"ONE YEAR RANDOMISED CLINICAL TRIAL TO COMPARE ULTRASONOGRAPHY GUIDED GASTRIC VOLUME IN PATIENTS AFTER OVERNIGHT FASTING AND AFTER INGESTION OF CLEAR FLUIDS TWO HOURS PRIOR TO SURGERY"

By

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Dissertation

Submitted to the
KLE University, Belagavi, Karnataka

In Partial Fulfillment
of the requirements for the degree of

M. D.
in
ANAESTHESIOLOGY

DEPARTMENT OF ANAESTHESIOLOGY,

JAWAHARLAL NEHRU MEDICAL COLLEGE,

BELAGAVI, KARNATAKA

APRIL – 2018

KLE UNIVERSITY, BELAGAVI, KARNATAKA

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ABBREVIATIONS

NPO	-	Nil per os
NBM	-	Nil by mouth
BSP	-	Bromosulphthalein
MRI	-	Magnetic resonance imaging
SPECT	-	Single photon emission computed tomography
GV	-	Gastric volume
RLD	-	Right lateral decubitus
MHz	-	Mega hertz
IVC	-	Inferior venacava
SMV	-	Superior mesentric vein
CN	-	Cranial nerve
US	-	Ultrasound
USG	-	Ultrasoography
KHz	-	Kilo hertz
PRF	-	Pulse repetition frequency
BMI	-	Body mass index
GERD	-	Gastro reflux esophageal disease
CSA	-	Cross sectional area
AP	-	Antero-posterior
CC	-	Craniocaudal
ECG	-	Electrocardiograph
GAV_W	-	Gastric air volume
NSAID	-	Non-steroidal anti-inflammatory

VIP	-	Vasoactive intestinal peptide
GIP	-	Gastric inhibiting peptide
SpO2	-	Peripheral oxygen saturation
S.D	-	Standard Deviation
ASA	-	American Society of Anesthesiologists
C.I	-	Confidence Interval

ABSTRACT

TITLE :

"ONE YEAR RANDOMISED CLINICAL TRIAL TO COMPARE ULTRASONOGRAPHY GUIDED GASTRIC VOLUME IN PATIENTS AFTER OVERNIGHT FASTING AND AFTER INGESTION OF CLEAR FLUIDS TWO HOURS PRIOR TO SURGERY"

INTRODUCTION:

Perioperative aspiration of gastric contents is a rare but serious complication of anaesthesia. The overall incidence in a mixed surgical population ranges between 0.1% and 19% depending on patient and surgical Factors and it has been the same over decades**.** Aspiration pneumonia is associated with significant morbidity, including prolonged mechanical ventilation and carries a risk of mortality as great as 5%. Sedation and general anaesthesia depress or impede the physiological mechanisms that protect against aspiration (the tone of the lower oesophageal sphincter and upper airway reflexes). Fasting before general anaesthesia aims to reduce the volume and acidity of stomach contents during surgery, thus reducing the risk of regurgitation/aspiration. Previous studies have shown that pH <2 and volume of gastric aspirate >25 ml (0.4ml/kg) predisposes a patient to pulmonary aspiration, hence a strict over -night fasting regimen was instituted. But prolonged fast doesn't guarantee empty stomach. Use of two-dimensional ultrasonography is an accurate non-invasive tool to determine gastric volume . Hence in an attempt to reduce the fasting hours of a patient pre-operatively without increasing the risk of pulmonary aspiration we compared the gastric volume using ultrasonography and pH of gastric

aspirate by pH strip in patients after overnight fasting and after ingestion of 200 ml clear fluids (water) 2 hours prior to surgery

METHODS:

The study was conducted in 60 patients undergoing elective surgery belonging to ASA 1 after obtaining Institutional ethical committee clearance & written informed consent from all the patients. Thorough pre anaesthetic evaluation was done, investigations were noted. After having met inclusion and exclusion criteria and having obtained informed consent, patients were randomized based on computer generated randomization table into one of the two groups.

- Group A: Patients with Overnight fasting
- Group B: Patients receiving 200 ml of clear fluids (water) 2 hours before surgery.

Gastric antral dimensions were noted and gastric volume was calculated .

RESULTS:

We observed that the age and gender distribution were comparable between the two groups. The mean gastric volume by USG in group A is 29.7±8.0ml and group B is 19.2±4.9 ml. The reduced gastric volume in group B is statistically significant (<0.00001).

The mean pH of gastric aspirate in group A is 1.4 and group B is 2.63. Which shows that group B has a better outcome in terms of gastric pH and is statistically significant ($p<0.00001$).

CONCLUSION:

The mean gastric volume in patients who had 200 ml of clear fluid 2 hours prior (group B) was lesser than patients who fasted overnight (group A).

The mean pH in patients who had 200 ml of clear fluid 2 hours prior (group B) was higher than patients who fasted overnight (group A).

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INTRODUCTION

Perioperative aspiration of gastric contents is a rare but serious complication of anaesthesia. The overall incidence in a mixed surgical population ranges between 0.1% and 19% depending on patient and surgical Factors and it has been the same over decades[1-6]

Aspiration pneumonia is associated with significant morbidity, including prolonged mechanical ventilation, and carries a risk of mortality as great as 5%. Pulmonary aspiration is involved in up to 9% of all anaesthesia-related deaths[1,7,8]. In particular , aspiration of solid particulate matter , large volumes or fluid with low pH carries high morbidity .Sedation and general anaesthesia depress or impede the physiological mechanisms that protect against aspiration (the tone of the lower oesophageal sphincter and upper airway reflexes)[9,10]

Several anesthetic related interventions are recommended to minimize aspiration risk. Some of them are timing of anaesthesia and surgery, regional vs general anaesthesia technique, mode of induction and airway management modality and pre-operative fasting.

Fasting before general anaesthesia aims to reduce the volume and acidity of stomach contents during surgery, thus reducing the risk of regurgitation/aspiration . Despite recent guidelines[11,12] stating that it is appropriate to reduce the interval of clear fluid ingestion to 2 hours prior to surgery[13] , it is common practice to follow " nil by mouth" or nulla per os (NPO) after midnight for both solids and clear fluids

Previous studies have shown that pH <2 and volume of gastric aspirate >25 ml (0.4ml/kg) predisposes a patient to pulmonary aspiration, hence a strict over -night fasting regimen was instituted. However, the cochrane data base has reviewed several studies showing that prolonged with-holding of oral fluids does not improve gastric pH or volume and not permitting a patient to drink fluids pre-operatively may even result in significantly higher gastric fluid volumes[14] .Long fasting hours prior to surgery is a great discomfort to the patient[14]

The volume of gastric contents can be assessed by various methods like aspiration using a nasogastric tube, Paracetamol absorption, electrical impedance tomography, radiolabeled diet, polyethylene glycol dilution are all invasive methods to determine gastric volume and gastric emptying time[15-19] .Trans-abdominal 2-dimensional ultrasonography has been used to assess the size of various organs. It can also be used to assess the gastric volume Also the use of two-dimensional ultrasonography is an accurate non-invasive tool to determine gastric volume[20].

Hence in an attempt to reduce the fasting hours of a patient pre-operatively without increasing the risk of pulmonary aspiration we compared the gastric volume using ultrasonography and pH of gastric aspirate by pH strip in patients after overnight fasting and after ingestion of 200 ml clear fluids (water) 2 hours prior to surgery

OBJECTIVES

Primary objective: To compare gastric volume using ultrasonography in patients after overnight fasting and after ingestion of clear fluids (water) 200ml 2 hours prior to surgery.

Secondary objective: To assess pH of gastric aspirate.

REVIEW OF LITERATURE

The purpose of pre-operative fasting is to reduce the risk of regurgitation and aspiration of gastric contents during surgery. Pre-operative aspiration of gastric contents is rare but serious complication of anaesthesia. The overall incidence in a mixed surgical population ranges between <0.1% and 19% depending on patient, surgical factors and has not changed in the last few decades[1-6]. Aspiration pneumonia is associated with significant morbidity including prolonged mechanical ventilation and carries a risk of mortality up to 5%[1,7,8]. One of the main risk factors for aspiration is the presence of gastric content. The critical threshold of gastric fluid that by itself increases aspiration risk is controversial, but healthy fasted patients frequently have residual volumes of up to 1.5 ml/kg without significant aspiration risk[1,21,22].

To achieve this goal, the recommendation on preoperative fasting have varied with time. For elective surgery the order for nil by mouth after midnight or 6 hours of ingestion of food, although clear fluids may be taken up to 2 hours prior surgery[11,12]. Despite recent guidelines it is a common practice to follow nil by mouth after midnight for solids and liquids. Long fasting hours are of great discomfort for the patient undergoing surgery.

It has been reported that traditional preoperative fast does not ensure an empty stomach[,23,24,25]. The gastric content volume is one of the main factors involved in the pathophysiology of pulmonary aspiration, therefore it would be useful to be able to quantify gastric content volume before performing general anaesthesia

A study was conducted by EM Mcgrandy and AG Macdonald[26] on 50 patients to investigate the effect of administering water preoperatively on gastric volume and pH. 100ml of water was given 2 hours prior to induction of anaesthesia in one group , while the other group fasted. The median volume of gastric aspirate in patients who had 100 ml of water 2 hours prior to surgery was smaller than patients who had fasted overnight, although this difference was not statistically significant. There was no significant difference in pH between the two groups.

S.Phillips, S.Hutchinson and T.Davidson[27] compared the effects of preoperative drinking of clear fluids until 2 hours before the surgery with conventional preoperative fasting. The study was done on 100 patients undergoing elective surgery. Ingested fluid volume did not correlate with residual gastric volume or pH. The gastric pH of patients drinking clear fluids until 2 hours before operation was greater than those who had fasted, but this was statistically in significant.

In a study conducted on 211 healthy adults scheduled for elective ambulatory surgery to compare gastric volume and pH by Malcom Scarr et.al[28] on patients allowed to ingest clear fluids less than 3 hours , 3 to 4.9 hours, 5 hours and nothing after midnight before surgery found that there was no significant changes in gastric volume and pH.

Effects of fasting intervals on gastric volume and pH were evaluated by Riaz hussain et al[29] in a study done on 65 patients aged between 15 to 50 years undergoing general anaesthesia for elective surgery. The study revealed that fasting interval more than 8 hours neither reduce gastric fluid volume nor increase pH more than 2.5. There was no relationship between a prolonged fast and safe gastric environment.

A.D Suntherland et.al[30] studied 132 adult female patients undergoing day care surgery on the effects of preoperative fasting on morbidity and gastric contents .It was concluded that neither the severity of symptoms of fasting nor the duration of fast correlated with the gastric volume or pH

M.Miller et al[31] undertook a comparative study to compare gastric volume and pH in 45 patients undergoing gynaecological surgery after overnight fasting and after light breakfast less than 4 hours before the surgery. It was found out that there was no statistically significant differences in gastric volume or pH between the groups. This study does confirms that prolonged fasting doesn't guarantee empty stomach .This study also demonstrates that on the morning of elective surgery , a light breakfast 2-3 hours prior surgery does not influence the volume and pH of gastric contents.

Effects of preoperative consumption of 150 ml coffee or 150 ml orange juice 2-3 hour before surgery after overnight fasting were compared with overnight fasted patients on changes in gastric fluid volume and pH, severity of hunger and thirst. Andrew Hutchinson[32] conducted this study on 150 patients scheduled for elective surgery. It was found that the 3 groups had no significant differences in volume or ph. However patients who didn't receive coffee or orange juice were more thirsty and hungry than those who did receive.

Mark crawford et al[33] conducted a study on 100 children undergoing elective surgery aged 1-14 years to compare gastric fluid volume and pH . Children were fasted after giving 2 ml/kg of water for 2 , 4 and 6 hours before surgery. The duration of fasting had no effect on gastric fluid volume and pH. This study concluded that 2 ml/kg of clear fluid orally taken 2 hours before surgery is safe

A study on 90 children aged between 1-10 years was undertaken to compare gastric fluid volume and pH following ingestion of water and sugar-containing fluid given at 2, 4 and 8 hours before surgery by Gojendra rajkumar and M K Mehta[34]. The children received 2ml/kg of water or sugar-containing fluid. It was observed that groups which received water or sugar containing fluid had significant increase in pH and lower gastric fluid volume respectively. It was concluded that ingestion of clear fluids 2 hours prior surgery in healthy children is unlikely to substantially affect the gastric fluid volume and pH , while at the same time it may provide some psychological benefits by increasing patient comfort and decreased .hunger and thirst.

J.Roger maltby et al[35] conducted a study on 140 patients to compare gastric volume and pH after receiving 150 ml water 2 to 3 hours before surgery and overnight fasting. Patients received either oral ranitidine 150 mg or a placebo tablet with nonabsorbable dye bromosulphthalein (BSP) 50 mg in 10 ml water followed by 150 ml water or no further fluid. Patients who received 150 ml water with placebo had significantly less residual gastric volume in comparison with those who had only BSP , pH remained unaltered. Ranitidine premedication significantly reduced gastric volume and acidity in comparison with placebo group. The group which received ranitidine and 150 ml water had lower gastric volume and higher pH in comparison to group which received BSP and placebo. The severity of thirst was lower in patients who were given 150 ml water.

A study to compare gastric fluid volume and pH between routine preoperative fasting and 2 hour fast for clear fluid was done by Susan C Nicolas[36] in 100 pediatric inpatients undergoing elective cardiac surgery. The study group were allowed to have unlimited quantity of clear fluid. There was no significant difference between the groups in gastric volume or pH. Children in study group were less thirsty and less hungry in comparison with control group. It was concluded that children may be allowed to have clear fluids up to 2 hour before surgery without increase in risk of aspiration of gastric contents.

Gastric residual volume and pH after 1 hour and 2 hour preoperative clear fluid fasting were compared in 131 children undergoing elective surgery under general anaesthesia by AR Schmidt[23]. There was no significant differences in hunger and thirst between the groups. It was observed that 1 hour clear fluid fasting does not alter gastric residual volume or pH significantly compared with 2 hour clear fluid fast

Many methods have been used to determine the gastric volume and pH of the contents. The most commonly used method being aspiration of the gastric contents using a ryles tube and measurement of pH using a pH paper. The other methods to measure gastric volume are single photon emission computed tomography[37] (SPECT) , magnetic resonance imaging[38] (MRI) and use of ultrasonography to determine the gastric content volume. The most commonly used method to determine the gastric content volume being aspiration via orogastric or nasogastric tube may underestimate the true gastric content volume. Moreover aspiration is limited to fluid so that intra gastric air volume has not been considered. Use of ultrasonography to determine gastric content volume appears to be more appropriate as it can take both liquid and gaseous contents into consideration.

Evaluation of Gastric volume using ultrasonography in children before and after carbohydrate containing drink before surgery was done by I K Song et al[39]. 86 paediatric patients less than 18 years under going elective surgery were enrolled in the study. At 8 hours of fasting initial first ultrasonography assessment of Gastric volume was done. 2 hours before the surgery patients were given carbohydrate containing drink 15ml/kg for patients younger than 3 years, 10ml/kg for more than 3 years. Gastric volume was reassessed using ultrasonography before induction of general Anaesthesia. In the study it was found that consumption of carbohydrate drink 2 hour prior to induction of anaesthesia reduced Gastric volume. Children may be benefitted by carbohydrate drink ingestion up to 2 hour before surgery.

