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IMPACT OF WEIGHT LOSS SURGERY AND DIABETES STATUS ON SERUM ALT LEVELS

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Abstract

PURPOSE—ALT is used to detect NAFLD and has been associated with increased risk of metabolic syndrome and T2DM. Bariatric procedures result in significant weight-loss and a rapid resolution of T2DM. We aimed to study the impact of bariatric interventions on ALT levels in patients with or without T2DM, and compare this effect between different types of weight-loss procedures.

METHODS—We reviewed 756 patients undergoing bariatric surgery. Demographics, co-morbidities, baseline and postoperative ALT and HbA1C levels, weight-loss data and diabetes status were recorded. ALT levels were compared between different procedures and between diabetics and non-diabetic patients. Chi-square test, ANOVA and t-test were used to evaluate outcomes.

RESULTS—Males and diabetics had significantly higher ALT at baseline. Both RYGB and LAGB resulted in significant reduction in ALT levels beginning at the 3rd postoperative month (20% and 17% respectively compared to baseline, $p<0.001$). ALT remained at the new low level up to year-3 after surgery. The degree of reduction was similar for both procedures and independent of the degree of weight-loss. In diabetics, ALT reduction was associated with improvement in disease but in T2DM patients who remained on insulin, ALT remained elevated.

CONCLUSIONS—RYGB and LAGB decrease ALT levels to the same degree and independent of weight loss. Our data confirm higher ALT in diabetics and demonstrate a rapid normalization after bariatric surgery with a simultaneous decrease in HbA1C. These results suggest that ALT may be used as a marker of metabolic improvement after bariatric surgery.

Keywords

Bariatric surgery; T2DM; RYGB; LAP-BAND; metabolic syndrome

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Conflict of Interest We, the authors, verify that the submitted material has not been published and is not currently submitted for publication elsewhere. We agree to the inclusion of our names in the list of authors on the manuscript in the order shown on the title page. D. Xourafas, A. Ardestani and S. W. Ashley have no conflicts of interest or financial ties to disclose. A. Tavakkoli has been a consultant for GlaxoSmith Klein and Novartis pharmaceutical. He is has an equity interest in Avaxia Biologics, Inc.

INTRODUCTION

Obesity in the United States has been increasingly cited as a major health issue in recent decades. The rates of obesity in the United States are among the highest in the world with 74.6% of Americans being overweight or obese [1]. Obesity results in increased visceral fat accumulation and insulin resistance and risk for progression to a broad spectrum of metabolic disorders such as type II diabetes mellitus (T2DM), hypertension (HTN), cardiovascular disease (CVD) and Non-Alcoholic Fatty Liver Disease (NAFLD) [2]. As a result, obesity is an important risk factor for much of adult morbidity and mortality [3].

Bariatric surgery is the best available therapy for treatment of morbid obesity and its associated co-morbidities. Many studies demonstrate that such procedures are not only characterized by a sustained lowering of weight but also improvements in insulin resistance, dyslipidemia and most importantly, a reduction in all cause mortality [4, 5]. These findings have been the driving force behind a dramatic increase in the number of such procedures in the recent years. Roux-en-Y Gastric Bypass surgery (RYGB) is the most common weight loss procedure, followed by Laparoscopic Adjustable Gastric Banding (LAGB) which constitutes approximately 40% of weight loss procedures in the US. Laparoscopic sleeve gastrectomy has become increasingly popular over the last few years. Despite differences in degree of weight loss between the 3 procedures, they all result in a significant reduction in BMI and improvements in metabolic parameters.

Alanine aminotransferase (ALT) is a liver enzyme commonly used to detect NAFLD, and is used as a marker of central and visceral adiposity [6]. Increased serum ALT levels have recently been associated with an increased risk of Metabolic Syndrome (MetS), CVD and T2DM [7]. Several prospective studies have shown that even modest elevations of serum ALT predict the development of MetS [8, 9]. Interestingly, higher levels of the enzyme, even when within the normal range, are now thought to be associated with an increase in the risk of developing T2DM and MetS, [9] leading to a lowering of the upper limit of the normal range to 19U/L and 30U/L for females and males, respectively [10].

Although many have studied the impact of weight loss surgery on BMI and obesity-related co-morbidities, the impact of such interventions on serum ALT levels have not been well-studied. The aim of the present study is to evaluate the long term effect of different types of bariatric procedures (RYGB and LAGB) on serum ALT levels and investigate any association between degree of weight loss and postoperative ALT changes. Importantly, we studied the impact of diabetes status on the serum ALT levels, and looked for an association between ALT changes and improvements in T2DM status in a large group of patients undergoing weight loss surgery. Our studies highlight a role for ALT as a biomarker of metabolic improvement after bariatric surgery.

MATERIAL and METHODS

Following institutional research committee approval, we performed a retrospective review of a prospectively entered database of bariatric procedures at the Brigham and Women’s Hospital. Baseline data were collected from March 1999 to March 2009. Inclusion criteria were adult patients who had undergone weight loss surgery during the above period (open or laparoscopic RYGB, or LAGB) and had recorded pre-operative and post-operative ALT levels. Exclusion criteria included acute or chronic liver disease including hepatitis A, B or C, autoimmune liver disease, hemochromatosis, Wilson’s disease, medication-induced liver disease, alcohol abuse and simultaneous cholecystectomy at the time of surgery. Alcohol abuse was defined based on the chart review of all hospitalizations and self-reported alcohol consumption of more than 2 drinks per day [11].

Out of 2,432 obese patients undergoing bariatric procedures within this time period, 756 patients met our inclusion and exclusion criteria. Type of surgery (open or laparoscopic RYGB, or LAGB) and weight loss data were recorded. Age, gender, height, weight, BMI and relevant co-morbidities such as T2DM status with associated baseline and postoperative treatment strategies, HTN, hyperlipidemia and CVD were also registered. Obesity was defined as BMI >30.

