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# A 10-year Investigation of the Causes and Rates of Deaths due to Four Different Surgical Weight Loss Methods in Tehran

Mehdi Mesri<sup>1</sup>, Masoud Ghadipasha<sup>2\*</sup>, Mehdi Forouzes<sup>2</sup>, Aram Samira<sup>1</sup>,  
Alimohammad Alimohammadi<sup>1</sup>, Seyed Hassan Saadat<sup>3</sup>, Seyed Morteza Hosseini<sup>1</sup>,  
Mohammad Chehrazi<sup>4</sup>

<sup>1</sup>Quran and Hadith Research Center, Baqiyatallah University of Medical Sciences, Tehran, Iran

<sup>2</sup>Research Center of Tehran Forensic Medicine Organization, Forensic Medicine, Legal Medicine Organization Research Center, Tehran, Iran

<sup>3</sup>Psychology-behavioral Sciences Research Center, Baqiyatallah University of Medical Sciences, Tehran, Iran

<sup>4</sup>Department of Epidemiology and Reproductive Health, Reproductive Epidemiology Research Center, Royan Institute for Reproductive Biomedicine, ACECR, Tehran, Iran

## ABSTRACT

**Background:** Weight loss is associated with reductions in comorbidities. Weight loss surgery improved weight loss outcomes more than non-surgical interventions but it is associated with adverse effects. Two objectives for this study were: first to compare death rates between two different purposes of these surgeries (therapeutic vs. aesthetic); and second to determine autopsy causes of deaths among them.

**Methods:** Authors studied all deaths due to surgical weight loss methods (gastric bypass; sleeve gastrectomy; abdominal liposuction; gastric balloon) referred to the forensic medicine dissection hall in Tehran city from 2008 to 2017 within a retrospective cross-sectional study. We divided them into two different groups according to purpose of surgery (Group A (therapeutic) vs. Group B (aesthetic)).

**Results:** Authors studied 44 cases, including 12 men and 32 women. Most victims in both groups were in the age range of 31–40 years. Gastric bypass was the most frequent surgical method in Group A, on the other hand, in Group B, it was abdominal liposuction. The most common cause of death was peritonitis in Group A; in Group B, it was pulmonary thromboembolism. The total number of deaths increased during study.

**Conclusions:** The findings showed that deaths in females were more common in both groups; this may be because women are more likely to undergo these kinds of surgeries; but it may be because female's immunity system specificities' like Interleukins and the same as females immunity system role in their mortality dominancy in burns. Further investigation needs to determine causes of females' mortality dominances' in weight loss surgeries.

**Key words:** Death, Weight loss, Surgical method, Tehran

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**Corresponding author:** Masoud Ghadipasha  
**e-mail** ✉: m.ghadipasha@yahoo.com  
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## INTRODUCTION

Obesity is associated with many health problems and a higher risk of death. The weight loss is associated with reductions in comorbidities, such as diabetes, metabolic syndrome and sleep apnea, although the benefits for hypertension and improvement in lipid profiles are less

clear. Compared to conventional treatment, surgery is also associated with greater short term improvements in some aspects of health related quality of life, but not others. A systematic review showed that weight loss surgery improved weight loss outcomes more than non-surgical interventions. Surgery and conventional treatment were both associated with adverse effects [1].

Several studies show that weight loss or bariatric surgery may have a role in treating Obstructive sleep apnea (OSA) [2].

