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ASSESSMENT OF GASTRIC AND GALLBLADDER EMPTYING IN SCHISTOSOMAL PATIENTS BEFORE AND AFTER HASSAB'S DEVASCULARIZATION OPERATION.

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Objectives: *Gastric and gallbladder (GB) dysmotility were documented in liver cirrhotic, but the effect of surgery for bleeding gastro-esophageal varices on motility still not clear. This study assessed the effect of Hassab's gastro-esophageal devascularization (GED) operation on gastric and GB motility in schistosomal patients.*
Patients & methods: *Thirty schistosomal patients with bleeding varices, who underwent GED operation, were subjected to gastric and GB motility study using ultrasonography, before and after surgery. The results were compared to each other and fifteen matching controls.*
Results: *Schistosomal patients had significantly impaired gastric emptying for semisolids, measured by gastric emptying (%) at 30 minutes, and GB emptying, measured by ejection fraction (%), compared to controls (64.67±12.98% Vs. 74.89±12.78%, P=0.016) and (44.47±10.57% Vs. 52.98±8.94%, P=0.011) respectively. Following surgery both gastric and GB emptying were significantly reduced compared to pre-operative values (54.29±14.45% Vs. 64.67±12.98%, P=0.004) and (38.95±9.47% Vs. 44.47±10.57%, P=0.007) respectively. Multivariate analysis revealed that preoperative gastric emptying, Child's grad and variceal grad were the independent predictive factors influencing postoperative gastric emptying, while no factor was identified to influences postoperative GB emptying.*
Conclusion: *Schistosomal patients had impaired gastric and gallbladder emptying which became worth after GED operation. Prophylactic measures had to be taken to improve outcome.*

Keywords: *Schistosomiasis, Non-shunt surgery, Gastrointestinal dysmotility, Portal hypertension.*

INTRODUCTION

Patients with chronic liver diseases had a high prevalence of gallstones than healthy subjects, and the prevalence increase with the progression of the liver disease. Impaired gallbladder emptying in cirrhotic patients with billiary stasis was suggested as contributor to the increased incidence of gallstones.(1,2)

Recent studies have shown that gastric emptying significantly delayed in patients with liver cirrhosis with portal hypertension than controls. This delay in the gastric emptying may produce gastrointestinal symptoms.(3,4)

Although scintigraphy is considered the standard method for measurement of gastric and gallbladder emptying, however, it requires expensive equipment and is not free from radiation burden. Ultrasonography, which is a non-invasive method, had been used for study of gallbladder

emptying by measuring its ejection fraction, as well as, gastric emptying by measurement of the change in the antral cross sectional area, for many years, with comparable efficacy as scintigraphy.(5,6)

In spite of the fact that patients with liver cirrhosis, specially those with esophageal varices, had gastric and gallbladder dysmotility,(4) to date, the effect of surgical operations for bleeding varices (shunt or non-shunt surgery) on both gallbladder and gastric motility is not clear.

This study was conducted to assess the gastric and gallbladder motility, in schistosomal patients with bleeding varices before and after gastro-esophageal devascularization (GED) non-shunt operation, described by

Hassab,[7] using ultrasonography.

PATIENTS AND METHODS

Patients Selection

The study included 30 patients with chronic liver disease due to schistosomal hepatic fibrosis, admitted to the Surgical Department, Alexandria Main University Hospital. Including criteria were; 1) History of schistosomiasis or positive schistosomal serology, 2) History of bleeding gastro-esophageal varices, 3) Good liver condition i.e. Child-Pugh's class A and B, 4) No history of previous surgical or endoscopic interventions, 5) Availability for follow-up for at least 6 months after surgery.

Fifteen hospitalized patients matching with patients as regards; the age and sex, non-diabetic and without gastrointestinal or liver diseases were the control group for assessment of the normal motility pattern. The study design was approved by the Scientific and Ethical Board of Alexandria Faculty of Medicine. Informed consent was obtained from each subject before any examination or surgical intervention.

Preoperative Assessment

The diagnosis of schistosomal hepatic fibrosis was made by preoperative serology and confirmed by histopathological examination of the operative wedge liver biopsy. Preoperative clinical and laboratory assessment (including hepatitis markers) was done and patients were graded according to Child-Pugh's classification. Preoperative upper gastrointestinal endoscopy was performed to assess the presence of gastro-esophageal varices; its site, size, grad and presence of risk signs.

