*British Journal of Nutrition* (2005), **93**, 509–513
DOI: 10.1079/BJN20041383


# Early enteral feeding compared with parenteral nutrition after oesophageal or oesophagogastric resection and reconstruction

S. Gabor[1]*, H. Renner[1], V. Matzi[1], B. Ratzenhofer[2], J. Lindenmann[1], O. Sankin[1], H. Pinter[1], A. Maier[1], J. Smolle[1] and F. M. Smolle-Jüttner[1]

[1]*Department of Surgery, Division of Thoracic and Hyperbaric Surgery and*
[2]*Department of Anesthesiology, University of Medicine Graz, Auenbruggerplatz 29, A-8036 Graz, Austria*

*(Received 17 June 2004 – Revised 12 October 2004 – Accepted 12 November 2004)*

After resective and reconstructive surgery in the gastrointestinal tract, oral feeding is traditionally avoided in order to minimize strain to the anastomoses and to reduce the inherent risks of the postoperatively impaired gastrointestinal motility. However, studies have given evidence that the small bowel recovers its ability to absorb nutrients almost immediately following surgery, even in the absence of peristalsis, and that early enteral feeding would preserve both the integrity of gut mucosa and its immunological function. The aim of this study was to investigate the impact of early enteral feeding on the postoperative course following oesophagectomy or oesophagogastrectomy, and reconstruction. Between May 1999 and November 2002, forty-four consecutive patients (thirty-eight males and six females; mean age 62, range 30–82) with oesophageal carcinoma (stages I–III), who had undergone radical resection and reconstruction, entered this study (early enteral feeding group; EEF). A historical group of forty-four patients (thirty-seven males and seven females; mean age 64, range 41–79; stages I–III) resected between January 1997 and March 1999 served as control (parenteral feeding group; PF). The duration of both postoperative stay in the Intensive Care Unit (ICU) and the total hospital stay, perioperative complications and the overall mortality were compared. Early enteral feeding was administered over the jejunal line of a Dobhoff tube. It started 6 h postoperatively at a rate of 10 ml/h for 6 h with stepwise increase until total enteral nutrition was achieved on day 6. In the controls oral enteral feeding was begun on day 7. If compared to the PF group, EEF patients recovered faster considering the duration of both stay in the ICU and in the hospital. There was a significant difference in the interval until the first bowel movements. No difference in overall 30 d mortality was identified. A poor nutritional status was a significant prognostic factor for an increased mortality. Early enteral feeding significantly reduces the duration of ICU treatment and total hospital stay in patients who undergo oesophagectomy or oesophagogastrectomy for oesophageal carcinoma. The mortality rate is not affected.

**Early enteral feeding: Oesophagus: Immunonutrition: Parenteral nutrition: Nutrition**

Oesophageal cancer patients are frequently malnourished due to oesophageal stenosis, due to their underlying nutritional habits, or because of systemic effects of their neoplasm. Though it has been documented that the degree of malnutrition correlates positively with the incidence of postoperative complications (Mercer & Mungara, 1996), both the pressing time schedule for oesophageal resection and the inherent catabolic situation usually do not allow a preoperative reversal of malnutrition. Resection itself, however, means a further major catabolic stress. Therefore, it is vital to provide adequate postoperative nutrition as soon as possible to counteract catabolism and to reduce complications.

Over the last three decades, experimental and clinical studies have been done to try to identify the optimal postoperative nutritional support and the best way to deliver it. There is evidence that the small bowel recovers its ability to absorb nutrients almost immediately after surgery, even in the absence of peristalsis. Early enteral feeding has been shown to preserve the integrity of gut mucosa and to keep up its immunological function (Sand *et al.* 1997).

The aim of this study was to investigate the impact of early enteral feeding on the postoperative course following oesophagectomy and reconstruction in patients with oesophageal cancer.

