

Role of Body Mass Index, Physical Activity and Nutrients in Cholelithiasis in Guntur, Andhra Pradesh

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KEY WORDS Gallstones. BMI. Contraceptives Pills. Dietary Fiber. Refined Sugar. Vitamin C. Nutrition

ABSTRACT To compare dietary intakes of gallstone patients and controls, 82 gallstone patients and 117 randomly selected control subjects without gallstones were enrolled in the study. The presences of gallstones were determined by ultrasonography. Both patients and control subjects completed a questionnaire exploring their dietary intake. Anthropometric measurements were collected. Blood samples were analyzed for serum glucose, triglycerides, total cholesterol, low density lipoprotein cholesterol (LDL-C), high density lipoprotein cholesterol (HDL-C) and serum calcium. Oral contraceptive usage was significantly higher in gallstone patients than controls. Patients were significantly older than controls, had less physical activity and higher Body Mass Index (BMI). However, HDL-cholesterol, serum calcium levels were found significantly higher in controls. Dietary intake including energy, proteins, refined sugar, sodium, calcium, and iron were significantly higher in patients. Dietary fiber and vitamin C levels were significantly lower in patients. Dietary interventions that emphasize the prevention, effect of some nutrients and the contributory effect of others might provide a method of avoiding the formation of gallstones.

INTRODUCTION

Gallstone disease (Cholelithiasis) has been reported among female with advancing of age and a spurt in it has been noted recently. It has been identified as one of the diseases of civilization and modern affluent lifestyles of the developed nations (Diehl et al. 1987). There has been a significant increase in the incidence of cholelithiasis the world over including India and remains as a clinical enigma. The risk factors for the development of cholelithiasis include obesity, repeated pregnancy, use of contraceptive pills, a family history of gall stones, Diabetes Mellitus (DM), smoking, plasma lipids, dietary factors, chronic liver disease and possibly major abdominal surgery (Kosters et al. 2003).

Disease definition and ascertainment in studies on Gall stone diseases (GBD) are particularly problematic because as many as two-thirds of cases with gallstones are asymptomatic or silent (Heaton 1979). Gall stone related

symptoms and complications are among the most common gastroenterological disorders requiring hospitalization. Present study throws light on weight profile, relationship between physical activity and weight profile, dietary intakes and Body Mass Index (BMI), correlation between weight profile and serum lipid profile and serum calcium of experimental and control group subjects in an urban city Guntur in Andhra Pradesh.

MATERIALS AND METHODS

The present study conducted in Government hospitals and private nursing homes of Guntur city was spread over a sample size of 82 cholelithiasis cases (study group) and control group of 117 subjects of healthy males and females on the basis of matched age, sex and socio-economic status. The study group of 82 comprised 57 females and 25 males whereas control group consisted of 90 females and 27 males.

Anthropometric Survey: Anthropometric measurements namely, height, weight, waist, hips and Mid Arm Circumferences (MAC) sample were recorded by using standardized tools and techniques (Jelliffe 1966). Body Mass Index (BMI) WHO classification (WHO 1995) was calculated from the anthropometric data and physical activities classification based on occupation (Gopalan et al. 1978).

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Blood Bio-chemical Estimations: Blood samples were collected (5ml) after an overnight fast to estimate fasting glucose, cholesterol, triglycerides, LDL-C, HDL-C (Warnick and Albers 1978) and serum calcium (o-CPC method) (Moorhead and Briggs 1974).

Dietary Survey: A 24 hour recall is used to establish the typical meal for conducting a diet history and food frequency questionnaire as a cross-check. Statistical analyses done by SPSS include mean, standard deviation and chi-square test.

RESULTS

Socio demographic data of cases and controls was analyzed using chi-square test. Gallstone patients used significantly more oral contraceptive pills and they were more literate and affluent compare to controls (Table 1). The oral contraceptive usage increases biliary cholesterol secretion there by raising the level of cholesterol precipitation and gallstone formation.