Effects of sugared clear fluid on Gastric emptying and residual volume in children were investigated by S. Schmitt[38]. 14 healthy children aged between 6-14 years were included in this prospective, blinded randomized crossover trial. Gastric volume was evaluated using magnetic resonance imaging. The children either received 3 ml/kg or 7 ml/kg of clear syrup containing carbohydrate. Gastric volume were evaluated using MRI at 30 minutes before (fasting Gastric volume), immediately after drinking syrup (0 minutes), 30 minutes after syrup ingestion and 60 minutes post syrup ingestion. Gastric volume 1 hour after ingestion of fluid depended on the amount of liquid volume ingested. Gastric volume after 60 minutes of 3 ml/kg syrup was significantly smaller than after ingestion of 7ml/kg and within the range of fasting overnight.

A K Sethi et al[40] studied 60 ASA 1 children 5 year or less posted for routine elective surgery. Real time ultrasonography was used to measure Gastric Antral dimensions. Gastric volume was measured after overnight fast in all patients. After the initial scan patients were divided into 4 groups of 15 children. They received either glucose 10 ml/kg, low fat milk 10ml/kg, breast milk unlimited or nothing. Scans were repeated every 30 minutes until the dimensions of Gastric antrum approximated the fasting levels. Group which received glucose attained Gastric area within 1.75 hour, while low fat milk and breast milk attained within 2.75 hour. This study concluded that a fasting of 3 hour for milk and 2 hour for clear liquid was safe in children.

A study was conducted by A Perlas et al[41] to validate a mathematical model for ultrasound assessment of gastric volume by gastroscopic examination using direct suctioning of gastric fluid under gastroscopic examination on 108 patients .The study reported a new prediction model i.e, gastric volume =27+14.6*rt lateral cross sectional area -1.28*age(yr) to assess gastric volume non invasively at the bedside based on sonographic measurements of right-lateral cross sectional area. This model predicts volumes from 0 to 500 ml and is applicable to non-pregnant adult patients with BMI<40kg/m2

BASIC SCIENCES

ANATOMY OF STOMACH[42,43]

The **stomach** is the expanded part of the alimentary tract between the esophagus and the small intestine. It is specialized for the accumulation of ingested food, which it chemically and mechanically prepares for digestion and passage into the duodenum. In most people, the shape of the stomach resembles the letter J; however, the shape and position of the stomach can vary markedly in persons of different body types (bodily habitus) and even in the same individual as a result of diaphragmatic movements during respiration, the stomach's contents, and the position of the person (i.e., whether lying down or standing). The stomach acts as a food blender and reservoir; its chief function is enzymatic digestion. The *gastric juice* gradually converts a mass of food into a semiliquid mixture, *chyme* (G. juice), which passes fairly quickly into the duodenum. An empty stomach is only of slightly larger caliber than the large intestine; however, it is capable of considerable expansion and can hold 2 to 3 L of food. A newborn infant's stomach, approximately the size of a lemon, can expand to hold up to 30 mL of milk.

PARTS OF STOMACH

The stomach has four parts :

Cardia: the part surrounding the cardial orifice.

Fundus: the dilated superior part that is related to the left dome of the diaphragm and is limited inferiorly by the horizontal plane of the cardial orifice. The superior part of the fundus usually reaches the level of the left 5th intercostal space.

The cardial notch is between the esophagus and the fundus. The fundus may be dilated by gas, fluid, food, or any combination of these.

Body: the major part of the stomach between the fundus and the pyloric antrum.

Pyloric part: the funnel-shaped outflow region of the stomach; its wide part, the pyloric antrum, leads into the pyloric canal, its narrow part (Fig.1). The pylorus (Greek. gatekeeper), the distal, sphincteric region of the pyloric part, is a marked thickening of the circular layer of smooth muscle (Fig.1), which controls discharge of the stomach contents through the pyloric orifice into the duodenum.

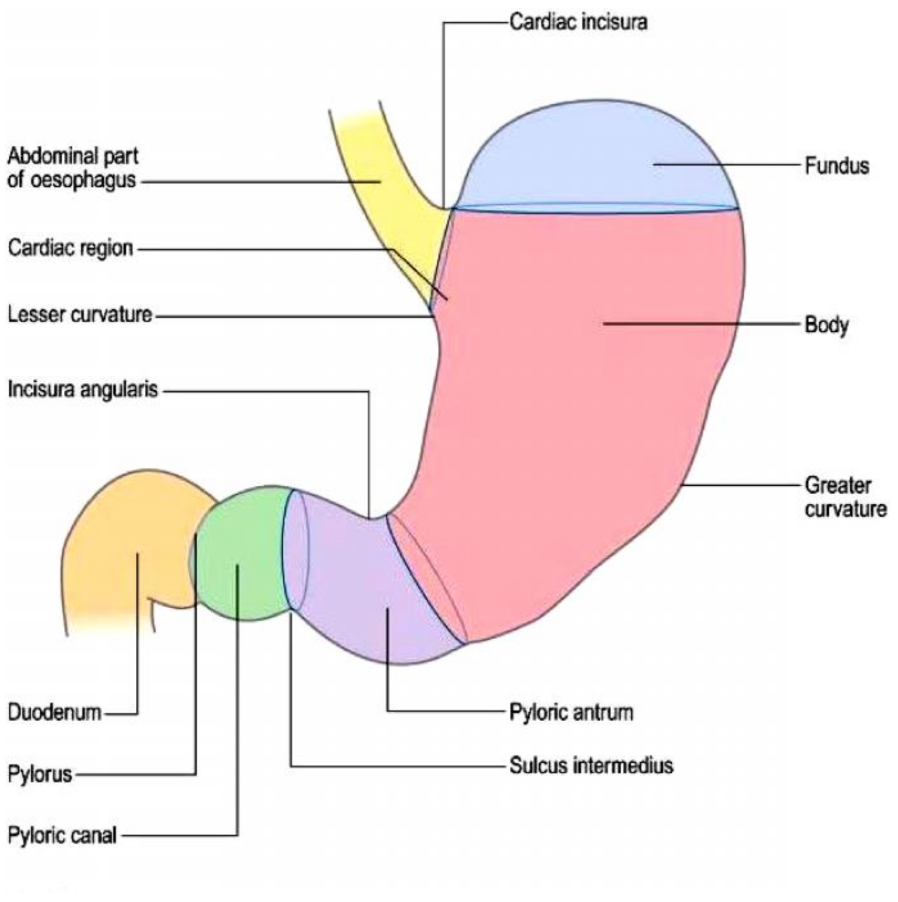

Figure.1- The parts of stomach

The stomach also has two curvatures:

Lesser curvature: forms the shorter concave border of the stomach; the angular incisure (notch) is the sharp indentation approximately two thirds the distance along the lesser curvature that indicates the junction of the body and the pyloric part of the stomach (Fig.1).

Greater curvature: forms the longer convex border of the stomach.

Intermittent emptying of the stomach occurs when intragastric pressure overcomes the resistance of the pylorus. It is normally tonically contracted so that the pyloric orifice is reduced, except when emitting chyme. At irregular intervals, gastric peristalsis passes the chyme through the pyloric canal and orifice into the small intestine for further mixing, digestion, and absorption.

Interior of the Stomach

The smooth surface of the gastric mucosa is reddish brown during life, except in the pyloric part, where it is pink. In life, it is covered by a continuous mucous layer that protects its surface from the gastric acid the stomach's glands secrete. When contracted, the gastric mucosa is thrown into longitudinal ridges called gastric folds, or gastric rugae ; they are most marked toward the pyloric part and along the greater curvature. A gastric canal (furrow) forms temporarily during swallowing between the longitudinal gastric folds of the mucosa along the lesser curvature. It can be observed radiographically and endoscopically. The gastric canal forms because of the firm attachment of the gastric mucosa to the muscular layer, which does not have an oblique layer at this site. Saliva and small quantities of masticated food and other fluids pass through the gastric canal to the pyloric canal when the stomach is mostly empty.

The gastric folds diminish and obliterate as the stomach is distended (fills).

Relations of the Stomach

The stomach is covered by peritoneum, except where blood vessels run along its curvatures and in a small area posterior to the cardial orifice. The two layers of the lesser omentum extend around the stomach and leave its greater curvature as the greater omentum . Anteriorly, the stomach is related to the diaphragm, the left lobe of liver, and the anterior abdominal wall. Posteriorly, the stomach is related to the omental bursa and the pancreas; the posterior surface of the stomach forms most of the anterior wall of the omental bursa (Fig.2).

The bed of the stomach, on which the stomach rests in the supine position, is formed by the structures forming the posterior wall of the omental bursa. From superior to inferior, the stomach bed is formed by the left dome of the diaphragm, spleen, left kidney and suprarenal gland, splenic artery, pancreas, and transverse mesocolon and colon.

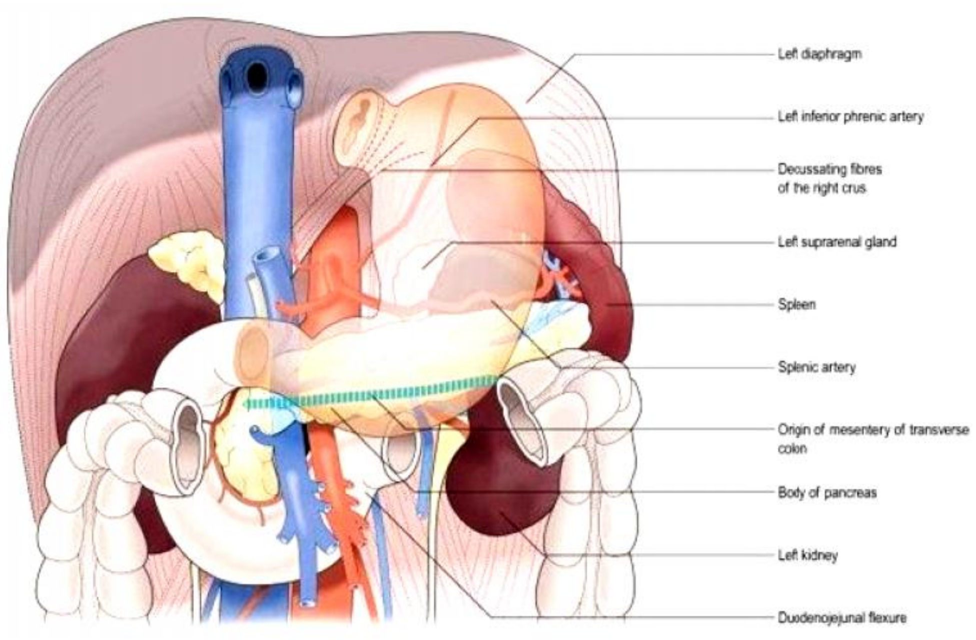

Figure.2- Relations of stomach

BLOOD SUPPLY

The stomach has a rich arterial supply arising from the celiac trunk and its branches. The origin, course, and distribution of the arteries of the stomach are described in Table 1. Most blood is supplied by anastomoses formed along the lesser curvature by the right and left gastric arteries, and along the greater curvature by the right and left gastro-omental arteries. The fundus and upper body receive blood from the short and posterior gastric arteries.

Table 1: Arterial Supply to Abdominal Foregut Derivatives-Esophagus, Stomach, Liver, Gallbladder, Pancreas, and Spleen

Artery	Origin	Course	Distribution
Celiac trunk	Initial abdominal aorta (within aortic hiatus)	After short anteroinferior course, bifurcates into splenic and common mesenteric arteries	Esophagus, stomach, proximal duodenum, liver/biliary apparatus, pancreas
Left gastric	Celiac trunk	Ascends retroperitoneally to esophageal hiatus, giving rise to an esophageal branch; then descending along lesser curvature to anatomose with right gastric artery	Distal (mostly abdominal) part of esophagus and lesser curvature of stomach
Splenic	Celiac trunk	Runs retroperitoneally along superior border of pancreas; traverses spenorenal ligament to hilum of spleen	Body of pancreas, spleen, and greater curvature and posterior stomach body
Posterior gastric	Splenic artery posterior to stomach	Ascends retroperitoneally along posterior wall of lesser omental bursa to enter gastrophrenic ligament	Posterior wall and fundus of stomach
Left gastro-omental (left gastroepiploic)	Splenic artery in hilum of spleen	Passes between layers of gastrosplenic ligament to stomach, then along greater curvature in greater omentum to anastomose with right gastro-omental artery	Left portion of greater curvature of stomach
Short gastric	Splenic artery in hilum of spleen	Passes between layers of gastrosplenic ligament to fundus of stomach	Fundus of stomach
Hepatica	Celiac trunk	Passes retroperitoneally to reach hepatoduodenal ligament; passing between layers to porta hepatis; bifurcates into right and left hepatic arteries	Liver, gallbladder and biliary ducts, stomach, duodenum, pancreas and respective lobes of liver

Cystic	Right hepatic artery	Arises within hepatiduodenal ligament in triangle of Calot	Gallbladder and cystic duct
Right gastric	Hepatic artery	Runs along lesser curvature of stomach to anastomose with left gastric artery	Right portion of lesser curvature of stomach
Gastroduodenal		Descends retroperitoneally, posterior to gastroduodenal junction	Stomach, pancreas, first part of duodenum, and distal part of bile duct
Right gastro-omental (right gastroepiploic)	Gastroduodenal artery	Passes between layers of greater omentum along greater curvature of stomach to anastomose with left gastro-omental artery	Right portion of greater curvature of stomach
Superior pancreaticoduodenal	Gastroduodenal artery	Divides into anterior and posterior arteries that descend on each side of pancreatic head, anastomosing with similar branches of inferior pancreaticoduodenal artery	Proximal portion of duodenum and superior part of head of pancreas
Inferior pancreaticoduodenal	Superior mesenteric artery	Divides into anterior and posterior arteries that ascend on each side of pancreatic head, anastomosing with similar branches of superior pancreaticoduodenal artery	Distal portion of duodenum and head of pancreas
aFor descriptive purposes, the hepatic artery is often divided into the common hepatic artery, from its origin to the origin of the gastroduodenal artery, and hepatic artery proper, made up of the remainder of the vessel.			