Gastrointestinal surgery has excellent but variable outcomes on the glycemic control of diabetic patients depending on the type of surgery. The metabolic effect of bariatric/metabolic surgery on T1DM has elicited significant interest because of the already-proven benefits on T2DM and the potential production of similar results for T1DM, which forms 10% of diabetic load [3]. The most effective therapy to treat obese and related comorbidities is bariatric surgery, in which Roux-en-Y gastric bypass (RYGBP) and sleeve gastrectomy (SG) are two most popular procedures. SG is one of the most popular procedures (37%) in the world. SG is a technically less complex procedure with short learning curve and effective weight loss, but it suffers from two outstanding disadvantages including high risk of weight regain and gastro-esophageal reflux disease (GERD). Mini-gastric bypass (MGB), also known as single anastomosis gastric bypass or omega gastric bypass is a newly emerged procedure originated from Rutledge. Due to safe and simple process as well as effective outcomes, MGB has quickly become one of the most popular procedures in many countries. Despite of popular status, the extension of MGB is still limited by some concerns such as gastric and esophageal bile reflux, marginal ulcer, poor follow-up, and remnant gastric cancer [4]. Visceral adipose tissue (VAT) is an important risk factor for the metabolic complications associated with obesity. Therefore, a reduction in VAT is considered an important target of obesity therapy [5]. Fat embolism syndrome may occur in patients suffering from multiple traumas (long bone fractures) or plastic surgery (liposuction), compromising the circulatory, respiratory and/or central nervous systems [6]. We did not find any official and definitive statistics about the number and causes of deaths related to surgical weight loss methods in Iran. Therefore, we aimed to study all deaths due to four surgical weight loss methods (abdominal liposuction, sleeve gastrectomy, laparoscopic gastric balloon, and gastric bypass surgery) referred to the forensic medicine dissection hall in Tehran city from 2008 to 2017, within a retrospective cross-sectional study.

## MATERIALS AND METHODS

### Study design

In this retrospective cross-sectional study, we examined the autopsy reports of all deaths due to four surgical weight loss methods including laparoscopic Roux-en-Y gastric bypass (GB), laparoscopic sleeve gastrectomy (SG), abdominal liposuction, laparoscopic adjustable gastric banding or laparoscopic gastric balloon (referred to the forensic medicine dissection hall in Tehran) during 10 years from March 2008 to March 2017. As a rule, all deaths related surgeries in any hospital of Tehran must refer to the dissection hall in order to determine certain cause of death through autopsy; accordingly, when we investigated the autopsy files of all post (weight loss) surgical deaths in Tehran dissection hall, we were able to obtain all the autopsy files related to any kind of deaths after weight loss surgical methods.

### Data collection

We designed a questionnaire containing all information required in our study such as gender, age-group, past drug history, past medical history, aim of weight loss surgery (therapeutic vs. aesthetic), type of surgery and autopsy cause of death each year. For assess our questionnaire validity, we sent it to two social medicine specialists and one epidemiologist and also for assessing its reliability we registered each questionnaire autopsy file number.

The data from the autopsy files belonged to weight loss surgeries' deaths from all hospitals of Tehran was extracted to complete our questionnaire. We had not mentioned any deceased identity information in our study. We had extracted public data from their autopsy files such as sex, age-group, autopsy cause of death, past diseases, past drug history and total numbers each year. The Code of ethical approval is IR.LMO.REC.1396.37.

### Inclusion and exclusion criteria

The exclusion criteria in our study were insufficient data on characteristics of any weight loss surgical death; however, there were any autopsy file with insufficient data. The total numbers of weight loss surgical deaths during ten-year study were fifty-one. Among them; autopsy found seven positive toxicology samples, therefore we excluded these files from our data, because we wanted to study pure weight loss surgical deaths without effect of any drug, opioid, stimulants or alcohol in victims' blood or tissue samples. Thus, from fifty-one weight loss surgical autopsy files, forty-four files were included in our study.

### Statistical analysis

By examining the autopsy files from Tehran forensic medicine dissection hall and compared with male and female characteristics of deaths during the ten-year study, data were coded and analyzed by SPSS version 24 software. We utilized descriptive statistics, chi-square test and independent sample t-test. Significance level was recorded as  $p < 0.05$ .