Weight Profile: There are more number of overweight and obesity cases in the study group

in comparison to the control group for both male and female groups (Table 2). In the total study group also the numbers of over weight and obesity cases are more in comparison to the control group. Thus, it may be inferred from above results that people with more weight are more prone to the risk of cholelithiasis. Studies conducted by Garrow and James (1993), Rosai (1996), Abhyankar (1996), confirm obesity as a marked risk factor. Gallstone patients were significantly older (44.73 ± 10.93) and had higher BMI ($26.55 \pm 6.3\text{kg/m}^2$) than control patients (39.13 ± 5.26 and $24.8 \pm 4.9 \text{ kg/m}^2$) respectively. However, Waist Hip ratio (WH ratio) and mid arm circumference were found higher in cases as compared to controls (Table 3).

In the study group there are more percentage of cases in the sedentary activity level with higher BMI whereas in the control group the number of cases are made in the middle body mass index and moderate activity level (Table 4). It may be inferred that low physical activity and high weight profile people have a greater risk of cholelithiasis.

Biochemical Profile: Blood biochemistry measurements did not differ significantly between cases and control with the exception of HDL and

Table 1: Socio- demographic variables of the study samples.

Variables	Gall stone patients n=82	Control group n=117	P value
<i>Education</i>			
Literate	56 (68.2%)	42 (35.9%)	0.002
Illiterate	26 (31.8%)	75 (64.1%)	
<i>Monthly income</i>			
≤ 10000Rs	55 (67.1%)	87 (74.3%)	0.001
> 10000Rs	27 (22.9%)	30 (25.65%)	
<i>Number of children</i>			
≤ 4 children	63 (76.9%)	70 (59.83%)	0
> 4 children	19 (23.1%)	47 (40.17%)	
<i>Contraceptive usage</i>			
Yes	37 (45.1%)	18 (15.38%)	0.0145
No	45 (54.9%)	89 (84.62%)	

Table 2: Weight profile of gall stone cases and control group (study group n=87, control group n=117)

Weight profile BMI*	Male				Female				Total			
	Study group		Control group		Study group		Control group		Study group		Control group	
	No	%	No	%	No	%	No	%	No	%	No	%
Underweight BMI <18.5	3	10	-	-	12	23.1	23	25.5	15	17.2	23	19.6
Normal 18.5-24.9	10	33.4	22	81.5	17	32.7	64	71.1	27	33.0	86	73.5
Overweight 25-29.9	11	36.6	5	18.5	16	30.7	3	3.4	27	33.0	8	6.9
Obesity 30.0-39.9	6	20	-	-	7	13.5	-	-	13	15.8	-	-

* Based on W.H.O Cut-offs for BMI in adults.

Table 3: Anthropometric variables of the study population (mean $\pm$ S.D)

Variables	Gall stone patients n=82	Control group n=117	P value
Age (years)	44.73 $\pm$ 10.93	39.13 $\pm$ 5.26	0
B.M.I	26.55 $\pm$ 6.3	24.8 $\pm$ 4.9	0.016
WH ratio	0.85 $\pm$ 0.07	0.83 $\pm$ 0.06	0.512
M.A.C	29.02 $\pm$ 4.31	27.6 $\pm$ 5.32	0.091

Table 4: Physical activity and weight profile of gallstone patients and control group

Group	Physical	Body Mass Index (BMI)									
		< 18.5		18.5-24.9		25.0-29.9		30.0-39.9		Total	
		No	%	No	%	No	%	No	%	No	%
Study group n=82	Sedentary	10	66.7	19	70.4	23	85.2	12	92.3	64	78.1
	Moderate	4	26.7	6	22.2	3	11.1	1	7.7	14	17
	Heavy	1	6.6	2	7.4	1	3.7	-	-	4	4.9
Control group n=117	Sedentary	0	0	11	12.8	2	2.5	-	-	23	19.6
	Moderate	12	92.3	74	86.1	5	62.5	-	-	91	77.8
	Heavy	1	7.7	1	1.1	1	12.5	-	-	3	2.6

serum calcium levels, where cases had significantly lower HDL mean values (1.03 ± 0.41) than controls (1.22 ± 0.40) (Table 5).