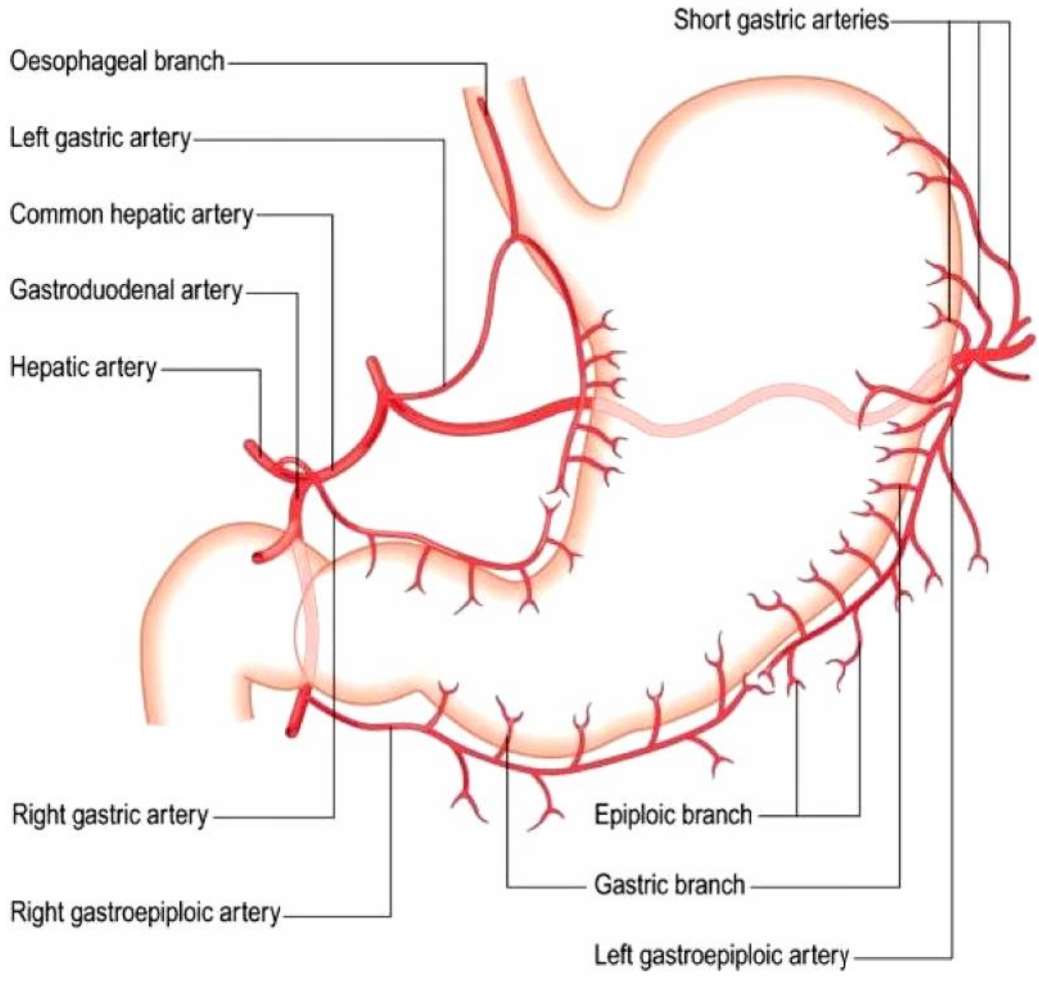

Figure. 3- Blood supply of stomach

The gastric veins parallel the arteries in position and course. The right and left gastric veins drain into the portal vein; the short gastric veins and left gastro-omental veins drain into the splenic vein, which joins the superior mesenteric vein (SMV) to form the portal vein. The right gastro-omental vein empties in the SMV. A prepyloric vein ascends over the pylorus to the right gastric vein. Because this vein is obvious in living persons, surgeons use it for identifying the pylorus.

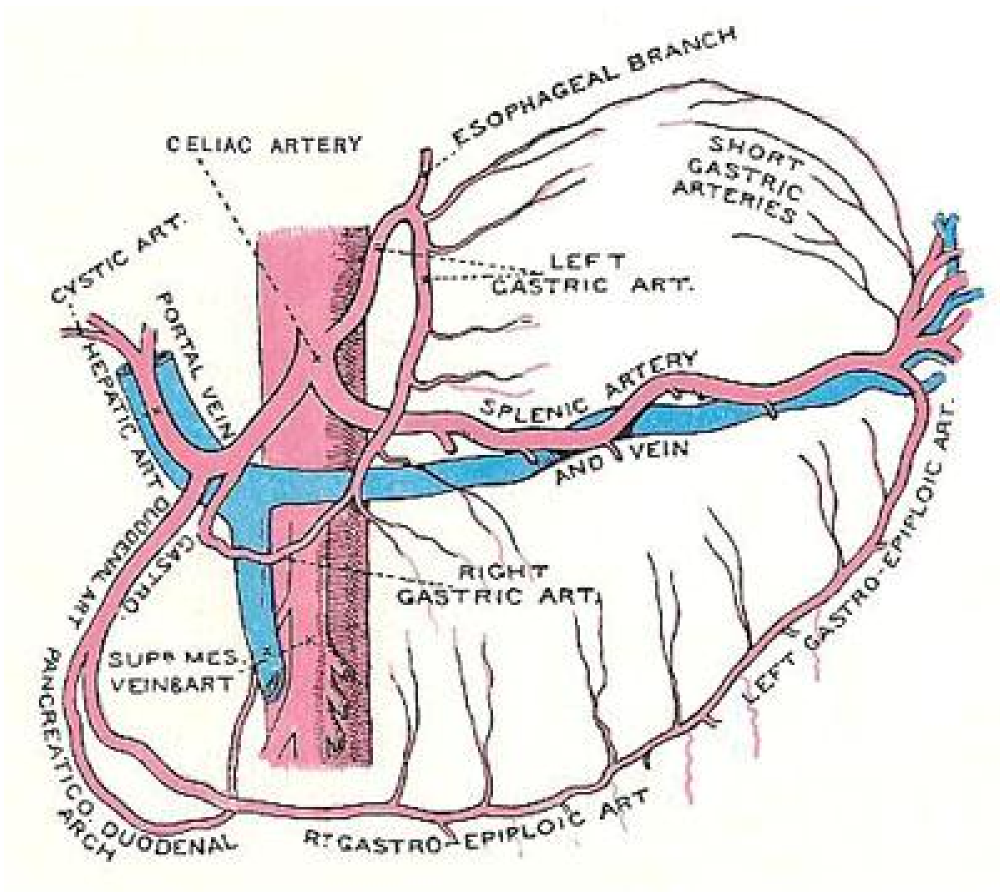

Figure.4- Arterial supply and venous drainage of stomach

LYMPHATICS

The gastric lymphatic vessels accompany the arteries along the greater and lesser curvatures of the stomach. They drain lymph from its anterior and posterior surfaces toward its curvatures, where the gastric and gastro-omental lymph nodes are located. The efferent vessels from these nodes accompany the large arteries to the celiac lymph nodes. The following is a summary of the lymphatic drainage of the stomach:

Lymph from the superior two thirds of the stomach drains along the right and left gastric vessels to the gastric lymph nodes; lymph from the fundus and superior part of the body of the stomach also drains along the short gastric arteries and left gastro-omental vessels to the pancreatico-splenic lymph nodes.

Lymph from the right two thirds of the inferior third of the stomach drains along the right gastro-omental vessels to the pyloric lymph nodes.

Lymph from the left one third of the greater curvature drains along the short gastric and splenic vessels to the pancreaticoduodenal lymph nodes.

NERVE SUPPLY

The parasympathetic nerve supply of the stomach (Fig.5) is from the anterior and posterior vagal trunks and their branches, which enter the abdomen through the esophageal hiatus. The anterior vagal trunk, derived mainly from the left vagus nerve (CN X), usually enters the abdomen as a single branch that lies on the anterior surface of the esophagus. It runs toward the lesser curvature of the stomach, where it gives off hepatic and duodenal branches, which leave the stomach in the hepatoduodenal ligament. The rest of the anterior vagal trunk continues along the lesser curvature, giving rise to anterior gastric branches. The larger posterior vagal trunk, derived mainly from the right vagus nerve, enters the abdomen on the posterior surface of the esophagus and passes toward the lesser curvature of the stomach. The posterior vagal trunk supplies branches to the anterior and posterior surfaces of the stomach. It gives off a celiac branch, which runs to the celiac plexus, and then continues along the lesser curvature, giving rise to posterior gastric branches.

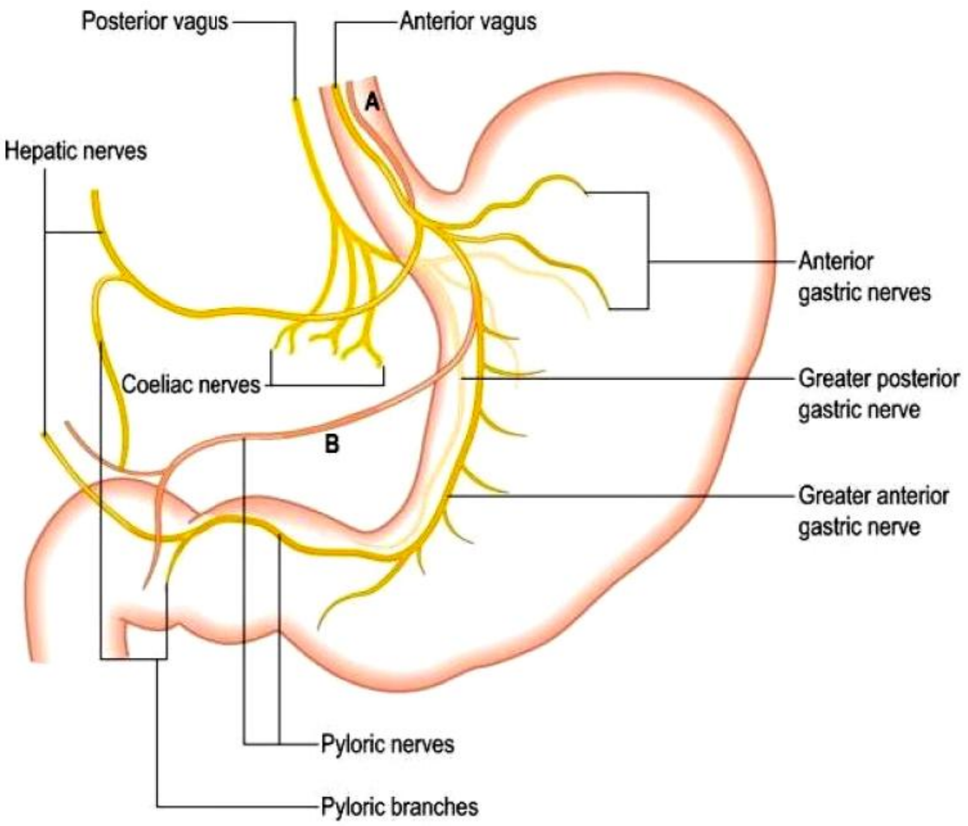

Figure. 5- Nerve supply of stomach

The sympathetic nerve supply of the stomach from the T6 through T9 segments of the spinal cord passes to the celiac plexus through the greater splanchnic nerve and is distributed through the plexuses around the gastric and gastro-omental arteries

HISTOLOGY

Like the other parts of the gastrointestinal tract, the human stomach walls consist of an outer mucosa, and inner submucosa, muscularis externa, and serosa. The gastric mucosa of the stomach consists of the epithelium and the lamina propria (composed of loose connective tissue), with a thin layer of smooth muscle called the muscularis mucosae separating it from the submucosa beneath.

The submucosa lies under the mucosa and consists of fibrous connective tissue, separating the mucosa from the next layer. Meissner's plexus is in this layer. The muscularis externa lies beneath the submucosa and is unique from other organs of the gastrointestinal tract, consisting of three layers:

- The *inner oblique layer:* This layer is responsible for creating the motion that churns and physically breaks down the food. It is the only layer of the three which is not seen in other parts of the digestive system. The antrum has thicker skin cells in its walls and performs more forceful contractions than the fundus.

- The *middle circular layer:* At this layer, the pylorus is surrounded by a thick circular muscular wall which is normally tonically constricted forming a functional (if not anatomically discrete) pyloric sphincter, which controls the movement of chyme into the duodenum. This layer is concentric to the longitudinal axis of the stomach.

- Auerbach's plexus (AKA myenteric plexus) is found between the outer longitundinal and the middle circular layer and is responsible for the innervation of both (causing peristalsis and mixing)

- The *outer longitudinal layer* is responsible for moving the bolus towards the pylorus of the stomach through muscular shortening.

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GLANDS

In humans, different types of cells are found at the different layers of the gastric glands:

Table 2- Gland of stomach

Layer of stomach	**Name**	**Secretion**	**Region of stomach**
Isthmus of gland	Foveolar cells	mucus gel layer	Fundic, cardiac, pyloric
Body of gland	Parietal (oxyntic) cells	Gastric acid and intrinsic factor	Fundic only
Base of gland	Chief (zymogenic) cells	Pepsinogen and gastric lipase	Fundic only
Base of gland	Enteroendocrine (APUD) cells	Hormonesgastrin, histamine, endorphins, serotonin, cholecystokinin and somatostatin	Fundic, cardiac, pyloric

PHYSIOLOGY OF STOMACH[43]

Gastric Secretions-

The cells of the gastric glands secrete about 2500 ml of gastric juice daily. This contains a variety of substances and gastric enzymes, whose role is to kill ingested bacteria, aid protein digestion, stimulate the flow of bilary and pancreatic juices and provide the necessary pH for pepsin to begin protein degradation.

Table 3: Contents of normal (fasting) gastric juice

Cations: Na^+, K^+, Mg^{2+}, H^+
Anions: $Cl^–$, HPO_4^{2-} , SO_4^{2-}
Pepsins: I–III
Gelatinase
Mucus
Intrinsic factor
Water

Mucus Secretion

The most abundant epithelial cells are mucus secreting columnar cells, which cover the entire luminal surface and extend down into the glands as “mucous neck cells”. These cells secrete bicarbonate-rich mucus that coats and lubricates the gastric surface and serves an important role in protecting the epithelium from acid and other chemical insults. It is made up of glycoprotein subunits bound by disulphide bonds and forms a water-insoluble gel that is impermeable to H^+ ions. Production is stimulated by luminal acid and vagal activity, and is increased by prostaglandins.

Therefore aspirin non-steroidal anti-inflammatory drugs (NSAIDs) increase the damage to the stomach by inhibiting prostaglandin formation as well as by crystallising out in the gastric cells. Bicarbonate is also secreted from parietal cells. These epithelial barrier cells are very adherent due to tight junctions between them. After epithelial disruption the cells migrate along the exposed basement membrane to fill in the defect and then stick tightly together. Gastric cells also can turn over rapidly in response to injury, as there is a rich mucosal blood flow providing oxygen, bicarbonate and nutrients and removing acid. Blood flow is normally increased simultaneously with acid secretion and is reduced by aspirin and alcohol

Pepsinogen Secretion

The chief cells secrete pepsinogens, contained in zymogen granules. These are the precursors of the pepsins (proteases) in gastric juice. Once secreted, pepsinogen I is activated by the presence of gastric acid into the active protease pepsin. This is an endopeptidase that is largely responsible for the initiation of protein digestion into smaller peptides and polypeptides. It splits the long amino acid chains in the region of peptide bonds containing aromatic amino acids. It acts at pH 1.5–2.5 and above pH 5.4 is inactivated. It is released mainly by vagal stimulation but also by histamine gastrin secretion, alcohol, cortisol, caffeine and acetazolamide. Pepsinogen release may also occur during periods of hypoglycaemia and prolonged increased intracranial pressure.

Hormone Secretion

The principal hormone secreted from the gastric epithelium is gastrin, a peptide that is important in control of acid secretion and gastric motility

Other Secretions

Gastric epithelial cells secrete a number of other enzymes, including an acid-resistant lipase and gelatinase. The lipase hydrolyses triglycerides of medium- and short-chain fatty acids into glycerol and free fatty acids. Intrinsic factor, a glycoprotein secreted by parietal cells, is necessary for intestinal absorption of vitamin B_{12}. It acts by combining with the vitamin B12 and is necessary for its attachment to receptors in the terminal ileum. Lack of intrinsic factor due to reduction in parietal cell mass following gastric surgery, or the production of antibodies to the cells, called pernicious anaemia, leads to megaloblastic anaemia. Secretion of intrinsic factor occurs following vagal, gastrin or histamine stimulation of the parietal cells.

The Formation and Secretion of Gastric Acid

Stimulation of the parietal cells results in acid secretion. These cells contain multiple tubulovesicular structures within their cytoplasm that on stimulation move to the mucosal membrane and fuse with it, producing a microvillous appearance that increases the surface area. This results in the presence of the H^+-K^+ ATPase that transports the H+ onto the luminal surface. This secretion is isotonic with other fluids and its pH is <1.

