THE VALUE OF PAEDIATRIC UPPER GASTROINTESTINAL CONTRAST STUDIES

A NAIROBI STUDY

A DISSERTATION SUBMITTED IN PART FULFILLMENT FOR THE DEGREE OF MASTER OF MEDICINE IN DIAGNOSTIC RADIOLOGY, UNIVERSITY OF NAIROBI.

BY

DR. G. N. MWANGO, MB.Ch.B (NBI)

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DECLARATION

Candidate

This dissertation is my original work and has not been presented for a degree in any other University.

Signed: Mwango.

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MB.Ch.B. (Nbi)

Supervisor

This dissertation has been submitted for examination with my approval as University Supervisor.

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Martin Shimba for the statistical analysis.
My parents, brothers and sisters for their love and support throughout the duration of this course.

CONTENTS

SUMMARY

In this prospective study carried out over a period of 6 months (July - December 1998) to determine the value of paediatric upper gastrointestinal studies, a total of 67 children under 5 years of age were investigated. 58.1% of the children were female.

The most common radiological finding was gastro-esophageal reflux (GER) which was found in 44.8% of the patients. The male to female ratio was 1:2. A third of these patients with GER were found to be underweight for age compared to the 7 out of 30 patients who presented with recurrent pneumonia. There is a likelihood that the main complication of GER is failure to thrive and more studies are needed to evaluate this relationship further.

INTRODUCTION

The major role of the gastrointestinal tract(GIT)is to digest food and absorb nutrients. This enables the child to achieve his optimal growth and development.

The gut is embryologically derived from the endoderm (1) and is morphologically well developed by the twelfth week of gestation so that even very young preterm babies are able to sustain nutrition by the enteral route (2,3). Disease processes affecting the alimentary tract may present with symptoms of disordered function such as dysphagia, vomiting and diarrhoea or more insidiously with evidence of failure to thrive and poor linear growth (2-5).

The anatomy of the esophagus in infants and children is similar to that in adults (Fig. 1) except for a few radiological differences. Air is more commonly seen in the esophagus of children especially neonates (2). However massive amounts of air may be due to excessive air swallowing and gastro-esophageal reflux (GER). Pulmonary disease with poor respiratory excursion may result in relatively low intrathoracic pressure and secondary esophageal dilatation seen as pneumoesophagus in the chest radiograph (4). Other causes of massive pneumoesophagus include obstruction at the distal esophagus from stenosis, achalasia, tracheoesophageal fistula, paralysis from caustic burns, acute vomiting in gastroenteritis

or ingestion of toxic substances (4). Scleroderma is another cause of excessive amounts of air in the oesophagus more seen in adults than in children.

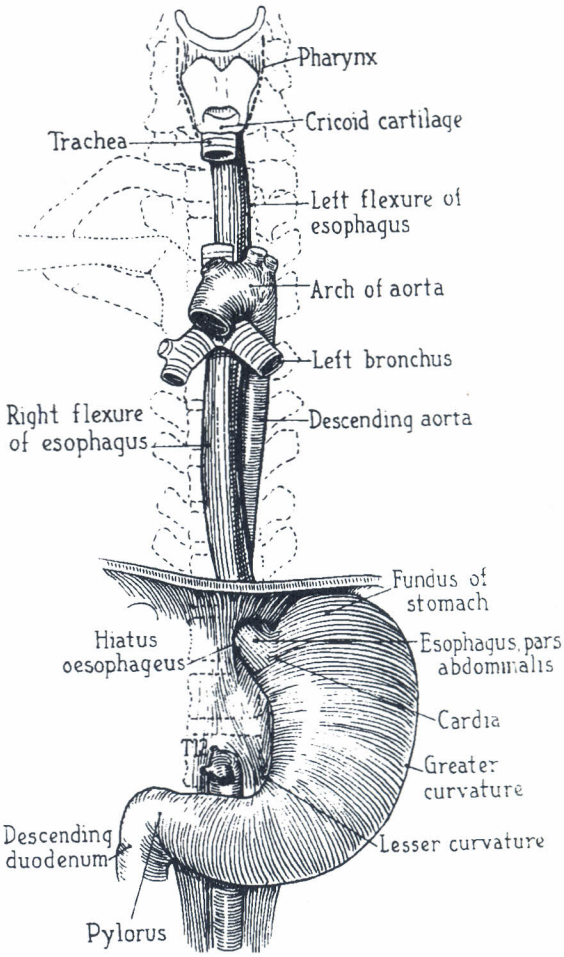


Fig 1: Schematic drawing of the upper gastro-intestinal tract showing the esophagus. stomach and 1st part of the duodenum.(In Caffey's Pediatric X-ray Diagnosis. F.N. Silverman (ed) 8th edition. Year Book Publishers inc. 1985)

The normal impressions of the aorta, left main bronchus or left atrium may be seen on the esophagogram but are less prominent than in adults (2,4).

Usually coordinated suckling and swallowing are well developed at term (2,3) but the infant must learn how to burp. However it usually encounters feeding difficulties when first presented with solid foods during weaning. This difficulty in swallowing or feeding could be due to disco-ordinate esophageal motility or esophageal obstruction (2-5). The obstruction could be an external compression as in a mediastinal mass or a vascular anomaly or due to an internal obstruction as in an esophageal web (2-5). At birth the most common structural cause of dysphagia is esophageal atresia (2,5). In older children dysphagia occurs more commonly from esophageal strictures which may result from the accidental ingestion of corrosives or from esophagitis as a consequence of severe gastro-esophageal reflux (GER) (4,5).

Furthermore the techniques for the upper gastrointestinal system studies in children are also different as significant morbidity, even mortality can result from a careless or improperly performed procedure (2). There is no substitute for a careful history taking and physical examination as the clinical evaluation and subsequent investigations depend on these findings. Due to the harmful effects of ionizing radiation especially to cells undergoing rapid mitosis, the

risk of neoplasia especially to the thyroid gland is of great concern in children due to their life expectancy. Sonography is therefore the initial modality of choice in the investigation of many paediatric problems (2). However bowel gas reduces the usefulness of sonography and contrast studies are often used initially (2-5). This usually entails a single or double contrast barium examination for the investigation of feeding problems or obstructing lesions while in suspected esophagitis a double contrast barium study is the investigation of choice (2). Thus radiology plays a crucial role in the investigation of upper GIT disorders in children. This study aims at documenting some of the radiological findings in paediatric upper GIT studies done here in Nairobi.

The study will aim at demonstrating the clinical indications for the contrast investigation, the radiological findings and their relative prevalence and if there is any correlation between the indication and radiological findings. The contrast used will be barium sulphate mainly. Any difference in technique will also be documented.

LITERATURE REVIEW

The pathogenesis of GER is not well understood. The infantile esophagogastric junction differs from that in older children (Fig 2) in some aspects. In infants the hiatus is a more narrow channel and the angle at which the esophagus enters the stomach is less acute (5). The squamocolumnar junction is usually not seen (6). In addition infants have a more fetal type of lower esophageal sphincter with very elastic upper and lower phrenicoesophageal membranes that serve to weld the hiatal margin of the diaphragm to the esophagus and its adventitia. All these features may predispose to both GER and hiatus hernia (2).

More recent studies have shown that normal gastro-esophageal function to be a complex mechanism that depends on effective esophageal motility, timely relaxation and contractility of the lower esophageal sphincter, the mean intraluminal pressure in the stomach and the ease of gastric outflow (7). More than one of these factors may be deficient in the child with GER. GER has stimulated alot of interest (7-9) as it is one of the most frequent symptomatic clinical disorders affecting the gastrointestinal tract of infants and children (2). It has been found to be more the rule than the exception in infants less than 4 months of age (4). This is inspite of the resting basal esophageal sphincter pressure in infants being higher than that in adults (10). This does not explain the relatively

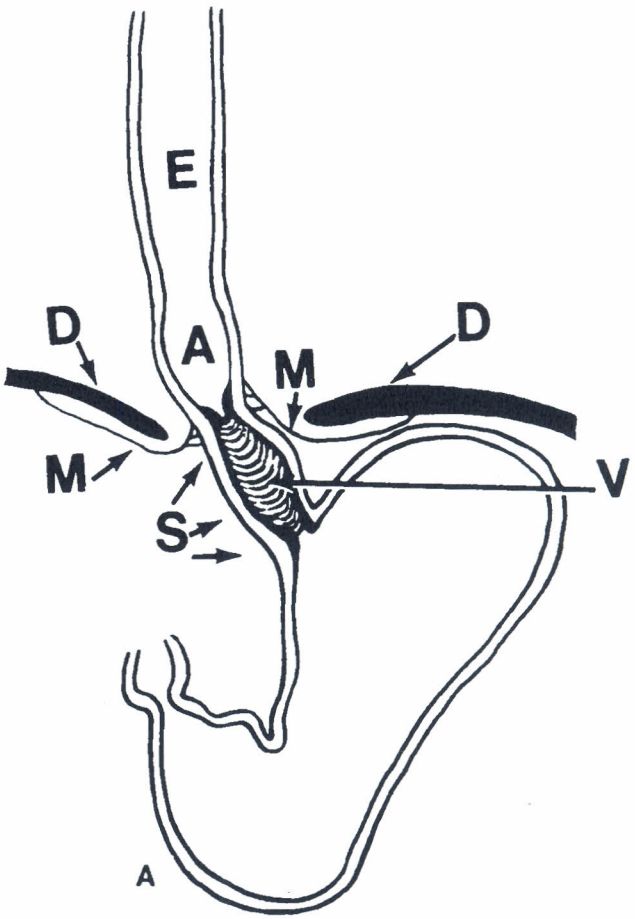


Fig 2: Gastro-esophageal junction; Diagrammatic representation.

