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Cross-sectional analysis of the medium-term impact of bariatric surgery on pharmacological expenditure

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ABSTRACT

Introduction: Obesity and associated diseases represent an important health and economic problem since pharmacological treatment for many of these pathologies needs lifelong subsidies. Theoretically, bariatric and metabolic surgery decreases the medication requirements of patients for these diseases but may result in other types of pharmacological needs. This study aims to demonstrate whether there is a real decrease in pharmacological expenditure after bariatric surgery.

Material and methods: Retrospective cross-sectional analysis of patients who were treated in our centre between 2012 and 2015, comparing different associated comorbidities and pharmacological expenses one month before and 2 years after surgery.

Results: A total of 280 patients underwent surgery; 36.8% of patients had diabetes, 50% hypertension, 11.1% cardiovascular disease, 13.9% osteoarticular disease, 13.6% endocrine disorders, 30% non-diabetic metabolic disorders, and 35.4% psychiatric disease. At 2 years after surgery, 12.1% of patients continued medication for diabetes, and 28.2% for arterial hypertension. Additionally, 9.3% of patients still had cardiovascular disease, 7.1% osteoarticular disease, 10.4% endocrine disorder, 13.9% non-diabetic metabolic disorder, and 29.3% psychiatric disease. Median pharmacological expenditure before surgery was 17 euros per month; 2 years after surgery, it was 12 euros a month, resulting in a significant decrease ($p < 0.001$).

Conclusions: In a 2-year follow-up after bariatric surgery, a decreased prevalence of obesity-related diseases and associated pharmacological expenditure was observed, showing the efficiency of this intervention over the medium term and potentially over the long term.

1. Introduction

Overweight and obesity as well as associated pathologies are a serious health problem for both developed and underdeveloped countries; currently, these conditions are considered a global pandemic (Crawford et al., 2010; World Health Organization, 2000).

Bariatric surgery results in long-term improvement and decreased body weight; moreover, in many cases, obesity-related diseases are resolved (Arterburn et al., 2005).

These obesity-related diseases (directly or indirectly associated) are usually controlled by means of pharmacotherapy. This pharmacological need is usually lifelong if obesity is not resolved or improved, representing important costs for different health systems or patients themselves (Padwal et al., 2004).

Two years after surgery is the time when the majority of patients get the maximum benefit from it, although in a significant number of patients there will be a recovery of weight in the following 2–3 years (50% will recover 25% of the maximum weight lost) which would lead to the recurrence of comorbidities and, potentially, of the cost of the medication.

This study aims to analyse the pharmacological needs in patients undergoing surgery for morbid obesity, comparing the time prior to surgery and after a two-year follow-up to assess whether there is a real decrease in these needs and associated pharmacological expenditure.

2. Material and methods

The present cross-sectional retrospective study was carried out

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Table 1
Preoperative demographic and comorbidity factors.

		TOTAL	SLEEVE	BYPASS	P-Value
		n = 280	n = 107	n = 173	
Age[a]		52 (43–57)	51 (41–57)	52 (44–58)	0.082[b]
Gender					
	Male	90 (32.1%)	35 (32.7%)	55 (31.8%)	0.90[c]
	Female	190 (67.9%)	72 (67.3%)	118 (68.2%)	
Weight kg[a]		125 (113–142)	141 (124–148)	120 (110–132)	< 0.001[b]
BMI[a]		47 (43–52)	53 (48–58)	44 (42–47)	< 0.001[b]
Arterial hypertension		140 (50%)	52 (48.6%)	88 (50.9%)	0.80[c]
Diabetes		103 (36.8%)	28 (26.2%)	75 (43.4%)	0.005[c]
OSAS		240 (85.7%)	90 (84.1%)	150 (86.7%)	0.60[c]
CPAP use		237 (84.6%)	90 (84.1%)	147 (85%)	0.87[c]
Cardiovascular comorbidity		31 (11.1%)	16 (15%)	15 (8.7%)	0.12[c]
Osteoarticular comorbidity		39 (13.9%)	16 (15%)	23 (13.3%)	0.72[c]
Endocrine comorbidity		38 (13.6%)	8 (7.5%)	30 (17.3%)	0.02[c]
Metabolic comorbidity		84 (30.0%)	27 (25.2%)	57 (32.9%)	0.18[c]
Psychiatric comorbidity		99 (35.4%)	36 (33.6%)	63 (36.4%)	0.70[c]
Other comorbidity		18 (6.4%)	4 (3.7%)	14 (8.1%)	0.21[c]