The H+ is obtained from the ionisation of water, which is then actively transported into the gastric lumen in exchange for K+ that has been recycled from the membrane. Chloride ions are also actively transported into the gastric lumen. The resulting OH^- ion is neutralised by the carbonic acid buffer system to form a bicarbonate ion that diffuses into the interstitium to be replaced by a further Cl^- ion. There is a HCO_3^-–Cl– exchange mechanism within the interstitium, but Cl^- also enters the cell with Na+. The carbonic acid is replenished by the hydration of CO_2, which is produced by cellular metabolism from the abundance of carbonic anhydrase within the mucosa. After a meal this results in the development of a negative respiratory quotient; thus arterial CO_2 is higher than venous and the gastric venous return is alkaline with a high HCO_3^- content.

Gastric Hormones

Gastrin

Experiments in the early twentieth century using injected extract of pyloric mucosa stimulated secretion of gastric acid and pepsinogen. This action was thought to be hormonal in origin and the active substance was called gastrin . However, this theory was initially disputed because this action was similar to that of histamine and the isolation of gastrin was not performed until the late 1960s when two related heptadecapeptides were identified from hog antral mucosa. These heptadecapeptides were isolated in the pyloric zone. The highest density of gastrin-producing G cells occurs in the distal 3.0 cm of the stomach, where the concentration of gastrin is 500 times higher than in the body of the stomach. The first part of the duodenum also contains a significant level of G cells. These cells originate from neuroectoderm together with other cells of the APUD series. Microscopically they are piriform in shape and located in the mid and deep zones of the pyloric mucosal glands. Electron microscopy shows that they possess microvilli extending into the lumen and that secretory granules are present in the basal parts of the cells. This allows for secretion of hormone into the bloodstream in response to luminal stimuli. There are two main types of gastrin, gastrin I and gastrin II, produced predominantly by the G cells of the pyloric mucosal zone. Other sources are the duodenal G cells, D cells in the islands of

Langerhans in the pancreas, and isolated G cells in the proximal-acid-producing region of the fornix and body of the stomach.

Table 4: The physiological and pharmacological effects of gastrin

Gastrin causes: Parietal cells to stimulate acid secretion
Pepsin and intrinsic factor secretion
Increased mitotic activity in the stomach and small bowel mucosa
Contraction of the lower oesophageal sphincter
The release of insulin, glucagon and calcitonin
Pancreatic stimulation and bile flow Small bowel secretion
Gastric and small bowel motility to increase the gastrocolic reflex

Somatostatin

Somatostatin suppresses gastric acid secretion by direct action on the parietal cells of the cardiac and oxyntic mucosal zones. Thus by lowering the pH, it also inhibits the secretion of gastrin through a feedback loop of low pH suppressing both gastric acid and gastrin secretion.

Vasoactive Intestinal Peptide (VIP)

Vasoactive intestinal peptide (VIP) is a polypeptide with strong vascular effects isolated from small intestine. It has been subsequently demonstrated in central and peripheral neurones, suggesting a neurotransmitter function.In the peripheral autonomic system VIP nerves occur in various regions, including the superior and inferior mesenteric ganglia, and the submucous (Meissner’s) and myenteric

(Auerbach's) plexuses of the intestinal wall In the stomach these nerves are found around oxyntic and pyloric mucosal glands. In the duodenumVIP (and substance P) is present innerves in the villi and muscularis mucosae and around blood vessels and between the lobules of Brunner's glands. Its actions include vasodilatation, thus lowering blood pressure, increased cardiac output, glycogenolysis and relaxation of smooth muscle. In the stomach there is significant inhibition of gastric secretion associated with VIP release

Substance P

In the gastrointestinal tract nerve fibres and neurones containing substance P (11-aminoacid peptide) are encountered along its entire length. However, they are least prominent in the oesophagus and upper part of the stomach, but the highest concentrations occur in the duodenum In the stomach substance P is found in the oxyntic zone in a few, thin fibres only and in fibres interconnecting in the pyloric antrum

Other Gastric Hormones

Encephalin

These are endogenous opiate-like compounds forming two pentapeptides, endorphin and enkephalin. They can be isolated throughout the gastrointestinal tract, although the highest concentration is found in the pyloric antrum.The role of these peptides is not clear.

Galanin

Galanin may act as a regulatory factor in the control of gastrointestinal motility. It is usually found in close association with VIP-containing nerves.

Neurotensin

This is secreted by N cells in ileal mucosa. However, small traces occur in the pyloric mucosal zone. The neurotensin level rises after a meal, but its function is still unclear. It may inhibit pentagastrin-stimulated gastric acid and pepsin secretion after a meal as well as delaying gastric emptying, resulting in the controlled release of chyme into the small intestine.

Absorption from the Stomach

The stomach absorbs very few substances. Fats are not absorbed. Polypetides are absorbed only slightly. Sugars are absorbed to an extent and this varies with the sugar and its concentration. Galactose is most readily absorbed followed by glucose, lactose, fructose and finally sucrose. Low concentrations of sugars are absorbed very slowly. Ethyl alcohol is absorbed fairly rapidly as are other lipid-soluble compounds including aspirin and other NSAIDs. These substances are also well-recognised causes of gastric irritation and their use (especially overuse) is commonly associated with development of gastritis and gastric ulcers. The stomach absorbs water readily with half the ingested volume absorbed in about 20 minutes.

Regulation of Gastric Secretion and Motility

Gastric function is classified into three phases in which secretory and motor activities are closely linked. Control of Gastric Acid Secretion Acid secretion may be divided into two phases interprandial, when acid secretion is 1–5 mmol/h, and stimulated where acid secretion is maximally 20–35 mmol/h. This is further subdivided into cephalic, gastric and intestinal phase. Normal subjects maximally secrete 0.5 mmol/h/kg body weight)

Interprandial

Resting secretion occurs in the absence of all intestinal stimulation. However, to abolish all gastic acid secretions, a bilateral vagotomy (truncal) and excision of the pyloric antrum would be necessary.

Stimulated Secretion

The Cephalic Phase- The cephalic phase is initiated by seeing, smelling and anticipating food. These influences act on the limbic system and hypothalamus and these nuclei stimulate the dorsal motor nucleus of the vagus. This stimulus is transmitted thought the vagus nerve to the enteric nervous system, resulting in release of acetylcholine in the vicinity of G cells and parietal cells. Binding of acetylcholine to its receptor on G cells induces secretion of the hormone gastrin, which, in concert with acetylcholine and histamine, stimulates parietal cells to secrete small amounts of acid. Additionally, a low level of gastric motility is induced. The release of acetylcholine and bombesin (gastrin-releasing peptide) initiates gastrin release from the G cells. The gastrin passes via the portal circulation to stimulate the parietal cells. It potentiates the effect of vagal stimulation, thus resulting in increased acid secretion.

The parietal cells also have H2 receptors (histamine) stimulated by the release of histamine from mast cells close to the parietal cells. The histamine sensitises the parietal cell to the action of gastrin and acetylcholine. The H2 receptor blockers (cimetidine and ranitidine) act on these receptors, thus reducing acid Secretion.

The Gastric Phase when food enters the stomach several additional factors come into play, foremost among them being distension and mucosal irritation. Distension excites stretch receptors and irritation activates chemoreceptors in the mucosa. These events are sensed by enteric neurones, which secrete additional acetylcholine, further stimulating both G cells and parietal cells. Gastrin from the G cells feeds back to the parietal cells, stimulating it even further, mediated by vagovagal reflexes through the dorsal motor nucleus. Additionally, activation of the enteric nervous system and release of gastrin cause vigorous smooth muscle contractions. The net result is that secretory and motor functions of the stomach are fully turned on – acid and pesinogen are secreted, pepsinogen is converted into pepsin and vigorous grinding and mixing contractions take place. However, acid secretion may be inhibited during the gastric phase by local mechanisms. If the antral pH falls to 1–1.5, inhibition of gastrin release occurs. This is mediated by two mechanisms – the effect of luminal acid on the microvilli of the G cell and the stimulation of somatostatin from D cells in the antrum, which acts inhibits directly on the G cells and parietal cells by a local paracrine effect.

The Intestinal Phase- As chyme is emptied into the small intestine control is necessary to limit gastric empting. This probably allows the duodenum time to neutralize the acid and efficiently absorb incoming nutrients. Hence, this phase of gastric function is dominated by the small intestine sending inhibitory signals to the stomach to slow secretion and motility. Two types of signals are used: nervous and endocrine. Distension of the small intestine, as well as chemical and osmotic irritation of the mucosa, is transduced into gastric-inhibitory impulses in the enteric nervous system – this nervous pathway is called the enterogastric reflex. Fat and carbohydrate in the chyme cause the release of GIP (gastric inhibiting peptide), which inhibits gastrin secretion. Secondly, enteric hormones such as cholecystokinin and secretin are released from cells in the small intestine and contribute to suppression of gastric activity. Gastrin also causes the release of calcitoninfrom the C cells of the thyroid gland, which inhibits further release of gastrin via a feedback loop. Collectively, enteric hormones and the enterogastric reflex put a strong brake on gastric secretion and motility. As the ingesta in the small intestine is processed, these stimuli diminish, the damper on the stomach is released, and its secretory and motor activities resume..

Gastric Motility and Hunger Contraction

Resting Electrical Activity Within the Stomach

A pacemaker in the longitudinal muscle close to the greater curve of the cardia controls the frequency of contractions. It depolarises at a rate of 3/minute, and each wave – the gastric slow wave (or basal electrical rhythm) – increases sodium permeability across the cell membrane and the impulse spreads through the longitudinal and circular muscles via low resistance junctions. These junctions make up about 12% of the membrane surface. In the empty stomach (approximately 50 ml volume), the resting potential is low (–50 mV) and although the waves pass at a rate of 3/minute, not all of these waves are equal in amplitude and do not set off an action potential. However, when the critical firing level is passed the resulting action otential sets off an excitation–contraction coupling and a contraction spreads throughout the stomach.

Intragastric Pressure

Intragastric pressure remains relatively constant at 5 mmHg (0.7 kPa) because as food passes into the stomach, the musculature of the fundus and body relaxes via a feedback loop – receptive relaxation. In addition, as wall tension rises so does the radius, thus keeping the intragastric pressure constant (law of Laplace). However, above 1000 ml, the radius cannot increase in size so the wall tension and intragastric pressure rises. Thus volumes above 1000 ml lead to stimulation of stretch receptors within the stomach wall.

Control of Gastric Motility

As the volume of the stomach passes 1000 ml the intragastric wall tension rises. This activates stretch receptors, again through a vagovagal reflex arc, which cause depolarisation in the longitudinal and circular smooth muscles. However, this leads to every slow wave being above the critical firing level. An action potential is therefore propagated with each slow wave and a contraction passes from the fundusthrough the body to the pyloric antrum. These now occur three times per minute and the force of the contraction also increases along the stomach. Initially low in the fundus, where the muscular layer is thinnest, at the pylorus intragastric pressure may reach 40–50 mmHg (5.3–6.7 kPa). The pyloric sphincter is not a high-pressure zone and is open in the resting phase. As a contraction wave arrives it contracts. However, since the canal was open before the rise in intragastric pressure some of the chyme passes through the pylorus (5–15 ml) before the gastric slow wave reaches it. When the slow wave reaches the antrum and pylorus they contract together – terminal contraction, and the pylorus closes. This phase of the contraction acts to recirculate or "churn" the gastric contents. Only when duodenal pressure drops due to relaxation does the pyloric pressure drop. Factors Modifying Gastric Motility Both vagal stimuli and gastrin increase antral motility and influence emptying. However, after a truncal vagotomy, the force of the antral pump is reduced and gastric emptying time is prolonged, hence the need for a drainage procedure after a truncal vagotomy. The force of the pump is also moderated by the volume and composition of the chyme.

Hormonal and neuronal mechanisms also regulate gastric emptying. These include duodenal distension – via a vagal feedback loop, increased duodenal osmolarity – via osmoreceptors, the presence of acid in the duodenum – via a local enteric neuronal pathway, and the release of GIP and chalesystokinin by fat in the duodenum. In addition, sympathetic stimuli reduce gastric emptying via the limbic and hypothalamic nuclei.

ULTRSONOGRAPHY BASICS[44,45]

Introduction

Ultrasound has been used to image the human body for over half a century. Dr. Karl Theo Dussik, an Austrian neurologist, was the first to apply ultrasound as a medical diagnostic tool to image the brain.1 Today, ultrasound (US) is one of the most widely used imaging technologies in medicine. It is portable, free of radiation risk, and relatively inexpensive when compared with other imaging modalities, such as magnetic resonance and computed tomography. Furthermore, US images are tomographic, i.e., offering a “cross-sectional” view of anatomical structures. The images can be acquired in “real time,” thus providing instantaneous visual guidance for many interventional procedures including those for regional anesthesia and pain management

Definition

Ultrasound is the term used to describe sound of frequencies above 20 000 Hertz (Hz), beyond the range of human hearing. Frequencies of 1–30 megahertz (MHz) are typical for diagnostic ultrasound

Diagnostic ultrasound imaging depends on the computerized analysis of reflected ultrasound waves, which non-invasively build up fine images of internal body structures. The resolution attainable is higher with shorter wavelengths, with the wavelength being inversely proportional to the frequency. However, the use of high frequencies is limited by their greater attenuation (loss of signal strength) in tissue and thus shorter depth of penetration. For this reason, different ranges of frequency are used for examination of different parts of the body:

- 3–5 MHz for abdominal areas
- 5–10 MHz for small and superficial parts and
- 10–30 MHz for the skin or the eyes.

Generation of ultrasound pulses

Ultrasound transducers (or probes) contain multiple piezoelectric crystals which are interconnected electronically and vibrate in response to an applied electric current. This phenomenon called the piezoelectric effect was originally described by the Curie brothers in 1880 when they subjected a cut piece of quartz to mechanical stress generating an electric charge on the surface. Later, they also demonstrated the reverse piezoelectric effect, i.e., electricity application to the quartz resulting in quartz vibration.4 These vibrating mechanical sound waves create alternating areas of compression and rarefaction when propagating through body tissues. Sound waves can be described in terms of their frequency (measured in cycles per second or hertz), wavelength (measured in millimeter), and amplitude (measured in decibel).

Ultrasound Wavel ength and Frequency

The wavelength and frequency of US are inversely related, i.e., ultrasound of high Frequency has a short wavelength and vice versa. US waves have frequencies that exceed the upper limit for audible human hearing, i.e., greater than 20 kHz.3 Medical ultrasound devices use sound waves in the range of 1–20 MHz. Proper selection of transducer frequency is an important concept for providing optimal image resolution in diagnostic and procedural US. High-frequency ultrasound waves (short wavelength) generate images of high axial resolution. Increasing the number of waves of compression and rarefaction for a given distance can more accurately discriminate between two separate structures along the axial plane of wave propagation. However, high-frequency waves are more attenuated than lower frequency waves for a given distance; thus, they are suitable for imaging mainly superficial structures. Conversely, low-frequency waves (long wavelength) offer images of lower resolution but can penetrate to deeper structures due to a lower degree of attenuation . For this reason, it is best to use high-frequency transducers (up to 10–15 MHz range) to image superficial structures and low-frequency transducers (typically 2–5 MHz) for imaging the lumbar neuraxial structures that are deep in most adults Ultrasound waves are generated in pulses (intermittent trains of pressure) that commonly consist of two or three sound cycles of the same frequency. The pulse repetition frequency (PRF) is the number of pulses emitted by the transducer per unit of time. Ultrasound waves must be emitted in pulses with sufficient time in between to allow the signal to reach the target of interest and be reflected back to the transducer as echo before the next pulse is generated. The PRF for medical imaging devices ranges from 1 to 10 kHz.