E	Esophagus	V	Esophageal vestibule
A	Esophageal ampulla	M	Phrenicoesophageal membrane
S	Lower esophageal sphincter		
D	Diaphragm		

higher incidence of GER in children than in adults. The most frequent complications of GER are failure to thrive as a result of caloric deprivation, recurrent bronchitis and pneumonia caused by repeated pulmonary aspiration of gastric fluid (7-10). Children with neuromuscular disorders and mental retardation have been found to have a higher incidence of disease from reflux (4).

Most children with GER have barium studies to evaluate the lower esophagus for evidence of stricture and to diagnose an associated gastric outlet obstruction as a cause of the reflux (11).

Other methods for investigating GER include esophageal PH monitoring, scintigraphy using 99mTc sulphur colloid, endoscopy and biopsy for signs of esophagitis. Reflux esophagitis can also occur without any predisposing abnormality (15) but is more like to occur when there is defective esophageal peristalsis (2-5, 15, 16). One of the earliest signs of esophagitis seen radiologically is the presence of irregular contractions which may occur when the reflux enters the esophagus (7). Other signs include stricture formation which may initially present with a stepladder appearance and rarely pseudomembranes (17, 18). Barrett's esophagus which may be predisposed by previous surgery as in the repair of esophageal atresia (2) is seen as a stricture or ulceration that is classically in the proximal esophagus but may be found also

elsewhere (19,20). In 13% of patients with GER no stricture or radiologic evidence of ulceration is seen (15). Other signs seen on double contrast examinations include distal esophageal widening, granular/nodular or reticular mucosal pattern, intramural diverticula (21-23). Indications for surgery include failure to thrive, persistent vomiting, hematemesis, stricture formation, hiatus hernia or partial thoracic stomach (24).

Another major differential diagnosis for infants who present with vomiting is hypertrophic pyloric stenosis (HPS) (2-5). It randomly affects 3 out of every 1000 neonates and infants 3 to 5 weeks of age. There is a male preponderance of 4:1 and a familial disposition also occurs. While vomiting is the predominant symptom, jaundice, dehydration and constipation commonly occur (25-29). Many clinicians and radiologists favour sonography as an initial imaging modality as there is no radiation exposure and it allows accurate measurements of the hypertrophied muscle. Ultrasound can also demonstrate other causes of vomiting like duplication cyst or annular pancreas (26). However fluoroscopy is more accurate in imaging intraluminal disorders such as antral web, malrotation and gastro-esophageal reflux (27, 28). It can demonstrate gastric peristalsis and elongation of the pyloric canal but does not permit determination of the thickness of pyloric muscle (28). Thus in a patient with a presumptive diagnosis of HPS, some workers recommend that the initial investigation to be

fluoroscopy as its more cost effective (29). They postulate that duplication of services resulting from initial negative or inconclusive ultrasound examinations requiring follow-up fluoroscopic studies results in 95% increase in cost (29).

Thus the indications for investigating the upper gastro intestinal system in children particularly in infants differs from that in adults. While in adults inflammatory conditions like peptic ulcer disease form the bulk of the disorders (in Mburu '98) in children GER and congenital anomalies are prevalent. Such a study documenting the various conditions that can be found in upper gastrointestinal contrast studies in Kenya has not been done in children.

The use of barium sulphate as a contrast media is due to its relative safety, non-toxicity and low osmolarity (2). It is also fairly cheap. It can be administered through a nasogastric feeding tube or using a feeding bottle (4). Here at KNH cup and spoon feeding method is also used in the older infant. Hyperosmolar water soluble contrast media are avoided in upper gastrointestinal studies due to the risk of lung toxicity, pulmonary edema or death when aspirated (2-5). They also have some pharmacological effects even when isosmolar which include cholinesterase inhibition, release of histamine and a serotonin-like substance in the bowel (12). The low osmolar non-ionic water soluble contrast media are ideal for investigating the GIT but are expensive. They have minimal

effect on the lungs, peritoneum and are not absorbed by the bowel wall thus delayed films are possible (2). However due to their expense they are usually reserved for procedures in which perforation or aspiration is known or suspected and in the use in premature infants. Bronchographic contrast media like dionosil can also be used in investigating the gut (2). This is especially where there is suspicion of an esophageal leak into the mediastinum or lungs. However due to their cost, unpleasant taste which reduces patient co-operation they have been largely replaced by the low-osmolar water soluble contrast media. They have also been found to be rapidly fatal if injected intraperitoneally in animal studies (30). Here at KNH 36% meglumine iopamide (36% uromiro) is usually used in suspected tracheoesophageal fistula where it is carefully introduced by a nasogastric tube placed in mid esophagus under screening control.

The spot films obtained during an upper gastrointestinal study include prone, supine, oblique and lateral views. The prone view is the least helpful because in this position swallowed or refluxed air collects adjacent to the gastro-esophageal junction rather than barium and thus the GER may be missed during fluoroscopy. Delayed films are useful as they may demonstrate reflux during a small bowel study (2). There is no general agreement as to the best method for testing for GER on barium swallow (2-5). If spontaneous reflux is not seen it may be elicited by gently rocking the supine child from left to the

right posterior oblique position (2). The classification of GER into minor and major is determined by the anatomical level reached by the reflux. Reflux is most significant when it occurs spontaneously and repeatedly reaches a level above the clavicles in the quiet infant who is lying supine (13,14). Major reflux has a higher incidence of pulmonary complications (13). During the barium examination it is important not to overfill the stomach. Only the amount of barium equal to which the child takes at a feeding should be given (11).

AIMS AND OBJECTIVES.

Aim:-To demonstrate the radiological findings in paediatric upper gastrointestinal studies.

Objectives:-

1. To establish the different indications for the contrast study.

2. To show the disease pattern of the upper GIT by radiological evaluation.

3. To assess the weight and clinical status of the patients in view of assessing their nutritional status.

4. To find out the relation if any of the radiological diagnosis and the clinical presentation.

Study Design:-

Descriptive prospective study done over a 6 months period.

PATIENTS, MATERIALS AND METHODS

Clinical problems of the gastrointestinal system of infants and young children differ from those of adults as they are more related to congenital abnormalities. (2). Thus single contrast examinations are usually considered adequate to demonstrate the lesion.

In this study the technique used was single contrast examinations. The preferred contrast was barium sulphate suspension unless in children with suspected tracheoesophageal fistula where water soluble 36% uromiro was used. This was carefully introduced into the esophagus using a nosogastric tube under screening control. Care was taken that minimal amounts if any were introduced into the lungs.

For neonates and infants under one year of age feeds were withheld for 3 - 4 hours prior to the examination. The older children could fast for 6 - 8 hours. However the technique was tailored to the particular child and it was sometimes found necessary to pass a paediatric nasogastric tube to aspirate the stomach contents before the examination.

Usually 15ml of micronized barium sulphate (microbar suspension 95% w/v) was used which was further diluted by an equal amount of warm water. This was then carefully given to the child using cup and spoon method either by the mother under

supervision or by the radiographer/radiologist resident. Contamination of the child's outer garments was avoided. Usually this amount of barium was found to adequately fill the stomach allowing one to assess the gastric emptying and thereby excluding gastric outlet obstruction. The last mouthful was given when the patient was lying supine with the head turned to the right side under screening control. This allowed assessment of the swallowing reflex and the esophageal peristaltic waves as the barium progressed down into the stomach. The supine position meant that most of the barium was at the stomach fundus and intermittent screening for 2 - 3 minutes was allowed to check for reflux. If none occurred the patient was gently rolled to the right anterior oblique position so that the barium was against the gastro esophageal junction. Further intermittent screening for 2 - 3 minutes was allowed. This position also allowed for subjective assessment of the angle between the esophagus and the stomach fundus. (Fig. 1).

Reflux was graded into minor or major reflux depending on whether it reached the distal 1/3 or carinal and clavicular level respectively (13,14).

Views of the esophagus - supine and left oblique were obtained as the patient was swallowing. Supine, lateral and prone views of the stomach and duodenum was also taken under screening control depending on the radiological finding. The radiographs

obtained were then reported under the supervision of a consultant radiologist.

The age, sex, clinical and radiological findings of the child under 5 years were then recorded in the interview form (appendix 1). The birth weight could be obtained from the child health card (appendix 2) where available or from interviewing the mother. The current weight was obtained by directly weighing the patient after the procedure.

This study included all the children who were 5 years of age and below who were booked for an upper gastrointestinal study during the study period July to December 1998 at Kenyatta National Hospital, Diagnostic Imaging Centre and Aga Khan Hospital. This consisted of patients referred from the private clinics, wards and the paediatric out-patient departments. Neither the immune status of the patient nor primary nutritional disorders were considered during the data collection and analysis.

RESULTS

The study involved 67 patients who were below 5 years of age. It took a period of 6 months (July 98 to December 98). Age range was 3 days to 54 months. Mean age was 11.58 months. (appendix 3).

Most of the patients were females - 58.1%. This was reflected in all the age groups studied (Fig 3).

The most common indication necessitating the radiological study was vomiting seen in 50.7% of patients. In children under 6 months of age vomiting was seen as an indication in 25 out of the 35 patients.

The next common indications in order of frequency were dysphagia (11), recurrent pneumonia (9), post-operative follow-up (5), hematemesis (2). Epigastric pain was seen as an indication in only 2 patients both of whom were over 2 years of age. (Fig 4).

Of the 67 patients studied 18 had normal findings. This comprised 26.9%. The most common finding was gastro-esophageal reflux (GER) seen in 30 patients. (Fig 5).

The male to female ratio was 1:2 (Fig 6). The other radiological findings included disordered esophageal motility

(4), pyloric stenosis (3) achalasia (2), duodenal bands (2), diaphragmatic hernia/eventration (2), stricture post-poisoning (2). (table 1).

