

**Original Article**

## **Sonographic Evaluation of Effect of Smoking and Fatty Meals on Gallbladder**

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Received: June 6, 2017 Accepted: December 21, 2017

doi: <http://dx.doi.org/10.3329/jemc.v8i1.35433>

### **Abstract**

**Background:** It is well established that fatty food causes gallbladder contraction by releasing cholecystokinin (CCK). Smoking also causes contraction of gallbladder. There are a limited number of studies evaluating the effect of smoking and fatty meals on gallbladder motility by ultrasonography. **Objective:** The aim of this study is to see the effect of smoking on gallbladder contraction in comparison with fatty meals. **Materials and Methods:** This cross sectional study was conducted on thirty young adult male volunteers having age between 18–40 years in the department of Radiology and Imaging of Bangabandhu Sheikh Mujib Medical University. Unbiased gallbladder volume measurement of each volunteer was taken on two separate days before and after taking fatty food and as well as before and after smoking at 5, 15, 30 and 60 minutes interval. All information were meticulously recorded in structured data collection sheet and analyzed statistically. Then mean gallbladder volume changes against time were presented graphically for two groups using the pre and post smoking values. **Results:** The result shows that smoking has contractile effect on gallbladder like fatty food. The mean comparison of net change of gallbladder volume before and after smoking and before and after fatty food intake in both smoker and non-smoker groups has been statistically significant ( $p < 0.05$ ). **Conclusion:** Fatty food and smoking should be strictly prohibited before ultrasonography of hepatobiliary system for better evaluation.

**Key words:** Smoking; Fatty meals; Gallbladder contraction

J Enam Med Col 2018; 8(1): 29–34

### **Introduction**

Smoking is still widespread in many societies in spite of its recognized relationship with many diseases.<sup>1</sup> Ultrasound evaluation of the gallbladder (GB) and biliary system is used as primary diagnostic tools and has been proven to be effective in diagnosing various types of gallbladder diseases, including the more common problem of cholelithiasis and dilatation of the ductal system.<sup>2</sup> For proper ultrasound visualization of the gallbladder, adequate distension of the gallbladder must be ensured. A six hours fast ensures an uncontracted gallbladder, the optimum condition for diagnosis of intra-luminal abnormalities.<sup>3</sup> Ingestion

of food, particularly of a fatty nature, stimulates the gallbladder to contract. The contracted gallbladder appears thick-walled and may obscure luminal and wall abnormalities.<sup>4</sup>

There are a limited number of studies evaluating the effect of smoking on gallbladder motility by ultrasonography. In a study carried out by Jonderko et al<sup>5</sup> in Kotowice, Poland on 10 healthy volunteers (4 female and 6 male, mean age 27.6 years) for observing the effect of cigarette smoking on gallbladder emptying and refilling after fatty meals, it was found that fasted GB volumes amounted  $14.7 \pm 1.8$  cm<sup>3</sup> without smoking,  $15.0 \pm 1.7$  cm<sup>3</sup> between 0–20

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minutes after smoking and  $14.4 \pm 2.4 \text{ cm}^3$  between 20–40 minutes after smoking. After taking fatty meals the GB volumes amounted  $6.6 \pm 1.2 \text{ cm}^3$  between 0–20 minutes and  $7.1 \pm 2.9 \text{ cm}^3$  between 20–40 minutes. They concluded that refilling is delayed in chronic smoker and in acute process, smoking might cause gallbladder smooth muscle contraction.<sup>5</sup>

Gallbladder imaging with provocative testing with cholecystokinin or fatty meals has been tried with oral cholecystography<sup>6,7</sup>, dynamic ultrasound and HIDA scintigraphy<sup>8-15</sup>. We use 3D ultrasound for estimation of gallbladder volume.

As there are a limited number of studies to evaluate the effect of smoking and fatty meals on gallbladder, we designed this study.