THE DOPPLER EFFECT

When ultrasound is transmitted towards a stationary reflector , the reflected waves (echos) will be of same frequency as those originally transmitted . However , if the reflector is moving towards the transmitter , the reflected frequency wil be higher than the transmitted frequency . Conversely , if the reflector is moving away from the transmitter , the reflected frequency will be lower than the transmitted frequency.

In medicine, Doppler techniques are used mainly to analyse blood flow .The observed Doppler frequency can be used to calculate blood velocity because the velocity of the ultrasound is known and the angle of the vessels to the beam direction can be measured, allowing angle correction. It must be noted that a Doppler shift occurs twice in this situation: first, when the ultrasound beam hits the moving blood cells and, second, when the echoes are reflected back by the moving blood cells. The blood velocity, V, is calculated from the Doppler shift by the formula:

$$\Delta f = \frac{f}{c} v \quad \cos\sim$$

U l t r a s o u n d – Ti s s u e I n t e r a c t i o n

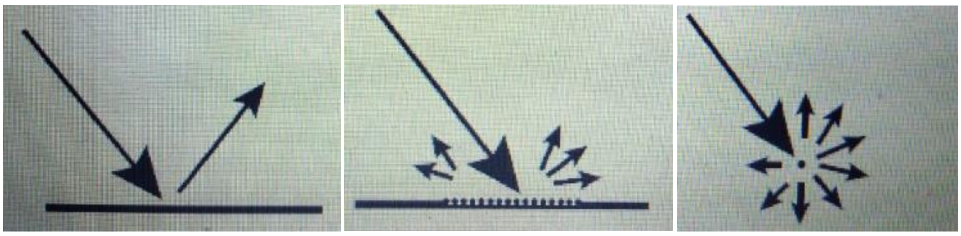
As US waves travel through tissues, they are partly transmitted to deeper structures, partly reflected back to the transducer as echoes, partly scattered, and partly transformed to heat. For imaging purposes, we are mostly interested in the echoes reflected back to the transducer. The amount of echo returned after hitting a tissue interface is determined by a tissue property called acoustic impedance. This is an intrinsic physical property of a medium defined as the density of the medium times the velocity of US wave propagation in the medium. Air-containing organs (such as the lung) have the lowest acoustic impedance, while dense organs such as bone have very high-acoustic impedance

Table 5.: Acoustic impedances of different body tissues and organs.

Body tissue	Acoustic impedance (10^6 Rayls)
Air	0.0004
Lung	0.18
Fat	1.34
Liver	1.65
Blood	1.65
Kidney	1.63
Muscle	1.71
Bone	7.8

The intensity of a reflected echo is proportional to the difference (or mismatch) in acoustic impedances between two mediums. If two tissues have identical acoustic impedance, no echo is generated. Interfaces between soft tissues of similar acoustic impedances usually generate low-intensity echoes. Conversely interfaces between soft tissue and bone or the lung generate very strong echoes due to a large acoustic impedance gradient. When an incident ultrasound pulse encounters a large, smooth interface of two body tissues with different acoustic impedances, the sound energy is reflected back to the transducer. This type of reflection is called specular reflection, and the echo intensity generated is proportional to the acoustic impedance gradient between the two mediums

Specular reflection Diffuse reflection Diffuse reflection



One direction Multiple direction Multiple direction

Low amplitude Low amplitude

Figure. 6 : Different types of ultrasound wave–tissue interactions.

A soft-tissue–needle interface when a needle is inserted "in-plane" is a good example of specular reflection. If the incident US beam reaches the linear interface at 90°, almost all of the generated echo will travel back to the transducer. However, if the angle of incidence with the specular boundary is less than 90°, the echo will not return to the transducer, but rather be reflected at an angle equal to the angle of incidence (just like visible light reflecting in a mirror). The returning echo will potentially miss the transducer and not be detected. This is of practical importance for the pain physician, and explains why it may be difficult to image a needle that is inserted at a very steep direction to reach deeply located structures.

Refraction refers to a change in the direction of sound transmission after hitting an interface of two tissues with different speeds of sound transmission. In this instance,because the sound frequency is constant, the wavelength has to change to accommodate the difference in the speed of sound transmission in the two tissues. This results in a redirection of the sound pulse as it passes through the interface. Refraction is one of the important causes of incorrect localization of a structure on an ultrasound image. Because the speed of sound is low in fat (approximately 1,450 m/s) and high in soft tissues (approximately 1,540 m/s), refraction artifacts are most prominent at fat/soft tissue interfaces.

Ultrasound techniques

The echo principle forms the basis of all common ultrasound techniques. The distance between the transducer and the reflector or scatterer in the tissue is measured by the time between the emission of a pulse and reception of its echo. Additionally, the intensity of the echo can be measured. With Doppler techniques, comparison of the Doppler shift of the echo with the emitted frequency gives information about any movement of the reflector. The various ultrasound techniques used are described below.

A-mode

A-mode (A-scan, amplitude modulation) is a one-dimensional examination technique in which a transducer with a single crystal is used (Fig. 1.12). The echoes are displayed on the screen along a time (distance) axis as peaks proportional to the intensity (amplitude) of each signal. The method is rarely used today, as it conveys limited information, e.g. measurement of distances.

B-mode

B-mode (brightness modulation) is a similar technique, but the echoes are displayed as points of different grey-scale brightness corresponding to the intensity (amplitude) of each signal

M-mode or TM-mode

M-mode or TM-mode (time motion) is used to analyse moving structures, such as heart valves. The echoes generated by a stationary transducer (one-dimensional B-mode) are recorded continuously over time

B-scan, two-dimensional

The arrangement of many (e.g. 256) one-dimensional lines in one plane makes it possible to build up a two-dimensional (2D) ultrasound image (2D B-scan). The single lines are generated one after the other by moving (rotating or swinging) transducers or by electronic multielement transducers. Rotating transducers with two to four crystals mounted on a wheel and swinging transducers ('wobblers') produce a sector image with diverging lines.

ULTRASOUND TRANSDUCERS

The essential element of each ultrasound transducer is a piezoelectric crystal, serving both to generate and to receive ultrasound waves.The ultrasound transducers differ in construction according to:

- Piezoelectric crystal arrangement,
- Aperture (footprint),
- Operating frequency (which is directly related to the penetration depth)

The following types of transducers are most often used in the critical ultrasound imaging: sector, linear and convex (standard or micro-convex).

Sector transducer:

- Piezoelectric crystal arrangement: phased-array (most commonly used)
- Footprint size: small
- Operating frequency (bandwidth): 1-5 mhz (usually 3.5-5 mhz)
- Ultrasound beam shape: sector, almost triangular
- Use: small acoustic windows, mainly echocardiography, gynaecological ultrasound, upper body ultrasound

Linear transducer:

- Piezoelectric crystal arrangement: linear
- Footprint size: usually big (small for the hockey transducers)
- Operating frequency (bandwidth): 3-12 mhz (usually 5-7.5 mhz)
- Ultrasound beam shape: rectangular
- Use: ultrasound of the superficial structures, e.g. Obstetrics ultrasound, breast or thyroid ultrasound, vascular ultrasound

Convex transducer:

- Piezoelectric crystal arrangement: curvilinear, along the aperture
- Footprint size: big (small for the micro-convex transducers)
- Operating frequency (bandwidth): 1-5 mhz (usually 3.5-5 mhz)
- Ultrasound beam shape: sector; the ultrasound beam shape and size vary with distance from the transducer, that causes the lack of lateral resolution at greater depths
- Use: useful in all ultrasound types except echocardiography, typically abdominal, pelvic and lung (micro-convex transducer) ultrasound

SONOANATOMY OF STOMACH

Scanning technique-

The stomach has been imaged with the patient in the supine, sitting, semi-sitting, or right lateral decubitus (RLD) position. The best position depends on the section of the stomach to be imaged and affects sonographic findings.

A curved array low-frequency transducer (2–5 MHz) with standard abdominal settings is most useful in adults. It provides the necessary penetration to identify the relevant anatomic landmarks[46]. A linear high-frequency transducer can be used in leaner or paediatric patients or to obtain detailed images of the gastric wall. The gastric wall is 4–6 mm thick and has a characteristic appearance of five distinct sonographic layers that are best visualized with a high-frequency transducer (e.g. 5–12 MHz) in the fasting state[46-49] . These layers help differentiate the stomach from other hollow viscus. Starting at the inner surface of the stomach, the first thin hyperechoic layer corresponds to the mucosal–air interface. A second hypoechoic layer is the muscularis mucosa. A third hyperechoic layer corresponds to the submucosa. A fourth hypoechoic layer is most prominent and corresponds to the muscularis propria, whereas a fifth thin hyperechoic layer is the serosa[46-49].

Table 6 : Sonographic presentation of the antrum and contents

	Empty	Clear fluid	Milk or suspensions	Solid
Antral shape	Flat, collapsed, or round (bull’s eye)	Round, distended	Round, distended	Round, distended
Antral wall	Thick, prominent muscularis propriae	Thin	Thin	Thin
Content	None (grade 0) or small amount of hypoechoic content (grade1)	Hypoechoic	Hyperechoic	Hyperechoic Heterogeneous (mixed with air)
Peristalsis	None	Present (usually fast waves)	Present	Present (usually slow waves)

Gastric antrum-

It is the gastric portion most consistently identified (98–100% of cases)[20,2.250].It is found superficially between the left lobe of the liver anteriorly and the pancreas posteriorly in a sagittal or para-sagittal scanning plane in the epigastrium[20,,41,48-51]. Important vascular landmarks including both the aorta or inferior vena cava (IVC) and either the superior mesenteric artery or vein have been used to standardize a scanning plane through the antrum[20,47,48,50,51]. Not only is the antrum highly amenable to ultrasound imaging, its evaluation accurately reflects the content of the entire organ

Gastric body -

The body of the stomach may be imaged by sliding the transducer towards the left subcostal margin using an oblique scanning plane[20,46,49,52-54]. In this plane, the anterior wall is consistently identified, extending from the lesser to the greater curvature[20]. However, the presence of air in the body frequently obscures the posterior wall, and it may be more difficult to image a full cross-section of the gastric body.

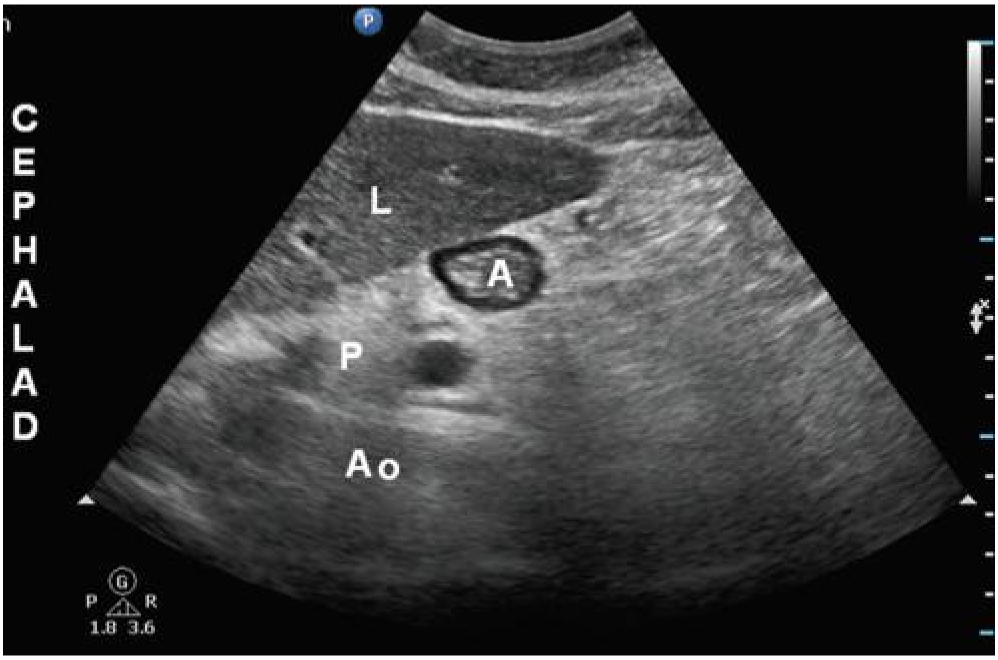


Figure. 7-Sonographic image of the gastric antrum of an empty stomach. Note the antrum appears small, with no visible content. The muscularis propia is seen distinctly as a thick hypoechoic layer of the gastric wall. A, antrum; L, liver; P, pancreas; Ao, aorta

Gastric fundus -

The fundus is located in the left upper quadrant of the abdomen, inferior to the diaphragm, anterior to the left kidney, and posterior to the spleen. It is the most challenging section of the stomach to image due to its deep location and the lack of a wide acoustic window due to the rib cage. Two different approaches have been described. A left lateral, intercostal, trans-splenic approach has been reported with limited success[20,49].Alternatively, a longitudinal scan in the mid-axillary line has been used[33.] Air is commonly found in both the fundus and the body, even in 'empty' stomach, which hinders visualization of these two sections.

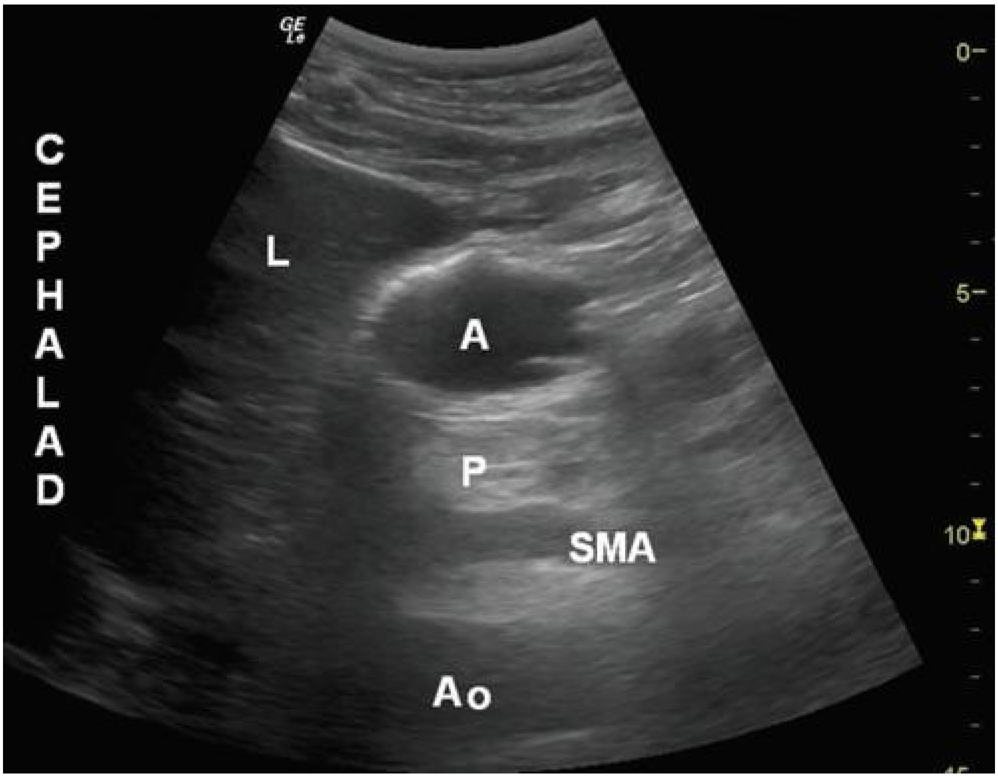


Figure. 8-Sonographic image of the gastric antrum containing clear fluid. Note the antrum appears distended with hypoechoic/anechoic content. A, antrum; L, liver; P, Pancreas; Ao, Aorta; SMA, supeior mesenteric artery

