Case report

THE EFFECT OF BARIATRIC SURGERY ON LIPID PROFILE AND LIVER FUNCTION IN PATIENTS WITH TYPE 2 DIABETES

Tamar Shervashidze[1], Rusudan Kvanchakhadze[1], David Abuladze[2], Liana Jashi[3], Miranda Shervashidze[4], Iamze Taboridze[1]

[1]David Aghmashenebeli University of Georgia, [2]Davit Abuladze Georgian-Italian Clinic, [3]"Avicena" Batumi Medical University, [4]Batumi Batumi Shota Rustaveli State University

Contact person: Iamze Taboridze, iataboridze@yahoo.com

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Rezume

Background: In patients with morbid obesity, with or without diabetes, bariatric surgery is more effective in improving metabolic disturbances compared to other treatment methods. Mechanisms contributing to dyslipidemia remission after bariatric surgery may include positive effects on fat distribution and function, improved insulin sensitivity, and reductions in liver fat content and improved liver function.

Objective: To evaluate changes in lipid profile and liver function following bariatric surgery.

Materials and Methods: We examined 91 patients with type 2 diabetes and morbid obesity who underwent bariatric surgery-sleeve gastrectomy— at the "David Abuladze Georgian-Italian Clinic". Patients ranged in age from 23 to 67 years (mean 46.67 ± 8.60), including 50 women and 41 men. Clinical and laboratory data were compared before surgery and 2–4 years after surgery. We evaluated demographic characteristics, type and frequency of diet, preoperative weight loss, diabetes characteristics and duration, antihyperglycemic medications used preoperatively, liver function tests, lipid profile, and the number of "Healthy days" before and after surgery.

Results: A significant decrease in weight was observed postoperatively (from 146.8 kg to 97.9 kg). The frequency of fatty liver disease significantly decreased (from 88 patients [96.7%] to 18 patients [19.78%], $p < 0.0001$), as did the frequency of dyslipidemia (from 66 patients [72.53%] to 37 patients [40.66%], $p < 0.0001$). The number of patients with elevated liver function tests also decreased significantly. The frequency of elevated ALT decreased from 27.47% to 1.10% ($p < 0.0001$), and elevated AST and GGT were no longer observed after surgery. Fatty liver and dyslipidemia were negatively correlated with diabetes remission.

The likelihood of fatty liver remission after surgery increases with preoperative weight loss of 5–10%, increased physical activity, and diabetes remission. Conversely, it is reduced by alcohol consumption, a sedentary lifestyle, thyroid dysfunction, a high-fat diet, and preoperative weight loss of less than 5%.

Conclusions: In type 2 diabetes, bariatric surgery not only leads to weight loss but also promotes metabolic normalization. Diabetes remission after surgery is negatively correlated with dyslipidemia and fatty liver disease. Further reductions in fatty liver disease are predicted by diabetes remission and behavioral factors.

Key words: Bariatric surgery, dyslipidemia, behavioral factors, weight loss.

The past four decades have witnessed a marked increase in the prevalence of obesity and related metabolic disorders, particularly type 2 diabetes mellitus and nonalcoholic fatty liver disease. Currently, bariatric surgery is the most effective treatment for this growing global health problem, influencing food intake, gut hormone secretion, metabolic signaling pathways, and adipose tissue function [1].

Hepatic steatosis associated with metabolic disorders represents a serious public health problem [2, 3].

In patients with or without diabetes mellitus, bariatric surgery more effectively improves metabolic abnormalities than other treatment methods in cases of morbid obesity [4,5].

Mechanisms that contribute to dyslipidemia remission after bariatric surgery may include: positive effects on adipose tissue distribution and function, improved insulin sensitivity, reduced liver fat content, and improved hepatic function.

In the literature, bariatric and metabolic surgeries have been linked to dyslipidemia. However, there are limited large-scale, long-term (>2 years) comparative studies examining the remission and relapse frequency of dyslipidemia after these procedures [6].

