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Original

The relationship between gallbladder motility and the presence of enterogastric reflux

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Abstract

BACKGROUND: The aim of the study was an estimation of the relation between the gallbladder (GB) motility function and the presence and quantity of enterogastric reflux (EGR).
MATERIAL AND METHODS: We investigated 172 patients: 90 with physiological GB function (filling and emptying) (FGB), 21 with impaired GB function (prolonged filling and ejection fraction < 45%) and 61 with afunctional gallbladder (AGB) (without visualisation).
The study was performed during 90 min (1 f/min) after i.v. application of 185 MBq 99m Tc-dietil IDA. After 30 min, a test meal was given while at the end the stomach was marked. According to the parameters from time activity curves over the stomach and hepatobiliary system, the index of EGR was calculated, while GB filling and ejection fraction were estimated from the GB time/activity curve.
RESULTS: Most frequently, EGR occurs in AGB (47.5%), followed by IGB (43%) and FGB (41%), without significant differences ($p > 0.05$). The significantly ($p < 0.05$) highest value of EGR was obtained in the patients with AGB in comparison to IGB and FGB. EGR values were in correlation ($r = 0.168$, $p < 0.05$) with the functional status of the GB. In the patients with pathological values of EGR (> 10%), significantly higher values ($p < 0.05$) are obtained in AGB than in IGB and FGB. Also, these values were in correlation with the functional status of the GB ($r = 0.284$, $p < 0.05$).
CONCLUSIONS: We can conclude that EGR occurs more frequently in the patients with afunctional GB in comparison with those with functional and decreased motor function. Also, EGR quantity is in correlation with the impairment of the GB function.
Key words: gallbladder motility, enterogastric reflux, hepatobiliary scintigraphy

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Introduction

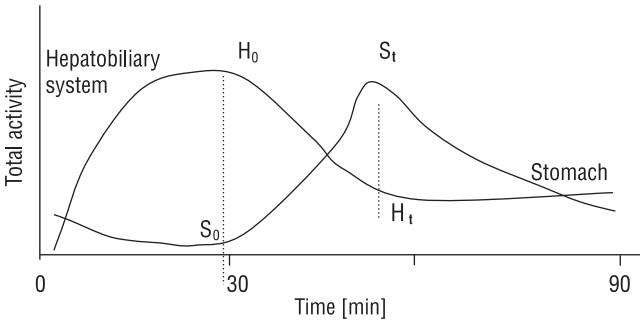
Patients with chronic cholecystitis and those after cholecystectomy suffer very often from dyspepsia with flatulence, belching, vomiting and epigastric pain. These can be attributed to the enterogastric reflux (EGR) caused by impaired pyloric function, continuous flow of bile into the duodenum [1, 2] or impaired duodenal motility.

In the physiological condition, the interdigestive motility of the gallbladder, duodenum and antrum is co-ordinated by the cyclic motor activity of the interdigestive mioelectric complex, while cholecystokinin (CCK) and parasympathetic stimulation regulate the digestive and interdigestive contractility of the gallbladder (GB) [3]. In the patients with cholecystitis or after cholecystectomy the release of bile into the duodenum becomes continuous because of the lack of the gallbladder reservoir function. The bile concentration function of the gallbladder is also lacking. This enables more bile to inflow and accumulate in the duodenum [4, 5]. Also, the bile inflow is changed because of the impaired motility [6]. In addition, the contractility of the pylorus in response to CCK stimulation is decreased after cholecystectomy [7].

The aim of the study is an estimation of the relationship between the functional status of the gallbladder and enterogastric reflux.

Material and methods

In order to estimate the relationship between gallbladder function and both frequency and quantity of EGR, scintigraphic examination of gallbladder motility and EGR were performed simultaneously in 172 patients.