## Materials and methods

### *Patients*

Between May 1999 and November 2002, forty-four consecutive patients (thiry-eight males and six females; mean age 62, range 30–82) with oesophageal cancer (stages I–III), underwent radical resection and reconstruction. All of them were given early enteral feeding (early enteral feeding group, EEF). Table 1 lists the EEF patients' characteristics: risk factors (diabetes mellitus, chronic obstructive pulmonary disease (COPD), history of cardiac disease or present New York Heart Association (NYHA) I–II, impaired renal function with serum creatinine $>1{\cdot}3$) and nutritional status (BMI, preoperative weight loss throughout the last 3 months, preoperative degree of dysphagia).

**Abbreviations:** COPD, chronic obstructive pulmonary disease; EEF, early enteral feeding group; NYHA, New York Heart Association; PF, parenteral feeding group; SIRS, Systemic Inflammatory Response Syndrome.

* **Corresponding author:** Dr S. Gabor, fax +43 316 385 4679, email Sabine.Gabor@meduni-graz.at

**Table 1.** Characteristics of the patients in the early enterol feeding group

| Characteristics | Value | Range |
|---|---|---|
| Age (y; mean) | 62 | 30–82 |
| Sex | | |
| Male | 38 | |
| Female | 6 | |
| Nutritional status | | |
| BMI | 25·9 | 17·6–36·8 |
| Preoperative weight loss | | |
| < 5 % | 12 | |
| > 5 % in 3 months | 14 | |
| > 5 % in 2 months | 14 | |
| > 5 % in 1 month | 4 | |
| Preoperative degree of dysphagia | | |
| Grade 0 | 6 | |
| Grade 1 | 11 | |
| Grade 2 | 17 | |
| Grade 3 | 10 | |
| Risk factors | | |
| Diabetes mellitus | 7 | |
| COPD | 8 | |
| Cardiac disease | 6 | |
| Impaired renal function | 4 | |
| Type of interponate | | |
| Stomach | 39 | |
| Jejunum | 2 | |
| Colon transversum | 3 | |

COPD, chronic obstructive pulmonary disease.

A matched historical group of forty-four patients (thirty-seven males and seven females; mean age 64, range 41–79) with oesophageal carcinoma (stages I–III) that had undergone resection and reconstruction between January 1997 and March 1999 served as control. No enteral feeding was given for 7 d (parenteral feeding group, PF). Table 2 lists the PF patients' characteristics.

**Table 2.** Characteristics of the patients in the parenteral feeding group

| Characteristics | Value | Range |
|---|---|---|
| Age (y; mean) | 64 | 41–79 |
| Sex | | |
| Male | 37 | |
| Female | 7 | |
| Nutritional status | | |
| BMI | 23·4 | 18·1–34·3 |
| Preoperative weight loss | | |
| < 5 % | 11 | |
| > 5 % in 3 months | 16 | |
| > 5 % in 2 months | 12 | |
| > 5 % in 1 month | 5 | |
| Preoperative degree of dysphagia | | |
| Grade 0 | 7 | |
| Grade 1 | 12 | |
| Grade 2 | 15 | |
| Grade 3 | 10 | |
| Risk factors | | |
| Diabetes mellitus | 7 | |
| COPD | 12 | |
| Cardiac disease | 9 | |
| Impaired renal function | 3 | |
| Type of interponate | | |
| Stomach | 33 | |
| Jejunum | 8 | |
| Colon transversum | 3 | |

COPD, chronic obstructive pulmonary disease.

*Surgery*

There was no difference in the preoperative and surgical management of either group. The preoperative oncological assessment included chest roentgenography, computed tomography of the chest and the abdomen, oesophagogastroscopy, abdominal sonography and bone scan.

Resection included oesophagectomy or oesophagogastrectomy in case of extended gastric involvement. Lymph-node dissection was done in the left gastric and paraoesophageal area.

Reconstruction of the upper intestinal continuity in the EEF group was done using the stomach (*n* 39), a pedicled jejunal loop (*n* 2) or the colon (*n* 3). Oesophagoenteral anastomoses were routinely done in the cervical position.

In the PF group the reconstruction was done with the stomach (*n* 33), a pedicled jejunal loop (*n* 8) and the colon (*n* 3).

