in the hope of preventing HIV transmission to their children. This study shows that the conditions required for safe formula feeding are present in Khayelitsha.

The authors wish to acknowledge the women who participated in the study, the field workers and the personnel from the different clinics who made this study possible.

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Percutaneous endoscopic gastrostomy in children — a 5-year experience

W G van der Merwe, R A Brown, J D Ireland, E Goddard

Introduction. Percutaneous endoscopic gastrostomy (PEG) has been performed on children since 1979. The indications for a PEG are wide ranging and while there are well-established benefits, it remains a procedure with recognised complications.

Goals and objectives. The goal of this study was to review our experience with this procedure at a South African paediatric tertiary referral hospital over a 5-year period. The objectives were to review PEGs with regard to patient characteristics, indications, anaesthesia time required and complications.

Methods. The study was a retrospective case record review.

Results. A total of 70 PEGs were performed. Patients had a mean age of 4 years and 3 months, and a mean weight of 12.2 kg at the time of performing the procedure. The mean anaesthetic time required for performing a PEG was 27 minutes. Fifty-four PEGs (77%) were performed for inability to swallow, 15 (21%) to improve caloric intake, and 1 (1%) for continuous enteral feeding. There were no deaths, 5 patients had major complications (6%), and 12 patients (17%) needed antireflux surgery subsequent to the placement of a PEG.

Discussion. There is an increasing demand for PEGs at our institution. The indications for a PEG in this series are similar to those reported in other series, although we may be underutilising PEGs to improve caloric intake. Our complication rates compare favourably with those reported in other series. We have, however, identified post-PEG gastro-oesophageal reflux disease as a complication we would like to reduce, and suggest a practical approach to do so.

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The first percutaneous endoscopic gastrostomy (PEG) was performed by Michael Gauderer, a paediatric surgeon at the Cleveland University Hospital, in June 1979. The following year he and his co-workers[1] reported on the first 12 cases in children. The procedure was based on the novel concept of sutureless approximation of a hollow viscus to the abdominal wall. With clear advantages over conventional surgical gastrostomy (viz. no need for a laparotomy, short anaesthetic time or conscious sedation, and quicker postoperative recovery) the procedure has grown rapidly in popularity among both adult and paediatric clinicians.

In the paediatric population PEG was initially most frequently used to assist in the feeding of neurologically impaired patients with dysphagia. In such cases PEG has established itself as an effective and convenient replacement for long-term nasogastric tube feeding with all its inherent

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problems. Over time, however, the applications of PEG in clinical practice have expanded considerably and individual studies and reports have now documented the role of PEG in a wide variety of clinical settings. These include patients with burns,[2] cystic fibrosis,[3] congenital heart disease,[5] cancer,[5] chronic cholestasis,[6] and AIDS.[7] In broad terms the indications for a PEG are well delineated in a review by Kimber and Beasley[8] viz.: (*i*) inability to swallow; (*ii*) to improve caloric intake; (*iii*) administration of unpalatable feeds or medications; and (*iv*) administration of continuous enteral feeding.

Goals and objectives

At our institution PEGs have been performed since 1994, with an active PEG programme initiated in 1997 in a joint effort by the paediatric gastroenterology and paediatric surgical services. The goal of this study was to review our experience with this procedure over the first 5-year period since initiation of this endeavour. The objectives were to review PEGs with regard to patient characteristics, indications, anaesthetic time and complications.

Methods

This was a retrospective study. All case notes of patients who underwent PEG from June 1997 to June 2002 were reviewed. The setting was the Red Cross War Memorial Children's Hospital, a paediatric tertiary referral hospital in the Western Cape, South Africa. During this period PEGs were performed by two members of a trained team comprising two paediatric gastroenterologists, a paediatric surgeon and a senior registrar in paediatric gastroenterology. The retrograde pull technique first described by Gauderer *et al.*[1] was used throughout, with the first member of the team performing a gastroscopy using a 9 mm Olympus endoscope and the second member of the team performing the operative part of the procedure. The PEG size used varied from French 14 to French 20 depending on the size of the patient and the intended use of the PEG.

