

# Predictors of complete remission of hypertension in patients over 65 years of age after bariatric surgery – a multicenter study

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## Abstract

**Introduction:** In the era of an aging society and a growing number of obese people, an increasing number of older patients are consulting bariatric surgeons. The incidence of hypertension (HT) also rises with age and body weight, making the treatment of the elderly a significant challenge.

**Aim:** To identify predictors of HT remission after bariatric surgery in patients over 65 years of age.

**Material and methods:** A retrospective study analyzed patients over 65 years old with HT who underwent laparoscopic bariatric procedures in Poland between 2008 and 2022. The data came from 11 bariatric centers. Patients were categorized into two groups: responders (R) and non-responders (NR). A multivariate logistic regression analysis was conducted to identify significant independent risk factors.

**Results:** The study analyzed 244 patients, with complete HT remission observed in 55 (22.5%) patients. Almost 90% of patients showed improvement in HT. The mean follow-up time was 47.4 months. Factors contributing to HT remission included HT duration of less than 5 years, the use of single medication, and a significant correlation with %EWL.

**Conclusions:** Bariatric surgery in patients aged over 65 has a positive effect on HT remission. The chance of HT remission increases with fewer medications, shorter HT duration, and greater weight loss after surgery.

**Key words:** bariatric surgery, predictors, older patients, remission of hypertension, obesity-related diseases.

## Introduction

Society's aging is a global phenomenon. In 2019, 9% of the world's population consisted of people aged 65 and over, and by 2050, every sixth inhabitant of the Earth will be in this group [1]. In Europe, United Nations forecasts predict that by 2030, the proportion of the population over 65 years of age will be 23.8%. This figure is twice as high as in 1990. According to Eurostat forecasts, by 2050, the number

of people aged over 65 years in European countries will increase by approximately 70%, and the number of people of working age (15–64 years) will decrease by 12% [2]. Moreover, it is also worth noting that life expectancy is increasing every year. In Poland, according to World Health Organization (WHO) data from 2019, it is estimated that a 60-year-old should live for another 22 years [3].

Obesity is a chronic disease, classified as a civilization disease, characterized by abnormal and ex-

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cessive accumulation of fat tissue. The main factor contributing to the development of the disease is improper nutrition [4]. The rapid increase in the number of patients aged over 65 years and obesity is associated with an increase in the population of obese people in this age group. According to the WHO, obesity affects over 20% of people around the world.

Based on many years of research, it is known that bariatric surgery is safe and the most effective method of weight loss [5, 6]. Moreover, it may have a beneficial effect on hypertension (HT). It leads to significant weight loss and improvement in metabolic parameters [7, 8]. Observational studies have shown that after bariatric surgery there is a significant reduction in blood pressure and the incidence of HT, including in elderly patients [9–11].

Elderly people are a special group of patients who may benefit from bariatric surgery but require a special approach and assessment before the procedure [12, 13]. There is no precise age limit that would exclude the possibility of surgery. However, many factors should be considered, such as health status, comorbidities, cognitive function, patient motivation, and expectations, as highlighted in the latest ASMBS (American Society for Metabolic and Bariatric Surgery) surgical guidelines [13].

## Aim

The study aimed to determine the factors predicting the remission of HT after bariatric surgery in patients over 65 years of age.

## Material and methods

This multicenter, retrospective analysis included patients over 65 years of age undergoing laparoscopic bariatric procedures in Poland from 2008 to 2022. The data came from 11 bariatric centers. Each of these centers performs over 100 operations a year. The entire group consisted of 284 patients. Inclusion criteria for this study included fulfillment of eligibility criteria for bariatric surgery, age over 65 years, and the presence of HT. Patients with missing or inconsistent data were excluded from the study. The follow-up rate is 78.0%. The analysis is in line with STROBE guidelines.