Serum ALT levels, HbA1C, weight and BMI were recorded before surgery (at baseline) and subsequently at one, three and six months, and then annually up to 3 years after surgery. Elevated ALT levels were defined according to the upper ALT limits of 19U/L and 30U/L for females and males respectively [10, 12].

T2DM status and other co-morbidities were obtained in detail by reviewing the medical records of all patients. CVD was defined based on patient record including any hospital admission with a primary or secondary discharge diagnosis of stroke, myocardial infarction, congestive heart failure, HTN or angina. We have decided a priori to limit our analysis to T2DM status of the patients due to our specific interest in relationship between T2DM and baseline ALT.

Serum HbA1C levels were recorded before surgery (at baseline) and subsequently at three, six months, and first year after surgery by reviewing the medical records of all patients with T2DM. Accordingly, pre and postoperative T2DM management with oral hypoglycemic medications and/or insulin as well as postoperative treatment modifications were also obtained. Such information was available from medication reconciliation records and pre and postoperative follow up visit data. Dates of medication discontinuation or dosage decrease were registered. T2DM resolution corresponded to both amelioration and full remission based on postoperative decrease and normalization of HbA1C and discontinuation or decrease of preoperative hypoglycemic medications.

ALT levels were initially compared with respect to age and gender. Subsequently, we compared serum ALT levels between and within groups of patients undergoing different type of surgeries (RYGB vs. LAGB). Further analysis detected the postoperative ALT variations between and within groups of patients with and without T2DM. Final analysis included ALT changes of T2DM patients with respect to different procedure.

Data is presented as mean ± standard deviation. Statistical analysis was performed using the following principles and tests: Categorical patient characteristics such as gender were compared between patient groups (DM vs. NON-DM and RYGB vs. LAGB) with Chi-square test. Continuous patient characteristics such as age, BMI, HbA1C and ALT levels were compared between the groups using the independent sample t-test, and within the groups with ANOVA (post-hoc method Tukey, was utilized for further confirmatory analysis). P-value of less than 0.05 was considered significant. The statistical analysis was conducted using SPSS (version 17.0 SPSS Inc, Chicago, Illinois). Pearson correlation was used to evaluate the relationship between baseline ALT and BMI (Comment#8) and paired student's t test was used to compare ALT levels between baseline and 1 year for T2DM patients who postoperatively remained insulin dependent.

RESULTS

Baseline values

At baseline, mean ALT for the study group was 29.1 ±28.9 U/L. There was no correlation between baseline BMI and ALT levels (Pearson's $r = 0.028$, $p = 0.45$) (Figure 1). Both male gender and T2DM status however, were associated with significantly higher ALT levels

(male vs. female, 41 ±33.2 vs. 27 ±27.5 U/L respectively, p<0.001) (T2DM vs. NON-DM, 37 ±37.2 vs. 27 ±26.4 U/L respectively, p<0.001).

Male patients below the age of 50 (age groups 20–50 years old) had significantly higher ALT levels compared to females in this age group (male vs. female, 49 ±40 vs. 28 ±27.5 U/L respectively, p<0.001) (Figure 2). Such age-based gender differences become attenuated and non-significant for patients in the older age group (50–70 years old).

Post-operative ALT changes based on procedure

ALT levels declined significantly post-operatively. To analyze the relationship between the postoperative ALT levels and different type of weight loss surgery, patients were divided into those who had RYGB (open or lap), (n=512) and those who had LAGB (n=244). Patient demographics and comorbidities were similar between the 2 groups (Table 1).

Although the BMI between the 2 groups was not statistically significant at baseline, by the 3rd postoperative month patients undergoing RYGB had a significantly lower BMI compared to those undergoing LAGB. This difference in the BMI between groups was maintained throughout the 3 year follow up period (final BMI 32 ±7 vs. 36 ±6.9, RYGB vs. LABG respectively; p<0.001), (Fig 3A).

Both types of surgery decreased the ALT levels to below 20 U/L by 6 months and this was maintained at the 3-year follow up (19.8 ±10 U/L and 19.1 ±9.1 U/L for patients undergoing RYGB and LABG respectively) (Fig 3B). RYGB and LABG procedures, both resulted in a similar and significant reduction of the ALT levels beginning at the 3rd postoperative month compared to baseline, despite significant differences in weight loss.

Post-operative ALT and HbA1C changes based on diabetes status

We subsequently analyzed post-operative changes in serum ALT between T2DM and non-diabetic patients. 172 patients were diagnosed with T2DM, for an overall T2DM prevalence of 23%. Patient characteristics are summarized in Table 2. We had small, but statistically significant differences between the 2 groups in terms of mean age and female gender. Despite statistical differences, the mean age of all patients was between a narrow range of 42 ±11 to 49 ±10 years, and in all groups more than 80% of the study participants were females.

As expected, patients with T2DM had increased prevalence of co-morbidities such as HTN, hyperlipidaemia and CVD compared to those without T2DM. However, there were no differences in baseline BMI, or the type of procedure that the patients underwent (RYGB or LAGB). Despite this similarity in baseline BMI, T2DM patients had statistically significant higher ALT levels at baseline compared to non-diabetics (37 ±34 vs. 27 ±26, respectively; p<0.05), (Table 2).

All weight loss procedures in both T2DM and NON-DM patients resulted in a significant reduction in the serum ALT levels by the 3rd postoperative month (21 ±10.8 vs. 20 ±16.3, T2DM vs. NON-DM respectively, p<0.001 compared to baseline). The levels had plateaued to below 21 by the 6th post-operative month and remained so up to 3 year after surgery (Fig 4-A).

Out of 172 patients with T2DM undergoing bariatric surgery, HbA1C levels were available for 125 patients. The mean baseline HbA1C was 8.3 ±1.9%. Following weight loss surgery the mean HbA1C level significantly decreased and reached a normal level of 6.1 ±0.6% at 3 months (p<0.001 compared to baseline). The HbA1C values continued to decrease to 6

±0.9% at 6 months (p<0.001 compared to baseline) and finally reached the level of 5.8 ±0.8% at 1 year after surgery (p<0.001) (figure 4-B).