Results

A total of 70 PEGs were performed in the 5-year period and the number performed increased steadily over this period (Fig. 1). The mean age of patients at the time of PEG was 4 years and 3 months (range: 1 month - 15 years and 1 month). The mean weight was 12.2 kg (range: 2.2 - 45 kg). Follow-up ranged from 1 month to 5 years. All the procedures were performed under general anaesthesia and the mean anaesthetic time was 27 minutes (range: 10 - 60 minutes). Thirty of the procedures were performed during elective admission, with length of hospital stay ranging from 1 to 5 days. The remainder of the procedures were performed during a long stay in hospital for other reasons (defined as more than 10 days for the purposes of this study).

The indications for PEG are summarised in Table I. In this study indications were considered to fall into one of three categories: (*i*) inability to feed or swallow (54 cases, 77%); (*ii*) to improve caloric intake (15 cases, 21%); and (*iii*) administration of continuous enteral feeding (1 case, 1%). In no case was administration of unpalatable medications or feeds

Table I. Clinical indications for a PEG (*N* = 70)

Inability to feed/swallow	
Cerebral palsy	15
Neurological regression	2
Syndromes	7
Acute neurological damage	
Infective	6
Trauma/hypoxia	10
Muscular weakness	2
Chronic tracheostomy	2
Total	44 (63%)
Improve caloric intake	
Cystic fibrosis	4
Congenital heart disease	4
Chronic lung disease	1
HIV/AIDS	1
Total	10 (14%)
Continuous enteral feeding	
Short bowel syndrome	1
Total	1 (1%)
Inability to feed/ unpalatable medicines/feeds	
Neurological regression/seizures	2
Syndrome with seizures	2
Brain tumour/seizures	2
Metabolic disorders	2
Immunodeficiency syndrome	1
Syndrome with faecal loading	1
Total	10 (14%)
Improve caloric intake/ medicines/feeds	
Chronic renal failure	3
Fanconi syndrome/cystinosis	1
Nephrogenic diabetes insipidus	1
Total	5 (7%)

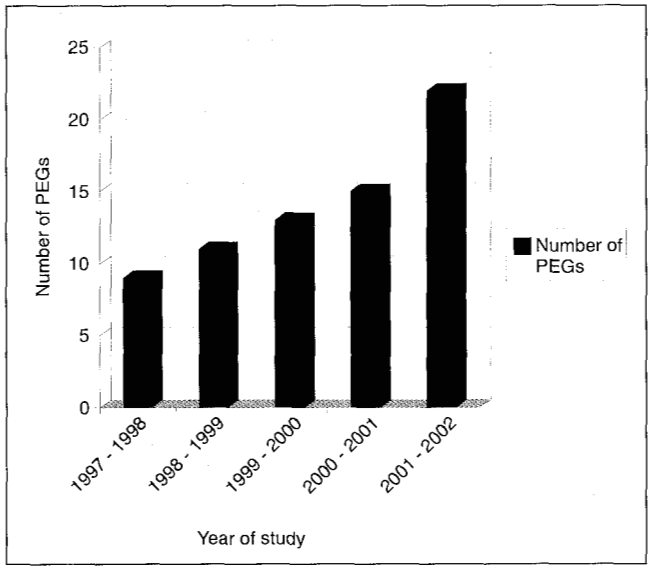


Fig. 1. Number of PEGs performed per year of study.

considered to be the sole indication for a PEG, but where this was considered to form part of the indication this has been indicated as such in Table I.

There was no mortality associated with the placement of a PEG during the 5-year study period. Five complications were considered to be major. Of these the most severe and life threatening was an oesophageal perforation resulting in a pneumomediastinum. This complication occurred while introducing a 9 mm gastroscope into the oesophagus of a 2.3 kg baby. The patient made a full recovery with conservative management. A further 2 patients developed significant stomal complications requiring conversion to surgical gastrostomy. There was 1 case of submucosal migration of the internal PEG bumper, the so-called buried-bumper syndrome. This complication is illustrated in Fig. 2. Finally, 1 patient developed significant sepsis after placement of the PEG.