In the study by Natália S. Lira et al., the SG group showed a significant improvement in total cholesterol levels, although the change was less pronounced than in the RYGB group. Total cholesterol decreased by 8.7% at three months postoperatively and by 6.7% after 24 months of follow-up [7].

Total cholesterol (TC) and triglyceride levels generally decrease, while high-density lipoprotein (HDL) levels increase within 2 years after surgery [8].

According to research by Charu Sharma and others, patients' lipid profiles improved 3 years after sleeve gastrectomy. The results particularly confirmed an increase in high-density lipoprotein (HDL) levels [9].

In a study published in journal "Endocrinología, Diabetes y Nutrici n", the effects of bariatric surgery on lipid profiles were evaluated over the next 60 months. The results showed that RYGB (Roux-en-Y gastric bypass) sig-

nificantly reduced total cholesterol levels, whereas SG (sleeve gastrectomy) did not. These findings suggest that RYGB may be more effective overall in reducing cholesterol levels in the long term.

At the end of the 60-month observation period, 54.8% of patients in the RYGB group met the criteria for complete remission of hypercholesterolemia (P < .001), compared to only 14.3% in the SG group (P = ns).

Nonalcoholic fatty liver disease (NAFLD) is very common in type 2 diabetes mellitus (T2DM), likely due to the high prevalence of obesity and insulin resistance associated with T2DM [10].

Our research **aims to** assess changes in the lipid profile and liver function.

MATERIALS AND METHODS:

We studied 91 patients with type 2 diabetes and morbid obesity at the David Abuladze Georgian-Italian Clinic, where they underwent bariatric surgery (sleeve gastrectomy). The patients' ages ranged from 23 to 67 years (mean age: 46.67 ± 8.60), and the group included 50 women and 41 men.

We compared patients' clinical and laboratory data before surgery and 2 to 4 years after surgery.

We studied the patients' demographic characteristics, type and frequency of diet, preoperative weight loss, diabetes characteristics, age, preoperative medications (A/D), liver function tests, lipid profile, and the number of healthy days before and after surgery.

Additionally, we compared patient characteristics by gender before and after surgery.

According to the Third National Cholesterol Education Program (NCEP) report, dyslipidemia is considered present in a patient when at least one of the following serum lipid indicators is abnormal:

- Total cholesterol ≥ 200mg/dL;
- LDL ≥ 130mg/dL;
- Triglycerides ≥ 150mg/dL;
- HDL < 50mg/dL for women or < 40mg/dL for men [11].

Statistical analysis

For qualitative indicators, frequency and percentage values were determined; for quantitative indicators, the mean and standard deviation were calculated. Qualitative indicators were compared between groups using Fisher's exact test (F criterion), and changes before and after surgery were assessed using the Wilcoxon Signed Ranks Test.

Quantitative characteristics were compared using Student's t-test for independent samples. The equality of variances was tested using Levene's test. To compare quantitative data before and after surgery, the paired Student's t-test was applied.

Results were considered statistically significant when $p < 0.05$.

Statistical analysis was performed using SPSS version 23.

RESULTS:

Significant weight loss was observed in patients following bariatric surgery. The changes in

The weight change after surgery is shown in Diagram 1.

As shown in the diagram, the decrease in average patient weight after the operation appears reliable. Weight loss is accompanied by the normalization of metabolism. A reliable decrease in the frequency of patients exhibiting liver function abnormalities is also noted.

The change in liver function in patient samples after surgery is presented in Table 1.

The frequency of fatty liver disease and dyslipidemia is significantly reduced. The frequency of patients with elevated liver function tests is also significantly reduced.

There is no longer an increase in AST and GGT levels after surgery.

In this phase of the study, we analyzed the distribution of fatty liver disease by gender (Table 2). Patients demonstrated a decrease in the frequency of consuming simple carbohydrates and an increase in the frequency of consuming protein-rich foods.