Introduction

Objectives

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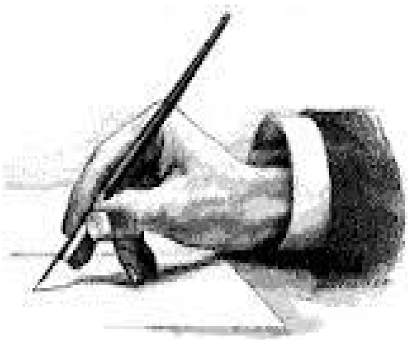


Annexure-I

Annexure-II

Annexure-III

Annexure-IV

Annexure-V

MATERIALS AND METHODS

The present study was conducted at KLE'S Dr.Prabhakar Kore Hospital and Medical Research Centre, Nehru nagar, Belagavi from January 2016 to December 2016.

a) **Study design:**

A One Year Randomized clinical Trial.

b) **Study Period:**

One year from January 2016 to December 2016.

c) **Sample size**:

Total sample size was 60 patients

Group A- Overnight fasting patients - 30

Group B- Patients who ingested 200 ml of clear fluid (water) 2 hours before surgery -30

d) **Selection Criteria:**

<u>Inclusion</u>

1. Patients undergoing elective surgery under general anaesthesia.
2. Age: 18 to 50 years.
3. ASA Grade I patients.
4. Provides consent
5. BMI < $30kg/m^2$

Exclusion Criteria :-

1. Patient refusal to consent.
2. Patients with GERD.
3. Pregnant patients.
4. ASA grade II , III and IV patients.

e) Sample size(n):

Using the formula, sample size

$$\text{Sample Size (n)} = \frac{2\,(Z\alpha_{/2} + Z_{1}\text{-}_{\beta})^2\,(SD^2)}{d^2}$$

Level of significance is taken as 5%

Power of the test used is taken as 80%

Type I error rate $\alpha = 0.05$ and

Type II error rate $\beta = 0.2$

Taking the level of significance at 5% (α=0.05),

Power of the test as 90% (β=0.2), and

using two tailed test we get

$Z\alpha$=1.96

$Z_{1\text{-}\beta}$=0.84

SD= Standard deviation of mean gastric volume of overnight fasted patients.

d = effect size = 1.65 (6% of the mean gastric volume value of 27.48 in fasted patients)

The clinical significance of the effect size value is that any difference of mean value upto 1.65 between the fasting and 2 hour 200ml clear fluid group this study will be able to detect.

The study result is expecting to find a mean gastric volume value less than 27.48±2

Hence,

$Z\alpha = 1.96$

$Z\beta = 1.28$

Mean gastric volume for fasted patients = 27.48

SD= 1.98 =2

d =1.65

$$\text{Sample Size (n)} = \frac{2\,(1.96 + 0.84)^2\,(2^2)}{(1.65)^2}$$

n = 22.94

For ease of calculations and sake of consistent result, sample size was taken as 30. There are two groups of 30 each group.

f) **Sample procedure:** One year randomized control trial. Randomization was done by computer generated randomization chart.

g) **Place :** KLES Dr.Prabhakar Kore Hospital and Medical Research Centre, Nehru Nagar, Belgaum.

h) **Methodology:** After obtaining the approval of ethical committee and written informed consent , a total of 60 patients undergoing surgery under general anaesthesia were included in the study.

After having met inclusion and exclusion criteria and having obtained informed consent, patients were randomized based on computer generated randomization table into one of the two groups.

- Group A: Patients with Overnight fasting
- Group B: Patients receiving 200 ml of clear fluids (water) 2 hours before surgery

Preoperatively the patient's intravenous (IV) line was secured with either 18 G or 20 G branula and IV fluid was started at 5 ml/kg/hr. Patient was positioned in right-lateral position and using ultrasonography probe 3-5 Mhz, the gastric antrum was visualized by placing the probe in saggital plane which was seen as round to ovoid and has been compared with a 'target' or 'bulls eye' pattern

Then antral CSA is measured by using two perpendicular diameters and the formula of the area of an ellipse : $CSA = (AP \times CC \times \pi)/4$

AP=ANTERO-POSTERIOR DIAMETER (in cm)

CC= CRANIOCAUDAL DIAMETER (in cm)

And Gastric volume was calculated using the formula

$GV = 27+14.6\times$rt-latCSA (in cm^2)$-1.28\times$age(years)

Then the patient was shifted to the operation theater and monitors like electrocardiograph (ECG), pulse oximeter and non-invasive blood pressure were attached and baseline readings taken. The patient was preoxygenated for 3 minutes and patients were premedicated with glycopyrolate, midazolam, fentanyl and induced with thiopentone and vecuronium. Then patients were intubated with appropriate size of endotracheal tube. The patients were maintained with oxygen , nitrous oxide , vecuronium. An 16G and 14G Ryles tube was inserted in male and female respectively and its position confirmed by auscultation over the epigastrium for insufflated air. Gastric aspirate was obtained through a 20 ml syringe with the patient supine with an assistant massaging over the upper abdomen, as well as with various other positions like trendelenburg , left lateral and right lateral positions to facilitate maximal aspiration.

The volume of aspirate was noted and pH measured using a standarized pH strip. The following parameters were noted : Sex, age, weight, type of surgery, duration of surgery ,gastric volume by ultrasonography, gastric aspirate volume, duration of fasting and interval between ingestion of water and surgery will be noted.

STATISTICAL ANALYSIS :

Results were given as mean+/- SD. Data collected was analyzed using student t-test. Differences were considered significant if P values are <0.05

RESULTS

Group A- Patients with Overnight fasting - 30

Group B- Patients receiving 200 ml of clear fluids (water) 2 hours before surgery after the Overnight fasting and -30

Table 7: Gender distribution of the two study groups.

Gender	Group A		Group B	
	No.	**%**	**No.**	**%**
Male	10	33.3	12	40
Female	20	66.7	18	60
Total	30	100	30	100

Result: The sex distribution of study subjects in both the study groups is almost equal.

Table 8 : Age distribution of the two study groups.

Age (years)	Group A		Group B	
	No.	**%**	**No.**	**%**
18-25	6	20.0	13	43.4
26-33	6	20.0	6	20.0
34-41	9	30.0	7	23.3
42- 49	8	26.7	3	10.0
50	1	03.3	1	03.3
Total	30	100	30	100

Result: Majority of the study subjects in the control group are in the age group of 34-41 years (30%) whereas majority of the study subjects in the test group are in the age group of 18-25 years (43.4%).

Figure 9 : Pie chart showing the gender distribution in Group A

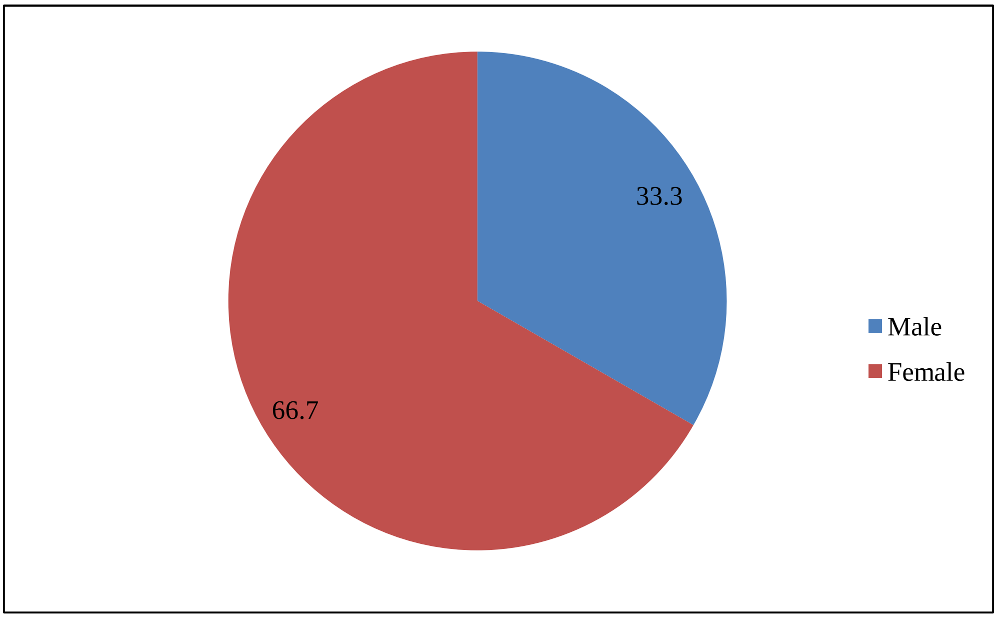


Figure 10 : Pie chart showing gender distribution in Group B

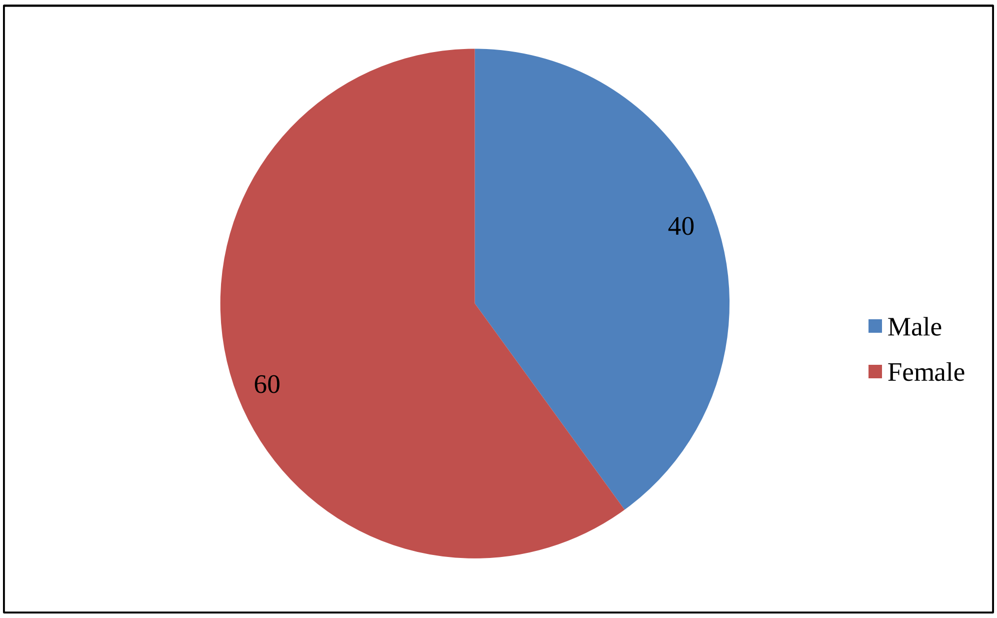


Figure 11 : Bar Chart showing age distribution of the two study groups

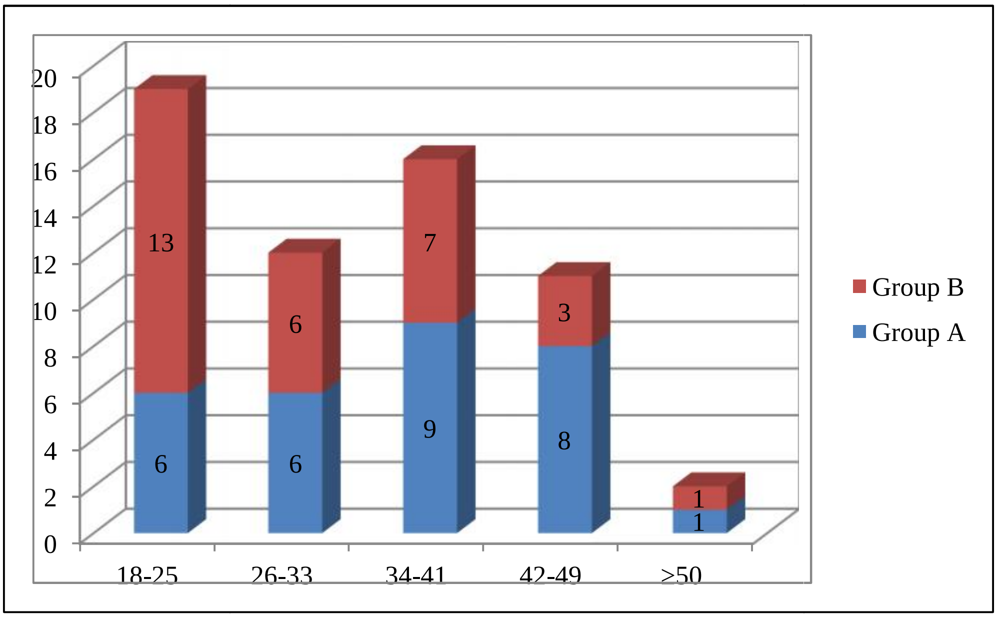


Table 9: Means age distribution according to gender in the two study groups.

Group A		Group B	
Male	33±11.1	**Male**	32.08±11.4
Female	36.16±8.76	**Female**	27.61±7.7
Overall	35.43±9.57	**Overall**	29.4±9.45

Results: The mean age of the male study subjects in both the groups are almost equal. The female study subjects in test group are much younger than the control group with mean age of 27.61±7.7 years and 36.16±8.76 years respectively.

Table 10 : Showing the values of clinical parameters in the two groups.

Variables	**Group A (Mean±SD)**	**Group B (Mean±SD**	**Calculated Unpaired t-test value**	**p value**
Mean pH of gastric aspirate during intra-operative period	1.4±0.50	2.63± 0.61	9.69	<0.00001
Mean gastric volume by gastric aspiration during intra-operative period	26.7±7.5	13.47±4.8	9.70	<0.00001
Mean Gastric volume by USG	29.7±8.0	19.2±4.9	6.07	<0.00001