In the EEF group we used a double-lumen Dobhoff 16/9 F Naso–Jejunal Feeding/Gastric Decompression Tube R (Sherwood Davis & Geck; Sherwood Medical Company, St. Louis, MO, USA), inserting the feeding tube into the jejunum 30 cm distal to the duojejunal fold or to the lowermost anastomosis, respectively, while the decompression tube, facilitating evacuation of the interponate, was positioned well within the stomach or in the part of the bowel replacing the oesophagus.

In the PF group a 16 F double-lumen naso-gastric tube (Vygon Double Lumen Gastric Tube; VYGON, Ecouen, France) was placed into the stomach or into the part of the bowel replacing the oesophagus for decompression of gas and evacuation of liquids.

Tri-lumen central venous catheters were inserted routinely in both groups.

Perioperative antibiotic prophylaxis was administered in all patients. It comprised metronidazole $3 \times 100$ mg and cefazolin $3 \times 2$ g.

*Feeding protocol*

The nutritional goal was 104 375 kJ/kg per d (25 kcal/kg per d) in both groups.

The EEF group was administered an enteral diet (Fresubin Standard R; Fresenius Kabi AG, Bad Homburg, Germany) by nasojejunal tube, starting 6 h after the end of the operation. The enteral infusion rate was begun with 10 ml/h for 6 h on the day of operation and was increased stepwise up to the nutritional goal that was reached on the 6th postoperative day. On the 1st, 2nd, 3rd, 4th and 5th postoperative day the energy intake by the enteral route was 1753·5, 2339, 2922·5, 3506 and 4676 kJ (420, 560, 700, 840 and 1120 kcal), respectively. Until the 5th postoperative day the enteral feeding was combined with parenteral nutrition (Isocal 2000 R; Fresenius) to reach the nutritional goal.

In case of side-effects of enteral nutrition (abdominal cramps, vomiting, diarrhoea) a reduction of the jejunal infusion rate or even an intermittent stop was scheduled. In the latter case it was planned to resume the enteral nutrition as soon as possible, if necessary at a lower rate.

The PF group was administered isocaloric total parenteral nutrition (Isocal 2000 R). It was continuously infused during 24 h, the calorie source being represented by carbohydrates (70 %) and lipids as long-chain triglycerides (30 %).

On the 7th postoperative day a fluoroscopically controlled swallow of water-soluble contrast medium was done to assess the oesophagogastric or oesophagoenteral anastomosis, respectively. Thereafter, oral feeding using first liquid and then semiliquid food was begun in both groups. In the case of cervical anastomotic dehiscence enteral nutrition was kept up after the 7th day, either by feeding tube or by oral feeding, according to the local situation.

*Factors entering analysis*

The following parameters were included in the analysis: the preoperative nutritional status according to the nutritional risk screening (ASPEN, 2002) were estimated using the preoperative weight loss during the last 3 months ($<5\%$, $>5\%$ in 1, 2 and 3 months), the preoperative degree of dysphagia (grade 0 = none; grade 1 = dysphagia for solid food; grade 2 = dysphagia for semisolid food; grade 3 = dysphagia for liquids) and the preoperative BMI.

Furthermore, the risk factors (diabetes mellitus, COPD, history of cardiac disease or coexistent cardiac disease <NYHA II, impaired renal function), the interval until the first bowel movements after the operation (d), episodes of Systemic Inflammatory Response Syndrome (SIRS) or signs of sepsis not due to a surgical complication, length of need to stay on the Intensive Care Unit (ICU; d), length of postoperative hospital stay (d) and 30 d mortality were evaluated.

Episodes of SIRS or sepsis not due to a surgical complication were defined according to the criteria of the ACCP-SCCM Consensus Conference Committee (Bone *et al.* 1992). For the diagnosis at least two of the following criteria had to be fulfilled: systolic blood pressure <90 mmHg, tachycardia >90/min, respiratory rate >20/min or peripheral arterial $CO_2$ tension ($PaCO_2$) <32 mmHg, temperature >38·0 or <36·0°C, leukocytosis >12 000/μl or leukopaenia <4000/μl or >10 % immature (band) forms.

Surgical complications observed in our patients were wound infection and anastomotic dehiscence which were also included in the analysis.