**Materials and Methods**

This cross sectional study was carried out in the department of Radiology and Imaging, Bangabandhu Sheikh Mujib Medical University from 1<sup>st</sup> March, 2007 to 29<sup>th</sup> February, 2008. A total of 30 volunteers were included in the study, of them 15 were nonsmokers (Group I) and 15 were smokers (Group II). All the volunteers were young adults with age between 18 to 40 years. Ultrasonography of HBS was done first and volunteers with no gallbladder abnormality were included in this study. Then unbiased gallbladder volume measurement was done on two separate days before and after taking fatty food as well as before and after smoking. On the first day (control examination) after 8 hours overnight fasting, GB volume was measured. Then 30–40 gm fat-containing meals were given to the volunteers and participants were asked to eat the meals within two minutes. After that GB volumes were measured at 5, 15, 30 and 60 minutes.

To avoid the start of cephalic phase of digestion, volunteers and meals were kept in separate rooms until examinations. On the second day gallbladder volumes were again measured after 8 hours overnight fasting (control examination). After that, two cigarettes were given to the participants who were encouraged to consume the cigarettes in 5–10 minutes with deep inhalations. Approximately three minutes after the smoking, GB volumes were measured at 5, 15, 30 and 60 minutes. The same procedures were repeated in smoker and nonsmoker groups. GB volume changes against time were presented graphically for both the groups using the pre- and post-smoking values and pre- and post-food consumption values.

The following outcome variables were observed.

Demographic and clinical variables: Age and sex of the patient, socio-economic condition, built, presence of gallbladder pathology.

Imaging variables: Ultrasound findings — size and shape of the gallbladder.

**Results**

Table I shows the mean gallbladder volumes at different times before and after smoking. It was found that the mean  $\pm$  SD of gall bladder volumes at different times of smoking were not statistically significant ( $p > 0.05$ ) except at 15 minutes after smoking ( $p < 0.05$ ).

Table II shows the mean gallbladder volume at different times before and after fatty food intake. It was found that the mean  $\pm$  SD volumes at different times after fatty food intake were statistically significant ( $p < 0.05$ ) except before fatty food intake and 60 minutes after fatty food intake.

Table III shows the mean difference of gallbladder

Table I: Mean comparison of effects of smoking on gallbladder volume (in  $\text{cm}^3$ ) between two groups (N=30)

Time	Group I (n=15)	Group II (n=15)	p values
Before smoking	$21.0 \pm 4.4$	$22.6 \pm 4.0$	0.310 <sup>ns</sup>
5 minutes after smoking	$15.0 \pm 4.5$	$17.9 \pm 3.8$	0.059 <sup>ns</sup>
15 minutes after smoking	$11.6 \pm 3.7$	$14.7 \pm 3.6$	0.029 <sup>s</sup>
30 minutes after smoking	$9.6 \pm 2.8$	$10.5 \pm 1.9$	0.321 <sup>ns</sup>
60 minutes after smoking	$7.8 \pm 2.1$	$9.0 \pm 1.6$	0.074 <sup>ns</sup>

Group I: Non-smoker; Group II: Smoker; p value reached from Unpaired t-test; ns=not significant ( $p > 0.05$ ); s=significant ( $p < 0.05$ )

volumes in Group I at different times of smoking and fatty food intake. It was statistically significant ( $p < 0.05$ ) except before and 5 minutes after smoking and fatty food intake.

Table IV shows comparison of gallbladder volume at different times of smoking and fatty food intake in Group II. It was found that the difference of means was statistically significant ( $p < 0.05$ ) except before and 5 minutes after smoking and fatty food intake.

The net change of gall bladder volume before smoking to after smoking at different times in Group I were statistically significant ( $p < 0.05$ ). The results are shown in Table V.

The net change of gall bladder volume before and after smoking and fatty food intake at different times in both groups is shown in Table VI. The net change of mean gall bladder volume was statistically significant ( $p > 0.05$ ) after smoking and fatty food in both groups.

Table II: Mean comparison of effect of fatty food on gallbladder volumes (in  $\text{cm}^3$ ) between two groups (n=30)

Time	Group I (n=15)	Group II (n=15)	p values
Before fatty food	20.9 ± 4.6	22.4 ± 3.6	0.335 <sup>ns</sup>
5 minutes after fatty food	12.4 ± 4.3	16.6 ± 4.3	0.012 <sup>s</sup>
15 minutes after fatty food	7.8 ± 3.9	10.9 ± 3.3	0.023 <sup>s</sup>
30 minutes after fatty food	4.3 ± 2.6	6.7 ± 2.8	0.020 <sup>s</sup>
60 minutes after fatty food	2.8 ± 2.2	4.3 ± 2.3	0.080 <sup>ns</sup>

