Original Article

Effect of Biliopancreatic Diversion on Hypertension in Severely Obese Patients

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Hypertension is a medical disorder frequently associated with severe obesity, and the effect of weight loss on the reduction of blood pressure has been well established. In this study, the relationships between the weight loss surgically obtained by biliopancreatic diversion and blood pressure were investigated in a population of severely obese patients with preoperative hypertension. At 1 year following the operation, blood pressure was normalized in more than half of patients; in a further 10% of cases the hypertensive status resolved within the 3-year follow-up period. The resolution of hypertension was independently associated with age and body weight and was unrelated to sex, the amount of weight loss, or body fat distribution. In severely obese patients with hypertension undergoing bariatric surgery, biliopancreatic diversion is advisable since it achieves and supports the maintenance of body weight close to the ideal value. (*Hypertens Res* 2005; 28: 119–123)

***Key Words*: blood hypertension, obesity, obesity surgery**

Introduction

Metabolic syndrome is a severe health impairment that increases mortality predisposing patients to acute cardiovascular events, and that is frequently seen in morbidly obese patients (*1–4*). Biliopancreatic diversion (BPD) is a highly effective procedure for the surgical treatment of morbid obesity; in fact, the operation achieves a fully satisfactory weight loss in the vast majority of the cases, and this weight loss is maintained in the long run (*5*). Furthermore, after BPD, a complete recovery from the metabolic alterations associated with obesity is observed: in nearly all the obese diabetic patients, the serum glucose level normalizes within the first postoperative months and remains in the physiological range for the long term, and in the patients with high cholesterol levels, a sharp reduction of the serum low density lipoprotein cholesterol concentration is seen, with a long-term improvement in lipid pattern (*5*). Hypertension is a main component of metabolic syndrome and leads to a further increase of risk for cardiovascular mortality and sudden death. In most studies, weight reduction has been associated with lowering of blood pressure and therefore with the improvement of the subject's cardiovascular conditions (*6*, *7*). The resolution of hypertension has been observed in most obese hypertensive patients after bariatric surgery (*8–13*). However, the weight loss is not accompanied by a lowering of blood pressure in all cases, and the relationship between weight reduction and the recovery from hypertension is still poorly understood.

The aim of this study was to investigate the effects of BPD on hypertension in severely obese patients. To this end, we examined a group of severely obese patients with hypertension prior to BPD and throughout a 3-year follow-up period.

Methods

The charts of 734 consecutive obese patients undergoing BPD at the Department of Surgery of the University of Genoa School of Medicine between January 1994 and January 2000 were reviewed, and the study was carried out on the 461

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Table 1. Anthropometric and Blood Pressure Data in the Complete Set of the Obese Patients with Arterial Hypertension Submitted to Biliopancreatic Diversion (BPD)

	Prior to BPD	1 year after BPD	2 years after BPD	3 years after BPD
BW (kg)	134.4±125.6	87.0±16.8*	82.3±16.7*	84.4±16.8*
BMI (kg/m^2)	49.0±9.1	31.4±7.7*	30.0±5.4*	30.6±5.4*
WHR (cm/cm)	1.034±0.121	0.963±0.107*	0.953±0.099*	0.950±0.108*
SBP (mmHg)	161±23	136±20*	133±22*	132±20*
DBP (mmhg)	99±16	85±11*	82±12*	81±9*
HR (cases)		221/435 (51%)	236/421 (56%)	243/412 (59%)

BW, body weight; BMI, body mass index; WHR, waist/hip ratio; SBP, systolic blood pressure; DBP, diastolic blood pressure; HR, hypertension resolved. *$p<0.001$ *vs.* preoperative data.

Table 2. Early and Late Postoperative Complications in 458 Consecutive Obese Patients with Hypertension Undergoing Biliopancreatic Diversion (BPD)

	Complications within 1 year after BPD	Complications 1–3 years after BPD
Surgical complications	10 (2.2%)	
Anastomotic leak	1	
Pulmonary embolism	3	
Wound disruption	2	
Bleeding	4	
Anemia	114 (24.9%)	92 (20.1%)
Stomal ulcer	9 (2%)	7 (1.5%)
Protein malnutrition	8 (1.8%)	12 (2.5%)
Peripheral neuropathy		2 (0.4%)

(63%; 190 males and 271 females) severely obese patients who were considered hypertensive before BPD; all patients gave their written informed consent for the operation. Hypertension was defined by either the chronic use of antihypertensive drugs (97 patients) or by systolic blood pressure (SBP) equal to or greater than 140 mm Hg and/or diastolic blood pressure (DBP) equal to or greater than 90 mmHg (*14*). Three patients (0.6%) died of operative complications (2 of pulmonary embolism and 1 of heart attack), and were eliminated from the analysis. The final study group then consisted of 189 males and 269 females, ranging in age from 18 to 57 years (mean 41.5). Table 1 shows the mean values of the initial body weight (BW, kg), body mass index (BMI, kg/m^2) and SBP and DBP. Early and late postoperative complications observed in the patients are given in Table 2.