Ultrasonographic Motility Assessment

Gastric and gallbladder motility studies were done simultaneously using the same ultrasound device (Sonaline Sienna ultrasound machine, Siemens), and were performed by the same operator. Gastric emptying was evaluated according to Bolondi et al,[8] by measuring the change in the gastric antral surface area (AA) in a sagittal plane through the aortico-superior mesenteric vein plane. The gallbladder emptying was assessed according to Doods et al,[9] by measuring the post-prandial change in the gallbladder volume and calculation of the gall bladder ejection fraction (EF).

The study began in the morning, with the subjects fasted over night. Any medications that might influence gastro-intestinal motility were prohibited for 24 hours before the study, and smoking was stopped on the morning. Patients were instructed to assume the upright position between the measuring periods.

After measuring the fasting gallbladder volume and fasting gastric antral area, subjects were requested to drink a liquid fatty formula, formed of one glass (450ml) of full cream milk mixed with 60ml corn oil, to distend the gastric antrum and stimulate gallbladder contraction. The patient was instructed to drink the test meal over 5 minutes.

Assessment of Gallbladder Motility

The fasting gallbladder volume (FV), in both patients and controls, was assessed first with the subject in the supine position. The gallbladder was scanned in tow perpendicular views; sagittal and transverse. The gallbladder volume was measured by the elliptical method,[9] where the volume = 0.52 X length X width X depth of the gallbladder (Figure 1A). The volume was calculated automatically using the built-in caliper and calculation program of the ultrasound machine. The gallbladder residual volume (RV) was measured in the same way at the end of the study i.e. 45 minutes following drinking of the test meal (Figure 1B). The gallbladder motility was measured by calculation of the ejection fraction (EF), from the formula:

EF = (1 - RV / FV) X 100%.

Assessment of Gastric Motility

After measuring FV, the subject was positioned in the sitting position with backward tilt. The fasting gastric antral surface area (FAA) was measured from the inside wall of the stomach (the anterio-posterior and lateral to lateral dimensions), by taking a sagittal scan through the aortico-superior mesenteric vein plane, during the period of gastric relaxation (Figure 2A). The surface area was also automatically calculated. Immediately after finishing the test meal (time 0), the maximum antral area (MAA) was measured in the same way (Figure 2B). The antral area was then measured every 10 minute till 30 minute (AA 30), which was the end point of the study of gastric emptying (Figure 2C). The gastric emptying rate in relation to the time is calculated from the formula:

Gastric emptying percent at 30 minute = MAA - AA30 / MAA - FAA X 100%.

Pre and Postoperative Symptomatic Assessment

Patients were assessed for symptoms of GB disease, GERD, gastric stasis (damping) and other gastrointestinal manifestation. Pre and postoperative symptoms were scored according to the following score.[10]

0 = Asymptomatic patients.
1 = Postprandial fullness.
2 = Gallbladder dyspepsia.
3 = Infrequent vomiting (once per week).
4 = Repeated vomiting (> once per week), bilious

vomiting or epigastric pain.

Operative Technique

Gastro-esophageal devascularization (GED) non-shunt operation as described by Hassab[7] was done by on of the senior staff. Excision of hepatic wedge biopsy was done for histopathological examination. Care was taken during esophageal devascularization to identify and protect the main vagal trunks and their large and small branches. Also, during lesser curve devascularization and coronary vein ligation, care was taken to protect vagal branches as the coeliac, hepatic, pyloric branches and nerve of Latarjet to minimize gastric and GB de-enervation.

Postoperative Follow-up

Patients were followed up for; 1) Morbidity and mortality, 2) Change in gastric and GB motility at least six months after surgery, 3) Symptomatic outcome of surgery, assessed by the symptomatic score.

Statistical analysis

Data was presented as the mean and standard deviation. Statistical analysis of the collected data was implemented using SPSS (statistical package for social science, V. 11.5). Independent-samples T-test and paired-samples T-test were used for continuous comparisons. Pearson's Chi-square test was used for categorical comparisons. Statistical significance was at the level 0.05.

The mean minus two standard deviation of the EF of controls was considered as the cut off point of the least GB emptying (representing 95% of the studied population). Patients below this figure were considered to have abnormal GB emptying. The same principle was applied to calculate the cut off point of the least gastric emptying.