Group I: Non-smoker; Group II: Smoker; p value reached from unpaired t-test; ns=not significant ( $p > 0.05$ ); s=significant ( $p < 0.05$ )

Table III: Mean comparison of gallbladder volume (in  $\text{cm}^3$ ) after smoking and fatty food intake in Group I (n=15)

Time	Smoking (n=15)	Fatty meal (n=15)	p values
Before	21.0 ± 4.4	20.9 ± 4.6	0.975 <sup>ns</sup>
After 5 minutes	15.0 ± 4.5	12.4 ± 4.3	0.123 <sup>ns</sup>
After 15 minutes	11.6 ± 3.7	7.8 ± 3.9	0.010 <sup>s</sup>
After 30 minutes	9.6 ± 2.8	4.3 ± 2.6	0.00 <sup>s</sup>
After 60 minutes	7.8 ± 2.1	2.8 ± 2.2	0.001 <sup>ns</sup>

Group I: Non-smoker; p value reached from unpaired t-test; ns=not significant ( $p > 0.05$ ); s=significant ( $p < 0.05$ )

Table IV: Mean comparison of gallbladder volume (in  $\text{cm}^3$ ) after smoking and fatty food intake in Group II (n=15).

Time	Smoking (n=15)	Fatty meal (n=15)	p values
Before	22.6 ± 4.0	22.4 ± 3.6	0.908 <sup>ns</sup>
After 5 minutes	17.9 ± 3.8	16.6 ± 4.3	0.383 <sup>ns</sup>
After 15 minutes	14.7 ± 3.6	10.9 ± 3.3	0.006 <sup>s</sup>
After 30 minutes	10.5 ± 1.9	6.7 ± 2.8	0.001 <sup>s</sup>
After 60 minutes	9.0 ± 1.6	4.3 ± 2.3	0.001 <sup>ns</sup>

Group II: Smoker; p value reached from unpaired t-test; ns=not significant ( $p > 0.05$ ); s=significant ( $p < 0.05$ )

Table V: Comparison of net change of gallbladder volumes (in cm<sup>3</sup>) between before and after smoking in Group I (n=15)

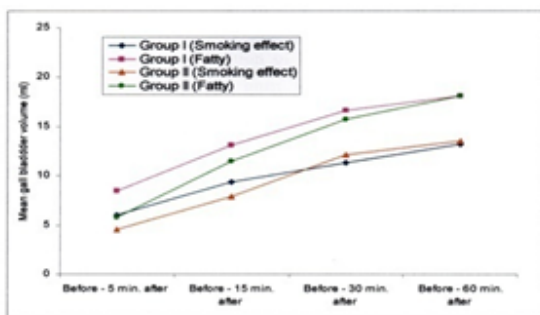
Time	Mean ± SD	Mean differences	p values
Before (a)	21.0 ± 4.4		
After 5 minutes (b)	15.0 ± 4.5	6.0 ± 2.2 (a-b)	0.001 <sup>s</sup>
After 15 minutes (c)	11.6 ± 3.7	9.4 ± 2.3 (a-c)	0.001 <sup>s</sup>
After 30 minutes (d)	9.6 ± 2.8	11.3 ± 2.1 (a-d)	0.001 <sup>s</sup>
After 60 minutes (e)	7.8 ± 2.1	13.2 ± 2.8 (a-e)	0.001 <sup>s</sup>

p value reached from paired t-test; ns=not significant (p>0.05); s=significant (p<0.05)

Table VI: Mean comparison of net change of gallbladder volume (in cm<sup>3</sup>) between before and after smoking and fatty food intake in both groups (N=30)

Time	Smoking		Fatty food		p values
	Group I Mean±SD	Group II Mean±SD	Group I Mean±SD	Group II Mean±SD	
5 min. after	6.0 ± 2.2	4.6 ± 2.0	8.5 ± 4.3	5.8 ± 1.9	0.005 <sup>ns</sup>
15 min. after	9.4 ± 2.3	7.9 ± 3.2	13.1 ± 4.7	11.5 ± 2.1	0.001 <sup>ns</sup>
30 min. after	11.3 ± 2.1	12.1 ± 2.9	16.6 ± 4.4	15.7 ± 1.8	0.001 <sup>ns</sup>
60 min. after	13.2 ± 2.8	13.5 ± 3.0	18.1 ± 4.6	18.1 ± 2.2	0.001 <sup>ns</sup>