Height was measured to the nearest 0.5 cm and BW to the nearest 0.1 kg. The waist circumference was measured at level of the umbilicus and the hip circumference at the level of the anterior iliac spine with the subject in a supine position, and the waist-to-hip ratio (WHR, cm/cm) was used as an index of body fat distribution. The mean WHR values recorded prior to the operation are shown in Table 1. Blood pressure was taken as the average of two measurements made using a wide cuff sphygmomanometer with the patient lying down. After BPD, the patients were followed as usual. For the purposes of this study, anthropometric data obtained at the follow-up visits over a period of 3 years were considered. Hypertension was defined by either the chronic use of antihypertensive drugs or an SBP equal to or greater than 140 mmHg and/or a DBP equal to or greater than 90 mmHg (*14*), and was considered resolved when both SBP and DBP were consistently below 140 and 90 mmHg, respectively, without medication.

The differences between means were assessed by Student's *t*-test for paired data and independent comparisons, when appropriate. Multivariate logistic regression analyses were carried out in order to evaluate the relationships between arterial pressure outcome on one hand and anthropometric parameters and preoperative blood pressure data on the other. The statistical calculations were performed with Stat-View 5.0.1 software (SAS Institute Inc., Cary, USA).

Results

Table 1 shows the preoperative anthropometric and the blood pressure data and the changes observed throughout the 3-year follow-up period after BPD in the study group; the rate of follow-up ranged from 90% to 95%. As expected, at 1 year following the operation a marked reduction of BW and BMI values was observed, and the values remained substantially unchanged at the second and third years after the operation. Furthermore, a reduction of WHR values was seen in the first follow-up year, after which the reduced WHR values were maintained without further significant change during all the study period. Finally, at 1 year after BPD there was a sharp reduction in mean SBP and DBP, and these reduced values remained essentially unchanged until the third postoperative year. The mortality and the postoperative complication rates were similar to those observed in all obese patients undergoing BPD (*5*). Table 1 shows the resolution rate of hypertension according to the abovementioned criteria. By the first year following the operation, the blood pressure returned to the normal range in half of the preoperatively hypertensive subjects, and an additional nearly 10% of the cases showed normalized blood pressures in the second or third years. At the second-

Table 3. Preoperative Blood Pressure Data and Actual Anthropometric Findings

	1 year after BPD	2 years after BPD	3 years after BPD
a: BPD subjects with arterial hypertension normalization over the 3-year follow-up			
Age (years)	40±10.9*	38.2±10.7*	39.4±10.3*
BW (kg)	83.0±18.3*	81.0±16.3§	80.6±18.5*
BMI (kg/m^2)	30.0±7.2*	29.5±5.3‡	29.6±5.3§
WHR (cm/cm)	0.942±0.103	0.947±0.103	0.944±0.109
WL (kg)	47.6±16.7	54.7±20.7	52.5±20.7
Preoperative SBP (mmHg)	153±18*	156±22*	158±24§
Preoperative DBP (mmHg)	94±17*	96±16*	97±18‡
M/F	93/128	90/146	95/148
b: BPD subjects who did not reach the blood pressure normalization over the 3-year follow-up			
Age (years)	43.1±10	44.0±9.4	44.4±9.3
BW (kg)	91.4±19.0	84.7±16.7§	88.1±17.0
BMI (kg/m^2)	33.1±6. 2	30.8±5.8§	32.0±5.6
WHR (cm/cm)	0.975±0.127	0.961±0.086	0.971±0.105
WL (kg)	48.2±17.3	49.7±20.3	48.6±18.7
Preoperative SBP (mmHg)	168±25	167±24	166±23
Preoperative DBP (mmHg)	103±15	102±16	101±17
M/F	86/128	82/103	71/98

BPD, biliopancreatic diversion; BW, body weight; BMI, body mass index; WHR, waist/hip ratio; WL, amount of weight loss; SBP, systolic blood pressure; DBP, diastolic blood pressure; M/F, male/female ratio. *$p<0.001$ *vs.* still hypertensive BPD subjects; §$p<0.01$ *vs.* still hypertensive BPD subjects; ‡$p<0.02$ *vs.* still hypertensive BPD subjects.

and third-year follow-up, no relapse was seen in subjects whose blood pressure was normalized after the operation.

For each follow-up point, anthropometric data and preoperative blood pressure findings of the subjects whose blood pressure was normalized after BPD and those of subjects who remained hypertensive postoperatively are listed in Table 3a and b, respectively. At all the follow-up points, the BW and the BMI values of the subjects with resolved hypertension were lower than those observed in individuals who maintained their hypertensive status following BPD (Table 3a and b), while the WHR values and the amount of weight loss were essentially the same at all postoperative follow-up points, In addition, in comparison with the subjects whose blood pressure was normalized after weight loss, the subjects who remained hypertensive after BPD were older and had higher preoperative blood pressure values.