For this group of 125 diabetic patients, we recorded baseline and postoperative diabetes management strategy. Excluding 13 patients who were managed with diet, we had 112 remaining patients that were treated with medications pre-operatively. Prior to weight loss surgery, 63 of them (56%) were treated with oral hypoglycemic medications alone, 26 (23%) with insulin alone, while 23 (16%) were treated with both insulin and oral anti-diabetic medications.

Subsequently, we defined the T2DM remission rates based on preoperative medication use and discontinuation following surgery. We found that within a mean follow up of 6 months, 81 patients (73%) had completely discontinued all preoperative hypoglycemic agents, 15 patients (13%) continued on decreased dosage of medications and 16 patients (14%) had some agents discontinued while others decreased.

Post-operative ALT and HbA1C changes in T2DM patients based on procedure

We explored the differences in serum ALT levels of T2DM patients undergoing different types of surgery. Of the 172 T2DM patients, 116 had a RYGB and 56 a LAGB procedure. The baseline ALT levels between the two surgical groups were significantly different (40 ±39 vs. 31 ±20 U/L, RYGB vs. LAGB respectively, p<0.001), despite similar BMI at baseline (47.8 ±6.9 vs. 46.6 ±6.5, RYGB vs. LAGB, respectively, p>0.05). Even though the baseline ALT levels of T2DM patients undergoing different types of surgery were significantly different, their ALT levels were always above the current upper limits of 19U/L and 30U/L for females and males respectively and always significantly higher than the levels of NON-DM (mean ALT of 27 U/L). In both groups however, by the 3rd postoperative month, there were no differences in ALT levels, despite differences in weight loss (Fig 5).

Out of 125 patients with T2DM and available HbA1C levels, 87 patients underwent RYGB and 38 patients underwent LAGB. The mean baseline HbA1C in both groups was 8.3 ±1.8%. Following weight loss surgery the mean HbA1C level significantly decreased in both surgical groups and reached a level of 6.1 ±0.7% vs. 6.3 ±0.6% at 3 months for RYGB vs. LAGB respectively. At 6 months following surgery, values furthermore decreased to 5.9 ±0.9% for RYGB patients and remained stable at 6.3 ±0.9% for those undergoing LAGB. HbA1C levels finally reached the level of 5.8 ±0.8% vs. 6.2 ±0.7%, RYGB vs. LAGB at 1 year after surgery. Interestingly, we observed that even though the overall HbA1C reduction was more pronounced for RYGB from 8.3% to 5.8% vs. LAGB from 8.3% to 6.2%, we had no statistical significant differences between the two procedures with respect to HbA1C decrease.

Furthermore we have analyzed the medication use data based on procedure. At baseline, more patients undergoing LAGB were on oral hypoglycemic treatment compared to those undergoing RYGB (68% vs. 41%, LABG vs. RYGB respectively, p<0.05). In contrast, more patients who had RYGB were managed with insulin (45% vs. 26%, RYGB vs. LABG respectively, p<0.05). Despite this difference, 75% of T2DM patients who underwent RYGB vs. 66% of patients undergoing LAGB discontinued all diabetes treatment (p>0.05).

Thirty eight percent of the patients who preoperatively were on insulin and underwent RYGB (15 of 39 insulin dependent RYGB patients) vs. 70% of those on insulin who had a LAGB (7 of 10 insulin dependent LAGB patients) continued with insulin treatment at least for one year following surgery (p<0.01). Interestingly, irrespective of procedure, insulin dependent patients maintained high ALT levels at one year follow-up (mean ALT: 31 ±14

vs. 30 ±14, baseline vs. 1-year respectively, p=0.9) compared to the decreased ALT levels of insulin-free patients (mean ALT: 36 ±15 vs. 19 ±8, baseline vs. 1-year respectively, p=0.028) (Figure 6). The serum ALT levels of patients undergoing RYGB who postoperatively continued to be insulin-dependent remained at a level of 33U/L compared to 34U/L at baseline. Similarly the serum ALT levels of those that remained on insulin treatment following LAGB were 26U/L vs. 28U/L preoperatively.

DISCUSSION

Abnormalities of liver function tests, in particular elevations of ALT are often seen in obese subjects. ALT is regarded as a marker of the degree of liver fat accumulation that is commonly seen in obesity and can lead to insulin resistance and T2DM. In fact several studies have shown that ALT is a marker of T2DM and MetS, even after adjustment for BMI and other risk factors [8, 9, 13]. The stronger association of ALT vs. BMI to metabolic disorders likely reflects the role of ALT as a measure of central and visceral adiposity. Ruhl et al compared visceral fat, BMI and waist circumference in a multivariate adjusted model, and showed that only visceral fat was strongly and independently associated with increased ALT levels, whereas BMI and waist circumference were not [14]. Thus visceral adiposity is a major determinant of serum ALT, and ALT can be a marker of metabolically active intra-abdominal fat. Other investigators have shown that the fat accumulation in the liver is independent of BMI and overall obesity but it is associated with insulin resistance [15]. These studies confirm that ALT can be a marker of visceral adiposity and a risk factor for insulin resistance. Our study highlights the potential role of ALT as a marker of diabetes resolution and shows that weight loss surgery will lead to metabolic improvement which is independent of changes in BMI.

Bariatric surgery remains the gold standard approach for long term weight loss, which is associated with significant metabolic benefits. Despite the role of ALT as a marker of metabolic dysfunction, there have been few studies that have looked at long term effect of weight loss surgeries on serum ALT. Although improvements in serum ALT and liver injury have been documented after RYGB and LAGB [16, 17], the impact of different surgical procedures on this metabolic marker has not been well studied. Since different bariatric operations impact BMI and metabolic profiles at a different rate and to a different degree, we investigated ALT changes in a cohort of patients that underwent RYGB and LAGB, looking at the rate of ALT normalization following these interventions.

