

Research Article

Management of Hypertension and Diabetes in Obesity: Non-Pharmacological Measures

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Obesity has become a global epidemic over the past few decades because of unhealthy dietary habits and reduced physical activity. Hypertension and diabetes are quite common among obese individuals and there is a linear relationship between the degree of obesity and these diseases. Lifestyle interventions like dietary modifications and regular exercise are still important and safe first-line measures for treatment. Recently, bariatric surgery has emerged as an important and very effective treatment option for obese individuals especially in those with comorbidities like hypertension and diabetes. Though there are few effective drugs for the management of obesity, their efficacy is only modest, and they should always be combined with lifestyle interventions for optimal benefit. In this paper we aim to outline the non-pharmacological measures for the management of hypertension and diabetes in obesity.

1. Introduction

Hypertension, diabetes mellitus and obesity together form 24% of the global risk for mortality [1]. Cardiovascular disorders related to these life-style diseases form the major cause of morbidity and mortality among the sufferers worldwide. Obesity has become a global epidemic in the past few decades. Among the adult US population, 33.8% are obese, and another 34.2% are overweight [2]. Obesity is a risk factor for many diseases of which hypertension and type 2 diabetes mellitus are the most important.

Obese individuals (those with body mass index (BMI) more than 30 kg/m²) were found to have higher risk for diabetes mellitus (age-adjusted odds ratio (OR) = 3.66) and hypertension (age-adjusted OR = 3.72) compared to those with normal body weight [3]. Overweight individuals also had higher risk for diabetes and hypertension (age-adjusted OR = 1.59 and 1.88, resp.) and those with morbid obesity (BMI > 40 kg/m²) had the highest risk (age-adjusted

OR = 7.37 and 6.38, resp.) [3]. As there is a significant linear relationship between body weight and these two diseases, control of excess bodyweight is important for their prevention and treatment.

Over the past few decades, a lot of effective drugs have been developed for the treatment of hypertension and diabetes. However, the pharmacotherapy of obesity is still not very promising without lifestyle modification and/or surgical intervention. Therefore, we aim to discuss the treatment options without drugs for management of hypertension and diabetes in obesity through this paper.

2. Life-Style Interventions for Treatment of Hypertension and Diabetes in Obesity

2.1. Exercise for the Obese Hypertensive. The role of physical activity for treatment of hypertension is wellknown [4–6]. Aerobic exercise has shown to be associated with reduction

of systolic blood pressure (SBP) by 3.84 mm Hg and diastolic blood pressure (DBP) by 2.58 mm Hg in a meta-analysis examining large data from 54 randomized controlled trials [4]. More profound reduction of SBP (14.77 mm Hg) and DBP (5.63 mm Hg) has been observed in a recent study among obese patients after a 12-month regular exercise program along with dietary changes [7]. Significant reduction in body weight and cardiometabolic parameters like insulin resistance and hepatic fat also have been observed among the participants in this study.

Regular exercise along with dietary modifications has shown to be associated with significantly greater reduction in both SBP (4.5 mm Hg) and DBP (2.4 mm Hg) when compared with dietary adjustments alone among hypertensive patients [8]. Reduction in body weight was also higher among the former group. Weight loss has been found to be associated with a decrease in arterial stiffness [8, 9]. Better control of blood pressure among obese hypertensives following weight loss may be partly due to the reduction in arterial stiffness. Even minor reduction in the body weight has been associated with better control of hypertension and cardiovascular risk factors [10].

An average weight loss of 3.0 kg through lifestyle interventions corresponded 2.5 years later with a 30% reduction in combined cardiovascular events, poorly controlled blood pressure and the need to reinitiate antihypertensive medications [11]. Reductions in total body and abdominal fat, even without significant weight loss achieved through regular exercise, were found to be associated with improved SBP, DBP and cardiovascular risk factors [12]. Diet, Exercise, and Weight Loss Intervention Trial (DEW-IT) showed that exercise-incorporated lifestyle interventions can result in significantly better BP control among patients taking pharmacotherapy for hypertension [13].