Group I: Nonsmoker; Group II: smoker; p value reached from ANOVA test; ns=not significant (p>0.05); s=significant (p<0.05)



Group I: Non smoker; Group II: smoker;

Fig 1. Net change of gallbladder volumes (in cm<sup>3</sup>) between before and after smoking and fatty food intake in both groups

**Discussion**

For proper ultrasound visualization of the gall bladder, adequate distention of the gall bladder must be ensured. Some of the experienced radiologists faced

problem with contracted gallbladder during scanning in some smoker patients who had smoked just before examination. Since there was limited number of study regarding the acute effect of smoking on gallbladder contraction, they could not conclude the cause why gall bladder was found contracted in spite of adequate fasting. Smoking was suspected as the cause of gall bladder contraction beyond other regions. This study is aimed to conclude smoking as a cause of gallbladder contraction.

It was established that, in humans, evacuation of the gall bladder is accomplished by trigger mechanism which is set off by the presence of fatty foods, meat and hygroque cathartics in the duodenum and upper jejunum. Absorption of these substances by the mucous membrane results in the release of cholecystokinin (CCK), a hormone which rapidly circulates in the blood stream and simultaneously

produces contraction of the gallbladder and relaxation of the sphincter of Oddi. So effect of fatty food on gall bladder was included in this study to see the comparison of contraction with smoking.

The mean volume of GB was found  $21.0 \pm 4.4$  mL in nonsmokers (Group I) and  $22.6 \pm 4.8$  mL in smokers (Group II) in my study, Jonderko et al<sup>5</sup> conducted a study on 10 healthy volunteers (4 female and 6 male) where the mean fasted volume of GB was found  $15.7 \pm 1.8$  cm<sup>3</sup>. In another study conducted by Degirmenci et al<sup>16</sup> on 30 healthy volunteers (15 were nonsmokers and 15 were smokers), where the mean starving GB volumes were found  $23.3 \pm 3$  mL in the first day,  $21.9 \pm 3$  mL in the second day in nonsmokers and  $18.3 \pm 3$  mL in the first day,  $19.5 \pm 2.8$  mL in the second day in the smoker group. In the present study mean GB volume of nonsmoker group did not significantly differ with the study of Degirmenci et al.<sup>16</sup>

Mean comparison of effect of smoking in gallbladder volumes between smokers (Group II) and nonsmokers (Group I) at different times found that the mean ( $\pm$ SD) volume was  $21.0 \pm 4.4$  mL in Group I and  $22.6 \pm 4.8$  mL in Group II just before smoking. Five minutes after smoking the mean ( $\pm$ SD) gallbladder volume was  $15.0 \pm 4.5$  mL in Group I and  $17.9 \pm 3.8$  mL in Group II. Fifteen minutes after smoking the mean ( $\pm$ SD) gallbladder volume was  $11.6 \pm 3.7$  mL in Group I and  $14.7 \pm 3.6$  mL in Group II. Thirty minutes after smoking the mean ( $\pm$ SD) gallbladder volume was  $9.6 \pm 2.8$  mL in Group I and  $10.5 \pm 1.9$  mL in Group II. Sixty minutes after smoking the mean ( $\pm$ SD) gallbladder volume was  $7.8 \pm 2.1$  mL in Group I and  $9.0 \pm 1.6$  mL in Group II. The mean gallbladder volume repeatedly declined after smoking in both groups, but more in Group I and volume reduction is maximum in 1<sup>st</sup> 30 minutes.