Our study confirms an association between serum ALT, male gender and T2DM status. Preoperatively, male patients have significantly higher ALT serum levels compared to females. This is in accordance with the studies that have shown a higher visceral fat distribution in men compared to women [18, 19]. Although some believe that liver enzyme levels may increase progressively with increasing BMI, we did not observe this trend [20]. This is consistent with the observation that at any given BMI, liver fat content and ALT levels vary considerably and that ALT is more closely correlated to central adiposity, rather than absolute weight and BMI [14].

In this study we observed that ALT levels decrease significantly after bariatric surgery, reaching low normal values that are sustained in the long term. This decline was noted at the third post-operative month, reaching stable values by 6 months following surgery. There were no significant changes in the ALT levels over the subsequent 3 years of follow up. Although absolute changes in ALT levels may seem small, it should be highlighted that even modest changes in ALT levels are associated with changes in morbidity, supporting the hypothesis that ALT "normal" range needs to be interpreted with caution.

In our study, the mean pre-operative ALT level of T2DM patients was 37 while for the NON-DM it was 27. This degree of difference is consistent with a recent report in literature, where ALT level of non-obese, non-diabetic patients was found to be in the 20's while in those with insulin resistance and diabetes, the mean value was 32. These authors found that ALT was the determinant of insulin resistance independent of age, sex, and BMI [21].

An important finding of our study is that the ALT decreases are not related to the degree of weight loss. Despite the superiority of RYGB to LAGB in terms of excess weight loss, both procedures were equally effective in reducing serum ALT levels. As demonstrated in figure 3, despite the statistically significant differences of BMI reduction between procedures, the ALT reduction is equal between RYGB and LAGB. This is consistent with the finding that both procedures lead to significant reduction of liver fat and central adiposity. This phenomenon has been well documented for RYGB, but also LAGB. LAGB has been shown to be associated with a rapid initial visceral fat loss which is of greater degree to that of total body weight loss [22]. During the first 2 months after LAGB, there is preferential mobilization of visceral fat, as compared with total and subcutaneous adipose tissue that is associated with a significant reduction in liver volume [23]. This is the likely explanation for the rapid ALT decrease following banding procedures that is comparable to RYGB.

At baseline, T2DM patients also had a higher baseline ALT level, which is consistent with previous publications [24]. Our data reveal a rapid and significant decrease in serum ALT levels following bariatric procedures, with levels reaching those of the non-diabetic patients at 3 months. Since ALT is associated with visceral adiposity and liver fat accumulation, the rapid improvement in ALT levels of T2DM patients was expected. The observation that ALT levels remained low for up to 3 years after surgery reflects the durability of these operations in reducing visceral adiposity.

Interestingly, we found that the postoperative decrease in ALT levels parallels the reduction of Hb1AC levels, which decreases from a pre-operative value of 8.3% to 6.1% within 3 months of surgery. In addition to the significant postoperative decrease in HbA1C in T2DM patients, the discontinuation of hypoglycemic agents in 73% of patients is another factor that suggests the resolution of T2DM in our patient pool.

Our data showed no statistical differences between RYGB and LAGB in HbA1C normalization. This is however likely due to differences in baseline patient demographics. As previously noted, more insulin-dependent patients underwent RYGB than LAGB. Our results demonstrate that despite this baseline difference, with more severe T2DM patients undergoing RYGB, a higher percentage of patients showed improvements in their disease.

Furthermore, we document that both RYGB and LAGB reduced the ALT levels of T2DM patients in a similar manner. Irrespective of the type of procedure and despite significant differences in the weight loss between RYGB and banding procedures, ALT levels reached below 20 IU/Dl and were maintained at this level for up to 3 years of follow up. This provides further evidence that the reduction in ALT is not linked to total weight loss, even in T2DM patients. These findings suggested that ALT could be an indicator of T2DM improvement after bariatric surgery. To confirm this hypothesis, we focused on insulin dependent patients that underwent RYGB or LAGB, and divided them to those that became insulin free after surgery vs. those that remained insulin dependent. Although we were not able to assess preoperative medication use and NAFLD we found that ALT levels remained high for those that remain insulin-dependent vs. those that do not. This further strengthened our hypothesis that ALT may be used as a readily available marker of metabolic improvement after bariatric surgery.

Because of its retrospective nature, this study has the usual limitations associated with such study design. Specifically, we have hypothesized that the improvement in ALT levels is due to reduction in visceral adiposity however we were not able to provide data to support this, as biopsy or imaging data were not available pre- and post-operatively. Furthermore, due to the retrospective nature of the study and the lack of some data points, we were not able to gather information on baseline and postoperative medication use, or degree of NAFLD status at baseline, both factors that could influence ALT levels. We believe though that our data provides enough impetus to prospectively validate the role of ALT as a metabolic marker.

In conclusion, this study documents that both RYGB and LAGB result in a significant reduction in serum ALT levels. The decrease in ALT is similar between RYGB and LAGB despite statistically significant differences in post-operative weight loss, suggesting that the ALT decrease is independent of total weight loss. Following our results, further investigation is needed to confirm that ALT can be a surrogate marker of T2DM improvement after weight loss surgery.