*Statistical analyses*

Data were evaluated using the SPSS statistical program package (SPSS Inc., Sunnyvale, CA, USA). Descriptive statistics were performed using mean, standard deviation, standard error, and absolute and relative frequencies. Binary variables were tested for statistical relationships using Fisher's exact test. Student's *t* test was applied in order to assess statistical differences between two groups concerning continuous variables. In the exploratory analysis, a *P* value of $<0{\cdot}05$ was considered to indicate statistical significance.

## Results

Enteral feeding was well tolerated. Only in three cases did the infusion rate have to be reduced for 24 h because of diarrhoea. In no case was it necessary to stop enteral feeding. In nine patients the feeding tube showed dislocation during the first 4 d and had to be repositioned.

Three out of forty-four patients died in the EEF group within 30 d of the operation (days 7, 11 and 25). In the PF controls four out of forty-four patients died within 30 d of the operation (days 9, 14, 23 and 24). The difference is not statistically significant ($P>0{\cdot}05$). None of the accompanying diseases such as COPD, cardiac disease, diabetes mellitus or impaired renal function had a significant influence on mortality, neither did tumour stage, sex, age or preoperative weight loss $>5\%$. A poor nutritional status, however, was significantly connected with an increased mortality ($P=0{\cdot}012$). SIRS ($P<0{\cdot}001$) and sepsis ($P<0{\cdot}001$) were significant predictors of an increased mortality rate.

Six out of forty-four patients in the EEF group developed SIRS, one had sepsis, whereas in the PF group six patients developed SIRS and seven sepsis ($P>0{\cdot}05$, NS). Pneumonia occurred in four cases in the EEF group and in eleven of the PF patients ($P=0{\cdot}087$, NS) There was also no significant difference in the combined infection rate (pneumonia plus sepsis, $P>0{\cdot}05$; see Table 3).

There was a significant difference in the interval until the first bowel movements. In the EEF group they were observed at a median of 4 d postoperative (range 3–6 d; mean 3·64 (SEM 0·13) d) compared to 8 d postoperative (range 6–10 d; mean 7·95 (SEM 1·8) d) in the PF group ($P<0{\cdot}001$).

Anastomotic dehiscence (all of them cervical) occurred in twenty-one out of forty-four patients in the EEF group and in twenty-three out of forty-four in the PF group. Wound infection was found in one patient in the EEF group and three patients in the PF group, however, the difference is not statistically significant (see Table 3).

Patients were discharged from the ICU after a median of 10 d (range 2–100 d; mean 10·3 (SEM 2·3) d) in the EEF group and after a median of 19 d (range 9–120 d; mean 19·02 (SEM 2·61) d)

**Table 3.** Analysis of the patients in the early enteral feeding groups and the parenteral feeding group.

| | Early enteral feeding group | Parenteral feeding group | *P* |
|---|---|---|---|
| SIRS | 6 | 6 | >0·05 NS |
| Sepsis | 1 | 7 | >0·05 NS |
| Pneumonia | 4 | 11 | 0·087 NS |
| Mortality | 3 | 4 | >0·05 NS |
| Wound infection | 1 | 3 | >0·05 NS |
| Anastomotic dehiscence | 21 | 23 | >0·05 NS |
| Stay in ICU (d) | 10 (2–100) | 19 (9–120) | <0·01* |
| Total stay (d) | 26 (18–112) | 43 (30–140) | <0·001** |
| Interval until first bowel movements (d) | 4 (3–6) | 7·95 (6–10) | <0·001** |

ICU, Intensive Care Unit; SIRS, Systemic Inflammatory Response Syndrome.
*,**Values significantly different.

in the PF group ($P<0{\cdot}01$). The median length of postoperative hospital stay was 26 d (range 18–112 d; mean 25·7 (SEM 2·4) d) in the EEF group and 43 d (range 30–140 d; mean 44·1 (SEM 3·4) d) in the PF group ($P<0{\cdot}001$) (Fig. 1).

## Discussion

Malnutrition, cancer and major surgery are well-known factors capable of impairing the host immune response and thus increasing the risk of postoperative infections. Patients with oesophageal carcinoma are particularly prone to postoperative complications, since malnutrition is a common finding in them and because of a high prevalence of COPD and/or cardiac disease, usually caused by smoking.