[a] Median (interquartile range).
[b] (Mann-Whitney).
[c] (Fisher's exact).

between 2012 and 2015; 280 patients undergoing bariatric surgery were evaluated. Clinical support programmes were used for the collection of data, where all the pathologies and medication corresponding to each patient are included.

The following patient demographic and clinical variables were collected one month prior to surgery: age, gender, weight, height and BMI, as well as comorbidity factors associated with morbid obesity, considering that these comorbidities involve pharmacotherapy in every case. These comorbidities included arterial hypertension (HBP); diabetes (DM); obstructive sleep apnoea syndrome (OSAS) and the use of continuous positive airway pressure (CPAP); cardiovascular, osteoarticular, endocrine, metabolic, and psychiatric pathologies; and other comorbidities that were initially related to morbid obesity (hyperuricaemia, anaemia, hypocalcaemia, and hiatal hernia). The total pharmacological expenditure for each patient is expressed as the median at the time of analysis and not as an absolute value. In this price, CPAP is not included, since only pharmacological costs are considered. This total expense was calculated in euros for each patient during a period of 30 days immediately before and 2 years after surgery. This first study is performed at 2 years, knowing that it is the time of greatest benefits of bariatric surgery, waiting for a new comparison at 5 years.

In turn, the following surgical factors were considered: ASA anaesthetic, type of bariatric surgery (sleeve or bypass), postoperative complications (haemorrhage, fistula, pneumonia, or other), need for reintervention in the same admission, hospital stay (in days), aftermath, understanding the pathology that occurs throughout the follow-up as a direct consequence of bariatric surgery. This pathology included cholelithiasis, incisional hernia, anastomotic complications (stenosis or perforations), and internal hernias, as well as the need for reintervention (revision surgery).

Vertical gastrectomy (VG) or a gastric sleeve was initially indicated in patients with BMI > 50 kg/m^2 as the first intervention to facilitate a second intervention with a mixed technique. Subsequently, given the good results obtained, VG was extended to BMI between 35 and 40 with greater comorbidities. These comorbidities included age > 60 years; high-risk with severe hepatic, cardiac pathology, or chronic kidney disease; and gastric premalignant pathology.

Gastric bypass (RYGBP) was indicated for patients with BMI < 50 and metabolic disorders, especially type II DM. In the latter patients (DM), a different RYGBP approach was carried out to try to improve the metabolic component as defined later in the text. Similarly, the eating habits of patients were considered, and RYGBP was chosen for patients who peck at food. This surgery is the first choice for these patients due to the high failure rate of restrictive techniques. All patients included in the study underwent laparoscopic surgery.

The results on the variables allowed us to compare the total cost of all comorbidities two years after surgery with the previous cost. The included variables were weight and BMI, persistence or onset of comorbidities, including those in addition to comorbidities mentioned before surgery, those related to vitamin and nutritional deficits secondary to the surgery, and total median pharmacological expenditure.

Patients undergoing bariatric surgery—VG, conventional RYGBP (biliopancreatic pouch 60 cm and food pouch 150–200 cm), and metabolic RYGBP (biliopancreatic pouch 100 cm and food pouch 150–200 cm)—were included, with ages between 18 and 60 years according to the established indications. Gastric band removal and other revision surgeries were excluded from the study.