Multivariate analysis was done using leaner regression model; to identify the independent predicative factors that might influence the dependent factors i.e. GB and gastric emptying.

RESULTS

Out of 44 patients underwent Hassab's GED operation since Mars 2001 till Mars 2003, 30 patients were available for follow up 6-13 months (mean: 9.15 ± 2.45 months). Both patients and controls were matching as regards the mean age (37.8 ± 8.3 years Vs. 41.5 ± 9.6 years) (t=-1.308, P=0.198). Twenty-two patients (73.3%) were males, while out of the 15 controls, thirteen (86.7%) were males. There was no significant difference in the sex among the two groups (X^2=1.029, p=0.269).

Preoperative endoscopy revealed that all patients had esophageal varices grad II (33.3%), III (50%) and IV (16.75) with risk singes. While, eighteen patients (60%) had varying degree of gastropathy, four (13.3%) had gastric varices as well, but non had peptic ulcer. According to the preparative clinical assessment and laboratory work-up, sixteen patients (53.3%) were Child-Pugh's class (A), while fourteen (46.7%) were class (B). All patients were proved to have schistosomal hepatic fibrosis; 19 patients (63.3%) had pure fibrosis and 11 patients (36.7%) had post-hepatitic cirrhosis as well, by histopathological examination of liver biopsies.

Postoperative Morbidity and mortality

No hospital moralities were encountered. Two patients develop secondary hemorrhage and were successfully controlled surgically. Three patients developed moderate to sever chest infection, while five developed wound infection.

Out of the forty four patients, seven died from varicel bleeding and liver failure. Rebreeding developed in eight patients, two developed incisonl hernia and ascitis in three.

Symptomatic Assessment

The mean symptomatic score of patients was significantly higher postoperatively compared to preoperative value (1.57±0.977 Vs. 0.97±0.1.033) (t=-3.525, p=0.001). Moreover, the postoperative symptomatic score was significant higher compared to controls (0.78±0.802) (t=2.616, p=0.012). On the contrary, the preoperative score was comparable to controls (t=0.578, p=0.567).

Preoperative Motility Study

Preoperative ultrasound examination revealed patients had a significantly thicker wall gallbladder compared to controls (2.78±0.87cm Vs 1.49±0.54cm, t=5.265, p=0.000). Preoperative GB motility study revealed a significantly larger mean FV (fasting hypotonia) and RV (postprandial hypotonia) in patients compared to controls. Subsequently, gallbladder emptying, as measured by EF, was significantly lower in patients (Table 1).

As well, preoperative gastric emptying study revealed a significantly larger FAA (fasting hypotonia) and AA30 (postprandial hypotonia) in patients compared to controls, while MAA showed insignificant difference. Subsequently, the gastric emptying rate at 30 minutes was significantly lower in patients compared to controls Table 1.

Postoperative Motility study

Comparing the GB motility parameters in patients before and after surgery, the mean FV and RV were significantly larger postoperatively (postoperative hypotonia). Subsequently GB emptying, as measured EF, was significantly lower following surgery Table 2.

On comparing the gastric emptying parameters, there was no significant change in FAA, while MAA and AA30 were significantly larger after surgery (posoperative hypotonia). The gastric emptying rate (%) at 30 minutes showed a significant reduction after surgery (Table 2). Moreover, all gastric and GB motility parameters were significantly lower than controls (Table 3).

Considering the cut-off point of normal GB emptying as mean - 2SD of EF%, the calculated value was =52.98-(2X8.94)= 52.98-17.88=35.1%. According to this value non of the controls had impaired emptying. However, four patients (13.3%) before surgery and nine patients (30%) after surgery had impaired GB emptying (Fig. 3A). Still, there was insignificant difference in the number of patients with GB dysmotility before or after surgery (X^2=2.54, p=0.105).

Considering the cut-off point of normal gastric emptying as mean - 2SD of gastric emptying rate (%) at 30 minutes of controls, the calculated value was =75.35-(2X10.07)= 75.35-20.14=55.21%. according to this value non of the controls had impaired emptying. However, four patients (13.3%) before surgery and 13 patients (43.3%) after surgery had impaired gastric emptying (figure 3B). There was a significantly higher number of patients with impaired gastric emptying postoperatively (X^2=6.24, p=0.013).