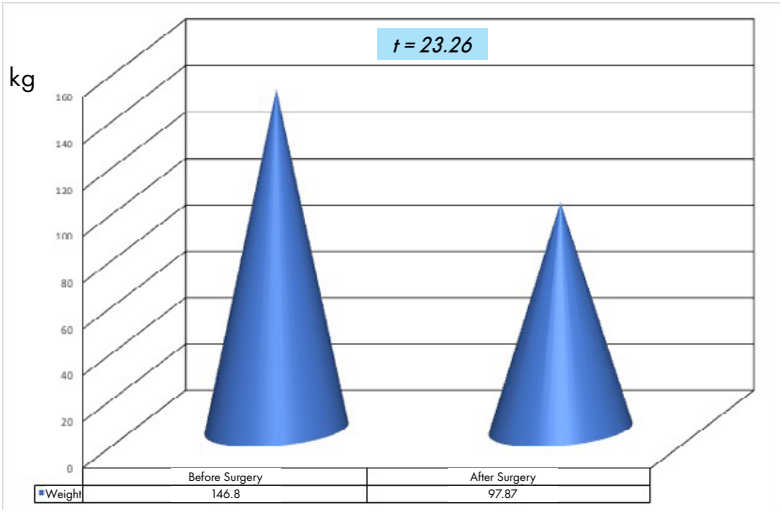

Diagram 1. Weight change after surgery

Table 1. Changes in clinical and laboratory characteristics after surgery

Factors		Before the Surgery		After the Surgery		
		n	%	n	%	p
Liver function sample elevation	ALT	25	27.47	1	1.10	<0.0001
	AST	24	26.37	0	0.00	<0.0001
	GGT	28	30.77	0	0.00	<0.0001
Comorbidities	Hypertension	75	82.42	27	29.67	0.000
	Fatty liver disease	88	96.7	18	19.78	<0.0001
	Dyslipidemia	66	72.53	37	40.66	<0.0001
Food type	Mixed	91	100	75	82.42	0.0001
	Simple Carbohydrates	58	63.74	19	20.88	<0.0001
	Protein	25	27.47	6	6.59	0.0003
	Complex Carbohydrates	78	85.71	5	5.49	<0.0001

Table 2. Distribution of fatty liver disease by gender

Factors	Man		Woman		F	p
Increased fatty liver (hepatosis) before surgery	51	98.08	37	94.87	0.71	0.4024
Fatty liver after surgery	12	23.08	6	15.38	0.82	0.3675
	<0.0001		<0.0001			

As observed, there was no statistically significant difference between sexes in the prevalence of fatty hepatosis before surgery, with 98.08% of males and 94.87% of females affected. After surgery, the frequency of fatty hepatosis decreased significantly in both groups, and no significant difference between the sexes was observed.

We conducted a correlation analysis to determine the relationship between fatty liver disease reduction and diabetes remission (Table 3).

Postoperative fatty hepatosis and dyslipidemia were negatively correlated with diabetes remission.

We used regression analysis to estimate the probability of remission of fatty hepatosis after surgery.

The relative chance of remission of fatty hepatosis after surgery is determined by: preoperative weight loss of 5-10%, increased physical activity, type 2 diabetes diabetes remission, reduced: alcohol consumption, sedentary lifestyle, thyroidopathy, fatty diet, preoperative weight loss <5%.

Table 3. The relationship between type 2 diabetes remission and liver function tests

		Diabetes remission
Fatty hepatosis after surgery	r	-0.252 *
	p	0.016
Dyslipidemia after surgery	r	-0.237 *
	p	0.024

Table 4. Estimation of the relative chance of remission of fatty hepatosis after surgery