During the last 15 years the role of the gut in host defence has been emphasized (Windsor *et al.* 1995) and early enteral feeding has been favoured over parenteral feeding after abdominal surgery (Kudsk *et al.* 1992; Moore *et al.* 1992). Similar to our results, other investigators have found that early enteral feeding significantly reduces infectious complications, length of stay in the ICU and hospital stay after major surgery (Braga *et al.* 1995; Mercer *et al.* 1996; Hochwald *et al.* 1997; Sand *et al.* 1997).

In SIRS and the development of multi-organ failure the intestine has a particular role to act as a 'motor'. Both operative trauma and anaesthesia cause intestinal dysfunction with impairment of bowel permeability and changes in the gut-associated lymphoid tissue. This might initiate, via bacterial translocation or endotoxinaemia, the liberation of oxygen free radicals and in consequence, for example, acute respiratory distress syndrome. Furthermore, this mechanism increases the susceptibility to postoperative sepsis and septic complications (Swank & Deitch, 1996; Weimann *et al.* 1999; Bastian & Weimann, 2002). Therefore, postoperative treatment must focus on preserving the protective and immunological function of the bowel mucosa.

Nasojejunal feeding tubes have been reported to carry a risk of aspiration pneumonia in about 7 % of patients (Baeten & Hoefnagels, 1992). We did not observe any case of aspiration in our collective, since evacuation of the stomach, the jejunum or the colon was routinely done in both groups, whereas the use of a Dobhoff tube facilitated enteral feeding, proximal evacuation notwithstanding. Obliteration or migration of the catheter are common technical problems associated with enteral tubes. We encountered such problems in nine of our patients, yet they were easily overcome.

**Fig. 1.** Dobhoff decompression/feeding tube.

Catheter jejunostomy has often been advocated for postoperative enteral feeding. However, since decompression and evacuation of the organ replacing the oesophagus or both oesophagus and stomach is advisable anyway, this would not obviate the need for a nasogastric tube, which conveniently can also be used for feeding. Moreover, catheter jejunostomy theoretically carries the risk of potential problems, due to the fixation of the jejunum to the abdominal wall, such as volvulus or abdominal pain caused by adhesions (Eddy *et al.* 1996; Yagi *et al.* 1999).

The observation that bowel movements took place significantly earlier in the EEF group underlines the fact that the postoperative bowel function itself normalizes more rapidly if early enteral nutrition is offered (Velez *et al.* 1997; Schilder *et al.* 1999). The overall immunological function might be improved by EEF: there was a trend towards a reduced incidence of SIRS, sepsis and pneumonia in the EEF group compared to the PF group, though the difference did not reach statistical significance.

The lower rate of perioperative non-surgical adverse events was reflected by a significantly shorter stay on the ICU and a significantly shorter postoperative hospital stay for the EEF patients. The latter effect, which is also connected with a lowering of costs, has already been described by other authors (Braga *et al.* 1995; Mercer *et al.* 1996).

We could not confirm the results of other authors, who found an increased breaking strength of anastomoses following enteral nutrition in an experimental setting (Kiyama *et al.* 1999), since the rate of anastomotic dehiscence did not differ between the two groups. Cervical oesophagoenteral anastomoses, however, are very much influenced by local factors such as perfusion and venous stasis (Furst *et al.* 2000; Maier *et al.* 2002; Briel *et al.* 2004). These effects might overcome possible positive influences by enteral nutrition.

Out of the preoperative factors such as coexisting diseases, weight loss and malnutrition, only the latter had a significant influence on 30 d mortality. The type of postoperative nutrition had no impact whatsoever on mortality.

## Conclusion

Early enteral feeding tends to reduce non-surgical postoperative septic or septiform complications in patients with oesophageal carcinoma who undergo resection and reconstruction. If compared to parenteral feeding both the stay on the ICU and in the hospital are significantly shorter. Mortality is not affected.

## References

ASPEN Board of Directors (2002) Guidelines for the use of parenteral, enteral nutrition in adult and pediatric care. *J Parenter Enteral Nutr* **26**, 9SA–12SA.