GER accounted for 44.8% of the radiological findings (Fig 6). In infants under 6 months it accounted for 48.6%.

All the patients studied except one were term deliveries with birth weights of at least 2kg. (Fig 7).

19 out of the 67 patients studied had low weight for age. (Fig 8). This comprised 28.6%. This was calculated using the WHO 3rd percentile as the cut-off weight limit. (appendix 2).

Of these underweight children 10 had GER, 5 had normal findings, 2 had achalasia cardia, 1 had disordered esophageal motility and 1 had trachea-esophageal fistula. (Fig 9).

Of the patients who were underweight but with normal radiological findings 2 were post-operative patients and the others had cardiac disease, poisoning and recurrent pneumonia respectively.

The most common indication for the patients found with GER was vomiting forming 55.1% followed by recurrent pneumonia 20.7% (Fig 10).

Fig 3: Sex distribution of Study Patients.

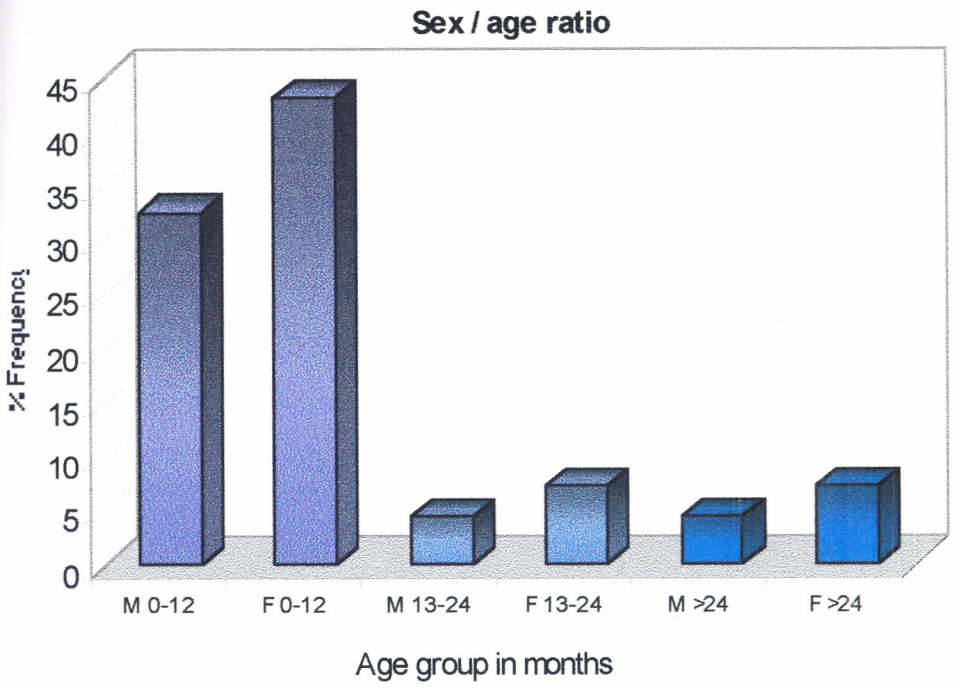
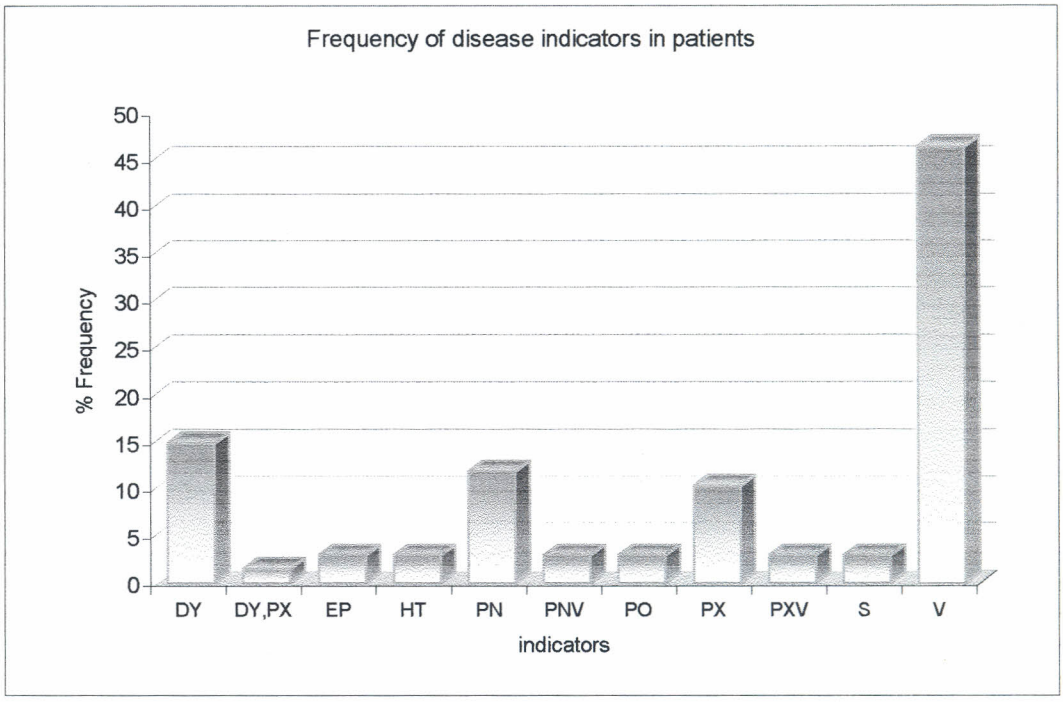
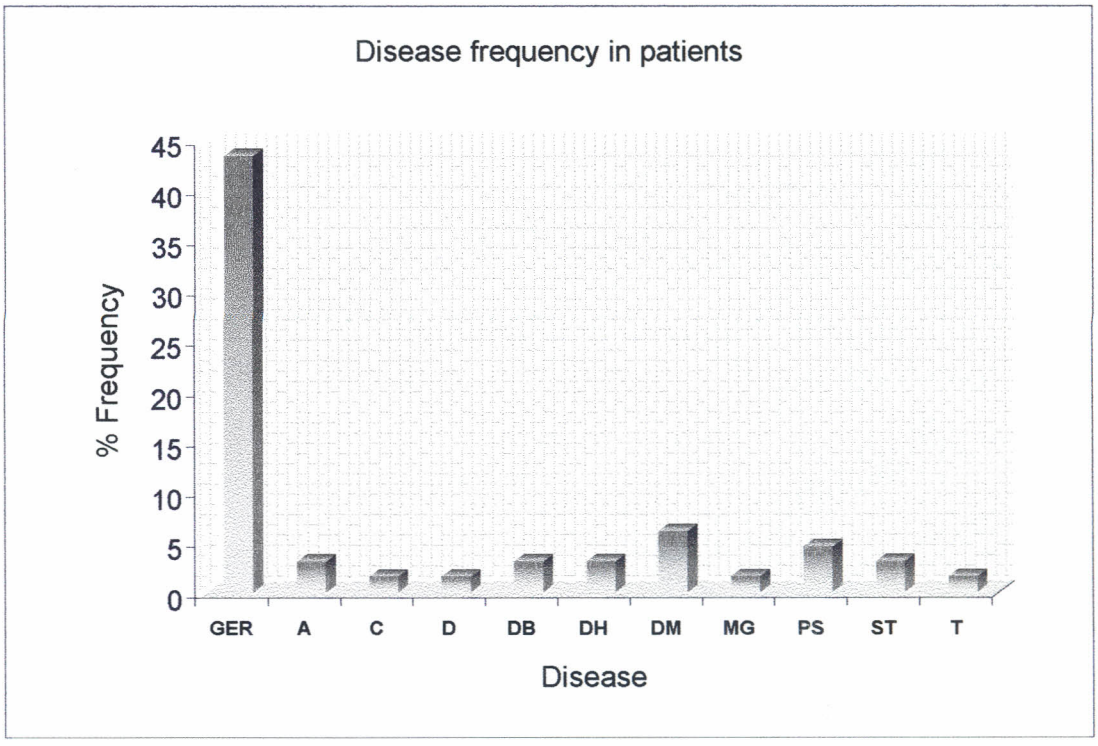


Fig 4: Frequency of the different indications in the study patients.



DY	Dysphagia	V	Vomiting
EP	Epigastric pain	PO	Poisoning
HT	Hematemesis	PX	Post operative
PN	Pneumonia	S	Strictures

Fig 5: Demonstrates the radiological findings in the study patients



Key:

G - GER

A - Achalasia

C - Cardiovascular

D - duodenitis

DB - Duodenal bands

T - Tracheo-esophageal fistula

DH - Diaphragmatic hernia

DM - Disco-ordinated motility

MG - Malposition and GER

PS Pyloric stenosis

ST - Stricture

Fig 6: Proportion of gastroesophageal reflux from the other radiological findings and its sex distribution.