### Data collection

The study included 244 patients over 65 years of age suffering from HT. The database contained

information on HT (duration of HT, the number of medications, changes in HT after surgery) and demographic characteristics of patients (sex, age, maximum body weight, preoperative body weight, body mass index (BMI)). It also included information on surgery (type of surgery, duration of surgery, length of hospital stay) and outcomes of bariatric treatment (current body weight and BMI, percentage of excess weight loss (%EWL), percentage of total weight loss (%TWL)). Outcomes of bariatric surgery were described according to ASMBS outcome reporting [14]. Complete remission of HT is defined as normotensive (blood pressure less than 120/80) without the use of antihypertensive medications. Preoperative examinations were performed the day before surgery. Postoperative examinations were routinely performed at each annual follow-up visit after surgery. All results correspond to the observation time.

Surgical techniques and perioperative care protocols were standard at each participating center. There was no specific pathway for bariatric patients over the age of 65. All patients followed the ERABS protocol [15]. Each patient prepared for surgery underwent echocardiography, electrocardiography, gastroscopy, chest X-ray, abdominal ultrasound, and necessary laboratory tests. Depending on the results, patients were consulted by a specialist. All operations were performed according to the guidelines [16]. Sleeve gastrectomy (SG) was performed using a bougie size of 36F, starting 4–6 cm from the pylorus. The length of the biliopancreatic limb was approximately 200 cm from the ligament of Treitz in the one anastomosis gastric bypass (OAGB). The biliopancreatic limb length was approximately 100 cm, and Roux-en-Y limb length was approximately 150 cm in Roux-en-Y gastric bypass (RYGB).

### Statistical analysis

A descriptive statistical analysis was conducted. All data were analyzed using Statistica software 13.PL (StatSoft Inc.). Continuous values were presented as the mean with standard deviation or medians with interquartile ranges when appropriate. Qualitative variables were compared using the Pearson  $\chi^2$  test. Significant variables in univariate logistic regression models were then adjusted in multivariate analysis to obtain significant independent risk factors and to calculate the odds ratio (OR) with

a 95% confidence interval (CI). *P*-values ≤ 0.05 were considered statistically significant.

### Ethical considerations

The data were completely anonymized. The study was conducted according to the ethical standards of the 1964 Declaration of Helsinki and its subsequent amendments. The study was approved by Bioethics Committee of the Military Chamber of Physicians in Poland (38/2023).

### Results

Altogether 244 patients were analyzed in the study; 55 (22.5%) patients had complete HT remission, 57 (23.4%) had partial HT remission, 98 (40.2%) had improvement in HT, and 34 (13.9%)

had no changes in HT. Nearly 90% of patients had at least improvement in HT. Patients were divided into two groups: responders (R) and non-responders (NR). In the R group, complete HT remission was achieved in 55 (22.5%) patients. In the NR group, 189 (77.9%) patients achieved partial remission, improvement, or no change in HT. Table I compares the preoperative and postoperative characteristics of both groups. The mean follow-up time was 47.4 months (46.7 months in the R group, 47.6 months in the NR group).

Patients in groups R and NR did not differ statistically significantly in terms of sex, age, preoperative BMI, preoperative weight loss, duration of follow-up, type of surgery, or operative time. Statistically significant differences were observed between responders and non-responders in the duration of HT, the