Predictors	B	SE	Forest	p	Exp(B)	95% CI for EXP(B)	
						Lower	Upper
Sedentary lifestyle	-5.26	1.89	7.74	0.0054	0.005	0.001	0.211
Thyreopathy	-2.29	1.16	3.92	0.0476	0.101	0.010	0.976
Fatty diet	-3.13	1.06	8.69	0.0032	0.044	0.005	0.351
Preoperative weight loss 5%-10%	8.21	2.72	9.10	0.0026	369.527	17.773	7680.148
Preoperative weight loss <5%	-3.15	1.34	5.56	0.0184	0.043	0.003	0.587
Alcohol Consumption	-6.00	2.00	8.99	0.0027	0.002	0.001	0.125
Remission of type 2 diabetes	3.20	1.02	9.79	0.0018	24.419	3.300	180.685
Increase in physical activity	3.48	1.22	8.13	0.0044	32.516	2.968	356.182

DISCUSSION:

Bariatric surgery has a beneficial effect not only on weight loss but also on metabolic changes [12], as it alters usual lifestyle habits, leading to medical interventions [13].

The lipid profile of patients 3 years after sleeve gastrectomy, as reported by Charu Sharma et al., confirms improvements in outcomes, particularly an increase in high-density lipoproteins (HDL). A study published in "Endocrinolog a, Diabetes y Nutrici n" evaluated lipid profiles up to 60 months after surgery. The results showed that RYGB (Roux-en-Y gastric bypass) significantly reduced total cholesterol levels, whereas SG (sleeve gastrectomy) did not. RYGB may be more effective than other procedures in reducing total cholesterol and improving long-term prognosis. At the end of follow-up (60 months), 54.8% of patients in the RYGB group met the criteria for complete remission of hypercholesterolemia (P < .001), compared to only 14.3% in the SG group (P = ns) [9].

According to our study, both liver function parameters and lipid profiles normalize with weight loss following bariatric surgery.

Bariatric surgery provides intermediate benefits in the treatment of fatty liver disease associated with metabolic dysfunction [14].

According to our data, after bariatric surgery, the incidence of fatty liver disease decreases, and liver function test results normalize.

Predictors of reduced fatty liver disease include preoperative weight loss of less than 5%, increased physical activity, and remission of type 2 diabetes.

CONCLUSIONS:

In type 2 diabetes, bariatric surgery not only results in weight loss but also normalizes metabolism. Following bariatric surgery, diabetes remission is negatively correlated with both dyslipidemia and fatty liver disease. Further reductions in fatty liver disease are predicted by diabetes remission and behavioral factors.

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ბარიატრიული ქირურგიის ეფექტი ლიპიდურ პროფილსა და ღვიძლის ფუნქციაზე ტიპი 2 დიაბეტის მქონე პაციენტებში

თამარ შერვაშიძე[1], რუსუდან კვანჭახაძე[1], დავით აბულაძე[2], ლია ჯაში[3], მირანდა შერვაშიძე[4], იამზე თაბორიძე[1]

[1]საქართველოს დავით აღმაშენებლის სახელობის უნივერსიტეტი; [2]დავით აბულაძის ქართულ-იტალიური კლინიკა, [3]„ავიცენა“ ბათუმის სამედიცინო უნივერსიტეტი, [4]ბათუმის შოთა რუსთაველის სახელმწიფო უნივერსიტეტი

პასუხისმგებელი პირი: იამზე თაბორიძე, iataboridze@yahoo.com

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რეზიუმე

მორბიდული სიმსუქნის მქონე პაციენტებში, დიაბეტით ან მის გარეშე,ბარიატრიული ქირურგია უფრო ეფექტურად აუმჯობესებს მეტაბოლურ დარღვევებს, ვიდრე მკურნალობის სხვა მეთოდები. მექანიზმები, რომლებიც ხელს უწყობენ დისლიპიდემიის რემისიას ბარიატრიული ოპერაციის შემდეგ, შეიძლება მოიცავდეს დადებით გავლენას ცხიმოვანი ქსოვილის განაწილებაზე/ფუნქციაზე, ინსულინის მგრძნობელობაზე, ღვიძლის ცხიმის შემცველობაზე/ფუნქციაზე.