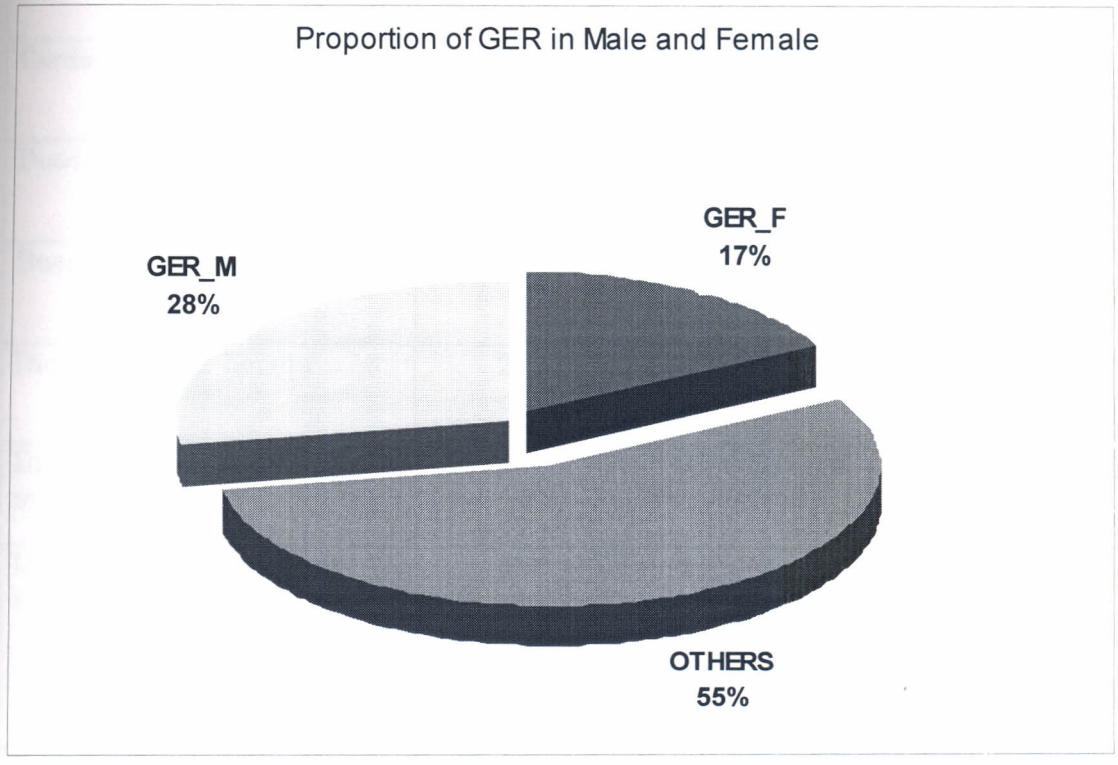


Table 1. Radiological Findings and Sex frequency

Findings	Male frequency	Female frequency	Total	% frequency
Normal	9	10	19	28.4
Gastroesophageal reflux	10	19	29	43.3
Achalasia cardia	1	1	2	3
Cardiovascular	-	1	1	1.5
Duodenitis	-	1	1	1.5
Duodenal band	1	1	2	3
Diaphragmatic hernia	2	-	2	3
Disco-ordinate esophageal motility	1	3	4	5.9
Malposition of small gut and GER		1	1	1.5
Pyloric stenosis	3	-	3	4.5
Stricture	1	1	2	3
TOF	-	1	1	1.5

Fig 7: Distribution of the birth weights of study patients

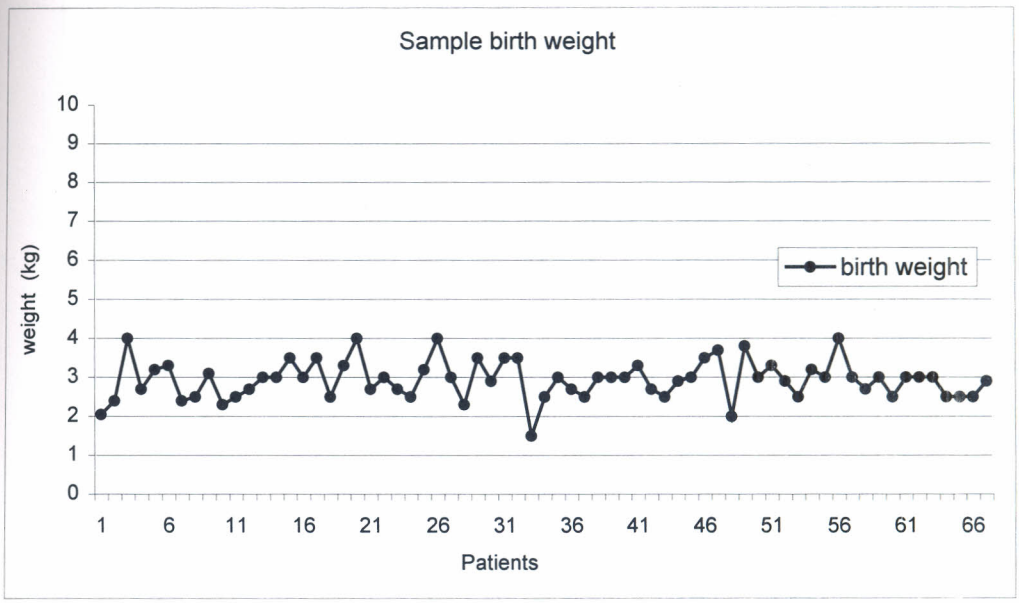


Fig 8: Compares the current and expected weights of study population.

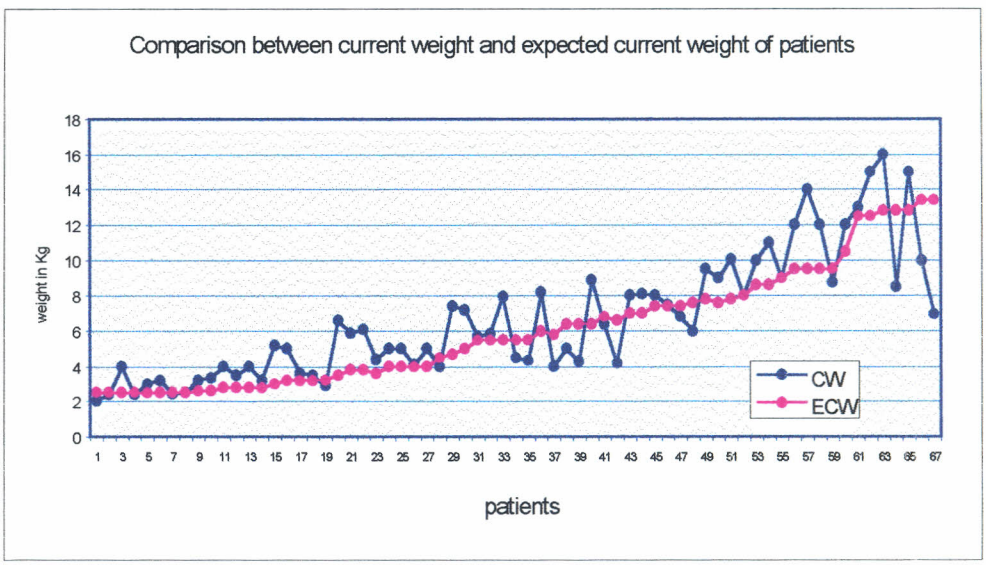
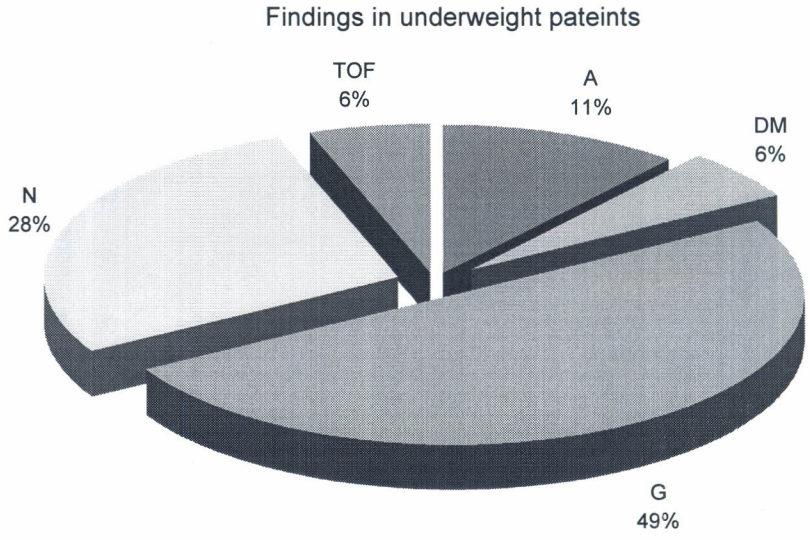


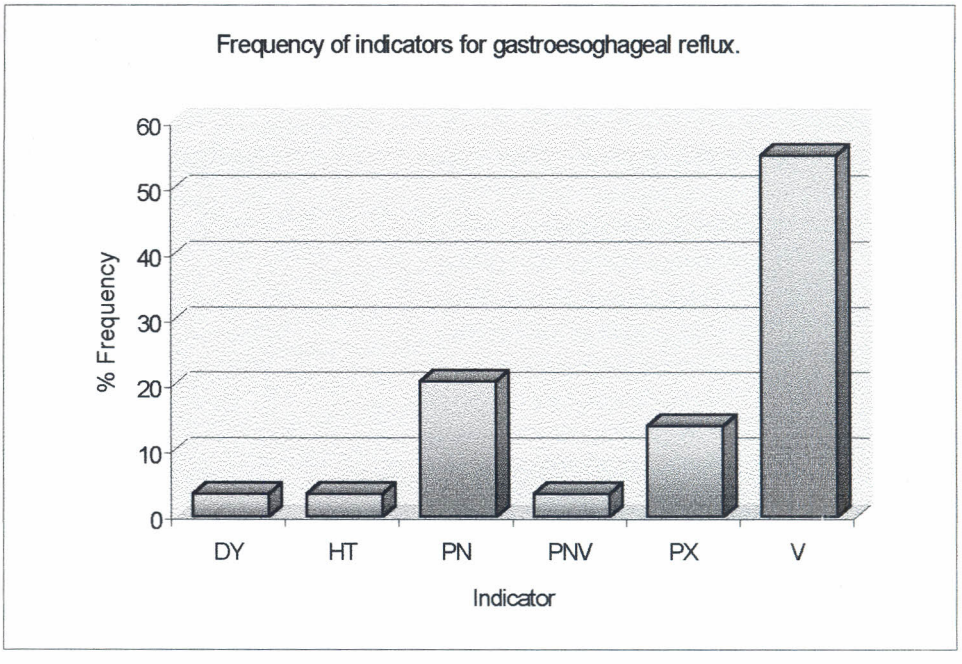
Fig 9: Radiological findings in underweight patients