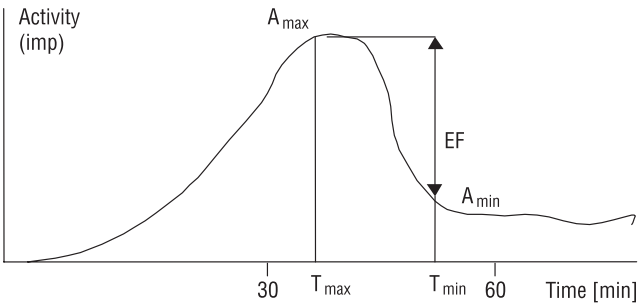
$$EGR\% = (S_t - S_0)/(H_0 - H_t) \times 100$$

Figure 1. Estimation of the index of enterogastric reflux. S_0 — activity in the gastric region immediately after test meal (31 min); S_t — maximal activity in the stomach region; H_0 — activity in the hepatobiliary region immediately after test meal; H_t — activity in the hepatobiliary region at the time corresponding to the maximal activity in the gastric region.

All patients underwent 90 min (1f/min) dynamic gamma camera acquisition, which started immediately after the intravenous injection of 185 MBq 99m Tc-dietil IDA. Thirty minutes post injection, the test meal (250 ml of milk, one egg, sugar) was given in order to provoke gallbladder contraction. In the last two minutes of the study the patient was given 18 MBq of 99mTc pertechnetate *per os*, to mark the stomach region.

At first, analysis of sequential scintigrams was performed, in order to evaluate the flow of the radiopharmaceutical through the hepatobiliary system (gallbladder and bile ducts) and duodenum, as well as retrograde flow to the stomach. Time activity curves from the hepatobiliary system, stomach and gallbadder regions of interest, respectively, were generated. The following parameters were derived from the curves: S_0 — activity in the stomach after ingestion of the test meal; S_t — maximal retrograde activity in the same region; H_0 — activity in the hepatobiliary system the moment after the test meal ingestion, and H_t — activity in the same region at the moment of the maximal retrograde activity in the stomach.

The index of EGR was calculated according to the equation: $100 \times (S_t - S_0)/(H_0 - H_t)$ (Fig. 1). The number of EGR episodes during the study was also determined. GB ejection fraction was calculated according to the formula: $EF\% = 100 \times (A_{max} - A_{min})/A_{max}$, where A_{max} is maximal activity in the gallbladder at the moment of test meal ingestion and A_{min} minimal activity in the gallbladder as a result of the stimulation (Fig. 2).



$$EF\% = 100 \times (A_{max} - A_{min})/A_{max}$$

Figure 2. Estimation of the gallbladder ejection fraction. A_{max} — activity immediately after meal stimulation; A_{min} — activity at the end of the gallbladder contraction.

According to the GB motility, patients were divided into three groups: 1) those with physiological GB function (FGB, n = 90), in which the GB was well visualised with physiological filling and emptying (EF > 45%); 2) with impaired GB function (IGB, n = 21) reflected in prolonged filling and decreased ejection fraction (EF < 45%); and 3) with afunctional gallbladder (AGB, n = 61) without visualisation, including patients after cholecystectomy.

The obtained results were evaluated by descriptive and analytical statistical methods: mean value (X), standard deviation (SD), coefficient of variation (CV%) and median (Med), analysis of variance, Kruskal Wallis' and Multiple range tests, as well as Pearson linear correlation.

Results

Values of EGR less than 10% were considered physiological [8, 9].

EGR occurred most frequently in AGB (47.5%), followed by IGB (43%) and FGB (41%), without significant differences ($p > 0.05$) (Table 1).

Taking into account all the examinees (those with abnormal as well as those with normal values of EGR), the highest value of EGR was obtained in the patients with AGB (19.2 ± 29.0%), followed by those with IGB (13.0 ± 14.8%) and FGB (11.5 ± 14.2%) (Table 2).