2.2. Exercise for Diabetes in Obesity. Regular exercise improves glycemic control in all forms of diabetes. Insulin resistance is the major cause for hyperglycemia in obese diabetics and physical activity is one of the best ways to reduce insulin resistance [7, 14–16]. Physical activity improves insulin resistance through various mechanisms. Hepatic lipid accumulation is one of the primary mechanisms that drive obesity-related insulin resistance and type 2 diabetes, and exercise can reduce the free fatty acid-induced hepatic insulin resistance [14]. Reversal of hepatic insulin resistance is related to the reduction in central adiposity induced by exercise. Weight loss achieved by regular exercise was found to improve hepatic insulin sensitivity better than weight loss induced through calorie restriction [16]. Exercise can also reduce hepatic glucose production and augment insulin-mediated suppression of hepatic glucose output [14, 17].

Exercise increases skeletal muscle glucose uptake and utilization. This effect is mediated by an increase in expression of glucose transporter 4 (GLUT 4, an isoform of glucose transporter) in skeletal muscle [18]. Exercise also induces an increase in muscle insulin sensitivity [19]. Through these adaptations in the muscle, physical activity improves

the peripheral glucose disposal and insulin resistance, and augments the glycemic control among obese individuals with diabetes.

Aerobic exercise has been demonstrated to improve the insulin sensitivity and reduce the glycemic load, without any significant change in energy intake, among obese men and women, and exercise may have a synergistic effect to reduce insulin resistance when combined with a low glycemic diet [15]. Despite the absence of weight loss, moderate-intensity exercise was associated with significant reductions in visceral obesity (an important determinant of insulin resistance) among obese individuals with type 2 diabetes [20].

Look AHEAD (Action for Health and Diabetes) is a US National Institutes of Health-funded long-term multicentric clinical trial studying the effect of an intensive lifestyle intervention on cardiovascular disease (CVD) morbidity and mortality in overweight/obese people with type 2 diabetes. Weight loss achieved by exercise and dietary changes among the intervention group resulted in better glycemic control and CVD risk factors [21]. Reduced medication use and lower therapeutic costs were the other benefits observed among this group after one year [22].

Diabetes Prevention Program (DPP) was a prospective multi-centre randomized clinical trial examining the diabetes incidence in overweight/obese adults managed with intensive lifestyle intervention or metformin or placebo. Exercise-incorporated lifestyle intervention reduced the incidence of type 2 diabetes by 58% and metformin by 31% when compared with placebo after 2.8 years of follow up [23]. Decreased diabetes risk by lifestyle intervention observed in the DPP trial was related to reductions of body weight, BMI, and central adiposity [24]. Follow up data from the trial has shown that the cumulative incidence of diabetes remained lowest in the lifestyle intervention group even after 10 years [25].

2.3. Dietary Measures for Hypertension Management in Obesity. The Dietary Approaches to Stop Hypertension (DASH) trial was a multicenter, randomized clinical trial that examined the effects of dietary patterns on blood pressure. This landmark study showed that a diet rich in fruits, vegetables and low-fat dairy products along with reduced saturated and total fat lowered systolic blood pressure by 5.5 mm Hg and diastolic blood pressure by 3.0 mm Hg more than a control diet [26]. For overweight or obese persons, the addition of exercise and weight loss to the DASH diet resulted in even larger BP reductions and cardiac risk factors [8].

Dietary sodium restriction (to <3 grams/day) is an important component of management of any patient with hypertension. Overweight/obese hypertensives were found to have higher salt sensitivity in observational studies [27, 28]. Obese subjects were also found to have an enhanced rate of renal tubular sodium reabsorption [29]. Animal studies showed that obesity is associated with salt retention by the kidney through reduction of natriuresis (increased clearance of atrial natriuretic peptide by adipose cells), increased sympathetic activity and activation of renin-angiotensin-aldosterone system (and high blood pressure as

a consequence) [30]. Hence, the beneficial effect of salt restriction would be more profound among obese hypertensives. A recent large population-based study reported from China adds evidence to this concept [31].

A long-term dietary intervention trial with a nutrient-fortified prepared meal plan (approximately 22% energy from fat, 58% from carbohydrate and 20% from protein) was found to be associated with better control of BP among obese/overweight hypertensives than with the usual care diet [32]. The dietary intervention group in this study also achieved better weight loss and improved cardiovascular risk factors. Combining a daily fish meal with a weight-loss diet has an additive effect on blood pressure among overweight hypertensives [33].