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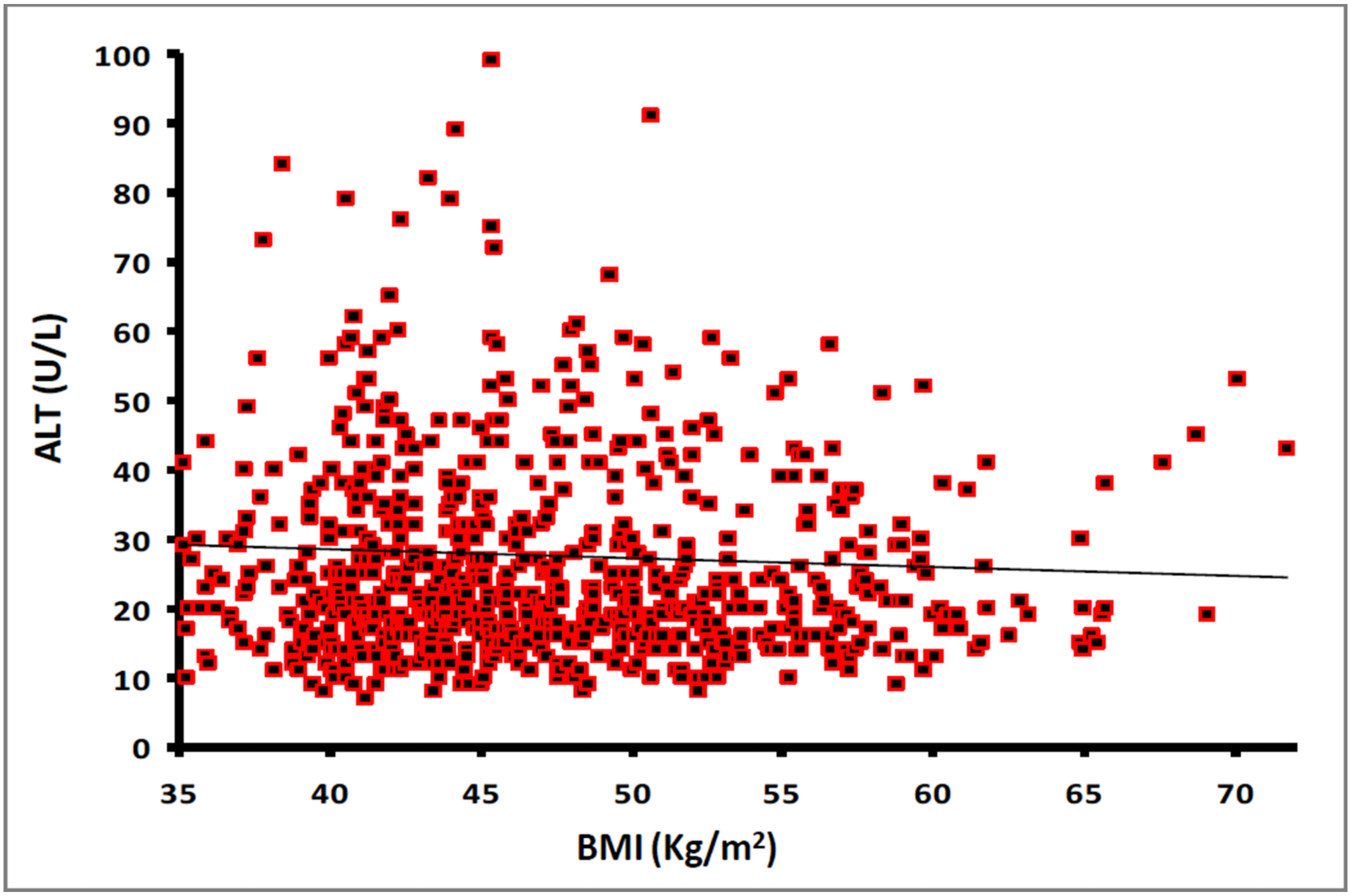


Figure 1.
There was no correlation between baseline ALT and BMI. At any given BMI, ALT serum levels vary considerably, depending on patient gender and T2DM status