Key:

A	Achalasia cardia
DM	Disco-ordinate esophageal motilty
G	Gastroesophageal reflux
N	Normal
TOF	Tracheo - esophageal fistula

Fig 10: Different presentations of patients found to have *gastroesophageal reflux.*



Key:

DY Dysphagia

HT Hematemesis

PN Pneumonia

PNV Pneumonia / Vomiting

PX Post operative

V Vomiting

ILLUSTRATIONS

1. A 1 month old female with a history of vomiting after feeds.

   Photomicrograph shows a normal esophageal outline with an acute gastro-esophageal junction. (angle of His)

   No gastroesophageal reflux was seen during screening. A normal upper gastro intestinal barium study

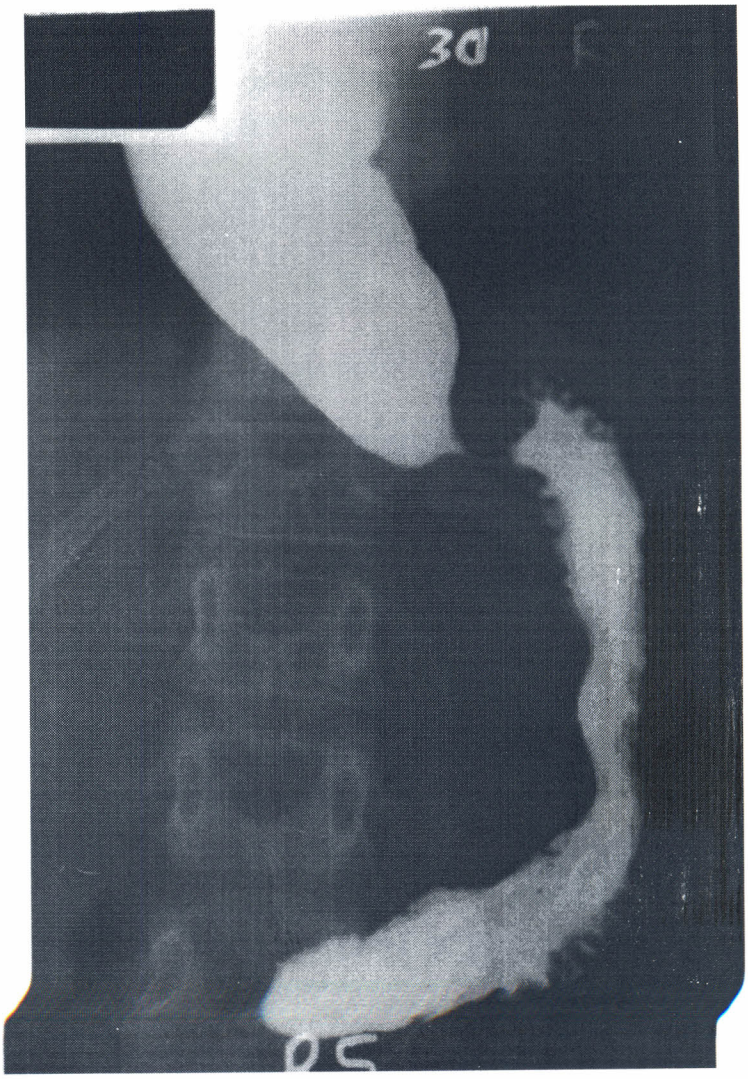
2. Major gastroesophageal reflux in a 8 month old female with history of recurrent pneumonia and vomiting.
Angle of His is obtuse.

2. **Achalasia Cardia**

a) A 6 week old male with persistent aspirates and poor weight gain. Birth weigh = 3.3 kg.

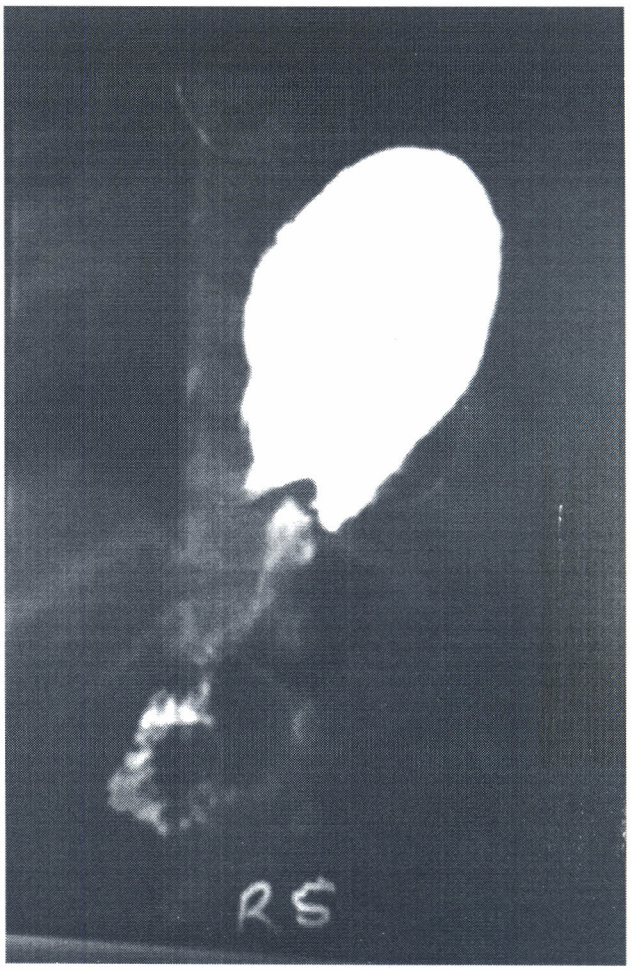
Current weight 2.9kg.

b) A 6 month old female with persistent vomiting. There was proximal esophageal dilatation with tapering and obstruction at the gastro-esophageal junction.



2. A 20 month old male with a history of dyspnea after feeding on and off since birth.

   Photomicrograph shows eventration of the diaphragm with organoaxial rotation of the stomach.