Statistical analysis (Kruskal-Wallis test and analysis of variance) (Table 3) did not show significant differences ($p > 0.05$) between the mentioned groups, while the Multiple range test (Table 4) showed significant differences ($p < 0.05$) in the EGR values be-

Table 1. Frequency of the pathological reflux in all the patients in comparison to the functional gallbladder condition

	Number of patients	Gallbladder condition	EGR	Frequency
	90	FGB	37	41%
	21	IGB	9	43%
	61	AGB	29	47.5%
Total	172		75	

$\chi^2 = 0.618$, DF = 2, $p > 0.05$

Table 2. Descriptive statistical parameters of EGR index in all patients considering functional gallbladder condition

Number of patients	Gallbladder conditionx	(EGR%)	(SD)	(CV%)	Med
90	FGB	11.5	14.2	123.5	9.00
21	IGB	13.0	14.8	113.8	10.00
61	AGB	19.2	29.04	151.2	9.00
Total 172					

$\chi^2 = 0.5$, DF = 2, $p > 0.05$, FGB — normal function of the gallbladder, IGB — impaired gallbladder function, AGB — afunctional gallbladder

Table 3. Significance of the EGR differences in all the patients considering functional gallbladder condition

Source of variability	DF	F	Significance
Between the groups	2	2.58	$p > 0.05$
Inside the groups	169		
Total	171		

Table 4. Significance of the differences of the EGR index between the groups

Compared groups	Significance
AGB/(FGB, IGB)	$p < 0.05$
IGB/FGB	$p > 0.05$

Table 5. Descriptive statistical parameters of the EGR values in patients with pathological values in comparison to the functional condition of the gallbladder

Number of patients	Gallbladder condition	(EGR%)	(SD)	(CV%)	Med
37	FGB	24.10	14.13	58.63	20.00
9	IGB	25.11	15.07	60.01	22.00
29	AGB	38.72	32.35	83.54	28.00
Total 75					

$\chi^2 = 0.66$, DF = 2, $p > 0.05$, FGB — normal function of the gallbladder, IGB — impaired gallbladder function, AGB — afunctional gallbladder

Table 6. Significance of the differences of the EGR values in the compared groups

Compared groups	Significance
AGB/(FGB, IGB)	$p < 0.05$
IGB/FGB	$p > 0.05$

tween the patients with AGB and those with IGB and FGB. EGR values were in correlation ($r = 0.168$, $p < 0.05$) with the functional status of the GB (Fig. 3).

When we considered only the patients with pathological values of EGR (EGR > 10%), the highest values were found in the patients with AGB (38.7 ± 32.3%), followed by those with IGB (25.1 ± 15.1%) and FGB (24.1 ± 14.1%) (Table 5). Kruskal-Wallis' analysis did not show significant differences ($p > 0.05$) between the groups (FGB, IGB and AGB) regarding EGR values, but the Multiple range test did ($p < 0.05$) (Table 6). The EGR values were in correlation ($r = 0.284$, DF = 75, $p < 0.05$) with the gallbladder motility impairment (Fig. 4).

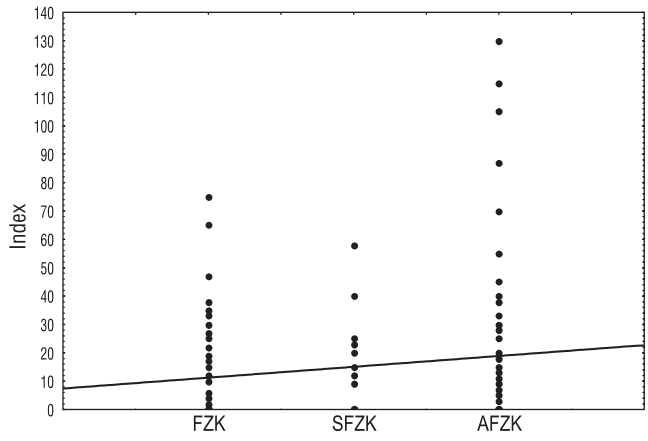


Figure 3. Correlation between the functional condition of the GB and EGR values.

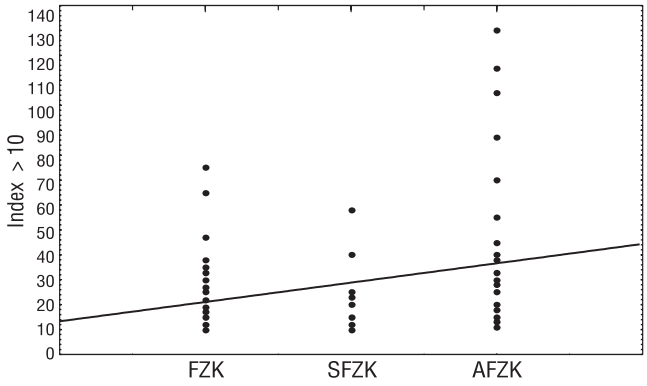


Figure 4. Correlation between the functional condition of the GB and EGR values in the patients with pathological values.