A systematic review to determine the long-term effects of weight loss on hypertension through dietary interventions versus pharmacologic treatment showed that the former approach resulted in greater weight loss and BP reductions than the latter [34]. The American Dietetic Association recommends the application of medical nutrition therapy (MNT) and lifestyle counseling as an integral component of the medical treatment for management of specific disease states and conditions (including hypertension and obesity) and should be the initial step in the management of these situations [35]. When pharmacotherapy becomes necessary for control, MNT may complement or enhance its therapeutic effectiveness, thereby reducing or eliminating the need for multiple medications.

Excess alcohol consumption is well known to raise the blood pressure in human beings. However, social drinking may not be very hazardous. According to the European Society of Hypertension and Cardiology recommendation, alcohol consumption in hypertensive subjects who drink alcohol should be limited to no more than 20 to 30 gm of ethanol per day for men and no more than 10 to 20 gm for women [36]. In obese hypertensives, low levels of drinking may help to reduce calorie consumption and thus may facilitate weight reduction.

Overall, weight reduction achieved through lifestyle interventions like dietary modification and regular exercise programs (at least 30 minutes/day on most days) help obese individuals with hypertension to obtain better BP control and reduce complications related to uncontrolled hypertension.

2.4. Dietary Measures to Treat Diabetes in Obesity. Nutritional intervention is of paramount importance in preventing diabetes, managing existing diabetes and preventing/slowing diabetic complications. Total calorie intake can be distributed as follows in a type 2 diabetic: 45–65% of total calorie intake as carbohydrate, 10–30% as proteins and less than 30% as total fat (<7% saturated fat) with <300 mg/day of cholesterol [37]. Total calorie intake must be appropriate to weight management goals of the individual. Macronutrient intake should be tailored according to the metabolic status of the patient (e.g., lipid profile). Similarly, there is no evidence-based recommendation for generalization of micronutrient supplements.

For obese diabetic, a weight losing diet containing either low-carbohydrate or low-fat calorie-restricted diet may be effective in the short term (up to 1 year) [37]. Standard weight loss diets provide 500–1,000 fewer calories than estimated to be necessary for weight maintenance. Up to 10% of weight loss can be achieved in 6 months with such diets. Lipid profiles, renal function and protein intake (in those with nephropathy) of patients on low-carbohydrate-diets should be monitored and adjustments of hypoglycemic drug therapy should be made to avoid the risk of hypoglycemia. Maintenance of weight loss after one year usually depends on the adherence to lifestyle interventions.

Intensive individualized dietary advice (according to the nutritional recommendations of the European Association for the Study of Diabetes) for six months has shown to reduce HbA1c by 0.4%, body weight by 1.3 Kg, BMI by 0.5 kg/M² and waist circumference by 1.6 cm when compared to controls, among overweight/obese diabetics on optimal medical treatment without adequate glycemic control [38].

A carbohydrate intake of 130 grams/day is recommended for patients as this provides adequate glucose for the central nervous system, without reliance on glucose production from ingested protein or fat, for its fuel needs [39]. Long-term metabolic effects of very-low-carbohydrate diets on brain are unclear (though brain may function even on lower carbohydrate diets) and such diets may result in imbalance of energy, fiber, vitamins and minerals, and may not be palatable.

3. Bariatric Surgery for Management of Obese Individuals with Hypertension and Diabetes

Few surgical procedures in the upper gastrointestinal tract, collectively termed as bariatric surgery, have emerged as important therapeutic options for management of obesity in the recent years. They are classified as purely restrictive (limiting the stomach volume) and primarily malabsorptive [40]. Restrictive procedures commonly used now are laparoscopic adjustable gastric banding and laparoscopic vertical sleeve gastrectomy. The main malabsorptive procedure in use now is Roux-en-Y gastric bypass.