Figure 12 : Comparison of mean pH between Group A and Group B

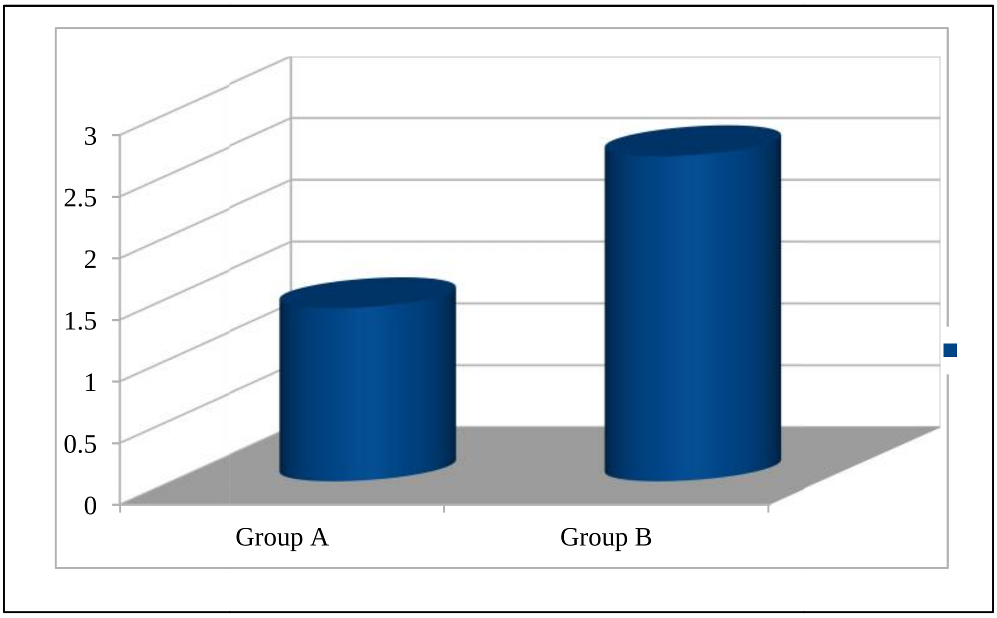
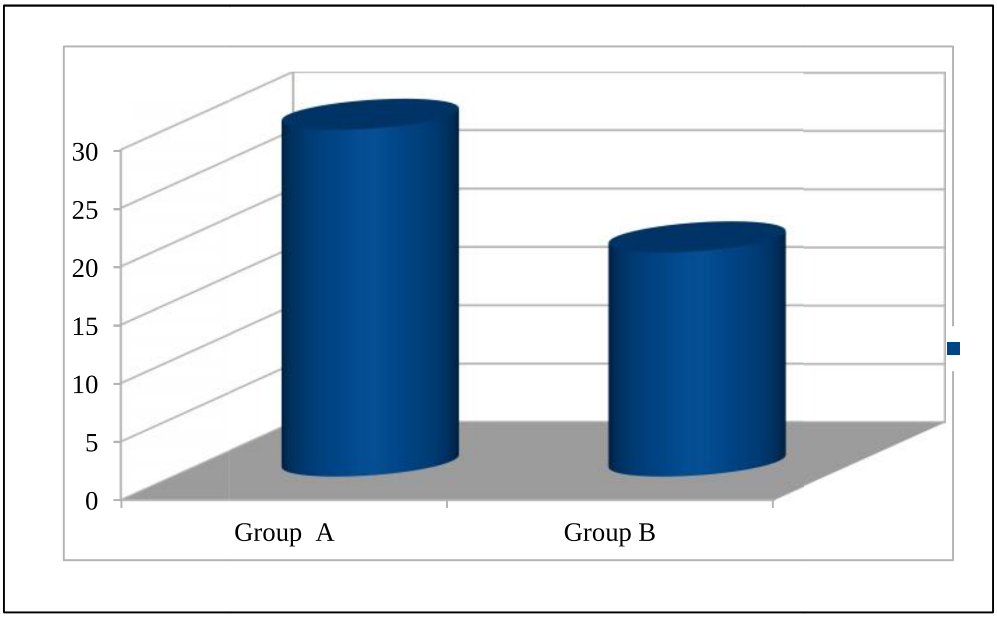


Figure 13 : Comparison of mean gastric volume by USG between Group A and Group B



Results:

The mean gastric volume by USG in group A is 29.7±8.0 ml and group B is 19.2±4.9 ml. The reduced gastreic volume in group B is statistically significant (<0.00001).

The mean pH of gastric aspirate in group A is 1.4 and group B is 2.63. Which shows that group B has a better outcome in terms of gastric pH and is statistically significant (<0.00001).

Figure 14 : Scatter diagram of gastric volume in relation to pH in group A

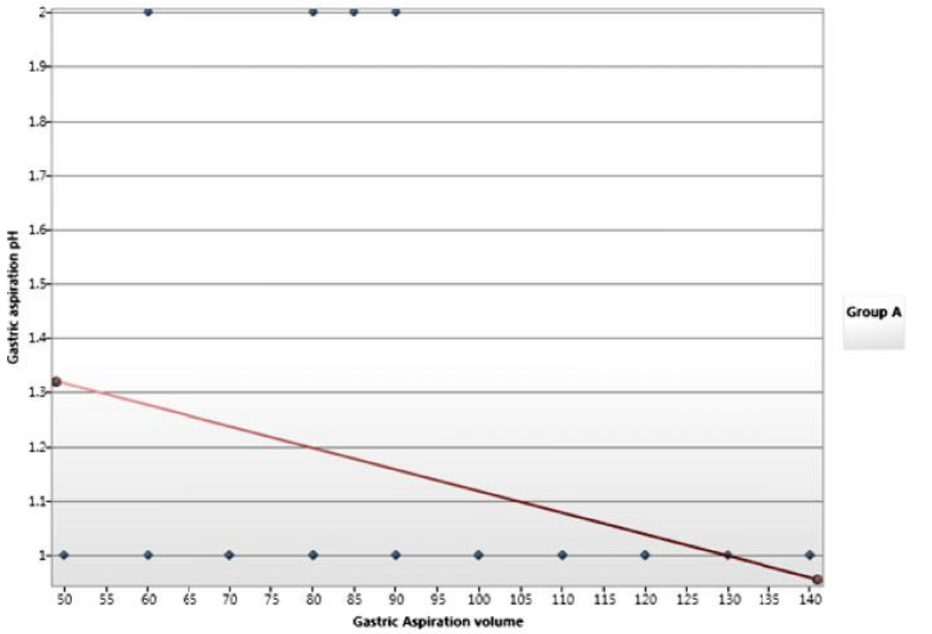
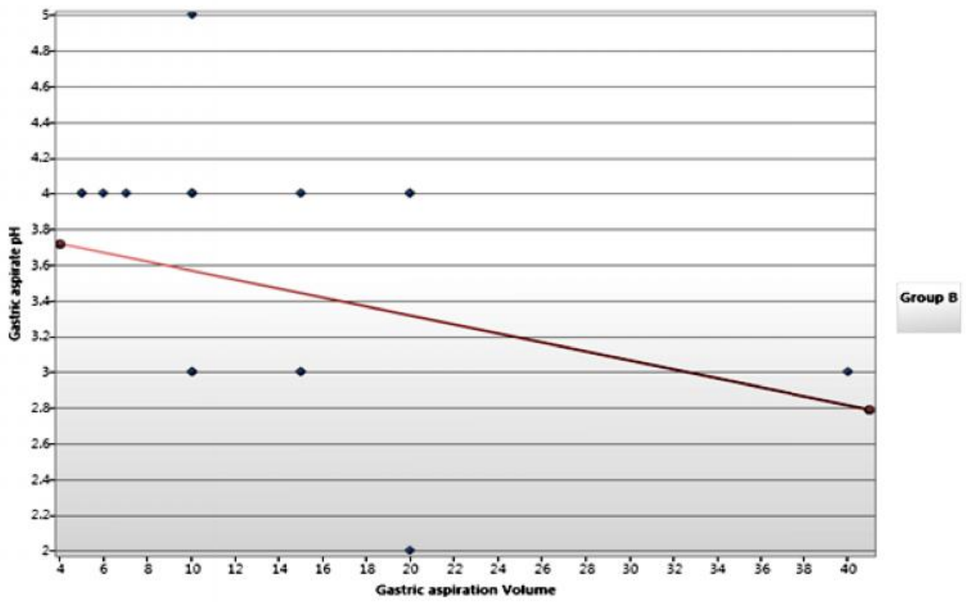


Figure 15: Scatter diagram of gastric volume in relation to pH in group B



Unpaired t test

(Null)H_o: There is no difference in pH, gastric volume between the test and control group (Alternative) H_1: There is a difference pH, gastric volume between the test and control group

Unpaired T test: two tailed test: meaning pH can be more or less so also the gastric volume. We are looking in both directions.

In unpaired test the two persons are different in age and gender. So not comparable.

Work out the mean and SD of the two groups separately and then compare.

In paired t test we only see the difference between the two groups

DISCUSSION

Fasting is considered a mandatory prequisite for elective surgery. It is widely believed that the goals of pre-operative fasting are (a) to increase gastric fluid pH and thus decrease the severity of pneumonitis should occur and (b) to decrease gastric fluid volume there by reducing the likely hood of aspiration of gastric contents[33].

The concept of empty stomach is universally followed to safeguard against vomiting, regurgitation and aspiration during anaesthesia[40]. However stomach can never be completely empty even after a midnight fast since it continues to secrete gastric fluid.

Prolonged fasting is associated with reduced gastric pH and increase in gastric volume , placing the patients at risk category for aspiration. Current guidelines[11,12] recommend clear liquids upto 2 h before surgery, which is a compromise between comfort, cooperation and hydration, on the one hand and security on the other[55.]

Gastric emptying is affected by different factors like obesity[56], gastrointestinal disorders and systemic diseases[29]. The rate of gastric emptying depends on several variables, including the volume of oral fluids[33].

Previous investigations in adults demonstrated different emptying rates for different fluids, with caloric load[57], carbonation, carbohydrate levels[58] and nutrient composition[59] a determining factor.

Various methods have been used to determine the gastric volume. Paracetamol absorption[19], electrical impedance tomography, radiolabelled diethyl polyethylene glycol dilution[19] and gastric content aspiration .Most of these are invasive methods to study gastric volume and emptying. Many of these are not applicable in perioperative period[52,60-63] .Gamma scintigraphy is a noninvasive method considered a gold standard[64,65].It has the drawbacks of cost, use of radiation, and is not a practical exam

Measurement of residual gastric volume by an aspiration technique may be criticized as underestimating the residual volume. MRI was used by Schmitz et al[38] to study the effects of different quantities of sugared clear fluids on gastric emptying and residual volume in children aged 6 - 14 years. Gastric fluid volume decreased rapidly with a median half-life of <30 min after drinking 7 ml/kg of standardized clear fluids. Body weight corrected gastric air volume (GAV_w) continued to increase until 30 -90 min post syrup in most children , but declined below initial value after 120 min ($P<0.008$).

Previous MRI studies in adults have shown the following elimination half-life : 38 min for 500 ml of glucose 10%[66], 100- 130 min for several meals and liquid nutrients[67,68], 21 min for water, 31 for non-carbonated carbohydrates, 47 for carbonated carbohydrates and 107 min for carbonated cola[69].

Previous studies have shown that pH <2.5 and volume of gastric aspirate >25 ml (0.4ml/kg) predisposes patients to pulmonary aspiration[14].

Although there are numerous studies on the safety of drinking clear liquids up to 2 h before surgery and establishment of preoperative fasting guidelines, many anesthesiologists and surgeons are still unsure of the practice. Therefore, noninvasive assessments at the bedside that could determine the volume of gastric contents in the perioperative period would be of interest to assist in assessing the risk of pulmonary aspiration. Until recently there was a lack of a non-invasive diagnostic method that could promptly assess gastric content and be applied perioperatively. Ultrasound is the first non-invasive technique that provides both quantitative and qualitatively validated information of gastric contents at bedside[20,41,70,71]. Several studies suggest that the gastric antrum is the stomach region that is more amenable to ultrasound examination[56-58].It can be identified in 98-100% of cases[20,22,50].Several mathematical models were developed for gastric volume calculation using the gastric antrum image and calculating its cross-sectional area[20,22,41].

A Perlas et al[41]. reported accurate linear model based on gastroscopic fluid assessment with a mean difference of 6 ml between the predicted and measured volumes. This study had 108 patients. It is applicable to adult , non pregnant subjects with BMI up to 40 kg/m^2. It can predict volumes up to 500 ml.

$$GV\,(ml) = 27 + 14.6 \times (Right.latCSA) - 1.28 \times Age \text{ (yr)}$$

Where GV- gastric volume,

Right.lat CSA- antral cross sectional area

In our study ultrasound was used to calculate the gastric volume with the above formula, 60 patients posted for elective surgery were examined. 30 each belonging to overnight fasting group and 30 patients after 2 hours of ingestion of 200 ml clear fluids. There were no incidence of vomiting or aspiration in both the groups.

In our study the distribution of sex were comparable in both groups with 33.3% male in group A and 40% male in group B. Age of patients were also comparable with majority of patients in age group between 26-41 years of age.

The mean gastric volume by ultrasonography in overnight fasting (group A) was 29.7± 8.0 ml , while patients who had 200 ml of clear fluid 2 hours prior (group B) had mean volume estimated by ultrasonography of 19.2± 4.9 ml which was statistically significant (p<0.00001). The mean pH measured by pH strip in group A was 1.4± 0.5 and that of group B was 2.63± 0.61. The difference in pH between the groups were statistically significant (p<0.00001).

EM Mcgrandy and AG Macdonald[26] investigated 50 patients on effect of administering water pre-operatively on gastric pH and volume. One of the group(group B) were fasted overnight , while the other group were given 100 ml of water 2 hours before surgery(group A).The median volume in group A was 16.5 ml(range:4-51.5 ml) while that of group B was 25 ml (range:0-58). Although the median volume in group A was less than group B, it was statistically insignificant. Median pH in group A 1.37 (range: 1.09-7.6) while in group B 1.36 (range: 1.12-4.0) were similar , but group A had more patients with value >2.5.

Pre-operative drinking of water and its effect on gastric volume and pH was investigated on 100 patients undergoing elective surgery by S Philips, S Hutchinson and T Davidson[27].Study group were allowed to have free clear fluids until 2 hour before surgery whereas control group fasted overnight. The mean water ingested was 388 ml in 6 hours in study group (Range: 50 – 1200ml).The mean gastric volume in study group was 21 ml(Range:0-80ml) whereas control group has mean volume of 19 ml (Range:0-63 ml).Study group had mean pH of 2.64 and control had 2.26. Residual gastric volume and pH were similar in both groups. Patients with gastric volume more than 0.4 ml/kg and pH <2.5 were similar. Ingested fluid volume did not correlate with residual gastric volume or pH. Although pH in study group was more than control group , the pH changes were insignificant statistically.

Malcolm scar and J Roger Maltby[28] studied the effect of oral fluids on residual gastric volume and acidity before elective surgery in 211 healthy patients. Patients were allowed to have 150 ml of tea or coffee or apple juice or water until 3 hours before surgery. The patients were retrospectively assigned to one of the 4 groups according to interval from last fluid ingestion until induction of anaesthesia (<3 hours, 3-4.9 hours, 5-8 hours, and nothing after midnight). The gastric volume and pH were 25 $\pm$ 21ml and 1.6 $\pm$ 1.0 in <3 hour of fluid intake , 24 $\pm$ 20ml and 1.9 $\pm$ 1.1 in 3-4.9hr , 31 $\pm$ 24 and 2.2 $\pm$ 1.7 in 5-8 hr group , 26 $\pm$ 22ml and 1.7 $\pm$ 0.7 in overnight fasting group. The differences between the group were statistically insignificant.

Effects of fasting interval on gastric volume and pH was studied by Riaz hussain[29] in 65 patients aged 15-50 years undergoing elective surgery under general anaesthesia. It was a observational study. The gastric volume in patients who fasted up to 8 hours had 27.857 $\pm$ 3.058 ml, 8.5 to 12 hours had 27.4 $\pm$ 2.98 ml, more than 12 hours had 27.470 $\pm$ 15.55 ml. The pH were 3.929 $\pm$ 0.997, 2.914 $\pm$ 0.355, and 2.848 $\pm$ 0.284 respectively in patients who had fasted up to 8 hours, 8.5-12 hours and more than 12 hours. Both the gastric volume (p=0.998) and pH(p=0.408) changes between the groups were insignificant. This study concluded that prolonged fasting had no added benefits but added to patients discomfort.

Flora margarida et al[55] used ultrasound for gastric volume evaluation after ingestion of different volumes of isotonic saline solution in 80 healthy volunteers. The volunteers were scanned 3 times. Gastric volume were estimated by scan after overnight fast, overnight fast followed by 200 ml saline or 500 ml saline after 2 hours of ingestion of liquid. The scans were graded as grade 0-antrum is empty in both supine and RLD, grade 1- Presence of liquid in RLD only, grade 2- Presence of liquid in both RLD and supine. Grade 2 suggested increased gastric volume. 81.25%, 68.75%, 71.25% were found grade 0 on scans in group fasting overnight, 200ml saline , 500ml saline respectively.5%, 13.75% and 18.75% of volunteers were found to be grade 2 in fasting, 200 ml saline and 500 ml saline group. However, this association was not statistically significant ($p = 0.07$).