Nutrition Profile: After analyzing the nutritive value of the food intake of the study participants both macro and micro nutrients

consumption were compared between cases and controls (Table 6). Patients consumed significantly more energy, protein, carbohydrate, fat, sugar, sodium, calcium, iron and vitamin A, vitamin B₁ and vitamin B₂ than the control subjects. However, the gallstone patients

Table 5: Blood biochemistry variable s of the study population (Mean $\pm$ SD)

Variables	Gall stone patients n=82	Control group n=117	P value
Fasting blood glucose (mmol/l)	5.87 $\pm$ 1.45	5.75 $\pm$ 1.45	0.629
Cholesterol (mmol/l)	4.40 $\pm$ 0.98	4.68 $\pm$ 0.94	0.085
LDL – Cholesterol (mmol/l)	3.03 $\pm$ 1.07	3.15 $\pm$ 0.84	0.374
HDL – Cholesterol (mmol/l)	1.03 $\pm$ 0.41	1.22 $\pm$ 0.40	0.005
Calcium (mmol/l)	2.10 $\pm$ 0.38	2.03 $\pm$ 0.37	0.001
Triglycerides (mmol/l)	1.49 $\pm$ 0.60	1.35 $\pm$ 0.67	0.003

Table 6: Differences in nutrients between gallstone patients and controls (Mean $\pm$ SD).

Variables	Gall stone patients n=82	Control group n=117	P value
Energy (K.cal)	2191 $\pm$ 1069	2040 $\pm$ 1329	0
Protein (gm)	112.2 $\pm$ 10	100 $\pm$ 12.4	0
Carbohydrate (gm)	275 $\pm$ 41.40	246.3 $\pm$ 49.70	0
Dietary fibre (gm)	18.7 $\pm$ 3.9	23.3 $\pm$ 2.4	0.04
Table sugar (gm)	197.9 $\pm$ 80.5	98.4 $\pm$ 32.2	0
Fat (gm)	82.9 $\pm$ 30.3	75.7 $\pm$ 19.4	0.004
Cholesterol (mg)	392.6 $\pm$ 81.80	396.2 $\pm$ 90.5	0.594
Saturated fats (gm)	29.0 $\pm$ 7.9	31.3 $\pm$ 6.5	0.121
Mono unsaturated fats (gm)	24.1 $\pm$ 5.06	25.1 $\pm$ 5.4	0.775
Polyunsaturated fats (gm)	19.7 $\pm$ 2.88	20.0 $\pm$ 3.1	0.016
Potassium (mg)	3138.7 $\pm$ 948.3	3420.3 $\pm$ 1094	0.106
Sodium (mg)	1957.8 $\pm$ 904.7	1696 $\pm$ 603	0
Calcium (mg)	622.9 $\pm$ 177	558 $\pm$ 191	0
Iron (mg)	19.3 $\pm$ 3.9	17.1 $\pm$ 3.5	0
Vitamin – A (μ g)	2423.5 $\pm$ 710	2241.7 $\pm$ 669	0.102
Vitamin – B1 (mg)	1.5 $\pm$ 0.1	1.47 $\pm$ 0.14	0.073
Vitamin – B2 (mg)	2.44 $\pm$ 0.3	1.87 $\pm$ 0.5	0
Vitamin – C (mg)	131.6 $\pm$ 29.1	157.19 $\pm$ 624	0.01

consume significantly less dietary fiber, potassium and vitamin C as compared to controls. Further-more, patients consumed, although not significant, less cholesterol, monounsaturated fat and polyunsaturated fat than controls.

DISCUSSION

The greater incidence of gallstones in older persons (Jorgensen and Jensen 1992) and in overweight (or) obese individuals (Misceiagna et al. 1999) is frequently reported in the literature. This tendency was also reported in the present study. Most studies that evaluated the relationship between lipids profile and GBD reported positive relationship between triglyceride concentration and GBD. In this study, the relationship was found in between triglyceride and total cholesterol with GBD. A number of epidemiologic studies have linked obesity, diabetes type 2 and hyperlipidemia of the type high serum triglyceride and low HDL, serum cholesterol to gallstone formation (Dowling 2000; Amigo et al. 1999; Paumgartner and Sauerbruch 1991).

Epidemiological studies have been performed in ultrasonographic population-based surveys and in prospective, cross-sectional or case-control studies in which the case groups are constituted by subjects harboring symptomatic gallbladder disease. The following dietary factors have been correlated to gallstone disease: energy intake, fatty acids, cholesterol, highly refined carbohydrates, alcohol, micronutrients and dietary fiber.