Multivariate analysis was done using leaner regression model, to identify the independent predictive factors that might affect GB emptying. The tested independent factors were: age, preoperative EF, liver pathology, Child's grad, variceal grad, gastropathy and GB wall thickness. Non of the tested parameters had significant effect on postoperative GB emptying (F=0.245, p=0.968). Using similar model with similar parameters for gastric emptying (except preoperative gastric empting), preoperative gastric emptying (p=0.028), Child's grad (p=0.008) and variceal grad (p=0.000) were the independent predictive factors that influence postoperative gastric emptying.

Table 1. Gall bladder and gastric motility parameters in patients and controls before surgery.

Motility parameters	Controls (n=15)	Patients (n=30)	t	p
1. G.B.:				
• FV (ml)	26.86±.6.12 (12.3-48.8)	32.76±8.47 (21-54.8)	2.15	0.038
• RV (ml)	12.73±4.75 (6.5-21.5)	18.44±7.43 (9.2-39.2)	2.71	0.010
• RF (%)	52.98±8.94 (37-91.6)	43.93±9.88 (16.3-63.6)	2.67	0.005
2. Gastric:				
• FAA(ml)	3.8±0.91 (2.4-5.5)	4.76±1.46 (2.2-8)	2.222	0.032
• MAA(ml)	15.21±2.49 (11.6-19.2)	16.41±2.47 (11.5-21.5)	1.451	0.131
• AA30 (ml)	6.37±1.66 (3.9-9.3)	8.53± 2.19 (4.6-13.2)	3.355	0.002
• G.E.30 (%)	77.35±10.7 (59.8-91.6)	67.75±11.18 (45-88.9)	2.986	0.005

FV=Fasting volume RV=Residual volume
EF=Ejection fraction FAA = Fasting Antral area.
MAA= Maximum Antral area. AA30= Antral area after 30 min.
G.E.30 (%) = Gastric emptying rate at 30 min.

Table 2. Gall bladder and gastric motility parameters in patients before and after surgery.

Motility Parameters	Preoperative (n=30)	Postoperative (n=30)	Paired-t	p
1. G.B.:				
• FV (ml)	32.76±8.47 (21-54.8)	38.94±10.92 (22-58)	-4.234	0.000
• RV (ml)	18.44±7.43 (9.2-39.2)	23.39±7.46 (12.5-23.4)	-5.766	0.000
• EF (%)	43.93±9.88 (16.3-63.6)	38.88±9.95 (18.2-56.7)	3.326	0.002
2. Gastric:				
• FAA (ml)	4.76±1.46 (2.2-8)	5.09±1.18 (2.8-8)	-1.644	0.111
• MAA (ml)	16.41±2.47 (11.5-21.5)	17.65±2.54 (12.6-23.5)	-2.548	0.016
• AA30 (ml)	8.53± 2.19 (4.6-13.2)	10.42±1.54 (7.9-14.2)	-3.336	0.002
• G.E.30 (%)	67.75±11.18 (45-88.9)	56.76±9.89 (40-82)	4.794	0.000

FV=Fasting volume RV=Residual volume
EF=Ejection fraction FAA=Fasting Antral area.
MAA= Maximum Antral area. AA30= Antral area after 30 minutes.
G.E.30 (%)= Gastric emptying rate at 30 minutes

Table 3. Gall bladder and gastric motility parameters in patients and controls after surgery.

Motility parameters	Controls (n=15)	Patients (n=30)	t	P
1. G.B.:				
• FV (ml)	26.86±.6.12 (12.3-48.8)	38.94±10.92 (22-58)	3.86	0.001
• RV (ml)	12.73±4.75 (6.5-21.5)	23.39±7.46 (12.5-23.4)	5.03	0.000
• RF (%)	52.98±8.94 (37-91.6)	38.88±9.95 (18.2-56.7)	-4.78	0.000
2. Gastric:				
• FAA(ml)	3.8±0.91 (2.4-5.5)	5.09±1.18 (2.2-8)	3.58	0.001
• MAA(ml)	15.21±2.49 (11.6-19.2)	17.65±2.54 (12.6-23.5)	3.06	0.004
• AA30 (ml)	6.37±1.66 (93.9-9.3)	10.42±1.54 (7.9-14.2)	8.09	0.000
• G.E.30 (%)	77.35±10.7 (59.8-91.6)	56.76±9.89 (40-82)	-6.54	0.000