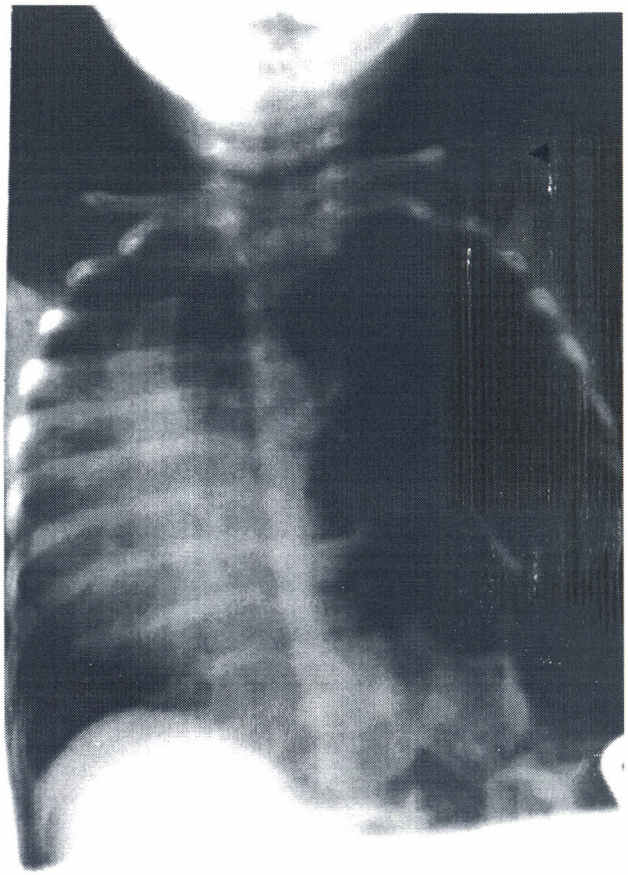


4. **Diaphragmatic Hernia**

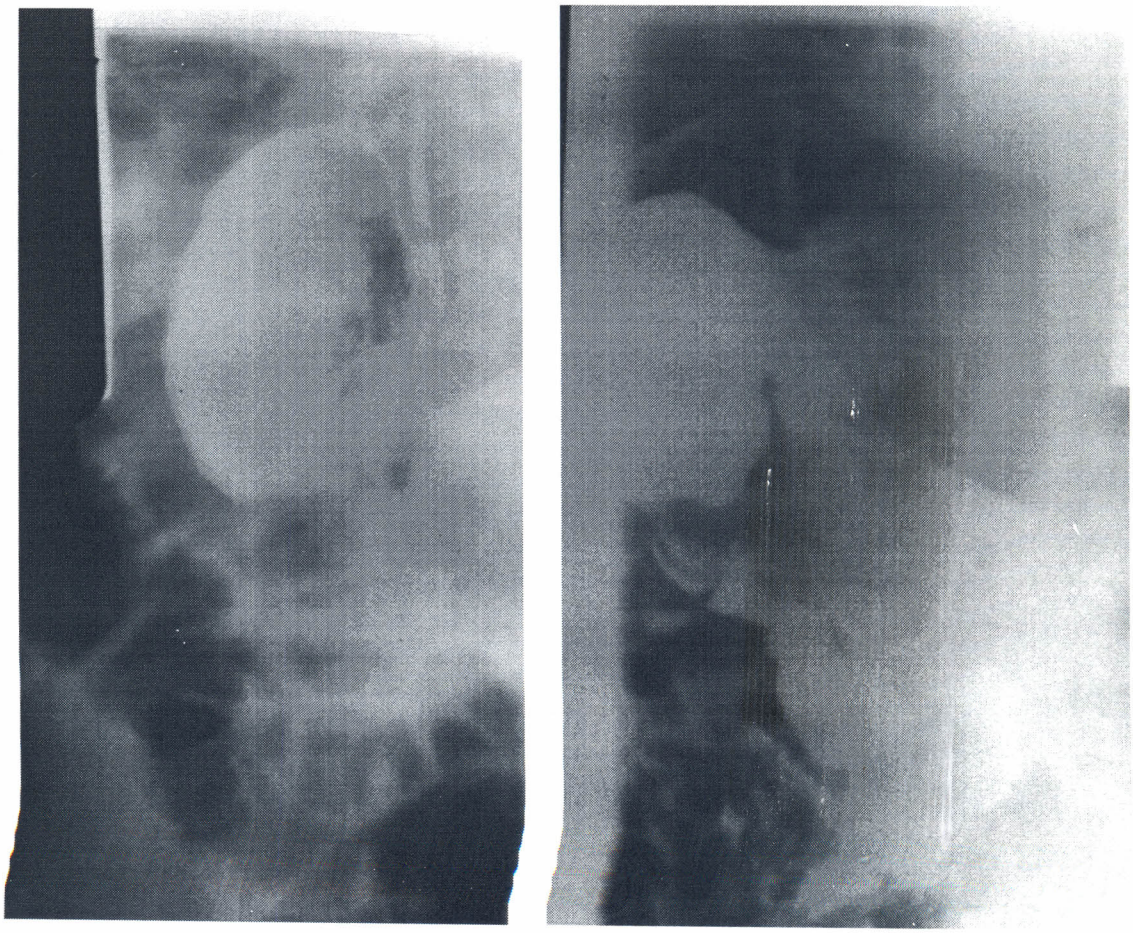
a) A 3 month old male weighing 4.1 kg with a history of dyspnea on feeding.

Clinical diagnosis was dextrocardia with situs inversus.

Photomicrograph shows a large left diaphragmatic hernia pushing the mediastinum to the right.

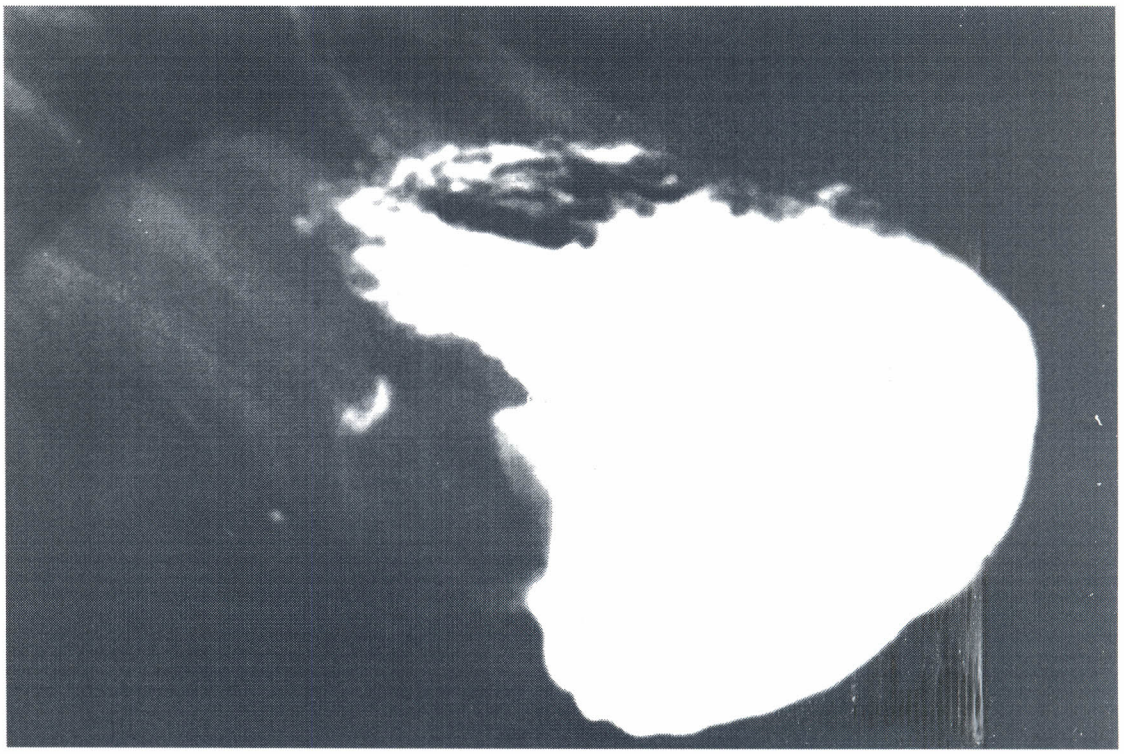


b) Same patient showing the gastroesophageal junction positioned below the diaphragm and the intrathoracic position of the body of the stomach. (Prone views)



5. **Pyloric stenosis** A 6 week old male with a history of projectile vomiting.

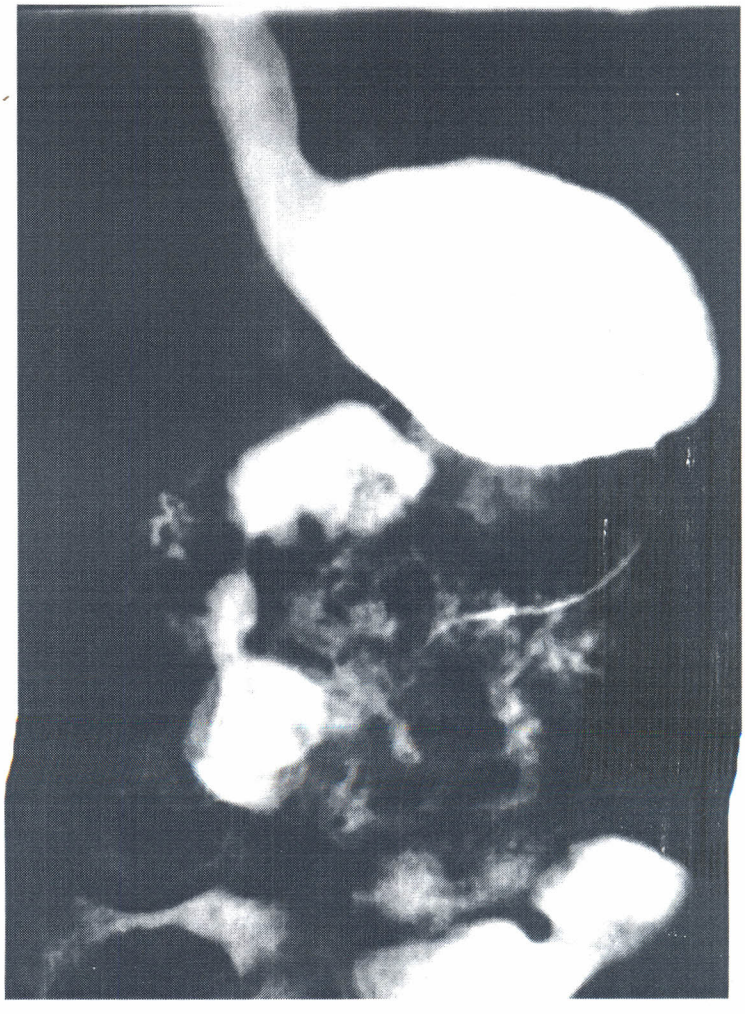
Photomicrograph shows a thickened antral muscle with an enlongated pylorus-`String sign'



6. 3 week old female with vomiting after feeds. No history of pneumonia.

Upper gastro intestinal study showed a normal esophagus and stomach in motility, outline and positioning. There was a persistent narrowing at the distal end of the 3rd part of the duodenum. Possibility of a duodenal band was suggested.

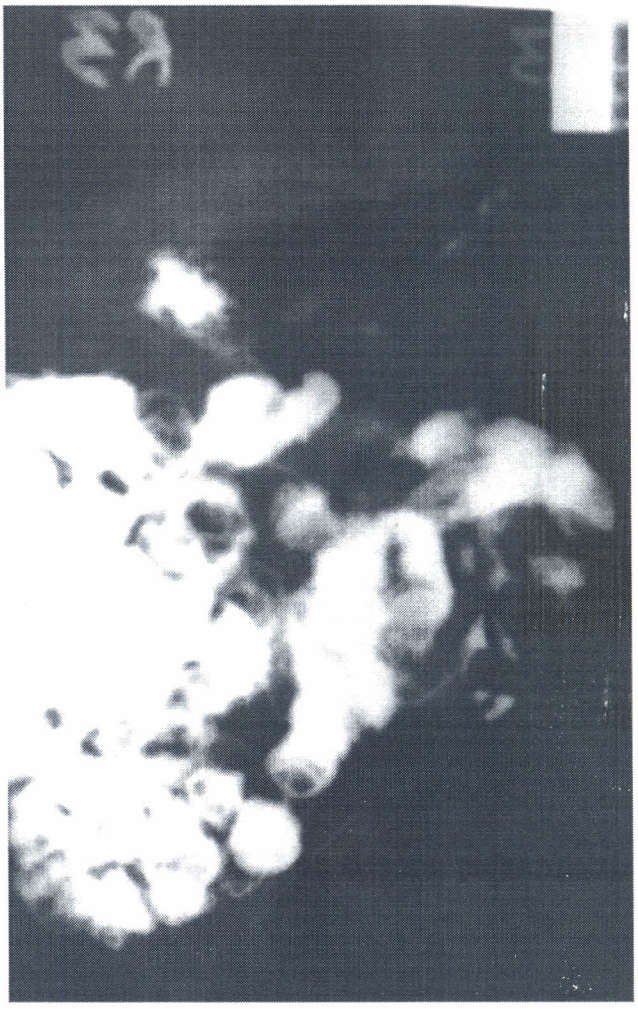
7. GER with a normally positioned small gut in a 2 day old female. Birth weight = 3Kg.



