastic left heart syndrome	2
Complex cardiac diseases	4
Other	1
Non-cyanotic disease	**18**
Cardiomyopathy	4
Atrial or ventricular septal defect	9
Right heart obstructive lesions	1
Atrioventricular septal defect with aortic coarctation	2
Other	2
Minor disease	**5**
Atrial or ventricular septal defect, patent arterial duct	5

- The final 5 patients had minor asymptomatic cardiac disease, with associated renal or gastrointestinal malformations. These children required no invasive cardiac procedure, such as catheterization or cardiac surgery, and received minimal medical therapy.

Each of the three groups was compared with patients without a gastrostomy, who received conventional nutritional support, such as feeding via a nasogastric tube, pump feeding, and receipt of caloric-dense feeds. The groups were matched for age, sex, underlying cardiac disease, and cardio-thoracic surgical or interventional cardiac catheterisation procedures. Measures of outcome were the anthropometrical parameters of body weight and its variation in relation to age and sex of each patient, expressed as the standard deviation score for body weight.

All data were obtained by review of the case notes, and included recording of body weight at cardiac follow-up clinic, as well as the weight recorded by the cardiac dietician.

In all the patients, the gastrostomy tube was inserted by the same operator (MD), using percutaneous endoscopy under general anaesthesia with a 12 french gauge Corflo device, using the pull-through technique.

The data were analysed using standard descriptive tests to establish median and range of body weight standard deviation score, and the age and length of follow up for each of the three groups. Within each group, as well as within the combined group, comparisons were made between study and control group with respect to body weight standard deviation score, length of follow up, and age. We used the non-parametric Wilcoxon signed rank test to compare the differences in body weight standard deviation score over the follow up period between the groups of

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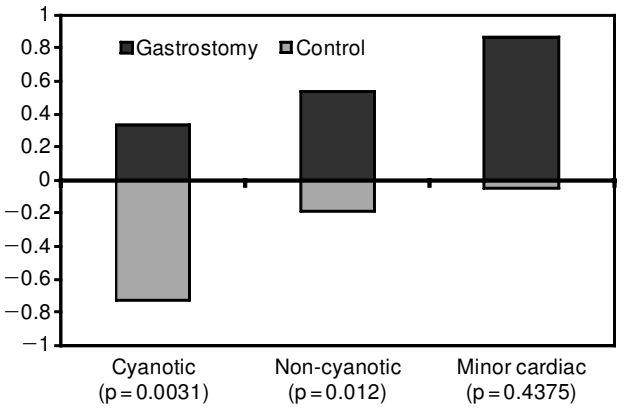

Figure 1.
Median changes of standard deviation score for body weight over the follow-up period illustrated for patients with gastrostomy (Gastrostomy) and their controls (Control) – these changes are displayed for each of the groups of cyanotic, non-cyanotic, and patients with minor cardiac anomalies).

patients and their controls (Software: StatsDirect). For each of variables, we calculated median and the 95% confidence intervals for differences between the medians for the patients and their controls (Fig. 1).

Results

In 17 children (46%), the gastrostomy tube was placed under general anaesthesia at the time of cardiac catheterization or cardiothoracic surgery. A separate general anaesthetic was required in the remaining 20 children (54%). Of these 20 isolated procedures, 7 were performed within a few weeks following cardiothoracic surgery or cardiac catheterization.

The median age at the time of the procedure was 262 days, with a range from 1 to 849 days, and the median length of follow up after insertion of the gastrostomy tube was 295 days, with a range from 19 to 1503 days. No complications were encountered, either directly related to the placement of the gastrostomy or secondary to its continued use during follow up. Three patients died in each group. Of these, two patients with hypertrophic obstructed cardiomyopathy died suddenly as a complication of their underlying cardiac disease, and one patient succumbed to renal failure.

Nutritional support via the gastrostomy was successfully discontinued in three patients after establishment of an adequate oral intake at a median of 18 months, with a range from 3 to 30 months. Inadequate parental compliance with one patient resulted in a severe drop in the standard deviation score for body weight from −1.89 to −4.21.

All but one of the cyanotic patients required some form of cardiothoracic surgery or catheter intervention, either prior to placement of the gastrostomy, or while on gastrostomic feeding. This is in sharp contrast to the non-cyanotic patients. Of these, 7 (38.9%) did not undergo any form of cardiac intervention during the period of follow-up.

The median standard deviation score for body weight of all the patients, irrespective of their grouping at the time of insertion of the gastrostomy tube, was −2.33, with a range from −4.22 to 1.12. Over the period of follow-up, 28 patients (76%) with a gastrostomy demonstrated an improvement in the standard deviation score for body weight. The median change in this score was significantly higher in those with a gastrostomy (+0.7) compared to those without a gastrostomy (−0.37) ($p = 0.0002$, 95%CI 0.535 to 1.41). This was independent of associated chromosomal disorders.

Cyanotic patients demonstrated a slight increase in their median standard deviation score for body weight, from −2.33 to −2.125, over a median period of follow-up of 211 days. In comparison, there was a decrease of median standard deviation score for body weight in controls from −0.9 to −1.635. The median change of standard deviation score for body weight was significantly higher in patients with gastrostomy (0.34) compared to controls (−0.73) ($p = 0.0031$, 95%CI 0.42 to 1.565) (Fig. 1).