FV=Fasting volume RV=Residual volume
EF=Ejection fraction FAA = Fasting Antral area.
MAA= Maximum Antral area. AA30= Antral area after 30 minutes.
G.E.30 (%)= Gastric emptying rate at 30 minutes

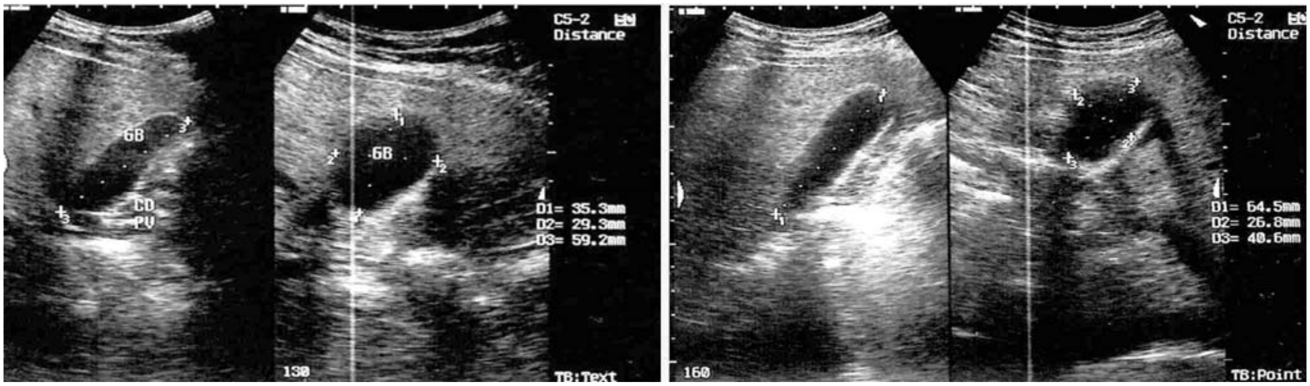


Figure 1. Utrasonogram of the gall bladder in two perpendicular plans (A: sagittal and B: transverse) for a patients after surgery, showing inadequate contraction (EF=14.5 %)

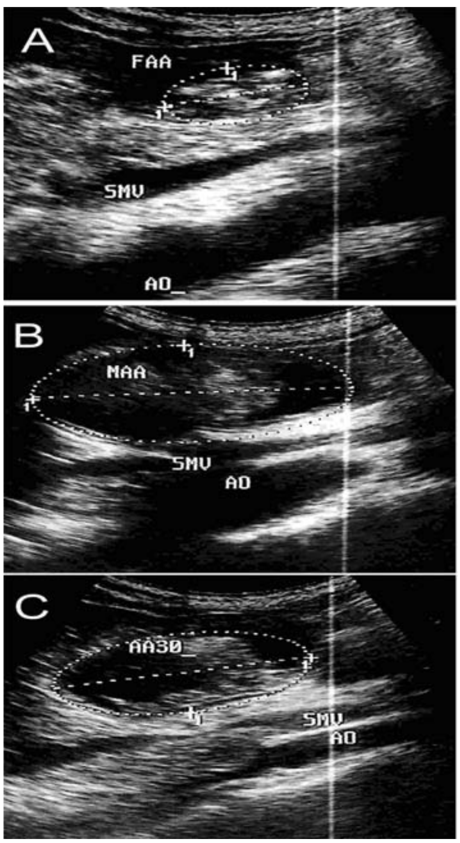
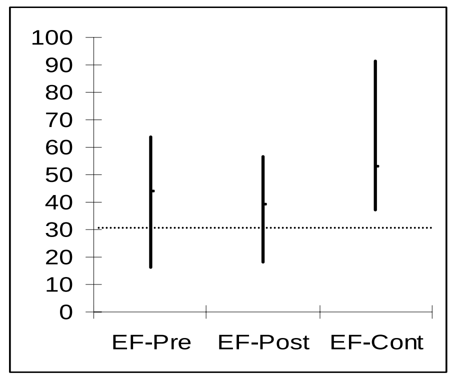
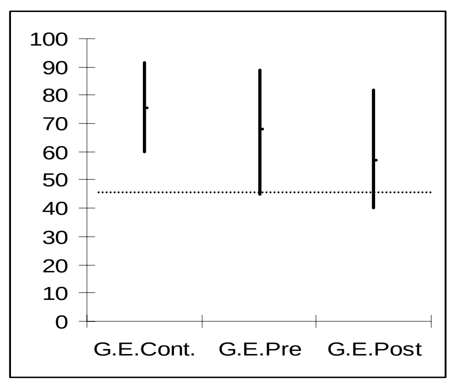