Discussion

Our results indicate that bile reflux mostly occurs in the patients with afunctional gallbladder, followed by those with impaired gallbladder function while it is most rare in the subjects with physiological GB function ($p > 0.05$). When all the patients were considered, as well as only those with EGR values over 10%, which corresponds to pathological values, the significant increase in EGR values was noticed in the patients with afunctional gallbladder in comparison to other two groups ($p < 0.05$), with non-significantly higher values in the patients with decreased gallbladder motility. Also, if we consider all the patients or only those with pathological EGR values, there was a correlation ($r = 0.168$, DF = 172, $p < 0.05$; and $r = 0.284$, DF = 75, $p < 0.05$) between the reflux quantity and GB functional status.

The results of other authors also point out the connection between the incidence and the quantity of bile reflux and the functional status of the gallbladder. Kelosalo et al. [10] proved the high incidence of reflux (67%) in the patients with calculosis (67%) and after cholecystectomy (89%). Similarly, Kalima and Sjoberg [11] found EGR in 60%, Eriksson et al.[12] in 85%, and Mackie et al. [13] in 18% of patients after cholecystectomy. Colleti et al. [14] proved reflux in 28.5%, Kennedy et al. [15] in 35%, and Oates and Achong [16] in 84% of the patients with cholecystitis. According to the results of Tsypliaev and Karakashly [17], biliary reflux was more frequent in the patients after cholecystectomy compared to those with cholecystitis, in which the quantity was higher. Colleti et al. [14] pointed out the association (86%) of acute cholecystitis with enteroogastric reflux and explained it as an irritation of the duodenum with inflamed gallbladder. Oates et al. [15] proved the existence of EGR in the patients with acute (80%) and chronic (86%) cholecystitis during morphine-stimulated cholescintigraphy. Buxbaum et al. [18] found EGR in 51% of patients after cholecystectomy, while Eyre-Brook [19] showed significant reflux in 60% of patients with afunctional gallbladder but in no-one with gallbladder calculosis and physiological gallbladder motility.

Considering the quantity of reflux, Mearin et al. [7] found that in the majority of patients after cholecystectomy antral motility was decreased with increased enterogastric reflux. According to Anselmi et al. [20], cholelithiasis, even in the functional gallbadder, leads to the occurrence of reflux, which is increased after cholecystectomy. In contrast, Hubens et al. [21] found no increase

of EGR after cholecystectomy, except in the case of dyspepsia, where EGR was proved in a high percentage (90%). Shih et al. [22] proved that during morphine-stimulated cholescintigraphy there was an increase of enterogastric reflux, more in acute than in chronic cholecystitis, which was in harmony with the abovementioned results of Oates and Achong [16]. Lorusso et al. [23, 24] showed significant increase in the quantity of enterogastric reflux after cholecystectomy, which was in accordance with Wilson et al. [25]. However, there was a certain number of controversial results. Thus, Marinho et al. [26] claimed that only cholecystectomy with sphincteroplasty increased the quantity of enterogastric reflux, while Arroyo et al. [27] proved increased quantity of reflux in patients with physiological gallbladder motility in comparison to those with the decreased one.

In complete contrast to our results, which proved a correlation between the functional status of the gallbladder and the quantity of enterogastric reflux, Caravel et al. [1] claimed that there was no correlation between the two events.

Conclusions

Our results confirmed that biliary reflux is most frequent in patients with afunctional gallbladder, followed by those with its decreased function, and that it is rarest in subjects with normal gallbladder motility. Significantly increased values of EGR were recorded in patients with afunctional gallbladder in comparison to those with impared or intact gallbladder function, with higher values of EGR in the former. Also, there was a certain correlation between the quantity of reflux and the functional status of the gallbladder. This indicates that treatment of gallbladder motility impairments could have a therapeutic effect on enterogastric reflux, too.

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