Calorie restriction may be through three mechanisms in bariatric surgery: (1) mechanical limiting of volume of the gastric pouch and reduction of its outlet (2) modulation of satiety by postprandial induction of neuro-hormonal signals (e.g., peptide YY, an anorexiant) and (3) restriction of calorie intake spontaneously adopted by patients to limit the burden of postprandial dumping syndrome [41]. Weight loss is achieved mainly through restriction of calorie intake. Significant weight loss following the surgery usually results in improvement of diabetes and hypertension.

A recent meta-analysis that included 621 studies with 888 treatment arms and 135,246 patients has shown that the weight loss overall was 38.5 kg or 55.9% excess body weight loss [42]. Overall, 78.1% of diabetic patients had complete resolution and diabetes was improved or resolved in 86.6% of patients. Improvement of diabetes usually occurs days after surgery even before significant weight loss is achieved.

Apart from calorie restriction obtained through the procedure, improvement of insulin resistance and insulin sensitivity (mainly related to weight loss) also contributes to better glycemic control among obese diabetic patients undergoing bariatric surgery. Other proposed mechanisms are through release of gut hormones like glucagon-like peptide-1 and glucose-dependent insulinotropic polypeptide (the incretin effect) and increase in the beta-cell mass [41].

Hypertension was resolved in 61.7% and resolved or improved in 78.5% of patients undergoing bariatric procedures [43]. The improvement in hypertension is mainly related to weight loss. In general, one percent reduction in body weight will decrease systolic blood pressure by 1 mm Hg and diastolic blood pressure by 2 mm Hg [43]. Reduction in salt sensitivity and alteration of renal hemodynamics brought about by weight loss may be the contributing factors for improvement of hypertension following bariatric surgery. A 14 mm Hg reduction in SBP and 12 mm Hg reduction in DBP was observed among obese hypertensives undergoing bariatric surgery in a recent clinical trial [44]. Discontinuation/ reduction of dose of antihypertensive medication can be achieved in many patients following bariatric surgery.

A recent study showed the distinct advantages of bariatric surgery over lifestyle interventions for treatment of obesity and related diseases like hypertension and diabetes [44]. The mean weight loss at one year was 30% and 8% in the surgical and lifestyle intervention groups, respectively. Remission rates of type 2 diabetes and hypertension were significantly higher in the surgery group than in the lifestyle intervention group (70 versus 33% and 49 versus 23%).

Bariatric surgery is a relatively safe (perioperative mortality rate 0.3%) procedure with only a few adverse consequences (4.3%) [45]. The most frequent and severe adverse events in the immediate postprocedure period are anastomotic leaks, hemorrhage and thromboembolic events. Long-term hazards are vitamin deficiencies, malnutrition, osteoporosis, psychiatric disorders and a slightly higher risk of accidental death [41, 46]. However, a Swedish study showed significantly reduced 10-year mortality risk with bariatric surgery when compared to nonsurgical treatment of obesity, making this treatment option a promise for many [47].

The Scottish Intercollegiate Guidelines Network (SIGN) recommends that bariatric surgery may be considered for patients with all three of the following: (a) BMI of 35 or more, (b) one or more severe comorbidities that are expected to have a meaningful clinical improvement with weight reduction (e.g., severe mobility problems, arthritis, type 2 diabetes), and (c) evidence of completion of a structured weight management program that covered diet, physical activity, and psychological and drug interventions but did not result in significant and sustained improvement in co-morbidities [48]. The most recent Diabetes Surgery Summit consensus conference recommends bariatric surgery for type 2 diabetic patients with severe obesity (BMI > 35 kg/m²) as well as in carefully selected, moderately obese patients (BMI: 30–35 kg/m²) who are inadequately controlled by conventional medical and behavioral therapies [49].

4. Conclusions

Weight loss achieved through lifestyle interventions like dietary adjustments and regular physical activity are safe and moderately effective measures for management of hypertension and diabetes in obesity. They also help to reduce the treatment costs related to pharmacotherapy and also to reduce the pill burden. Even when drug therapy is considered, lifestyle interventions should continue, to obtain the desired effects of medications. Bariatric surgery is more effective than lifestyle interventions for treatment and is remarkably safe in selected patient groups. These non-pharmacological interventions should be the first-line management option and should also be combined with pharmacotherapy for scientific treatment of these diseases.

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