Continuous variables are presented as the median (interquartile range), and qualitative variables are presented as frequencies (percentages). Categorical variables were compared using Fisher's exact test or McNemar's test. Continuous variables were compared using the Mann-Whitney U test or Wilcoxon test. For statistical analysis, the SPSS® software package, version 20 (IBM, Armonk, New York, United States) was used. The risk ratio with its safety confidence intervals at 95% (95%CI) for paired data was calculated before/after each intervention to compare the risk reduction intensity of type II DM after surgery involving the three surgical techniques. In all cases, statistical significance was considered at $p < 0.05$.

3. Results

Table 1 shows demographic results and comorbidity factors one month prior to surgery. Note that female was the predominant gender for this intervention. BMI was higher in patients undergoing VG, which makes sense considering the first indications for this technique. In patients with metabolic pathology (hypertension, DM2 and dyslipidaemia), RYGBP predominates over restrictive techniques.

Table 2 shows the surgical factors. Most patients were ASA III. Surgical complications were rare for both techniques. However, bleeding from stitches was the most frequent complication, which was more frequent in RYGBP. Only one reintervention was necessary during the 3 years of the study. Postoperative stay (in days) was similar for both techniques but somewhat longer for RYGBP.

Table 3 shows the results at two years after surgery in which

Table 2
Surgical factors and general outcomes of surgery.

		TOTAL	SLEEVE	BYPASS	P-Value
		n = 280	n = 107	n = 173	
Previous surgery		129 (46.1%)	43 (40.2%)	86 (49.7%)	0.14[c]
ASA					
	I	1 (0.4%)	0	1 (0.6%)	0.89[c]
	II	24 (8.6%)	10 (9%)	14 (8.1%)	
	III	255 (91%)	97 (91%)	158 (91.3%)	
Postoperative complications					
	Haemorrhage	5 (1.8%)	1 (0.9%)	4 (2.3%)	0.25[c]
	Fistula	1 (0.4%)	0	1 (0.6%)	
	Pneumonia	1 (0.4%)	1 (0.9%)	0	
	Other	4 (1.4%)	0	4 (2.3%)	
Reintervention		1 (0.4%)	0	1 (0.6%)	1[c]
Postoperative stay[a]		5 (4–5)	5 (3–5)	5 (4–6)	0.008[b]
Aftermath		47 (16.8%)	22 (20.6%)	25 (14.5%)	0.19[c]
Reintervention by sequelae		40 (89%)	18 (86%)	22 (92%)	0.65[c]

[a] Median (interquartile range).
[b] (Mann-Whitney).
[c] (Fisher's exact).

Table 3
Results at 2 years.

	TOTAL	SLEEVE	BYPASS	P-Value
	n = 280	n = 107	n = 173	
Weight kg[a]	90 (78–103)	100 (85–113)	85 (76–96)	< 0.001[b]
BMI [a]	33 (30–38)	37 (33–43)	32 (28–35)	< 0.001[b]
High blood pressure treatment	79 (28.2%)	33 (30.8%)	46 (26.6%)	0.49[c]
Anti-diabetic treatment	34 (12.1%)	10 (9.3%)	24 (13.9%)	0.35[c]
OSAS	18 (6.4%)	13 (12.1%)	5 (2.9%)	0.004[c]
CPAP use	17 (6.1%)	13 (12.1%)	4 (2.3%)	0.001[c]
Cardiovascular treatment	26 (9.3%)	14 (13.1%)	12 (6.9%)	0.09[c]
Osteoarticular treatment	20 (7.1%)	10 (9.3%)	10 (5.8%)	0.34[c]
Endocrine treatment	29 (10.4%)	6 (5.6%)	23 (13.3%)	0.03[c]
Metabolic treatment	39 (13.9%)	19 (17.8%)	20 (11.6%)	0.16[c]
Psychiatric treatment	82 (29.3%)	27 (25.2%)	55 (31.8%)	0.28[c]
Other treatments	157 (56.1%)	54 (50.5%)	103 (59.5%)	0.14[c]
Preoperative treatment cost [a]	17 (2–57)	14 (0–41)	24 (3–68)	0.14[b]
Treatment cost at 2 years [a]	12 (0–28)	11 (0–25)	13 (0–28)	0.44[b]