Application of multivariate logistic regression analysis to all patients revealed the factors predicting postoperative normalization of blood pressure. For all follow-up points, the recovery from hypertension was independently predicted by the subject's age, by the actual BMI values, and by the preoperative SBP, whereas it was completely unrelated to sex, to WHR values, or to the amount of weight loss (Table 4).

Discussion

The primary finding of this study was that hypertension was resolved at 1 year following BPD in 50% of the severely obese patients studied, and the resolution rate further increased to nearly 60% of the cases in the third year. These results are highly similar to those obtained following weight loss by gastric restrictive procedures or gastric bypass surgery, though in this report the criteria for hypertension were more rigid than those employed elsewhere (*8*, *10–13*).

The findings of previous investigations carried out after a conservative weight loss program (*15*) or gastric restrictive procedure (*16*) demonstrated that the blood pressure reduction was predicted by the amount of weight loss rather than the weight at stabilization, suggesting that in obese patients a moderate reduction of body weight might be sufficient to achieve most of the health benefits of weight loss (*17*). By contrast, in this investigation, the subjects whose blood pressure was normalized after BPD showed lower BW and BMI stabilization values than those who remained hypertensive postoperatively, whereas there were not significant differences in the amount of weight loss between these two groups. Furthermore, in the logistic regression model the resolution of hypertension at any follow-up point was independently related to age and BMI, while neither the amount of weight loss nor the WHR values showed any predictive value. Therefore, the results of the present study following BPD, like those of Carson *et al*. obtained after gastric bypass surgery (*8*), suggest that the greatest reduction of hypertension associated with severe obesity is obtained in subjects whose stabilization weight closely approximates the ideal, and more limited weight reduction might be ineffective. Moreover,

Table 4. Logistic Regression of Resolution of the Hypertensive Status (Dependent Variable) *vs.* Independent Factors in Hypertensive Obese Patients Following Biliopancreatic Diversion (BPD)

Independent variables	1 year after BPD		2 years after BPD		3 years after BPD	
	χ^2	*p*	χ^2	*p*	χ^2	*p*
BMI (kg/m^2)	3.903	0.0482	5.64	0.033	3.176	0.0415
WHR (cm/cm)	0.981	ns	0.1357	ns	0.509	ns
WL (kg)	0.490	ns	0.8239	ns	2.119	ns
Age (years)	3.741	0.0431	7.807	0.0052	8.503	0.0035
Preoperative SBP (mmHg)	2.456	0.014	0.136	ns	0.986	ns
Preoperative DBP (mmHg)	1.041	ns	1.102	ns	0.990	ns
Sex	1.765	ns	0.732	ns	2.007	ns

BMI, body mass index; WHR, waist/hip ratio; WL, amount of weight loss; SBP, systolic blood pressure; DBP, diastolic blood pressure.

changes in body fat distribution, as clinically evaluated by WHR values, seem have no influence in the post-BPD resolution of hypertension. Recent studies in obese patients have shown a close relationship between serum leptin and hypertension (*18–20*). Because it has been reported that the weight loss following BPD is accompanied by a marked drop in serum leptin levels (*21*), the present study indirectly supports the hypothesis that leptin may play a pivotal role in the development or maintenance of arterial hypertension in obesity.

In obese patients, both body mass and heightened sympathetic activation contribute to the blood pressure elevation (*22*), and the sympathetic hyperactivity might account for the resistance to weight loss of some hypertensive patients (*23*). Therefore, it can be speculated that the lack of normalization of sympathetic nervous system activity might be responsible for the poor blood pressure outcomes following BPD.

The resolution of hypertension after BPD was also independently associated to the age and SBP of patients prior to surgery. Hence, the postoperative persistence of hypertension in half of the subjects might be linked to poorly understood individual factors related to aging and to the degree of hypertension at baseline. It can be suggested that the relapse of hypertension occurring over the long term following gastric restriction procedures or gastric bypass surgery might be accounted for by both the weight regain and the action of these factors (*24*, *25*).

Whether the 3-year hypertension outcomes observed following BPD will be maintained over a longer period of time remains to be seen.

In conclusion, this study demonstrated that blood pressure was normalized within 1 year follow BPD in more than 50% of the hypertensive obese patients studied and that blood pressure remained within the normal range throughout the 3-year follow-up period in these patients. Although the resolution of hypertension was substantially dependent on the stable achievement of a healthy weight, other unidentified variables that are fully independent of weight loss prevented the normalization of blood pressure in nearly 50% of the cases. Therefore, in order to maximize the health benefits of bariatric surgery in obese patients with hypertension, an operative procedure that achieves and supports the maintenance of a body weight close to ideal value is advisable.

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