8. **Malpositioned gut**

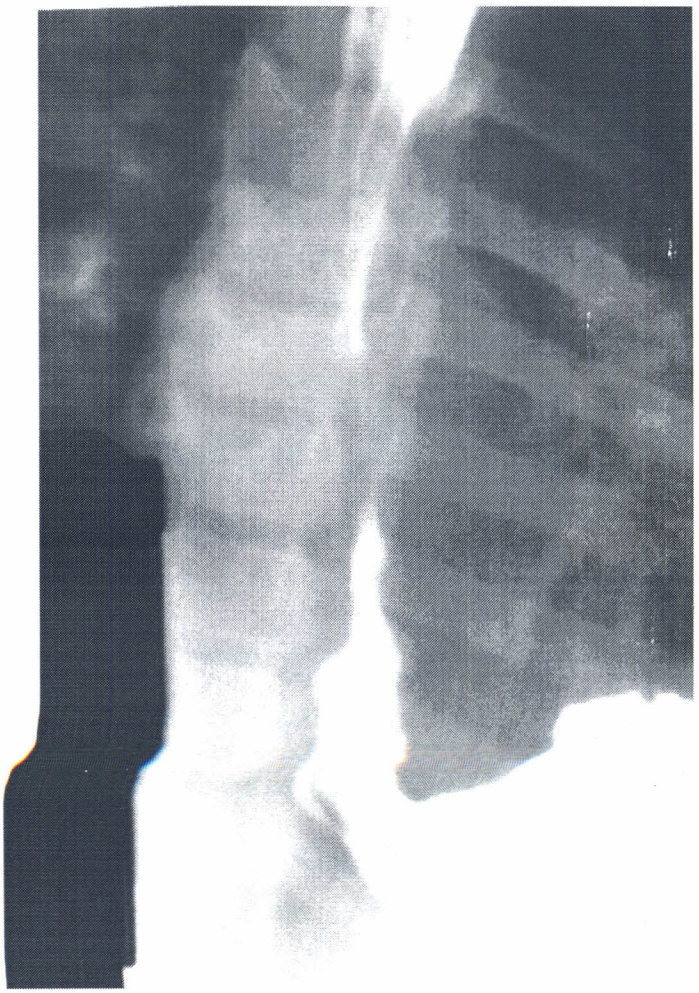
1year old female with history of vomiting on and off.

Barium study showed normal esophagus and stomach. There was *malposition of the small gut to the right side of the* abdominal cavity.



9. 8 month old male with poor weight gain (current weight = 4.28 kg) post-Nissen fundoplication procedure. Still had persistent vomiting.

   Barium study showed an atonic esophagus with a soft tissue mass in the region of the fundoplication. Reflux was still present.



DISCUSSION

Symptomatic GER is one of the most common problems encountered in medicine today. Although the true prevalence of GER is not known its major symptom heartburn was experienced in 36% of presumably healthy hospital employees (9). GER has also been found to occur in 44% of adults in U.S.A. most of whom do not seek medical help preferring to self-medicate with antacids (31).

GER has been found to be also the most frequent symptomatic clinical disorder affecting the GIT of infants and children (7,8,33,34) a finding supported by this study. This high prevalence has been recognized in children under 1 year of age since the early 1950's (4). A prevalence of 40% was seen in 100 hospitalized infants which was later produced in a study of 507 patients (13,32). In this study GER was found to occur in 44.8% of the examinations performed.

Due to this high prevalence the problem of identifying patients whose reflux is truly significant remains particularly where there is no evidence of esophagitis, stricture, esophageal dysmotility or observable aspiration. This had led to the classification of GER into normal, functional or pathogenic groups (33-36).

Normal GER is of short duration and may be seen in all

individuals. Functional GER regurgitation is common during infancy causing no ill effects while pathological GER causes diseases such as failure to thrive, coughing, irritability and excessive crying (33). It is imperative to distinguish normal and functional GER from pathological GER as the clinical management will differ. The prevalence of troublesome GER disease has been estimated to be 5.8% in both adults and children (46).

Several procedures have been developed to detect GER each with varying degrees of efficacy and reliability. The tests presently employed are radiology of the upper gastrointestinal tract showing barium GER, scintigraphy of the esophagus after ingestion of ^{99}mTc labelled meal indicating meal GER, prolonged pH probe monitoring of the lower esophagus depicting acid GER. There seems to be a controversy regarding the usefulness of these tests for the diagnosis of pathological GER (6,8,9,13,33,34). In a study of 89 infants and children presenting with signs and symptoms of GER 70% had significant acid GER, 36% had barium GER while only 17% had meal GER (33). There was no statistically significant correlation between the 3 examinations and it was concluded that they probably represent different phenomenon. Prolonged esophageal pH monitoring was considered to be the most reliable and the gold standard for detecting pathogenic GER (7-9,33). However this test is expensive and not widely available.

The main roles of barium studies in suspected GER are to assess an inadequate antireflux mechanism by observing the reflux of barium into the esophagus during screening and to detect gross morphological changes of reflux esophagitis (48). Various manoeuvres like abdominal compression have been advocated to increase the sensitivity of detecting reflux (9,48). Abdominal compression was not done in this study as it is not physiological. This allowed detection of only free or physiologic reflux which various studies have shown to have a high specificity of 88-94% and a low sensitivity of 20 - 25% (9,43 - 46). Compression studies however have a reduced specificity (75%) but a high sensitivity (71%) and may even be overly sensitive as may produce minor degrees of reflux which may not be a problem to the infant (4). The water siphon test has also been used to demonstrate occult reflux in the adult and to a lesser extent in the child (4,47). This test depends on the fact that with swallowing the gastroesophageal sphincter will open and any reflux of barium will be readily demonstrated. This may result in false positive results in as many as 25% of the patients (47). This unspecificity of barium examinations has also been supported by various studies which have shown a wide discrepancy of detection rates of GER which have been related partly to the use of provocative manoeuvres (44, 45, 48). Thus neither of these manoeuvres were used in this study.

All children who vomit regardless of cause have reflux thus any

examination of the vomiting child must be able to reliably identify obstructive lesions of the GIT. Barium studies therefore still remain as a crucial investigatory tool for the detection of GER. They are the only study to date that can reliably exclude gastric outlet obstruction which can be associated with GER. Their major drawback is that they are erratic in demonstrating minor reflux for which ambulatory pH monitoring and radionuclide studies are more reliable. (4). However the clinical significance of minor reflux still remains to be determined. It is therefore felt that barium studies particularly in the developing countries should be the first line of investigation for the vomiting child and any child who remains symptomatic after a normal or inconclusive examination can then be examined using the other imaging modalities.

In infants and children the most common conditions affecting the gastrointestinal tract are related to obstructive or developmental abnormalities. Inflammatory and neoplastic conditions are usually negligible. In this study out of the 67 children examined only one child aged 4 years was found to have duodenitis. The most prevalent finding was GER in 44.8%. In a study carried out at the Kenyatta National Hospital on the role of barium meal in the investigation of the gastrointestinal system in a largely adult study sample, only one patient out of the 320 studied had GER (41). Duodenitis was found in 14% while peptic ulcer disease was the most prevalent finding (41). This low prevalence of reflux in the above study may be

accounted for by the fact that reflux is not common here. However as the prevalence of GER in the pediatric age group compares favourably with studies done elsewhere (4,13,32) it is more likely that reflux is usually overlooked in the adult population both by the patients themselves as well as the attendant clinicians not necessitating radiological examinations.

In recent years there has been an increasing awareness of normal or alkaline reflux which may present as a false negative pH monitoring study (36,37). These patients usually have radiological evidence of reflux and have similar clinical features of vomiting, dysphagia, respiratory disease, anaemia and torticollis also found in acid reflux. In a study of 14 children with radiological evidence of GER but normal pH monitoring 10 had endoscopic and histological evidence of esophagitis. Operative management was recommended after failure of medical treatment and 13 out of the 14 patients were relieved of their symptoms (36). This underlines the fact that whereas pH monitoring is 100% reliable for diagnosing reflux when the esophageal pH is <4 (7) other imaging modalities may sometimes become necessary especially if the patient remains symptomatic.

Ultrasound (US) imaging for GER is now emerging as a new imaging technique with high reliability especially if colour doppler (CD) is added (37-40). In a double blind trial of 178

patients with suspected GER, US results were shown to compare favourably with barium swallow in 93% of cases. In the remaining cases US demonstrated more severe GER than the barium study (39) US demonstrated reflux was seen to be associated with symptoms in 32% of cases (40) and a recent study has shown unequivocal agreement between pH-metry and colour doppler US in 94% of cases (38). The sensitivity of reflux detection increased from 84.4% to 98% when CD was added to B-mode US. This improvement was thought to be due to the higher sensitivity of CD in the detection of rapid and small quantities of reflux. The small number of discrepancies between pH-metry and CDUS was attributed to the inability of the former to detect neutral reflux of contents or reflux of short duration <30 sec. while CD US may miss some cases of acid reflux due to the short time of examination (10 minutes) (38). Thus ultrasound provides a relatively cost-effective non-invasive, safe and physiologic method for detecting GER and can be recommended as a screening test of choice in symptomatic children and their follow-up.