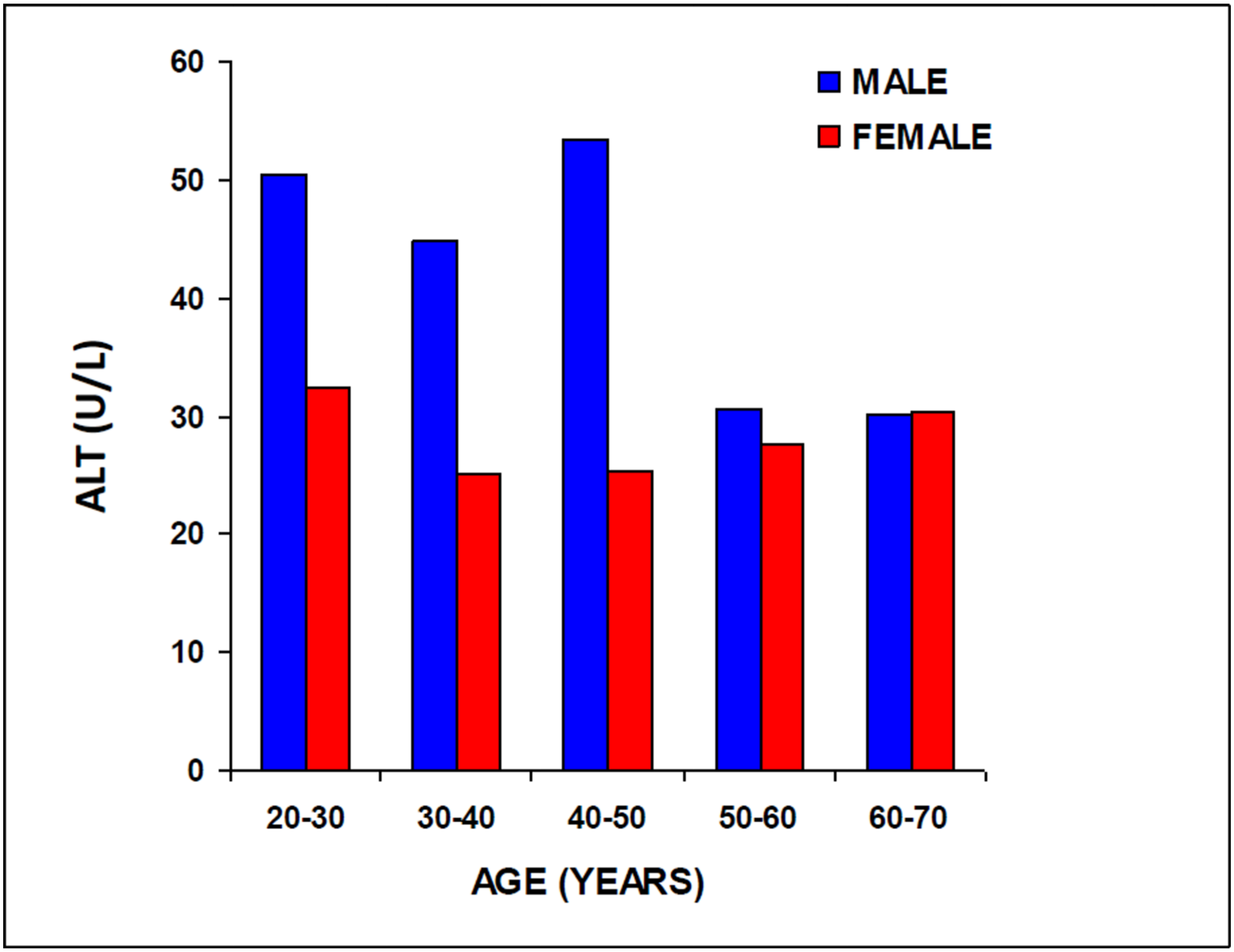


Figure 2.

Mean ALT levels for male and female patients at baseline. Male patients under the age of 50 had higher levels of ALT, however such age-based gender difference was not seen after the age of 50.

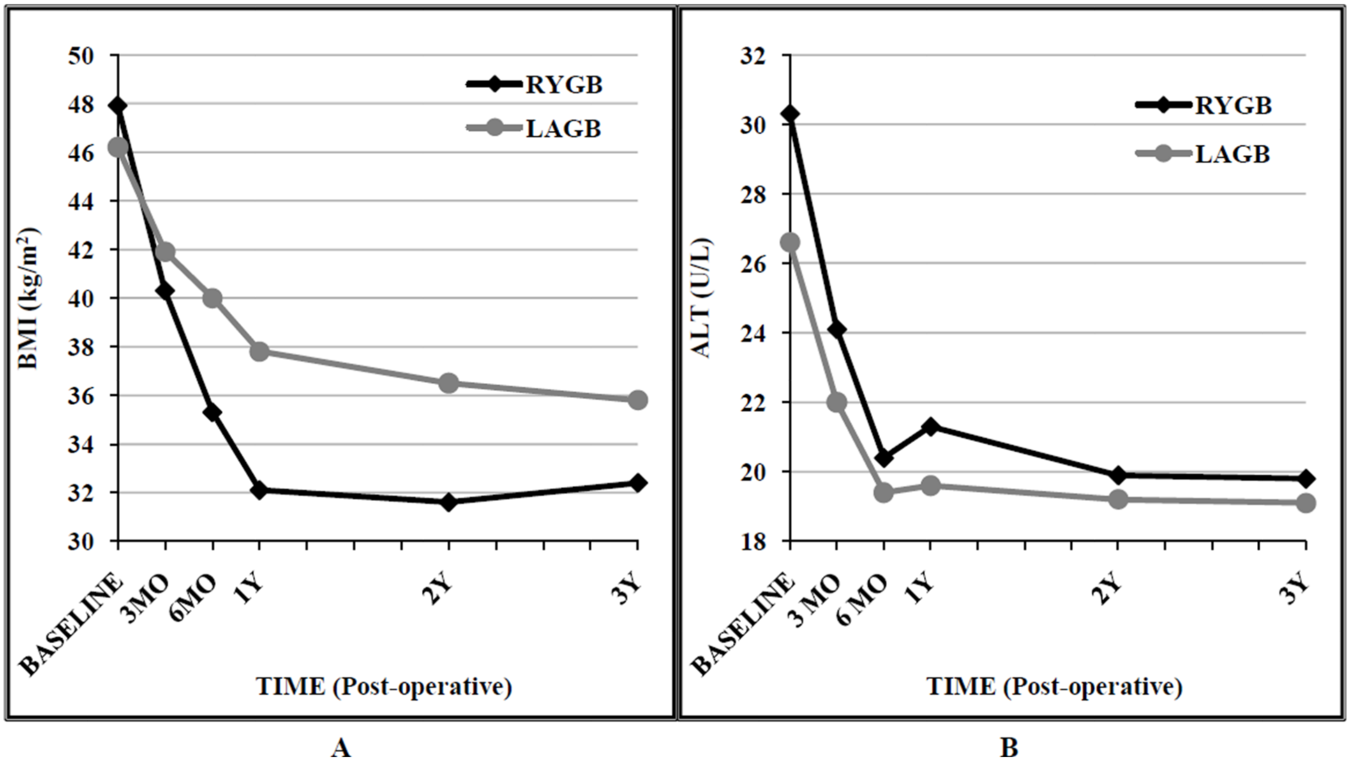
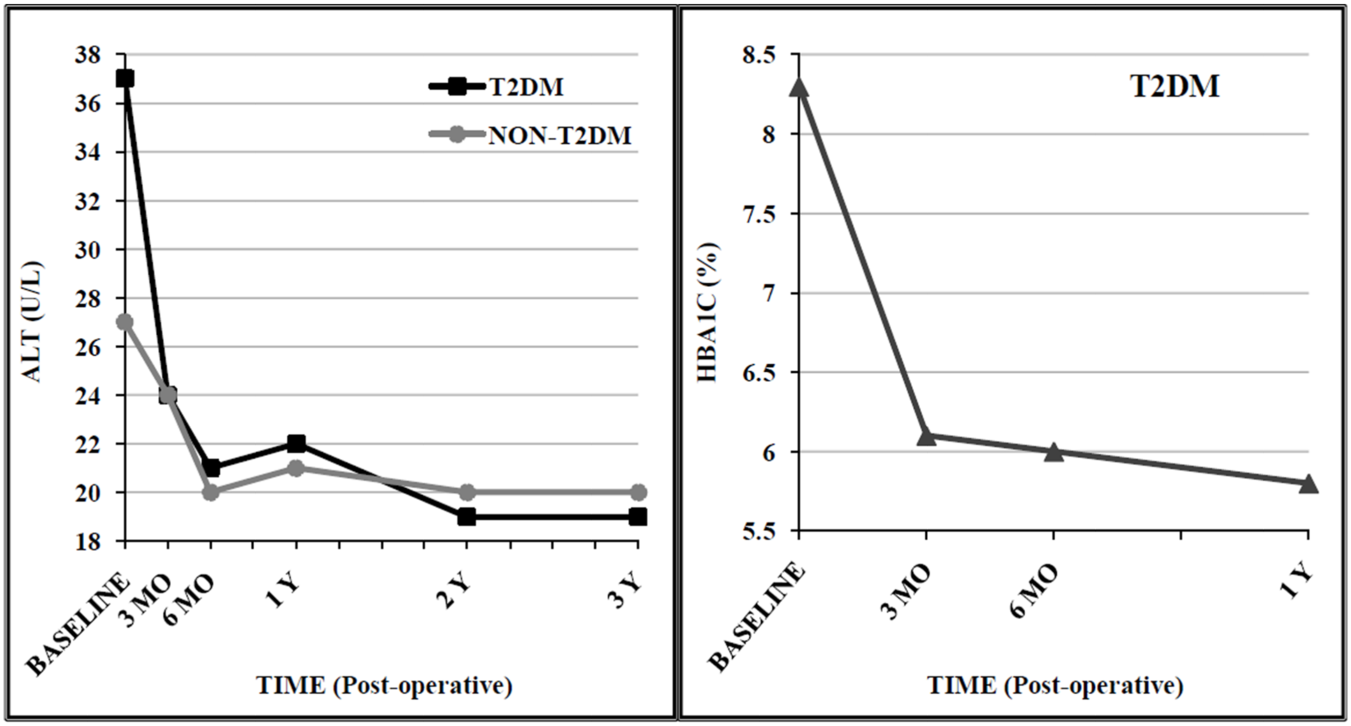