## RESULTS

### Gender

During our ten-year study, there were 44 victims, including 12 (27/3%) men and 32 (72/7%) women. Incidence of death in female was more than male ( $p < 0/001$ ), it may be showed female tendency to undergo weight loss surgeries more than male tendency, but There is not statistically difference between gender and cause of death ( $p = 0/26$ ).

We divided the victims into two different groups (A and B) according to their aim for undergoing surgical methods (therapeutic vs. aesthetic). There were 23 (52/3%) deaths in Group A vs. 21 (47/7%) deaths in Group B. Death was more common in Group A

(therapeutics) in males while it is quite the opposite in females.

The gender distribution has been shown in Table 1 and Figure 1.

**Table 1: Characteristics of deaths due to surgical weight loss methods during ten-year study**

	Variables	Group A (Therapeutics)	Group B (aesthetics)	Total
Sex	Number	23 (52/3%)	21 (47/7%)	44 (100%)
	Male	10 (22/7%)	2 (4/5%)	12 (27/3%)
	Female	13 (29/5%)	19 (43/2%)	32 (72/7%)
Age Group (In Years)	1-20	1 (2/3%)	0	1 (2/3%)
	21-30	1 (2/3%)	4 (9/1%)	5 (11/3%)
	31-40	12 (27/3%)	8 (18/1%)	20 (45/4%)
	41-50	7 (15/9%)	6 (13/6%)	13 (29/5%)
	51-60	2 (4/6%)	2 (4/6%)	4 (9/1%)
	61-70	0	1 (2/3%)	1 (2/3%)
Surgical Procedure	Gastric Bypass	10 (22/7%)	2 (4/6%)	12 (27/3%)
	Sleeve Gastrectomy	4 (9/1%)	3 (6/8%)	7 (15/9%)
	Abdominal Liposuction	4 (9/1%)	16 (36/3%)	20 (45/4%)
	Intra gastric Balloon	3 (6/8%)	2 (4/6%)	5 (11/3%)
Autopsy cause of death	Septicemia	3 (6/8%)	2 (4/6%)	5 (11/3%)
	Peritonitis due to Intestinal Perforation	12 (27/3%)	2 (4/6%)	14 (31/8%)
	Bleeding	1 (2/3%)	3 (6/8%)	4 (9/1%)
	Lidocaine Toxicity	0	0	0
	Intestinal Obstruction	0	0	0
	Pulmonary Thromboembolism	3 (6/8%)	9 (20/4%)	12 (27/3%)
	MultiOrgan Failure	0	2 (4/6%)	2 (4/6%)
	Acute myocardial Infarction	4 (9/1%)	2 (4/6%)	6 (13/6%)
	Hypoxic Ischemic Encephalopathy	0	1 (2/3%)	1 (2/3%)
	Past Medical History	2 (4/6%)	0	2 (4/6%)
Past Drug History	2 (4/6%)	0	2 (4/6%)	
Year	2008	0	2 (4/6%)	2 (4/6%)
	2009	0	1 (2/3%)	1 (2/3%)
	2010	1 (2/3%)	2 (4/6%)	3 (6/8%)
	2011	2 (4/6%)	1 (2/3%)	3 (6/8%)
	2012	1 (2/3%)	2 (4/6%)	3 (6/8%)
	2013	2 (4/6%)	1 (2/3%)	3 (6/8%)
	2014	6 (13/6%)	1 (2/3%)	7 (15/9%)
	2015	2 (4/6%)	3 (6/8%)	5 (11/3%)
	2016	4 (9/1%)	2 (4/6%)	6 (13/6%)
	2017	4 (9/1%)	6 (13/6%)	12 (27/3%)
*There is no statistical difference between gender and cause of death (p=0/26)				
**There was no statistical difference between cause of deaths according age-group (p=0.79)				
***Overall there was statistically difference between cause of deaths according to aim of surgery (p=0.04)				