Jonderko et al<sup>5</sup> found the mean volume of GB  $15.0 \pm 1.7$  cm<sup>3</sup> between 0–20 minutes after smoking and  $14.4 \pm 2.3$  cm<sup>3</sup> between 20–40 minutes after smoking. In our study the mean GB volume was found  $15.0 \pm 4.5$  mL in non-smoker group and  $17.19 \pm 3.8$  mL in smoker group 5 minutes after smoking and  $11.6 \pm 3.7$  mL in nonsmokers and  $14.7 \pm 3.6$  mL in smoker group 15 minutes after smoking. So the mean GB volume of our study at different times of smoking did not significantly differ from the study of Jonderko et al.<sup>5</sup>

Mean comparison of gallbladder volume after

smoking and fatty food intake in nonsmokers (Group I) at different times found that the mean ( $\pm$ SD) volume was  $21.0 \pm 4.4$  mL before smoking and  $20.9 \pm 4.6$  mL before fatty food intake. Five minutes after smoking the mean ( $\pm$ SD) gallbladder volume was  $15.0 \pm 4.5$  mL and after fatty food intake was  $12.4 \pm 4.3$  mL. Fifteen minutes after smoking the mean ( $\pm$ SD) gallbladder volume was  $11.6 \pm 3.7$  mL and after fatty food intake was  $7.8 \pm 3.9$  mL. Thirty minutes after smoking the mean ( $\pm$ SD) gallbladder volume was  $9.6 \pm 2.8$  mL and after fatty food intake was  $4.3 \pm 2.6$  mL. Sixty minutes after smoking the mean ( $\pm$ SD) gallbladder volume was  $7.8 \pm 2.1$  mL and after fatty food intake was  $2.8 \pm 1.6$  mL. The mean gallbladder volume declined after smoking and fatty food intake, though fatty food causes more reduction than smoking but in the initial period (within 5 minutes) the volume reduction is almost similar.

Mean comparison of gallbladder volume after smoking and fatty food intake in smokers (Group II) at different times showed that the mean ( $\pm$ SD) volume was  $22.6 \pm 4.0$  mL before smoking and  $22.4 \pm 3.6$  mL before fatty food intake. Five minutes after smoking the mean ( $\pm$ SD) gallbladder volume was  $17.9 \pm 3.8$  mL and after fatty food intake was  $16.6 \pm 4.3$  mL. Fifteen minutes after smoking the mean ( $\pm$ SD) gallbladder volume was  $14.7 \pm 3.6$  mL and after fatty food intake was  $10.9 \pm 3.3$  mL. Thirty minutes after smoking the mean ( $\pm$ SD) gallbladder volume was  $10.5 \pm 1.9$  mL and after fatty food intake was  $6.7 \pm 2.8$  mL. Sixty minutes after smoking the mean ( $\pm$ SD) gallbladder volume was  $9.0 \pm 1.6$  mL and after fatty food intake was  $4.3 \pm 2.3$  mL. The mean gallbladder volume repeatedly declined after smoking and fatty food intake. Though fatty food causes more reduction than smoking, in the initial period (within 5 minutes) the volume reduction is almost similar.

Comparison of mean gallbladder volume after smoking and fatty food intake in nonsmokers (Group I) and smoker (Group II) at different times showed that the mean gallbladder volume was not statistically significant ( $p > 0.05$ ) before smoking and fatty food intake in both groups whereas after smoking and fatty food intake the mean gallbladder volume was statistically significant ( $p < 0.05$ ) in both groups.

Mean comparison of net change of gallbladder volume between before and after smoking in nonsmoker

group showed that the net decline of mean ( $\pm$ SD) gallbladder volume was  $6.0 \pm 2.2$  mL after 5 minutes,  $9.4 \pm 2.3$  mL after 15 minutes,  $11.3 \pm 2.1$  mL after 30 minutes and  $13.2 \pm 2.8$  mL after 60 minutes. The mean gallbladder volume continuously declined after smoking in nonsmokers. The mean differences of gallbladder volumes between before smoking and after smoking at different times in nonsmokers were statistically significant ( $p < 0.05$ ). The same result was found in smoker group also.

Mean Comparison of net change of gallbladder volume between before and after smoking and fatty food intake in both nonsmoker and smoker groups at different times showed that the net change of mean gallbladder volume was statistically significant ( $p < 0.05$ ) after smoking and fatty food in both groups.

It is well known to all that fatty foods contract gallbladder. So fatty food intake before ultrasonography of HBS will lead to misinterpretation to operator as gallbladder is found contracted. This study showed that smoking also causes contraction of gallbladder by decreasing its volume. So real picture will not be evaluated by ultrasonography of patient who smoked before their examination. So smoking should be strictly prohibited before ultrasonography of HBS for better evaluation.

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