Figure 3.
A- BMI changes following different surgical procedures. During the 3 year follow up, RYGB and LAGB show a significant difference in the overall weight loss and reduction in BMI (32 vs. 36, respectively; $p<0.05$). B- ALT changes following different surgical procedures. During the 3 year follow up, both RYGB and LAGB decreased serum ALT levels (to 19.8 and 19.1 U/l, respectively at 3 years). The ALT reduction was similar despite significant differences in the weight loss.



A B

Figure 4.

A- Postoperative ALT changes in T2DM and NON-DM patients. Bariatric procedures decreased serum ALT levels starting at the 3rd postoperative month. This decrease was persistent up to the 3 years of follow up. B- Significant postoperative decrease and normalization of serum HbA1C levels in patients with T2DM from 8.3% to 6.1% at the first 3 months following surgery and subsequently to 5.8% at the first year following surgery.

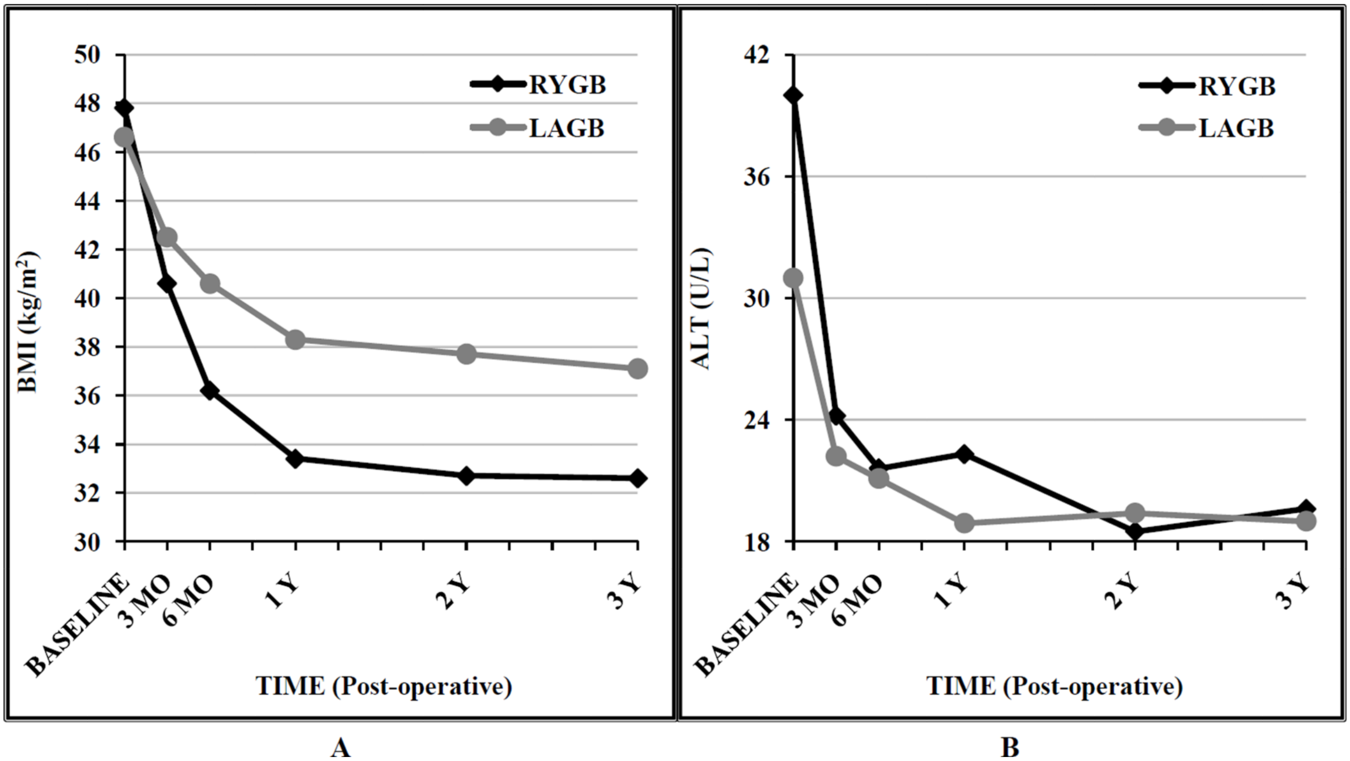


Figure 5.