Baeten C & Hoefnagels J (1992) Feeding via nasogastric tube or percutaneous endoscopic gastrostomy. *Scand J Gastroenterol* **27**, Suppl. 194, 95–98.

Bastian L & Weimann A (2002) Immunonutrition in patients after trauma. *Br J Nutr* **87**, Suppl. 1, 133–134.

Bone RC, Sibbald WJ & Sprung CL (1992) The ACCP-SCCM Consensus Conference on sepsis and organ failure. *Chest* **101**, 1481–1483.

Braga M, Vignali A, Gianotti L, Cestari A, Profili M & Di Carlo V (1995) Benefits of early postoperative enteral feeling in cancer patients. *Infusionther Transfusionmed* **22**, 280–284.

Briel JW, Tamhankar AP, Hagen JA, DeMeester SR, Johansson J, Choustoulakis E, Peters JH, Bremner CG & De Meester TR (2004) Prevalence and risk factors for ischemia, leak and striature of esophageal anastomosis: gastric pull-up versus colon interposition. *J Am Coll Surg* **198**, 536–541.

Eddy VA, Snell JE & Morris JA (1996) Analysis of complications and long-term outcome of trauma patients with needle catheter jejunostomy. *Am Surg* **62**, 40–44.

Furst H, Hartl WH, Lohe F & Schildberg FW (2000) Colon interposition for esophageal replacement: an alternative technique based on the use of the right colon. *Ann Surg* **231**, 173–178.

Hochwald SN, Harrison LE, Heslin MJ, Burt ME & Brennan MF (1997) Early postoperative enteral feeding improves whole body protein kinetics in upper gastrointestinal cancer patients. *Am J Surg* **174**, 325–330.

Kiyama T, Efron DT, Tantry U & Barbul A (1999) Effect of nutritional route on colonic anastomotic healing in the rat. *J Gastrointest Surg* **3**, 441–446.

Kudsk KA, Croce MA, Fabian TC, Minare G, Tolley EA, Porci A, Kuhl MR & Brown RO (1992) Enteral versus parenteral feeling. *Ann Surg* **215**, 503–513.

Maier A, Pinter H, Tomaselli F, Sankin O, Gabor S, Ratzenhofer-Komenda B & Smolle-Juttner FM (2002) Retrosternal pedicled jejunum interposition: an alternative for reconstruction after total esophago-gastrectomy. *Eur J Cardiothorac Surg* **22**, 661–665.

Mercer CD & Mungara A (1996) Enteral feeding in esophageal surgery. *Nutrition* **12**, 200–201.

Moore FA, Feliciano DV & Andrassy RJ (1992) Early enteral feeding compared with parenteral, reduces postoperative septic complications. *Ann Surg* **216**, 172.

Sand J, Luostarinen M & Matikainen M (1997) Enteral or parenteral feeding after total gastrectomy: prospective randomized pilot study. *Eur J Surg* **163**, 761–766.

Schilder JM, Hurteau JA, Look KY, Moore DH, Raff G, Stehmann FB & Sutton GP (1999) A prospective controlled trial of early postoperative oral intake following major abdominal gynecologic surgery. *Gynecol Oncol* **67**, 235–240.

Swank GM & Deitch EA (1996) Role of the gut in multiple organ failure: bacterial translocation and permeability changes. *World J Surg* **20**, 411–417.

Velez JP, Lince LF & Restrepo JI (1997) Early enteral nutrition in gastrointestinal surgery: a pilot study. *Nutrition* **13**, 442–445.

Weimann A, Bastian L, Grotz M, Heine J & Schlitt HJ (1999) Welche Bedeutung besitzt der Darm in der Ätiologie des Multiorganversagens. *Aktuelle Ernährungs-Med* **24**, 20–24.

Windsor AC, Klava A, Somers SS, Giullou PJ & Reynolds VV (1995) Manipulation of local and systemic host defence in the prevention of perioperative sepsis. *Br J Surg* **82**(11), 1460–1467.

Yagi M, Hashimoto T, Nezuka H, Ito H, Tani T, Shimizu K & Miwa K (1999) Complications associated with enteral nutrition using catheter jejunostomy after esophagectomy. *Surg Today* **29**, 214–218.