Following the placement of a PEG 12 patients (17%) developed gastro-oesophageal reflux disease (GORD) which was considered severe enough to require antireflux surgery. When analysed retrospectively, 3 of these patients had no symptoms of gastro-oesophageal reflux before the placement of the PEG while 9 had symptoms of gastro-oesophageal reflux but the results of investigations for gastro-oesophageal reflux were either normal or not considered to be of adequate significance to exclude the placement of a PEG (2 patients demonstrated mild gastro-oesophageal reflux on a barium swallow, 4 patients had a normal barium swallow, 1 had a normal milk scan, 1 had a normal ultrasound of the gastro-oesophageal junction while the final patient had normal barium, milk scan and pH studies.)

Again when analysed retrospectively, 47 of the total of 70 patients (67%) were asymptomatic for gastro-oesophageal

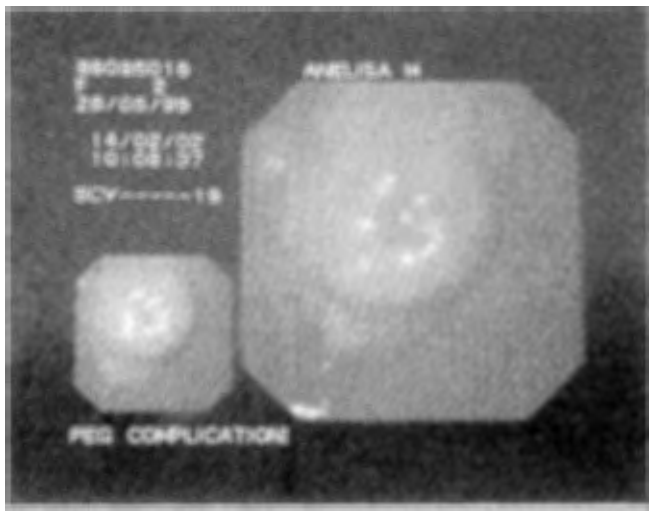


Fig. 2. Submucosal migration of internal bumper or buried-bumper syndrome.

reflux before the placement of a PEG and 3 (6%) developed GORD requiring surgery. Twenty-three patients (33%) had been symptomatic for gastro-oesophageal reflux, and of these 9 (39%) required antireflux surgery after the placement of a PEG.

Of the 70 cases, 7 PEGs have been removed completely after re-establishing oral feeding, 32 have been changed for a skin-level device or Foley catheter, and 18 remain *in situ*. Six of the PEGs were converted to a surgical gastrostomy (2 because of PEG stomal complications and 4 concomitant with antireflux surgery). Seven patients have died from causes unrelated to the procedure.

Discussion

There is increasing awareness of both the availability and indications for a PEG at our institution which is reflected in the steady increase in the number of procedures being performed. This is certainly in keeping with international experience. Matthewson *et al.*,[9] for example, report on the successful role of a multidisciplinary PEG advice team necessary to cope with the dramatically increased referral of patients to be considered for a PEG at their institution.

In our series the majority of procedures have been performed for children with a neurological condition resulting in swallowing difficulty. This is in keeping with other reported paediatric series, although we are using PEGs to improve caloric intake less frequently than some groups (Table II).[10-12] We need to strive to identify patients who can benefit from a PEG in this clinical setting where its efficacy is well established[2-7] as well as in cases where it can be specifically used to administer unpalatable medications or feeds.

We have shown that the anaesthetic time required for a PEG is relatively short and with increasing expertise it may become

Table II. PEG indications in paediatric series

	Van der Merwe *et al.* 2003 *N* = 70	Khattak *et al.*[10] 1998 *N* = 120	Behrens *et al.*[11] 1997 *N* = 139	Marin *et al.*[12] 1993 *N* = 70
Inability to swallow (%)	77	62	74	51
Improve caloric intake (%)	21	25	19	37
Special medicines/feeds (%)		10	5	9
Continuous enteral feeding (%)	1	3	2	3