ჩვენი **კვლევის მიზანია** ლიპიდური სპექტრის და ღვიძლის ფუნქციის ცვლილების შეფასება.

მასალა და მეთოდები: შევისწავლეთ შაქრიანი დიაბეტით დაავადებული, მორბიდული სიმსუქნის მქონე 91 პაციენტი, რომელთაც „დავით აბულაძის ქართულ-იტალიურ კლინიკაში” ჩაუტარდათ ბარიატრიული ოპერაცია - კუჭის „სახელოსებრი რეზექცია“ პაციენტების ასაკი მერყეობდა 23-დან 67 წლამდე (46.67+8.60), მათ შორის 50 ქალი და 41 კაცი.

შევადარეთ პაციენტთა კლინიკური და ლაბორატორიული მონაცემები ოპერაციამდე და ოპერაციიდან 2-4 წლის შემდეგ.

შევისწავლეთ პაციენტთა დემოგრაფიული მახასიათებლები, კვების ტიპი და ჯერადობა, წინასაოპერაციო წონაში კლება, დიაბეტის მახასიათებლები და ხანდაზმულობა, ა/დ მედიკამენტები (ოპერაციამდე), ღვიძლის ფუნქციური სინჯები და ლიპიდური სპექტრი, „ჯანმრთელი დღეების“ რიცხვი ოპერაციამდე და ოპერაციის შემდეგ.

შედეგები: ბარიატრიული ოპერაციების შემდგომ პაციენტებში აღინიშნა წონის მკვეთრი კლება (146.8 ოპერაციამდე და 97.9 ოპერაციის შემდეგ).

სარწმუნოდ მცირდება ცხიმოვანი ჰეპატოზის სიხშირე (შესაბამისად - 88 (96.7) და 18 (19.78), p<0.0001) და დისლიპიდემიის სიხშირე (66 (72.53) და 37 (40.66), p<0.0001).

სარწმუნოდ მცირდება იმ პაციენტთა სიხშირე, რომელთაც აღენიშნებოდათ ღვიძლის ფუნქციური სინჯების მატება. მცირდება ALT-ს მომატებული სიხშირე, შესაბამისად 25 (27.47) და 1 (1.10), (p <0.0001) საერთოდ აღარ გვაქვს AST და GGT-ს მომატებული მნიშვნელობა.

ოპერაციის შემდეგ ცხიმოვანი ჰეპატოზი და დისლიპიდემია უარყოფით კორელაციაშია დიაბეტის რემისიასთან.

რეგრესიული ანალიზის საშუალებით განვსაზღვრეთ ცხიმოვანი ჰეპატოზის რემისიის ალბათობა ოპერაციის შემდეგ.

ცხიმოვანი ჰეპატოზის რემისიის ფარდობით შანსს ოპერაციის შემდეგ ზრდის: წინა საოპერაციო წონაში კლება <5%, ფიზიკური აქტივობის გაზრდა, შაქრიანი დიაბეტის რემისია, ამცირებს: ალკოჰოლის მოხმარება, მჯდომარე ცხოვრება,თირეოპათია, ცხიმოვანი დიეტა, წინა საოპერაციო წონაში კლება<5%

დასკვნები:

- ტიპი 2 დიაბეტის დროს ბარიატრიული ოპერაცია, გარდა წონაში კლებისა, იწვევს მეტაბოლიზმის ნორმალიზებას;
- ბარიატრიული ოპერაციის შემდეგ, დიაბეტის რემისია უარყოფით კორელაციაშია დისლიპიდემიასთან და ცხიმოვან ჰეპატოზთან;
- ოპერაციის შემდგომი ცხიმოვანი ჰეპატოზის შემცირების პროგნოზს განსაზღვრავს დიაბეტის რემისია და ქცევითი ფაქტორები.

საკვანძო სიტყვები: ბარიატრიული ქირურგია, დისლიპიდემია, ქცევითი ფაქტორები, წონაში კლება.