[a] Median (interquartile range).
[b] (Mann-Whitney).
[c] (Fisher's exact).

postoperative weight loss and pathologies were collected. The significant OSAS decrease and associated CPAP use was striking.

Table 4 shows a comparison between the data one month before and 2 years after surgery. Weight loss was significant, as well as decreased comorbidities and associated medication for HBP, DM2, metabolic and osteoarticular pathology. However, for cardiovascular, endocrine and psychiatric pathology, the decrease after surgery was nonsignificant. Note that two years after the intervention, there was a significant expenditure increase related to other treatments involving nutritional and vitamin deficits, which require pharmacological support in most patients after bariatric surgery, especially in malabsorptive techniques.

Regarding VG, the before/after risk ratio for diabetes II was 0.36 (95%CI: 0.22 to 0.39; $p < 0.001$). A similar ratio, 0.34, was obtained for metabolic bypass (95%CI: 0.25–0.47, $p < 0.001$). For conventional bypass, the risk reduction intensity for diabetes II was somewhat lower, with a risk ratio of 0.29 (95%CI: 0.07–1.14), but this difference was nonsignificant ($p = 0.125$) due to the low diabetes prevalence (5%)

Table 4
Differences, preoperative phase - 2 years.

	YEAR 2	YEAR 0	Difference	P-Value
Weight kg[a]	90	125	−35	< 0.001[b]
BMI [a]	33	47	−14	< 0.001[b]
High blood pressure treatment	28.2%	50%	−21.8%	< 0.001[c]
Anti-diabetic treatment	12.1%	36.8%	−24.7%	< 0.001[c]
OSAS	6.4%	85.7%	−79.3%	< 0.001[c]
CPAP use	6.1%	84.6%	−78.5%	< 0.001[c]
Cardiovascular treatment	9.3%	11.1%	−1.8%	0.30[c]
Osteoarticular treatment	7.1%	13.9%	−6.8%	< 0.001[c]
Endocrine treatment	10.4%	13.6%	−3.2%	0.004[c]
Metabolic treatment	13.9%	30%	−16.1%	< 0.001[c]
Psychiatric treatment	29.3%	35.4%	−6.1%	0.04[c]
Other treatments at 2 years	56.1%	6.4%	+49.7%	< 0.001[c]

[a] Median.
[b] (Wilcoxon).
[c] (McNemar).

Table 5
Analysis of pharmacological expenditures.

	Year 0 (n = 280)	2 years (n = 280)
Lowest expenditure	0	0
Highest expenditure	241	220
Median expenditure (95%CI)	17 (11–27) *	12 (9–15) *
Interquartile range	2–58	0–27
Cases with increased expenditure (%)		88 (31%) **
Cases with decreased expenditure (%)		153 (55%) **
Cases without expenditure change (%)		39 (14%) **

*$p < 0.001$ (Wilcoxon); **$p < 0.001$ (Fisher's exact); CI: confidence interval.

before surgery for this group of patients.

Table 5 shows the results related to pharmacological expenditure. The median decrease in the total expense at 2 years after surgery was significant; a significantly larger proportion of cases had decreased expenditure compared to the proportion of cases showing increased expenditure or no variation. Fig. 1 shows this general tendency towards decreased spending, although the existence of a certain level of variability can be observed, represented by a considerable number of cases with atypical or extreme values.