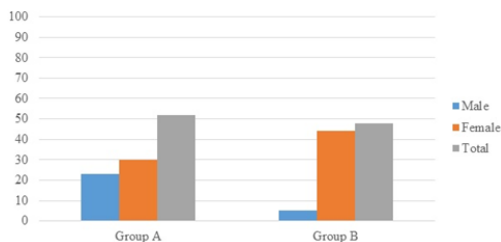


Figure 1: Sex among two groups

**Age-group**

There was one (2/3%) victim between 1–20 years; five (11/4%) victims between 21–30 years; nineteen (43/2%) victims between 31–40 years; fourteen (31/8%) victims between 41–50 years; four (9/1%) victims between 51–60 years; and one (2/3%) victim between 61–70 years (mean age ± SD: 35.2 ± 4.1 years). Deaths in age-group between 31-40 years were statistically more than other age-groups, but there was no statistically difference between cause of deaths according age-group (p=0.79). The age-groups details have been shown in Table 1 and Figure 2.

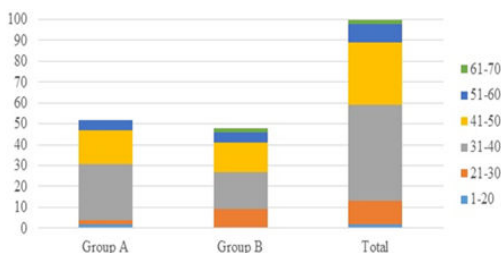


Figure 2: Age-groups among two groups

**Past drug history**

There were forty-two (95/5%) patient without any history of medication and two (4/5%) users of antihypertensive drugs.

**Past medical history**

During our ten-year study, there were only two (4/5%) patients with hypertension.

**Type of surgical method**

Among the different types of surgical methods, there were twelve (27/3%) cases of laparoscopic Roux-en-Y gastric bypass (GB); seven (15/9%) cases of laparoscopic sleeve gastrectomy (SG); twenty (45/4%) cases of abdominal liposuction; and five (11/3%) cases of intra-gastric balloon (laparoscopic gastric balloon). Overall, there was statistically difference between cause of deaths according to aim of surgery (p=0.04).

Figure 3 shows the various surgical procedures used in each group.

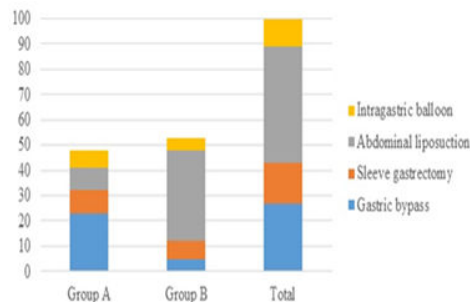


Figure 3: Surgical methods among two groups

**Causes of death as per autopsy**

According to autopsy reports, the causes of deaths included septicemia: five (11/3%); peritonitis due to intestinal perforation: fourteen (31/8%); bleeding: four (9/1%); Pulmonary thromboembolism (PTE): twelve (27/3%); multi-organ failure (MOF): two (4/6%); acute myocardial infarction: six (13/6%); and hypoxic ischemic encephalopathy: one (2/3%). The most common autopsy causes of deaths were peritonitis due to intestinal perforation 14 (31/8%) and Pulmonary thromboembolism 12 (27/3%), respectively. peritonitis due to intestinal perforation was more common in Group A (therapeutics) [12(27/3%)] vs. Pulmonary thromboembolism in Group B (aesthetics) [9(20/4%)]. Figure 4 show the causes of death through weight loss procedures as per autopsy in each group.