The results of our study reflect better outcome with both pH and gastric volume in patients who had 200 ml clear fluids 2 hours prior surgery. This result supports the present NPO guidelines for clear fluids as 2 hour which helps in reducing the preoperative discomfort of long fasting hours and dehydration of patients

Our study has some limitations,

(1) As with all ultrasound techniques, which is dependent on the equipment quality and also the operator, the antrum is not identifiable in all patients and several steps need to be performed systematically to obtain reliable results.

(2) The present study was conducted with healthy volunteers and, thus, the results may not be extrapolated to patients with chronic diseases or taken medications that alter the digestive system motility. For such patients, the fasting recommendations should be tailored.

CONCLUSION

The mean gastric volume in patients who had 200 ml of clear fluid 2 hours prior (group B) was lesser than patients who fasted overnight (group A).

The mean pH in patients who had 200 ml of clear fluid 2 hours prior (group B) was higher than patients who fasted overnight (group A).

SUMMARY

We conducted a study to compare ultrasonography guided gastric volume in patients after overnight fasting and after ingestion of clear fluids two hours prior to surgery in 60 patients undergoing elective surgery belonging to ASA 1.

The study was conducted after obtaining Institutional ethical committee clearance & written informed consent from all the patients. Thorough pre anaesthetic evaluation was done, investigations were noted. . After having met inclusion and exclusion criteria's and having obtained informed consent, patients were randomized based on computer generated randomization table into one of the two groups.

- Group A: Patients with Overnight fasting
- Group B: Patients receiving 200 ml of clear fluids (water) 2 hours before surgery.

Gastric antral dimensions were noted and gastric volume was calculated. We observed that the age and gender distribution were comparable between the two groups. The mean gastric volume in group B was lower than group A,which was statistically significantly ($p<0.00001$) . The mean pH in group B was higher than group A and was statistically significant ($p<0.00001$).

The results of our study reflect better outcome with both pH and gastric volume in patients who had 200 ml clear fluids 2 hours prior surgery. This result supports the present NPO guidelines for clear fluids as 2 hour which helps in reducing the preoperative discomfort of long fasting hours and dehydration of patients

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ANNEXURE-I

CONSENT FOR PARTICIPATION IN RESEARCH STUDY

Mr/Mrs/Miss. ______________________________ we are requesting you to enroll yourself in **"ONE YEAR RANDOMISED CLINICAL TRIAL TO COMPARE ULTRASONOGRAPHY GUIDED GASTRIC VOLUME IN PATIENTS AFTER OVERNIGHT FASTING AND AFTER INGESTION OF CLEAR FLUIDS TWO HOURS PRIOR TO SURGERY"** conducted J.N. Medical College, Belagavi under KLE university, Belagavi.

Respected Sir/Madam we request you to enroll yourself to participate in our study as you are eligible for participating in the study. During the study you will be asked some questions regarding your present complaint and you are supposed to answer to the best of your knowledge.

The purpose of research is to compare the gastric volume and pH of gastric contents in patients who have fasted overnight and who are allowed to have clear fluids till 2 hours before surgery.

Procedure Involved:

- If you agree to enroll yourself in my study, you will be allocated to one of the two groups (1 or 2) randomly , as per a computer generated randomization chart. You will be interviewed regarding your present, past and family history. Then you will be clinically examined in detail and investigated accordingly . According to the group which you belong to you will be asked to either fast overnight or take 200 ml of clear fluids(water) 2 hours before surgery.

Preoperatively intravenous (IV) line will be secured with either 18 G or 20 G branula and IV fluid will be started at 5 ml/kg/hr.Then you will be positioned in right-lateral position and using ultrasonography probe 3-5 Mhz, the gastric antrum is visualized by placing the probe in saggital plane which will be round to ovoid and has been compared with a ‘target’ or ‘bulls eye’ pattern

Then antral CSA is measured by using two perpendicular diameters and the formula of the area of an ellipse : CSA = (AP×CC×π)/4

AP= ANTERO-POSTERIOR DIAMETER (in cm)

CC= CRANIOCAUDAL DIAMETER (in cm)

And Gastric volume is calculated using the formula

Gv(ml) = 27+14.6×rt-latCSA (in cm^2)-1.28×age(years) .

Then you will be shifted to the operation theater and monitors like electrocardiograph (ECG), pulse oximeter and non-invasive blood pressure will be attached and baseline readings taken. The you will be anaesthetised and Ryles tube will be inserted and Gastric aspirate will be obtained .The volume of aspirate was noted and pH measured using a standardized pH strip

Benefits and Risks

The benefits of taking part in this research are that we can avoid long duration of nil per oral without risk of aspiration. The risks are minimal which include discomfort in the throat due to nasogastric tube insertion. There are no observable risks associated with the study.

Voluntary participation / Withdrawal

Taking part in the study is voluntary; you may choose not to enroll in this study. Your decision will not change present or future health care services offered to you at Dr. Prabhakar Kore Hospital.

Alternatives

Even if you decline the participation in the study, you will get the routine line of management with General anaesthesia.

Confidentiality

All information collected about you during the course of the study will be kept Confidential. The code numbers will identify you in this Study records and the information from this study may be published but your identity will be confidential in any publication. The only people to know that you are a research subject are members of the research team. No information about you or information provided by you during the research will be disclosed to other without your written permission except:

1. In emergency to protect your rights and welfare.
2. If required by law.

Authorization to Publish Results:

When the results of the research are published or discussed, in a conference, no information will be displayed that would disclose your identity. Any information that is obtained in connection with this study and that can be identified with you will remain confidential.

Financial Incentives for participation

No financial incentives are being offered to enrolled patients. It is purely being done with the idea of research and all the cost of the study will be borne by the investigator.

Compensation

In the event of injury, related to the study, treatment will be made available at Dr. Prabhakar Kore Hospital and MRC, Belgaum. No reimbursement, compensation or free medical care will be given by law.

Queries/ Contact details

If you have any queries about your rights as a study subject, you may call Dr. Ganga Pilli, Professor, Dept. of Pathology as Chairman of J. N. Medical College Institutional Ethics Committee on Human Subjects Research, Phone No. 9480275601 at J. N. Medical College, Belgaum

CONSENT FOR PARTICIPATION IN RESEARCH TRIAL

I, ______________________________ voluntarily agree for the participation as a subject of study. By signing this consent form I am not giving up any of my legal rights, I may withdraw from the study anytime. I am signing the consent form after having read or been read form in vernacular language, including the risks and the benefits and having all my questions answered.

Subject Name : _____________________

Signature or the Left Thumb Print of Subject : ________________________

Date: ______________

Witness Name : ________________ Signature: _______________

Date:

Investigators Name:_________________ Signature:_______________ Date:

Place : _______________

ANNEXURE-II

PROFORMA

"ONE YEAR RANDOMISED CLINICAL TRIAL TO COMPARE ULTRASONOGRAPHY GUIDED GASTRIC VOLUME IN PATIENTS AFTER OVERNIGHT FASTING AND AFTER INGESTION OF CLEAR FLUIDS TWO HOURS PRIOR TO SURGERY"

Patient Name: IP No.:

Age: Gender: Female/male

Height: cms Weight: kgs.

Date of Operation:

Occupation:

Address: Anaesthesiologist:

Preanesthetic Evaluation:

1. Chief Complaints:

2. Past History: HTN / DM / Asthma / Epilepsy / Rx allergy/Other relevant history

3. Treatment / Drug intake history :

4. History of previous surgeries and anaesthetic exposure

5. Family history

General physical examination

Pallor / Icterus / Clubbing / Cyanosis / Lymphadenopathy / Edema

Pulse Rate : BP :

Respiratory Rate : Temperature :

Systemic Examination

RS :

CNS :

CVS :

Abdomen :

Airway examination :

Jaw movements Teeth:

Airway assessment: Spine:

Investigations

Hb : Total Leukocyte Count :

Platelet count : Serum Urea :

Serum.Creatinine: RBS:

ECG : Chest X-Ray:

Urine R/M : Others :

ASA GRADE: I II III IV V E

Diagnosis :

Proposed Surgery:

Preoperative baseline values :

Pulse: BP:

Monitors attached :

Pulse oximetry:

NIBP :

ECG :

Preoperative parameters :

ANTERO-POSTERIOR DIAMETER (in cm)	CRANIOCAUDAL DIAMETER (in cm)	**GASTRIC VOLUME(ml)** GV = 27+14.6×rt-latCSA (in cm^2)-1.28×age(years)

Intra operative parameters :

Volume of gastric aspirate (by ryle's tube in ml)	
pH of gastric contents	

Intraoperative vital parameters:

TIME	HEART RATE	BP	SPO_2

Side effects :

ANNEXURE III - PHOTOGRAPHS

Photo 1: Ultrasound machine

Photo 2: Ultrasound transducer

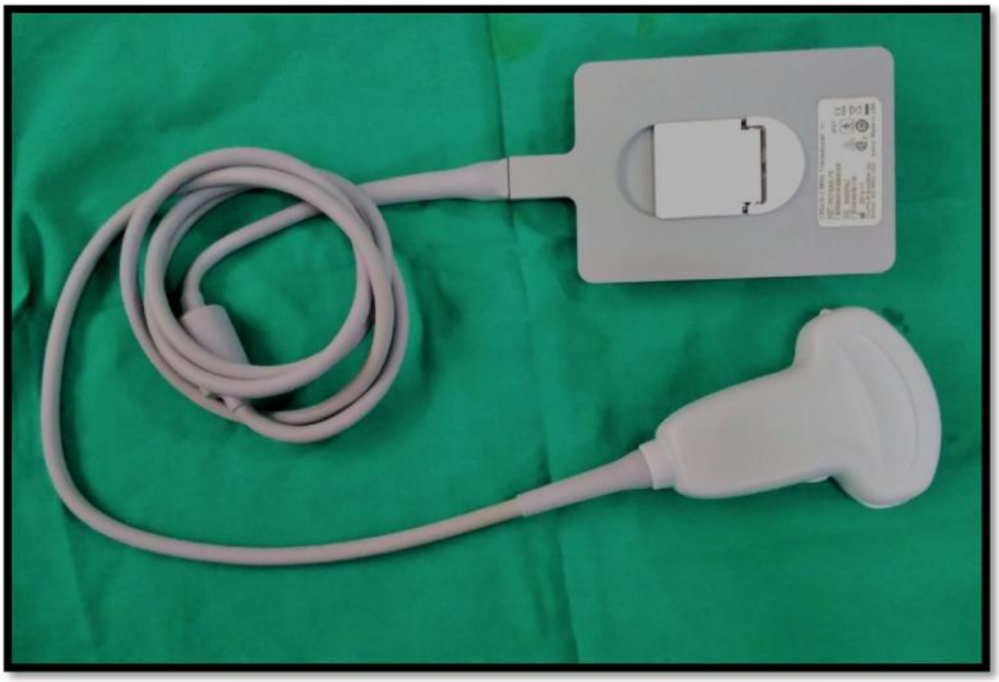

Photo 3: Sonoanatomy of stomach showing gastric antrum(A), liver(L), Pylorus(P), Superior mesenteric artery(SMA)

Photo 4: Position of transducer for imaging

Photo 5: pH strips

ANNEXURE-IV - MASTER CHART

GROUP A (OERNIGHT FASTING)								
SI NO.	NAME	AGE	SEX	IP NO.	WEIGHT	GASTRIC VOLUME		pH
						USG	ASPIRATE	
1	SANTOSH TERDALE	31	M	713730	66	28	24	2
2	JAYASHREE	34	F	713930	52	32	30	2
3	JYOTHI BADIGER	23	F	727802	52	26	24	2
4	SWAPNIL	19	M	702652	65	29	27	1
5	KASHINATH	36	M	721804	62	35	30	1
6	LAXMAN	33	M	716267	56	24	22	2
7	SANTOSH	31	M	727820	58	22	20	2
8	MAHADEVI	30	F	729959	65	28	26	1
9	SHENAZ	30	F	724624	51	66	60	1
10	SUSHILAVVA	45	F	726177	56	29	28	1
11	VIDYA MELAGE	30	F	727820	52	26	25	1
12	GOURAVVA	21	F	735599	45	27	20	2
13	RAJU	40	M	734489	58	29	25	2
14	ARŪN TORGAL	40	M	735863	62	33	30	1
15	BALAPPA	19	M	758843	55	44	40	1
16	RAGHUNATH	25	M	763813	59	24	22	2
17	MAYA	46	F	763840	55	26	25	1
18	SUSHMA	46	F	762766	60	27	20	2
19	SŪMAN PATIL	45	F	764566	56	28	26	1
20	BALAPPA	56	M	765513	55	28	24	2
21	LAXMI KATKAR	39	F	768264	54	28	25	1
22	MADAVI KOLI	38	F	768147	60	27	26	1
23	BASAA KAMBLE	45	F	771299	53	26	24	1
24	CHANAMMA KULKARNI	45	F	771889	55	22	20	2
25	LAXMI KATKAR	39	F	768264	50	28	27	1
26	TAIMINA MARUF	40	F	774277	68	29	25	1
27	MAHADEVI KANDAGAVE	42	F	773633	60	33	30	1
28	VIDYA	18	F	774624	50	30	28	1
29	UMA RAJESH GHASTI	43	F	776757	68	28	24	2
30	ARUDHA KANTEPPA AMAÑI	34	F	776757	62	29	25	1

GROUP B (CLEAR FLUIDS TILL 2 HOURS PRIOR SURGERY)								
SI NO.	NAME	AGE	SEX	IP NO.	WEIGHT	GASTRIC VOLUME		pH
						USG	ASPIRATE	
1	PARASHURAM	28	M	717539	65	18	15	3
2	OMANA PATIL	36	F	718367	59	16	10	3
3	ISAK SHEIK	26	F	715116	50	17	10	3
4	NITHIN LOHAR	22	M	730441	65	8	5	4
5	MANSÛRA	35	F	721760	52	9	5	3
6	HARISH	21	M	724268	62	19	10	2
7	PADMA PATIL	25	F	723488	59	25	20	1
8	SUSHANT	18	M	727954	56	17	10	2
9	ASMITA	30	F	735227	56	13	7	3
10	SUNITA PATIL	40	F	736248	56	17	13	3
11	MARUTI RAMNING	46	M	750957	59	30	26	2
12	MAHAVEER	50	M	763226	55	26	15	2
13	GURULINGAWWA	24	F	770580	50	19	10	3
14	SHILPA PATTANKUDE	20	F	770256	58	20	15	2
15	SABA	18	F	764455	52	18	12	3
16	SANVAKA KULLI	43	F	766119	50	20	15	3
17	GANGAWWA	18	F	768120	49	22	18	3
18	BASAPPA	45	M	767701	60	20	10	3
19	GEETA TOLAKE	32	F	768573	60	20	14	3
20	POOJA NAIK	25	F	769867	61	22	15	2
21	RUDRAVVA	35	F	771634	56	19	15	2
22	RAJNEET	26	M	771834	60	15	12	3
23	SURESH ASODE	36	M	772236	70	16	14	3
24	SANTOSH	37	M	773246	66	20	16	2
25	IBRAHIM MULLA	38	M	771642	80	28	24	2
26	LAXMI ANTARGATTI	19	F	772333	49	19	12	3
27	SHAILESH	18	M	772867	66	16	10	3
28	ASHWINI	20	F	774651	61	23	20	2
29	RAJESHRI GADIKAR	28	F	774770	58	28	14	3
30	GAURAVVA	23	F	775260	56	17	12	3

ANNEXURE-V

KEY TO MASTER CHART

SI No	Serial number
IP NO.	In patient number
USG	Ultrasonography