4. Discussion

Morbid obesity is a serious health problem and poses a challenge for

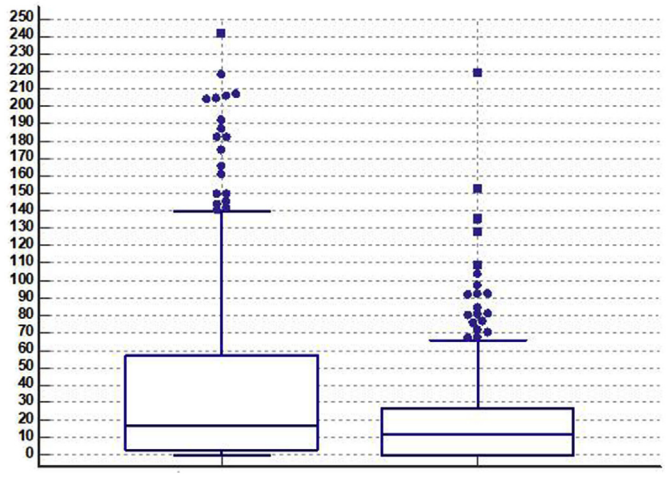

Fig. 1. Difference in pharmacological expenditures. Preoperative treatment expenditure and treatment expenditure at 2 years. Circles: outliers; Squares: extreme values.

the public health system budget. Thus, health interventions that manage to reduce obesity and its associated diseases will unequivocally result in significant savings in health costs for the population (Sánchez-Santos et al., 2013).

The simplest way to classify the economic burden of obesity is to divide expenses into direct and indirect costs (Powers et al., 2007; Terranova et al., 2012). Direct costs are the easiest to determine and include those associated with the diagnosis and treatment of the disease, cost of medication and cost of hospital and home services. By contrast, indirect costs are related to morbidity and mortality and reflect the loss of salary due to illness or disability and a loss of future earnings due to premature death. The present study considered only direct costs related to the pharmacological expenditure derived from obesity-associated comorbidities.

In a review by Von Lengerke and Krauth (2011), data were provided on 19 European studies assessing the impact of obesity on the cost of various diseases. In type I DM, obesity increases health costs by € 812 per year and by € 454 in type II DM, which implies a 78% higher per-capita cost when obesity and diabetes are associated.

The Delphi (Estudio prospectivo Delphi, 1999) prospective study showed that in Spain, obesity is responsible for 43% of the total cost of type II DM, 32% in arthropathies and more than 30% of the cost of heart diseases. These results approximate those collected in our study; considering that the number of patients and follow-up years were lower, we observed that 36.8% of obese patients were diabetic, 13.9% had osteoarticular disorders, and 11.1% had cardiovascular disorders.

Several studies and meta-analyses comprise 3000 to 12,000 patients and include the evolution of comorbidities after bariatric surgery (Adams et al., 2007)' (Christou et al., 2004)' (Batsis et al., 2008). Generally, these studies have shown remission of type II DM in 86.6% of patients (Buchwald et al., 2009) and improvement or resolution of hyperlipidaemia in 70%, hypertension in 61.7%, OSAS in 83%, and coronary heart disease in 32–56%.

In our study, after two years of surgery, the resolution of comorbidities was recorded without considering improvement since by definition in the prevalence design of the study, the existence of pathology is related to an active pharmacological treatment. Thus, if medication use persists, even at a lower dose, this comorbidity remains prevalent. In this sense, the decreased number of patients taking antidiabetic drugs, indicating the resolution of type II DM, was 24.7%. If we break down the result between VG and RYGBP, unsurprisingly, the malabsorptive technique obtained better results in absolute values, although the selection of cases to indicate either technique must be considered. However, when calculating risk ratios, the intensity of the differences for GV and metabolic RYGBP were quite similar in both cases. Regarding the percentage of patients taking antihypertensive drugs, the decrease was 21.8%; for osteoarticular pathology, the decrease was 6.8% and that for hyperlipidaemia was 16.1%.