**Table I.** Characteristics of patients

Variable	Responders	Non-responders	<i>P</i> -value
<i>N</i> (%)	55 (22.5)	189 (77.9)	
Female/male, <i>n</i> (%)	36/19 (65.5)	110/79 (58.2)	0.334
Follow-up [months] mean (SD)	46.7 (25.6)	47.6 (35.0)	0.518
Median age [years] (SD)	66.8 (1.6)	66.8 (1.8)	0.670
Median BMI [kg/m <sup>2</sup> ] (SD)	43.3 (5.2)	43.3 (6.1)	0.618
Median weight loss before surgery [kg] (SD)	5.0 (8.0)	7.4 (8.4)	0.081
Intragastric balloon before surgery, <i>n</i> (%)	3 (5.5)	20 (10.6)	0.443
Duration of HT before surgery*:			
< 5 years	11	10	0.004
5–10 years	15	47	
> 10 years	18	82	
Treatment of HT before surgery:			
One medication	36	52	< 0.001
Two medications	13	83	
Three or more medications	6	54	
Types of surgery:			
AGB	0	4	0.371
SG	46	154	
OAGB	7	16	
RYGB	2	15	
Operative time [min] mean (SD)	73.3 (37.7)	78.4 (39.5)	0.237
Length of stay [days] mean (SD)	2.3 (2.5)	2.7 (2.7)	0.009
Actual BMI [kg/m <sup>2</sup> ] mean (SD)	32.7 (5.3)	34.6 (5.6)	0.056
%TWL, % (SD)	25.3 (9.3)	19.6 (10.1)	0.003
%EWL, % (SD)	60.2 (24.9)	47.9 (24.8)	0.003

number of medications used, and the length of stay ( $p = 0.004$ ,  $p < 0.001$ ,  $p = 0.009$ , respectively). Among the outcomes, statistically significant differences between responders and non-responders were observed for %TWL and %EWL ( $p = 0.003$ ,  $p = 0.003$ , respectively).

All available factors contributing to the complete success of HT treatment were analyzed in univariate logistic regression models. The more medications the patient received before surgery and the longer HT lasted before surgery, the lower was the observed OR (Table II). Among the outcomes, the values of %EWL and %TWL increased significantly, and actual BMI significantly decreased the odds ratio of com-

plete HT remission in patients over 65 years of age ( $p = 0.002$ ,  $p = 0.003$ ,  $p = 0.026$ , respectively) (Table II). No significant differences were found between types of surgery and their impact on the complete remission of HT. However, for OAGB the frequency of complete remission of HT was higher than for SG (OR = 1.46).

All significant factors in univariate logistic regression were adjusted in multivariate logistic regression analysis. HT duration of less than 5 years and one medication use were found to be factors contributing to HT remission (Table III). %EWL was significantly associated with HT remission (Table III).

In the analyzed group, 13 (5.3%) complications occurred. Within the 30-day period, 8 (3.3%) compli-

**Table II.** Univariate logistic regression analysis for factors contributing to hypertension remission

Variable	OR	95% CI	P-value
Gender, female	0.735	0.04–1.38	0.335
Age	1.029	0.86–1.23	0.753
Weight loss before surgery	0.960	0.92–1.00	0.062
BMI before surgery	1.000	0.95–1.05	0.991
Time between first visit and surgery	1.005	0.97–1.54	0.803
Number of medications, one			
Two	0.160	0.06–0.41	< 0.001
Three and more	0.226	0.11–0.47	< 0.001
Length of HT, < 5 years:			
5–10 years	0.290	0.10–0.82	0.019
> 10 years	0.200	0.07–0.54	0.002
Type of surgery, SG:			
AGB	0.000	n/a	0.997
OAGB	1.465	0.5–3.78	0.430
RYGB	0.446	0.10–2.02	0.296
Length of stay	0.894	0.72–1.11	0.300
Operative time	0.996	0.99–1.00	0.402
Actual BMI	0.935	0.88–0.99	0.026
%EWL	1.020	1.01–1.03	0.002
%TWL	1.048	1.02–1.08	0.003

**Table III.** Multivariate logistic regression analysis for factors contributing to hypertension remission

Variable	OR	95% CI	P-value
Two medications vs one	0.124	0.04–0.36	< 0.001
Three or more medications vs. one	0.128	0.04–0.46	0.001
Duration of HT > 10 years vs. < 5 years	0.208	0.06–0.67	0.009
EWL%	1.127	1.04–1.22	0.004

cations of Clavien Dindo III were observed: 5 (2.0%) instances of intraperitoneal bleeding and 3 (1.2%) cases of leaks. Additionally, 3 (0.6%) instances of sleeve tightening necessitating reoperation and 2 (0.8%) occurrences of bile reflux were recorded. There were no postoperative deaths.