While a definite correlation has been found between GER and chronic respiratory problems (14,33-35,42) the relationship of GER and failure to thrive has not been as emphasized. In this study out of the 30 patients found to have GER, 10 were underweight for age while only 7 presented with recurrent pneumonia. The most common indication for the barium study was vomiting rather than recurrent pneumonia. Major reflux was

seen in all the patients who were underweight but the demonstration of aspiration was not possible. Thus there is a likelihood that the main complication of GER may be failure to thrive rather than recurrent pneumonia and a follow up study is required to evaluate the outcome of these patients.

CONCLUSION

Gastro-esophageal reflux remains the commonest upper GIT pathology in the paediatric age groups. Upper GIT radiological studies still play a crucial role in evaluating diseases of the upper GIT. They can demonstrate free reflux if present and can conclusively rule out gastric outlet obstruction, an important factor during the assessment of the vomiting child.

Most of the GIT pathologies found in the paediatric period are related to obstructive or developmental abnormalities. Inflammatory lesions are rare.

RECOMMENDATION

For the child with GER, ultrasound with colour doppler can be useful in follow-up studies as it provides a non-invasive, safe and cost-effective method. Studies done have shown that it has a high sensitivity of upto 98% (37 - 40) and it does not involve the use of ionizing radiation. It is particularly attractive for use in the paediatric age group where the risk of neoplasia is increased due to the life expectancy. It is recommended that study on the value of ultrasound in evaluating the vomiting child should be carried out and the results compared to those of upper GIT radiological studies.

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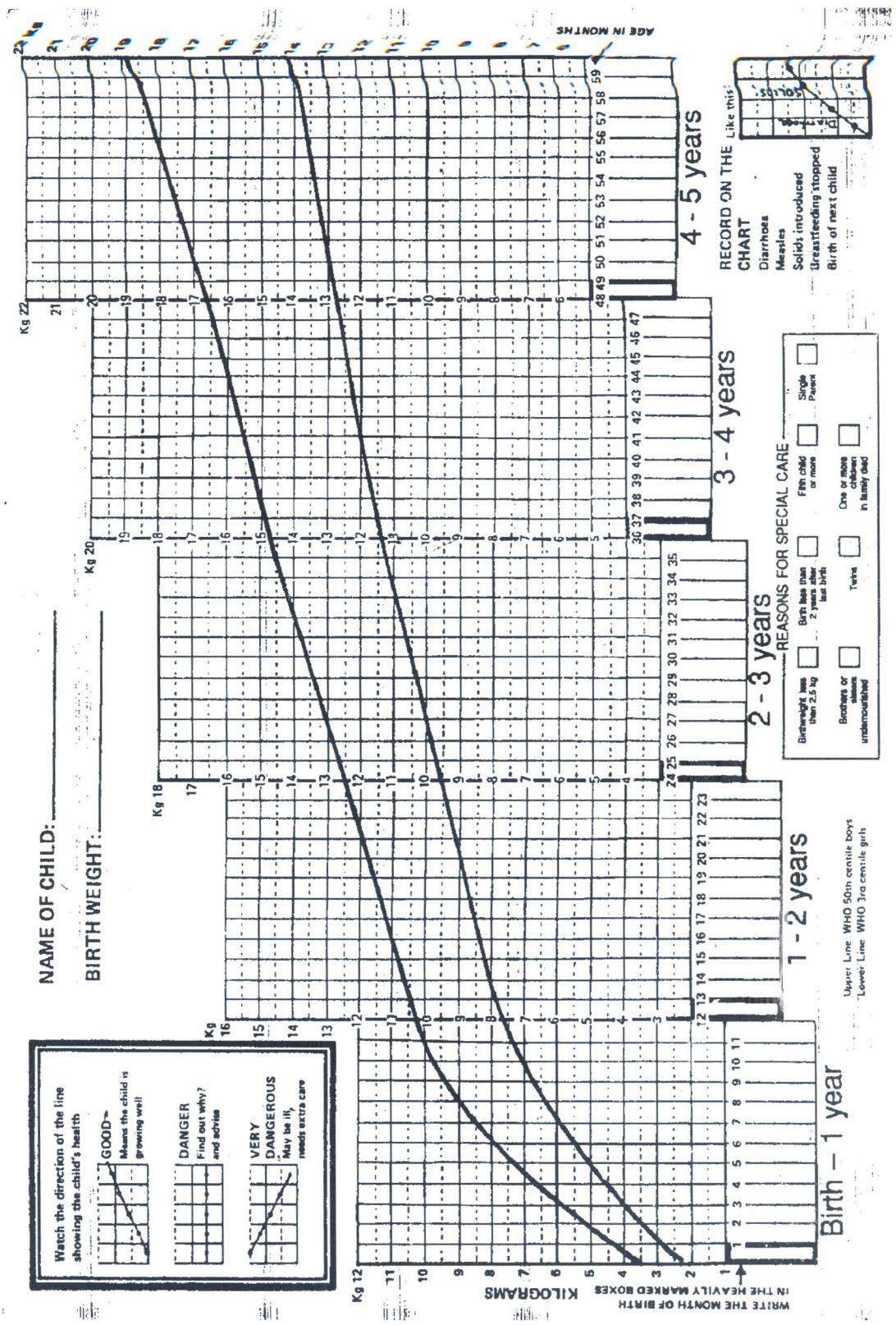
APPENDIX

Appendix 1

Data acquisition table

Study No	X-ray No	Age	Sex	Birth Weight	Current Weight	Clinical DX	Clinical findings	Radiological Findings

Appendix 2 Child health card, MOH 806



Appendix 3. Data obtained

Sample	Age months	Sex	BW	CW	IND	ECW	FNG
1	0.03	F	2.05	2.05	V	2.5	T
2	0.067	F	2.4	2.4	V	2.5	G
3	0.1	M	4	4	S	2.5	N
4	0.14	F	2.7	2.4	V	2.5	G
5	0.2	F	3.2	3	V	2.5	G
6	0.23	M	3.3	3.2	V	2.5	G
7	0.5	F	2.4	2.45	V	2.5	G
8	0.5	M	2.5	2.5	V	2.5	DM
9	0.67	M	3.1	3.2	V	2.6	PS
10	0.7	F	2.3	3.36	V	2.6	DB
11	1	F	2.5	4	V	2.8	N
12	1	F	2.7	3.5	PN	2.8	N
13	1	F	3	4	V	2.8	G
14	1	F	3	3.2	V	2.8	N
15	1.25	M	3.5	5.2	PNV	3	G
16	1.5	M	3	5	V	3.2	G
17	1.5	M	3.5	3.6	V	3.2	PS
18	1.5	M	2.5	3.5	DY	3.2	G
19	1.5	M	3.3	2.9	V	3.2	A
20	2	F	4	6.6	PNV	3.5	N
21	2.5	M	2.7	5.9	PN	3.8	G
22	2.5	F	3	6.1	V	3.8	G
23	2.5	M	2.7	4.4	V	3.6	PS
24	3	F	2.5	5	DY	4	N
25	3	M	3.2	5	PN	4	G
26	3	M	4	4.1	DY	4	DH
27	3	F	3	5	DY	4	C
28	3.5	M	2.3	4	V	4.5	G
29	4.5	M	3.5	7.4	PN	4.7	G
30	5	F	2.9	7.2	PN	5	G
31	6	F	3.5	5.7	V	5.5	DM
32	6	F	3.5	5.85	V	5.5	DM
33	6	F	1.5	7.95	V	5.5	G
34	6	F	2.5	4.5	V	5.5	G
35	6	F	3	4.35	V	5.5	A
36	7	F	2.7	8.2	V	6	G
37	7	F	2.5	4	DY	5.8	DM
38	8	F	3	5	PN	6.4	G
39	8	M	3	4.28	PX	6.4	G
40	8	F	3	8.9	V	6.4	G

Sample	Age months	Sex	BW	CW	IND	ECW	FNG
41	9	F	3.3	6.4	PN	6.8	G
42	9	M	2.7	4.2	PX	6.6	N
43	10	F	2.5	8	DY	7	N
44	10	M	2.9	8.1	PX	7	N
45	11	F	3	8	V	7.4	G
46	11	M	3.5	7.5	V	7.4	DB
47	11	F	3.7	6.8	PXV	7.4	N
48	12	M	2	6	DY	7.6	N
49	12	M	3.8	9.5	DY,PX	7.8	ST
50	12	F	3	9	HT	7.6	MG
51	12	M	3.3	10.05	V	7.8	N
52	14	M	2.9	8	PX	8	N
53	18	F	2.5	10	PX	8.6	G
54	18	F	3.2	11	PX	8.6	G
55	20	M	3	9	DY	9	DH
56	24	F	4	12	PO	9.5	ST
57	24	F	3	14	DY	9.5	N
58	24	F	2.7	12	V	9.5	G
59	24	M	3	8.75	PN	9.5	N
60	30	F	2.5	12	PX	10.5	G
61	45	M	3	13	EP	12.5	N
62	47	F	3	15	DY	12.5	N
63	48	F	3	16	EP	12.8	D
64	48	F	2.5	8.5	PO	12.8	N
65	48	M	2.5	15	V	12.8	N
66	54	F	2.5	10	V	13.4	G
67	54	M	2.9	6.96	HT	13.4	G

Appendix 4

Code Book

Diseases

A	Achalasia cardia
D	Duodenitis
DB	Duodenal band
DH	Diaphragmatic hernia/eventration
DM	Disco-ordinate esophageal motility
N	Normal
MG	Malposition of small gut
PS	Pyloric stenosis
ST	Stricture
T	TOF
G	GER
C	cardiovascular

Indicators

DY	Dysphagia
EP	Epigastric pain
HT	Hematemesis
PN	Pneumonia
V	Vomiting
PO	Poisoning
PX	Post-operative
S	stricture