Figure 2. (A) Sagittal epigastric scan over the aortico-superior mesenteric vein plan, showing the fasting gastric antral area (FAA) equals 2.6 cm. (B) same scan of the same patient, showing the maximum gastric antral area (MAA), equals 15.7cm. (C): Same scan of the same patient, showing the gastric antral area after 30 minute (AA 30) equals 11.7cm, with evident delayed emptying.



(A)



(B)

Figuer 3. Chart showing the pattern of galbladder (A) and gastric (B) empyting, with the dotted line represents the cut off point of normal empyting.
- EF-Pre=Preoperative EF. - EF-Post=Postoperative EF.
- EF-Cont=EF of controls.
- G.E.Cont=Gastric empyting of controls.
- G.E.Pre=Preoperative gastric empyting.
- G.E.Post=postoperative gastric empyting.

DISCUSSION

Although the best known method for the study of gastric emptying is scintigraphy,[11] Ultrasonogyh emerged as a new diagnostic tool for assessment of gastric motility. The technique is simple, reproducible, reliable, and devoid of radiation exposure, also, it allows for the simultaneous evaluation of gallbladder and gastric emptying. Ultrasonography has been increasingly used for the measurement of gastric motility, including gastric emptying. Different studies, using various test meals, reported very good correlation between both techniques.[9] Indeed, gastric and GB emptying had recently been studied mostly by ultrasound.[4,6,10]

Ultrasonographic measurement of antral cross-sectional area provides a valid alternative to scintigraphy for the measurement of gastric emptying.[11] Improved technology and new systems have expanded the possibilities of using ultrasound in clinical gastroenterology. Using the modern modalities, the examinations provided new information about contractions, distension, co-ordination of movements and flow.[12,13]

In the present study ultrasonography was used, as it allowed simultaneous evaluation of gallbladder and gastric emptying. The method was simple, with short learning curve. Also, carries a good patient compliance and not time consuming. Moreover, it is accurate and avoids the use of radioactive materials, which need special license.

Impaired GB emptying in cirrhotic patients had been documented, however, the mechanism is not clear.[1,2] Ali QM and colleges[14] studied 22 patients with portal hypertension due to advanced schistosoma mansoni infection. The gallbladder wall was grossly thickened, with reduction of gallbladder FV and EF, a similar result was obtained by the present study. They suggested that the significantly distended GB with large FV might indicate GB hypotonia or presence of non-bacterial inflammation of GB. Also, the impaired contraction with subsequent low EF, in spite of the small RV might be the consequence of either defective release of CCK or diminished GB response to CCK at the receptor site. Also, increased concentrations of GB relaxing peptides can result in early GB refilling observed in liver cirrhosis, before complete GB emptying, keeping GB nearly always distended.[15]

Delayed gastric emptying is considered as a fact in patients with liver cirrhosis,[4,7,14] and was confirmed in this study, although few reports showed accelerated gastric emptying in cirrhotic patients with oesophageal varices[16,17]. It is now proved that antral distention is the only neural stimulus known to increase gastric emptying.[18]

Another factor that control gastric emptying in cirrhotic and been suggested by Dumitruscus and colleges[19]. They suggested that the physical and chemical characteristics of the meal are the major determent of gastric emptying and may account for the large divergence of results. They documented that patients with liver disease and portal hypertension demonstrated delayed emptying of both the liquid and semisolid components of the meal. They reached the same results, as in the present study, that both patients and controls showed insignificant difference in the maximum postprandial antral distention (MAA). As antral distention is the only neural stimulus known to increase gastric emptying,[18] the significantly larger FAA (fasting hypotonia) may be a factor in delayed gastric emptying with normal antral distention.

The wide variation in the results and discrepancy in gastric emptying in cirrhotic patients, may be explained by the different methodology, type of patients, liver condition, degree of portal hypertension and its sequel and the type of meal whether liquid, semisolid or solid. We documented that the extent of the live disease and degree of oesophageal varices are indirect predictors to delayed gastric empting.