Energy intake has been directly associated to cholelithiasis risk, mainly by contributing to development of obesity. Obesity is a well known risk factor of gallstones primarily acting by increasing cholesterol synthesis, biliary cholesterol secretion and cholesterol super saturation (Hayes et al. 1992). A French study of 76 subjects with cholelithiasis detected by ultrasound, compared with paired control subjects, showed a higher risk associated to a high calorie diet (>2500 K. cal/day) (Caroli-Bose et al. 1998).

The present study results indicate that high intake of energy, proteins, carbohydrates, refined sugar and calcium may increase the risk of gallstone formation, whereas a high intake of dietary fiber, and vitamin C may protect against gallstone formation. With respect to energy intake, the results are similar to those obtained in the majority of studies that suggest the existence

of a positive relationship between high energy intake and GBD (Trautwein 1994; Ortega et al. 1997). The effect of carbohydrates on gallstone disease has been evaluated in several studies. In general terms, most of the studies revealed that consumption of refined sugars is directly associated gall bladder diseases. A high intake of refined sugars may increase the risk of gallstone development (Misceiagna et al. 1999).

A large number of epidemiological studies have shown that insoluble fiber intake is inversely associated to gall bladder disease. In cross-sectional study in Italy, a significant negative association between fiber intake and gallstones risk was detected²¹. In the present study, gallstone patients consumed more refined sugar and less dietary fiber compared to controls. The sugar could increase the likelihood of developing gallstones via an increased risk of obesity or an increase in insulin secretion and it tend to increase the cholesterol saturation of the bile and decrease the synthesis of bile acids (Caroli-Bose et al. 1998; Tandon et al. 1996). Insoluble fibre may protect against gallstone occurrence by reducing the generation of secondary bile acids such as deoxycholate, which has been associated with increased cholesterol saturation of the bile (Hayes et al. 1992; Low-Beer 1985).

Calcium has been hypothesized to protect gallstones by binding secondary bile acids including deoxycholate in the small intestinal lumen, thus reducing the deoxycholate and cholesterol content of the bile. While few studies showed no association between calcium intake and gallstone formations (Worthington et al. 1997) and few of them showed inverse association between dietary calcium and gallstones (Ortega et al. 1997). However, in the present study the gallstone patients consumed significantly higher dietary calcium other than the controls.

Vitamin C deficiency in guinea pigs reduces cholesterol 7 α -hydroxylase activity, leading to cholesterol super saturation of bile and formation of cholesterol gallstones (Simon 1993). Consistently, an experimental study in patients with gallstones and supplemented with vitamin C (2 g per day during two weeks) induced changes in bile composition and prolongation of nucleation time, suggesting that vitamin C supplementation may also influence the conditions for cholesterol crystal formation in humans (Gustafsson et al. 1997). The present study results shows that the control group consumed significantly more vitamin C compared to gallstone patients.

CONCLUSION

In view of the aforesaid results in the present study, the following conclusions could be drawn:

Individuals with overweight, obesity and low physical activity are more prone to the risk of cholelithiasis. The present study indicated that nutritional factors may play an important role in the etiology of gallstones and that most of these factors have been shown to play an important role in the etiology of other chronic diseases, such as type 2 diabetes, cardiovascular disease and cancer. The intake of calories, protein, carbohydrates, fat, sugar, saturated fat, sodium, calcium, iron and vitamin B2 are higher in study group as compared with control group whereas higher intake for dietary fiber, cholesterol, mono unsaturated fat, polyunsaturated fat, potassium, vitamin C were found in control group.

Factors associated with having gall stone among Guntur adults were age, more oral contraceptive usage, high triglycerides and low HDL, serum total cholesterol and sedentary life-style, high intake of table sugar, calcium, sodium and low intake of dietary fiber and vitamin C.

Gall stone disease is one of a cluster of diseases that characterize affluent societies and that most likely share common pathophysiologic links and mechanisms. Preventive strategies aimed at improving nutrition and energy imbalance may have a powerful effect on a series of pathologic conditions that represent a major source of morbidity and mortality in our society.

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