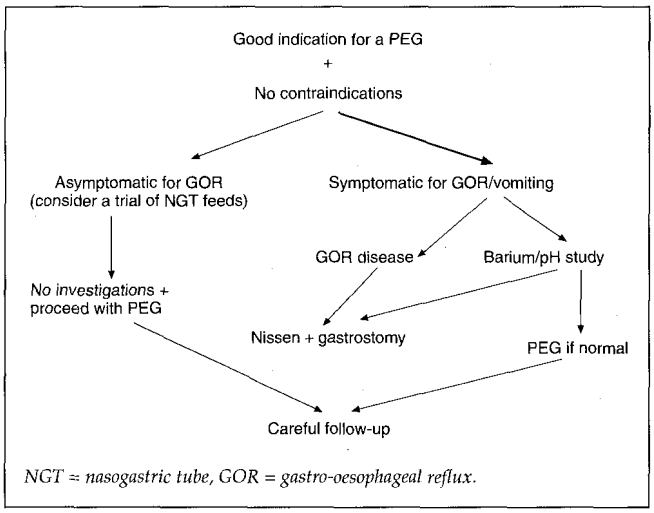
Table III. Incidence of major complications and GORD requiring surgery in paediatric series

	Van der Merwe *et al.* 2003 *N* = 70	Khattak *et al.*[10] 1998 *N* = 120	Marin *et al.*[12] 1993 *N* = 70	Gauderer *et al.*[13] 1991 *N* = 220
Major complications (%)	7	9	11	7
GORD requiring surgery (%)	17	8	7	13

even shorter. We have had no experience in this series of performing the procedure under conscious sedation. Where the procedure was performed during an elective admission, hospital stay was generally short. These are advantages that one expects of a PEG over a surgical gastrostomy.

Although PEG is now generally accepted as a safe and effective procedure, there is no doubt that it is associated with complications, both minor and major. In this series we focused only on major complications and our incidence rate of 6% was low when compared with that of other reported series in children[10,12,13] (Table III). Certain of the frequently reported major complications have not been experienced by us at all. These include gastrocolic fistula formation, major haemorrhage and intestinal obstruction. We attribute this success to both good patient selection (i.e. no contraindications to the procedure) and attention to intraoperative techniques that prevent complications. Such strategies are very well described by Beasley *et al.*,[14] and contraindications, although none are absolute, include previous upper abdominal surgery, abdominal organomegaly, presence of a ventriculoperitoneal shunt or peritoneal dialysis and small size of patient (particularly where a small gastroscope is not available). Although there are studies documenting the safety of PEGs in some of these scenarios (e.g. previous surgery[15] or small size[16]), we believe it is important to assess all these factors in each individual case before making the decision to proceed with a PEG.

The subject of gastro-oesophageal reflux in relation to PEG placement is a complex one and warrants individual attention. It remains unclear to what extent a PEG can influence pre-existing gastro-oesophageal reflux and whether it can cause gastro-oesophageal reflux in a previously well patient. The number of GORD patients requiring surgery in this series was relatively high when compared with other paediatric series (Table III). The results of this series, however, suggest that the risk of a previously asymptomatic patient developing GORD is low. This finding is in keeping with the results of a study reported by Puntis *et al.*[17] We have not had a formalised approach to investigation of patients symptomatic for gastro-oesophageal reflux, but on the whole investigations performed were not useful in predicting which patients would develop GORD and this is certainly the experience of other authors.[13] Of interest is that only 1 of our patients underwent a pH study, although the results of a study published by Sulaeman *et al.*[18] suggest that a pH study is a particularly useful investigation. In that study only 1% of patients who had a normal pH study developed GORD requiring surgery. In light of our findings and the available evidence in current literature on the subject, we propose a practical approach to PEG placement and gastro-oesophageal reflux (Fig. 3). This is also proposed to form the basis of a prospective study to determine which patients will benefit at the outset from antireflux surgery and to reduce the incidence of GORD following the placement of a PEG. However, we do not expect this to be a foolproof strategy and a key aspect to the successful application of a PEG programme will continue to be careful follow-up by a team that should ideally also include a stomal therapist, dietitian and speech therapist. This is important not only with regard to gastro-oesophageal reflux, but also the detection of minor and major complications (which may appear late), monitoring of optimal feeding and growth as well the timing of either removal or replacement of the PEG with an alternative feeding tube.



NGT = nasogastric tube, GOR = gastro-oesophageal reflux.

Fig. 3. Suggested practical approach in assessing GOR when considering a patient for a PEG.

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