In the present study, Hassab's GED operation was associated with increased number of patients with GB and gastric stasis. Moreover, both gastric and GB stasis, which excised in schistosomal patients before surgery became significantly aggravated after surgery. Also, the mean symyomatic score was significantly higher compared to the preoperative value which might be attributed at least partially to the postoperative dysmotility. Patients were followed and motility was studied at least six month after surgery, to give chance for any reversible damage to be corrected spontaneously.

Reviewing the literature, the issue of the effect of surgery on gastric and GB motility in patients with cirrhosis had not been studied before, except in the report of Jin et al[20] of China, who did Hassab's operation with intentional cutting of the vagi, and study GB function.

Before embarking in discussing this issue, we had to clarify some points:

- Extensive hiatal dissection and esophageal mobilization and devascularization, carry the risk of injury to the vagal trunks and their branches.
- Ligation of the left gastric vein may damage the celiac plexus, which carry both sympathetic and parasympathetic foregut innervations.
- Devascularization of the lesser curve is very tedious, and there are two important points:
  1. Preservation of the nerve of Latergieté and its branches, as they are the main motor supply to the gastric antrum.
  2. Preservation of the hepatic branch of the anterior vagus

and its pyloric branch.

We believe that the gastric and GB dysmotility that became exaggerated after GED operation is related to the operative technique, as the extensive gastro-esophageal devascularization is associated with high risk of accidental injury or damage of the vagal enervation of the fore-gut.

In spite of the lake of human studies to support this view, except the report of Jin and colleges [20], who conclude that the human vagus influences the GB motility, and cutting of the nerve inhibits the GB motility. Still few animal studies support this view. Traynor and associates[21] found that GB motility and emptying are entirely normal in the early period after vagal de-enervation by selective hepatobiliary vagotomy and truncal vagotomy. But this acute experiment represented only acute short term results that can be unreliable and different from the long term results. Yunoki,[22] reached the results that celiac branches of the vagus nerve modulate the interdigestive motor activity in the stomach, descending duodenum, gallbladder and sphincter of Oddi, however, resection of the pyloric branches had no influence on the interdigestive motor activities in all organs in dogs. Ueno and co-workers[23] found out that the treatment by vagal blockade or hexamethonium significantly reduced postprandial antral contractions and pyloric relaxations. Vagal blockades changed pyloric motor patterns from relaxation dominant to contraction dominant. Solid gastric emptying was significantly attenuated by treatment with vagal blockades.

Hassab's GED operation had been practiced more tam 50 years ago with many modifications, with minor side effects. Still, senior surgeons were selected to do the operation, to ensure adopting the best technique and results. However, the results were not very satisfactory; there was a significant decrease in both GB and gastric emptying, besides, one third of the patients had abnormal GB emptying and half the patients had abnormal gastric evacuation. Moreover, the patient's symptoms, reflected by the scoring system, became worst. We consider this work a new beginning for realizing the defect in the technique based on motility study. We recommend paying much effort to refine the technique to achieve better results.

Our experience in using ultrasonography in assessing both gallbladder an gastric motility gave us experience, confidence and believe that this method is an adequate tool for motility study.

REFERENCES

1. Li CP, Hwang SJ, Lee FY, Chang FY, Lin HC, et al. Evaluation of gallbladder motility in patients with liver cirrhosis: relationship to gallstone formation. Dig Dis Sci. 2000;45:1109-14.

2. Kao CH, Hsieh JF, Tsai SC, Ho YJ, Chen SD. Evidence of impaired gallbladder function in patients with liver cirrhosis by quantitative radionuclide cholescintigraphy. Am J Gastroenterol. 2000;95:1301-4.

3. Sobe H, Sakai H, Satoh M, Sakamoto S, Nawata H. Delayed gastric emptying in patients with liver cirrhosis. Dig Dis Sci 1994;391:983-7.

4. Ishizu H, Shiomi S, Kawamura E, Iwata Y, Nishiguchi S, Kawabe J, Ochi H. Gastric emptying in patients with chronic liver diseases. Ann Nucl Med. 2002;16:177-82.