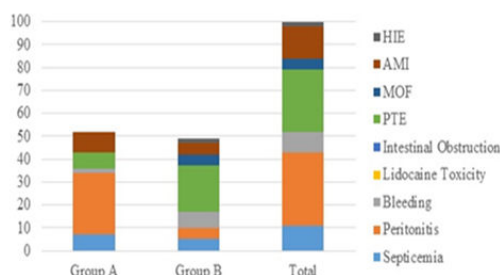


Figure 4: Cause of death as per autopsy among the two groups

**Each year rate of deaths**

The yearly death rates due to weight loss procedures in Tehran were two (4/6%) in 2008; one (2/3%) in 2009; three (6/8%) in 2010, 2011, 2012 and 2013; seven (15/9%) in 2014; five (11/3%) in 2015; six (13/6%) in 2016; and finally, 12 (27/3%) in 2017. Table 1 and Figure 5 show the yearly death rates due to weight loss procedures in each group.

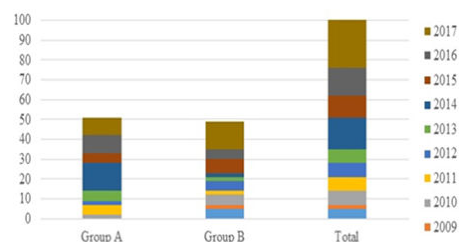


Figure 5: Each year deaths among the two groups

**DISCUSSION**

In this retrospective cross-sectional study during 10 years from 2008 to 2017, the autopsy reports of all deaths due to four different weight loss surgical methods (gastric bypass, sleeve gastrectomy, abdominal liposuction, and intra-gastric banding) referred to the forensic medicine dissection hall in Tehran city were studied. We extracted the required data from files for our questionnaire, including gender, age, method of surgery, aim of surgical procedure, past medical history, past drug history, cause of death as per autopsy, and number of deaths each year. The total numbers of weight loss surgical deaths during ten-year study were fifty-one. Among them; autopsy found seven positive toxicology samples, therefore we excluded these files from our data, because we wanted to study pure weight loss surgical deaths without effect of any drug, opioid, stimulants or alcohol in victims' blood or tissue samples. Thus, from fifty-one weight loss surgical autopsy files, forty-four files were included in our study. According to the aim of surgery, we divided our cases into two groups (Group A: therapeutic; Group B: aesthetic). The main goal of our study was to investigate the causes of death in patients who underwent different weight loss surgical procedures; we also compared deaths between the four surgical methods. There was a statistically significant difference in the female mortality rate ( $p < 0.05$ ); in fact, Incidence of death in female (73%) had statistically significant difference than male (27%) ( $p < 0.05$ ). Also the findings showed the most prevalent age group of victims' was 31–40 years in both groups.

The present study showed the most common surgical method in Group A (therapeutics) leading death was gastric bypass; and this result is in contrast with studies conducted in New York [7], USA [8], Mexico [9] and Finland [10]; also our findings showed that in Group B (aesthetics), the most common surgery leading death was abdominal liposuction and this result is in contrast with studies conducted in many countries [11] but it is similar to studies performed in Mexico [12], Korea [13]. Our study showed sleeve gastrectomy had a few death rates, so it is a safe method and this result is similar to studies performed in New York [7], USA [8], Finland [10], Poland [14], USA [15] and New York [16].

In this study, the most common autopsy causes of death were peritonitis due to intestinal perforation and this finding is similar to studies performed in Czech Republic [17], Italy [18]; and second cause of deaths was pulmonary thromboembolism, respectively; this finding is similar to studies performed in Mexico [12], USA [19]; but it is in contrast with studies conducted in many countries [11].

**CONCLUSION**

In this study, our findings showed more female deaths in both groups, this may be due to the increasing number of women undergoing weight loss surgical procedures. For men, healing was a greater aim than beauty; on the other hand, it was quite the opposite for women; but it may be

because female's immunity system specificities' like Interleukins and, the same as females immunity system role in their mortality dominancy in burns. Further investigation needs to determine causes of mortality dominancy in females in weight loss surgeries. We hope that our findings can help surgeons choose the best surgical methods for their patients and perhaps prevent some of these deaths.

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**CONFLICT OF INTEREST**

The authors declared no potential conflicts of interests.

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