A- BMI, B- ALT levels for T2DM patients following different surgical procedures. During the 3 year follow up, both RYGB and LAGB decreased ALT levels (19.6 and 19 U/l, respectively, $p<0.05$). This was despite a significant difference in the overall weight loss and reduction in BMI (34 vs. 38, respectively; $p<0.05$).

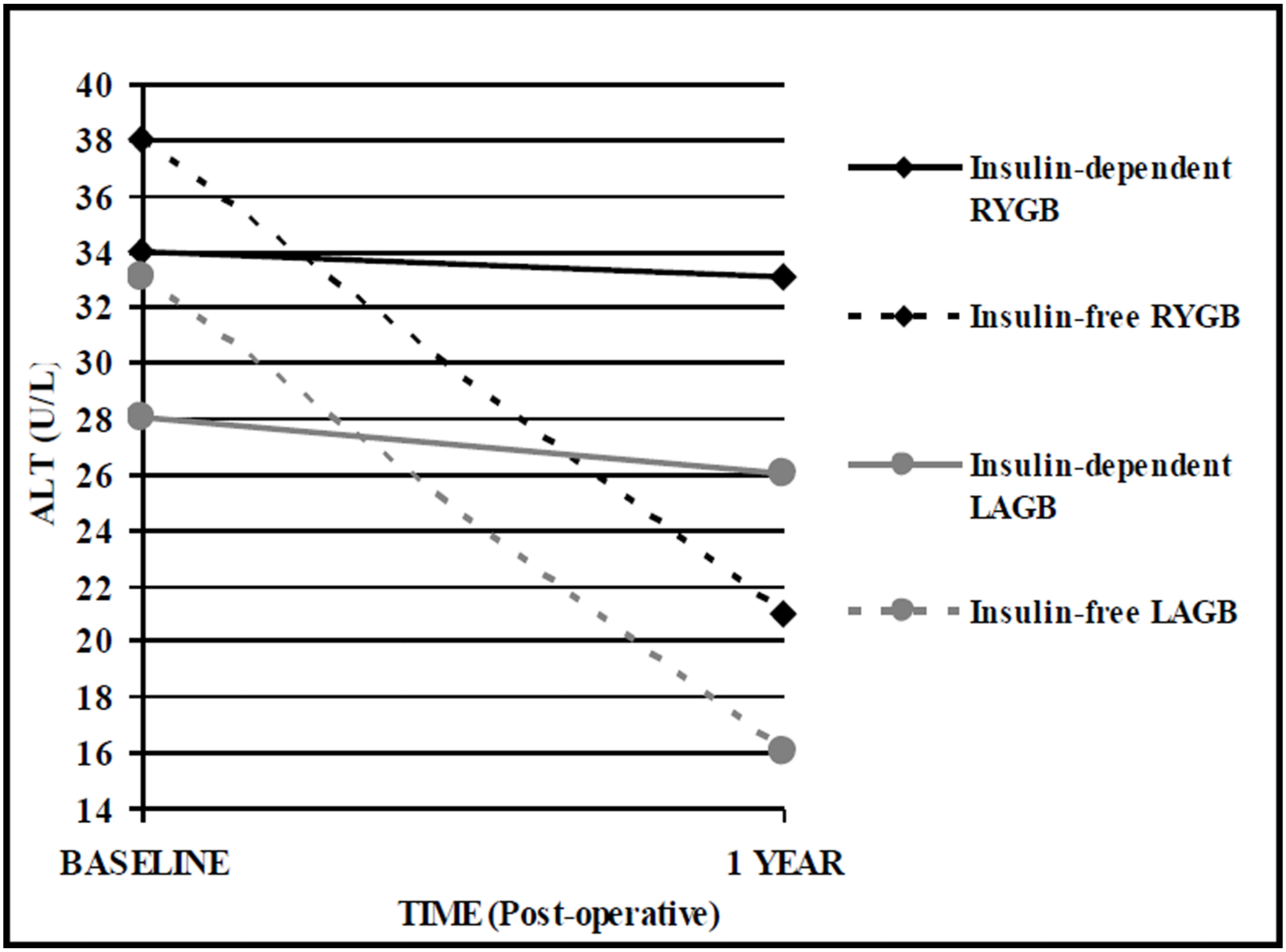


Figure 6.

Comparison of ALT levels between insulin-dependent T2DM who remained insulin dependent vs. insulin-free at 1-year of follow up. Patients are divided into those that underwent RYGB or LAGB. At 1 year, ALT levels remain high for those that remain insulin-dependent vs. those that do not.

TABLE 1

PATIENT CHARACTERISTICS FOR THE DIFFERENT WEIGHT LOSS PROCEDURES

	RYGB	**LAGB**	
Patient number	512	244	P-VALUE
Mean Age (years)	44 ±10.4	43 ±10.5	NS
% Female	85	83	NS
% T2DM	23	23	NS
Mean baseline BMI	47 ±6.9	46 ±6.4	NS

TABLE 2

BASELINE CHARACTERISTICS OF DIABETIC VS. NON-DIABETIC PATIENTS

	T2DM	NON-DM	
Patient number	172	584	P-VALUE
Mean Age (years)	49 ±10	42 ±11	<0.05
Female (%)	80	86	<0.05
Hypertension (%)	60	37	<0.05
Cardiovascular Disease (%)	4	1	<0.05
Hyperlipidemia (%)	27	18	<0.05
Mean baseline BMI	47 ±6.8	47 ±7.3	NS
Mean baseline ALT	37 ±34	27 ±26	<0.05
% undergoing RYGB	67	68	NS
% undergoing LAGB	33	32	NS