Similar results were obtained in non-cyanotic patients. The median standard deviation score for body weight increased over a median follow-up period of 294 days from −2.75 to −2.03 in patients with gastrostomy, compared to a decrease from −0.24 to −0.84 in controls. The median change of standard deviation score for body weight in patients with gastrostomy (+0.54) was significantly higher when compared to controls (−0.185) ($p = 0.012$, 95%CI 0.15 to 1.595) (Fig. 1).

The median standard deviation score for body weight of the 5 patients with minor cardiac anomalies, but with associated renal or gastroenteral diseases, increased from −1.6 to −0.66 in patients with gastrostomy, compared to a decrease from −1.39 to −1.48 in controls. Although the median change of the standard deviation score for body weight was again higher in patients with gastrostomy (+0.87) compared to controls (−0.05), these results were statistically not significant ($p = 0.4375$).

Discussion

Malnutrition has long been recognized as a significant problem in children with cardiac disease, and several modifications to traditional means of nutritional support have been explored.[11–13] Our study indicates the benefits of nutritional support via a percutaneous endoscopically constructed gastrostomy in

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undernourished children with cardiac disease. Not all patients responded with an improved gain in weight. The overall trend compared to a control population of patients supplied with nasogastrically delivered and caloric-dense formula, nonetheless, is favourable. Even for the 9 patients who did not demonstrate good weight gain, the gastrostomy may well have been beneficial. Nutritional support delivered via gastrostomy considerably reduces the stress experienced by parents of children with problems of feeding.

It is not always possible to identify the reasons why an individual patient may not benefit from nutritional support delivered via gastrostomy, as the cause maybe multifactorial. The increased severity of underlying cardiac and non-cardiac illness, and issues of compliance, may have a significant impact, and are difficult to validate. Our results do not suggest that cyanotic or non-cyanotic patients should be treated differently with respect to the potential benefit to be obtained from percutaneous endoscopic insertion of a gastrostomy tube. It appears, at first, as though non-cyanotic patients achieve a greater benefit from the placement of the gastrostomy compared to cyanotic patients, as their median improvement in standard deviation score for body weight is higher. In comparison to the control children, nonetheless, it is clear that cyanotic patients tend to lose weight more markedly without enteral nutritional support in comparison to those who are non-cyanotic. In contrast, the potential benefit of nutritional supplementation via gastrostomy in patients with minor cardiac anomalies depends on the severity of their associated medical problems.

An active decision to insert a gastrostomy should be made at an early stage, in order to optimise growth and acquisition of normal oromotor skills. The first two years of life are crucial, especially in patients who require Fontan-type palliation. In our opinion, a short period of failed nasogastric nutritional support should lead to consideration of the elective placement of a gastrostomy. None of the patients in our study encountered complications related to the placement and use of the gastrostomy tube, which is in keeping with other reports in the literature.[7,8,14]

The decision to insert a gastrostomy should be made carefully as part of a multi-speciality assessment.[15] A dietician should be involved early in the care of any patient who is failing to grow in order to optimise the conventional nutritional support and monitor the expected gain in weight. Assessment by a speech and language therapist is also invaluable at an early stage. The cardiologist and gastroenterologist should jointly assess and monitor all patients where there are concerns regarding nutritional status. A cardiac liaison nurse is the important link between the parents and other disciplines. The acceptance and compliance with this form of nutritional support is high, not least in part due to the fact that the therapy is effective.

Although the results suggest a beneficial effect of nutritional support via percutaneous endoscopic gastrostomy in chronically ill cardiac patients, our study has several limitations. We were unable to take into account the individual nutritional regime, or the types of formula, which could potentially have influenced the results. It is our view that the route of nutritional delivery has a profound effect on tolerance, and ultimately a greater benefit in terms of caloric intake. Additionally, it was not always possible to obtain a complete match between our patients and their controls for all surgical and non-surgical interventions, or for the period of follow-up. The follow-up itself was variable, with 8 patients being followed up for less than 100 days, and 3 patients for less than 50 days. We also failed to achieve an appropriate match of initial weight between patients with gastrostomy and their controls. Overall the median initial standard deviation score for body weight of the patients studied was much higher than the comparable score for their controls (-0.75 versus -2.33). It may well be the case that the scope for improving gain in weight is greater with those patients who are more severely underweight.

Future studies should include markers of the severity of illness, as well as an evaluation of the improvement of the standard deviation score for body weight in relation to the time following construction of the gastrostomy. Some issues remain unknown, such as the rate at which children acquire voluntary feeding skills, and when they dispense with the need for the gastrostomy. It will be necessary, therefore, prospectively to evaluate the benefits of early percutaneous endoscopic placement of a gastrostomy in nutritionally compromised children with cardiac disease based on a standardized protocol.

In summary, we emphasise that:

- Nutritional support via percutaneous endoscopic gastrostomy improves growth in infants and young children with congenital and acquired cardiac diseases.
- The median standard deviation score for body weight of patients receiving nutritional support via gastrostomy improved significantly over the period of study compared to a matched control group of patients supplemented via a nasogastric tube.
- No complications were observed in relation to the placement of the gastrostomy or its subsequent use.

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