5. Usami A, Mizukami Y, Onji M. Abnormal gastric motility in liver cirrhosis: roles of secretin. Dig Dis Sci. 1998;43:2392-7.

6. Acalovschi M, Dumitrascu DL, Csakany I. Gastric and gall bladder emptying of a mixed meal are not coordinated in liver cirrhosis: a simultaneous sonographic study. Gut. 1997;40:412-7.

7. Hassab MA. Gastro-oesophageal decongestion and splenectomy. A method of prevention and treatment of bleeding from oesophageal varices associated with bilharzial hepatic fibrosis: Preliminary report. J Int Coll Surg. 1964;41:6.

8. Bolondi L, Bortolotti ML, Santi V, Calletti T, Gaiant S, Labo G. Measurement of gastric emptying time by real-time ultrasonography. Gastroentrol. 1985;89:725-9.

9. Doods WJ, Groh WJ, Darweesh RMA, Lanoson TL, Kishk SMA, Kerm MK. Sonographic measurement of gall bladder volume. AJR. 1985;145:1009-12.

10. Tsai SC, Kao CH, Huang CK, Wang SJ, Chen GH. Abnormal gastric emptying in patients with liver cirrhosis. Kaohsiung J Med Sci. 1996;12:285-9.

11. Benini L, Sembenini C, Heading RC, Giorgetti PG, Montemezzi S, Zamboni M, Di Benedetto P, Brighenti F, Vantini I. Simultaneous measurement of gastric emptying of a solid meal by ultrasound and by scintigraphy. Am J Gastroenterol. 1999;94:2861-5.

12. Berstad A, Hausken T, Gilja OH, Hveem K, Nesje LB, Odegaard S.Ultrasonography of the human stomach. Scand J Gastroenterol (Suppl.). 1996;220:75-82.

13. Darwiche G, Bjorgell O, Thorsson O, Almer LO. Correlation between simultaneous scintigraphic and ultrasonographic measurement of gastric emptying in patients with type 1 diabetes mellitus. J Ultrasound Med. 2003;22:459-66.

14. Ali QM, Abdel-Rahirn IM, Doehnng-Schwertfegar E, Franke D, Kardorff R, Shelidi M, Ehrich JI. Ultrasonographic evaluation of gallbladder. function in patients with Schistoaoma mansoni infection. Trop Doci. 1999;20:113-5.

15. Sakamoto T, Fujimura M, Newman 3, Zhu XG, Greeley GH Jr, Thompson IC. Comparison of hepatic elimination of different forms of cholecystokinin in dogs. J Gun Invest. 1985;75:28-5.

16. TsaI Sc, Kao CII, Huang CK, Wang SJ, Chen GH, Abnormal gastric emptying in patients with liver cirrhosis. Kao Hsiung Hsueh Ko Hsueh Tsa Chih. 1996;12:I285-9.

17. Balan KK, Grime S, Sutton R, Critchley M, Jenkins SA. Abnormalities of gastric emptying in portal hypertension. Am J Gastroenterol 1996; 91: 530-4

18. Hveem K, Jones KL, Chatterton BE, Horowitz M. Scintigraphic measurement of gastric emptying and ultrasonographic assessment of antral area: relation to appetite. Gut. 1996;38:816-21.

19. Dumitrascu DL, Barnert J, Wienbeck M. Dumitrascu DL, Barnert J, Wienbeck. Gastric emptying in liver cirrhosis. The effect of the type of meal. Eur J Gastroenterol Hepatol. 1997;9:1073-80.

20. Jin HX, Wu SD, Zhang XF, Chen XY, Zhang GX. Gallbladder motility in patients with hepatic cirrhosis before and after portal azygous disconnection. World J Gastroenterol. 2004;10:3230-3.

21. Traynor OJ, Byrne PJ, Keegan B, Hennessy TP. Effect of vagal denervation on canine gallbladder motility. Br J Surg. 1987;74:850-4.

22. Yunoki Y. Effects of resection of celiac and pyloric branches of vagus nerve on the interdigestive motor activity of the upper digestive tract and biliary tree. J Smooth Muscle Res. 1995;31:33-41.

23. Ueno T, Uemura K, Harris MB, Pappas TN, Takahashi T. Role of vagus nerve in postprandial antropyloric coordination in conscious dogs. Am J Physiol Gastrointest Liver Physiol. 2004;288:487-95.