## Discussion

Our study is a retrospective analysis of 244 patients with HT over the age of 65 who underwent bariatric and metabolic surgery. The strength of the study is the assessment of factors predisposing to HT remission in patients over 65 years of age. It included data on one of the largest groups of patients over 65 years of age collected as part of a multidisciplinary reporting project with a satisfactory follow-up rate [17].

According to our multicenter study, the incidence of HT in patients aged over 65 years was 85.9%. Other authors comparing the occurrence of HT in older and younger patients suffering from obesity have noted that the risk of HT significantly increases with age [9, 10]. Nevo *et al.* reported that 75.8% of patients over 65 years of age had HT, and in younger patients, only 24.6% of patients had HT [9]. Statistically significantly, younger patients were more likely to improve or have HT remission compared to the older group (56.2% vs. 44%). Quirante *et al.* also noted in a group of 1,613 patients a significantly higher risk of HT in older people than in younger people (85% vs. 59%) [10]. Their study did not assess the remission of obesity-related diseases. However, the authors believed that the presence of comorbidities did not pose a risk of postoperative complications.

Garofalo *et al.* reported that remission of HT was observed in 42.9% of patients older than 65 years [11]. This is higher than in our study, although these authors also followed the ASMBS definition of complete remission. A likely reason was the longer follow-up in our study (> 3 years) and the analysis of a much larger number of patients than that reported in Garofalo's paper. Another study, also concerning patients over 65 years of age with a 2-year follow-up, was presented by Gholizadeh *et al.* [18]. 76% of patients had remission of HT, and 16% of patients had improvement in HT. In this sense, remission meant both complete and partial remission of HT defined by the ASMBS. According to our data, it would be 45.9%, which is much lower than the values reported in the cited paper. The difference is in the type of

surgery. Golizadeh analyzed only OAGB, while in our study, OAGB accounted for 9.4% and SG dominated with 82.0%.

An interesting paper was published by Dayan *et al.* [19]. They analyzed the results of OAGB compared with SG in patients over 65 years of age in a long-term follow-up. There were 41 patients after OAGB and 83 patients after SG. The remission of HT after OAGB was 73.3%, while the remission of HT after SG was 36.3%. The authors defined remission of HT, but OAGB had a statistically significant advantage. We observed similar conclusions in our study, but due to the disproportion in the number of operations, no significant differences could be observed.

There are several studies demonstrating HT remission in patients over 60 years of age after SG [20–24]. In this age comparison, the HT remission rate in older people was comparable to the HT remission rate in younger people. No statistical significance was demonstrated. A meta-analysis by Vallois *et al.* showed remission of HT in 44.9% of patients over 60 years of age (138/307) and 31.2% of patients under 60 years of age (161/516) [25]. Comparing patients over 70 years of age with younger ones, the authors also found no significant differences in HT remission between younger and older patients [26–28]. Additionally, Belluzzi *et al.* did not observe any differences between remission of HT in patients over 70 years of age after SG compared to Roux-en-Y gastric bypass (RYGB) [29]. It is worth noting, however, that all these studies are based on a small group of patients with short follow-up, and larger studies are needed for significant comparisons.

Our study has several limitations. The study is retrospective and comes from several centers, so there is a potential reporting bias. We did not have data on the types of antihypertensive medications and their doses. Furthermore, most procedures were SG and therefore may not be appropriate to compare with other types of surgery. Moreover, we did not have data from individual years of follow-up, only data regarding the last follow-up visit.

## Conclusions

Bariatric surgery in patients over 65 years of age has a positive effect on the remission of HT. Most patients had at least improvement in HT. 22.5% of patients had complete remission of HT. The fewer

medications a patient takes and the shorter the duration of HT, the greater is the chance of HT remission. Moreover, the greater the weight loss after surgery, the greater is the chance of HT remission.

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## Conflict of interest

The authors declare no conflict of interest.

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