The lowest decrease, which was nonsignificant, was found in cardiovascular, endocrine and psychiatric pathologies. This small decrease may be due to the less direct relationship with obesity as with the aforementioned pathologies. Regarding cardiovascular disease, the analysis shows that anticoagulant and antiplatelet drugs were most frequently used when treating arrhythmias and as prophylaxis after placing cardiac devices. The use of these drugs remained constant after bariatric surgery as there is no relationship with the resolution of established ischaemic diseases.

Regarding endocrine pathology, the most commonly used drug was levothyroxine in relation to hypothyroidism. In these cases, regardless of the cause that triggers the issue, most patients continue to use levothyroxine after surgery but at a different dose. Psychiatric pathology should disappear after weight loss induced by bariatric surgery to improve physical appearance and quality of life. However, in many patients, this pathology remains and can even result in an increased need for drugs. In these cases, we must consider that these patients are chronic consumers who often have personality disorders or basic pathologies that make complete resolution of symptoms very complicated.

Regarding medication savings, the literature shows controversial results due to the variety of different studies on how to measure comorbidities and their resolution and the surgical techniques used. In this sense, reaching a general conclusion is complicated. In a prospective study by Sampalis et al. (2004), there was an average decrease in treatments per patient by 66%, which was the cut-off point for the cost-effectiveness ratio at 2.5 years after surgery. Mäklin et al. (2011) concluded that bariatric surgery represents savings of € 16,130 per treated patient. Christou (2009) showed that operated patients had significantly fewer cancer diagnoses (2 vs. 8%), fewer heart problems (5 vs. 27%), fewer infections (9 vs. 37%), less arthritis (5 vs. 12%), and fewer respiratory problems (3vs. 11%). The health cost of the non-operated group far exceeded that of the operation after the third year of follow-up. In our study, the total expenditure decrease after two years of bariatric surgery was significant, with the median decreasing from 17 euros per month to 12 and differences depending on the type of pathology as mentioned above.

In general terms, it can be said that, although in 55% of cases there is a decrease in total pharmacological expenditure, in 45% it remains unchanged or even experiences an increase (14% unchanged and 31% with increase). It is necessary to emphasize the role played by prescriptions related to vitamins and nutritional supplements, since their increase after bariatric surgery is 47.9%, being the highest value of differences at two years ($p < 0.001$).

The comparison between obesity costs and bariatric surgery is also complex, especially considering different countries, since financing in the different European health systems differ radically from that in the USA. The Spanish National Health System has defined a DRG that encompasses the surgical treatment for obesity with an average cost of € 7468. Studies show an investment recovery and spending reduction after 4–5 years, which means a profitable investment over the medium term (Flum and Dellinger, 2004; Ewing et al., 2010; Picot et al., 2009; Keating et al., 2009). The present study did not include bariatric surgery costs, only the direct cost implied by the improvement in comorbidity and subsequent improvement in pharmacological expenditure, without comparing it to intervention costs.

Given our results, the strengths of this study are the high number of patients, which allows greater accuracy, as well as the large number of evaluated variables that offers a wide range of analysis possibilities. However, we measured pharmacological expenditure in euros per month; even though this measure was carried out with maximum objectivity, it might represent a weakness because of its lower

reproducibility due to the large fluctuation in drug prices and dose variability.

Thus, we conclude that this study demonstrates a decrease in pharmacological expenditure two years after bariatric surgery, implying the crucial role of this intervention in the resolution of comorbidities associated with morbid obesity. It should be considered that these interventions involve metabolic changes, leading multiple patients to consume vitamin or nutritional supplements, sometimes for life. However, given the results and considering the great benefits, this expense is acceptable and cannot be compared to the costs associated with previous comorbidities.

Conflicts of interest

The authors declare no conflict of interests.

Ethical approval statement

For this type of study formal consent is not required.

Informed consent statement

Does not apply.

Agreements

I want to thank all my fellow bariatric surgeons who have made this study possible.

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