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RESEARCH ARTICLE

METABOLIC CHANGES AFTER BARIATRIC SURGERY A LONGITUDINAL COMPARATIVE STUDY

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ABSTRACT

- To compare the outcome of Bariatric surgery in terms of metabolic changes among the study subjects.
- To compare the outcome of Bariatric surgery in terms of attaining fertility.

Material and methods: A longitudinal study was conducted at two tertiary care hospitals in the Department of Laparoscopic and Bariatric Surgery, Bangalore, for a period of 4 years from January 2012 to December 2015. A total of 290 study subjects who were admitted in the two tertiary care hospitals during the study period having comorbidities like dyslipidemia, diabetes hypertension, Polycystic Ovarian Syndrome (PCOS) on Ultrasonography (USG) and consented for bariatric surgery were included in the study. The patients who were not available for 12 months follow-up were excluded from the study.

Results: Majority 40.3% were in the age group of 26-40 yrs of which 74.5% of the study subjects were females. The excess weight loss was recorded among 53.1% of the study subjects. Glycemic control was achieved in terms of resolution of FBS among 95.5% of them at 6th month and 100.0% at 12th month, PPBS among 86.5% at 6th month and 95.1% at 12th month and HbA1c among 74.5% at 6th month and 84.8% at 12th month. Dyslipidemia and hypertension also showed a significant reduction with 100% fertility rate. **Conclusion:** Excess weight loss, metabolic improvement in term of glycemic control, control of dyslipidemia, remission of hypertension was observed. Thus our study recommends bariatric surgery for achieving better metabolic control among obese individuals.

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INTRODUCTION

Overweight and obesity ranks as fifth leading risk of global deaths and the problems are now rising in low-and middle-income countries, particularly in urban settings. Among 1.4 billion overweight adults aged 20 years and older, over 200 million men and nearly 300 million women were obese (World Health Organization, 2014). The non-communicable risk factor survey phase 2 carried out in India, showed high prevalence of overweight in all age groups except in 15-24 years group and was higher among females than males and in urban areas than in rural areas (Government of lndia, 2011). 1.3 per cent males and 2.5 per cent females aged more than 20 years were obese in India in the year 2008 (World Health Organization, 2014). At least 3.4 million adults die each year due to overweight or obesity. In addition, the burden of diabetes (44.0%), ischaemic heart disease (23.0%), certain cancers (7.0-41.0%) are attributable to overweight and obesity (World Health Organization, 2014). The association between severe obesity and premature death from diabetes, hypertension and CHD is well recognized (World Health Organization, 1984). Overnutrition is the basic cause of obesity. Excess consumption of energy dense foods than needed may lead to prolonged postprandial hyperlipidaemia and deposition of triglycerides in adipose tissue resulting in obesity (Oliver, 1981). In obesity, it is known that a relative insulin resistance takes place in peripheral tissues, mainly adipose tissues, while the insulin secretion will be normal or increased. The reduction in the insulin sensitivity of the large adipocyte has been attributed to the decreased affinity of the insulin receptors or to a reduction in their number in the cell membrane. Through a feedback mechanism the secretion of insulin is stepped up', thus leading to a state of hyperinsulinism. Practically, all hypotheses concerning the genesis of obesity could be linked to over-nutrition, to a hyper-energy food intake. This becomes a sound basis for preventive and therapeutic recommendations (Tasher, 1986). Considering the impact of obesity on health, obesity needs to be tackled.

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The interventions viz., non-pharmacological interventions (lifestyle modifications and nutritional interventions) pharmacological interventions (Phentermine, Sibutramine, Orlistat Erlanger, 2008) or surgical management through bariatric surgery are the therapeutic options available for obesity (Jammah, 2015). Due to the unsatisfactory outcomes of the presently applied medical modalities of treatment number of bariatric procedures has sprung up as one of the important modalities of treating obesity. The bariatric procedures has been conventionally classified under three different groups viz., 1) restrictive - weight loss achieved solely by limiting intake (gastric banding, GS); 2) malabsorptive - weight loss produced as a result of total interference with digestion and absorption (intestinal bypass); and 3) Mixed – restrictive and malabsorptive (gastric bypass, duodenal switch) (Pories, 2008).

Though the mechanism of weight loss with these operations relies mainly on restriction of food intake, malabsorption of ingested food, or a combination of the two, the actual mechanisms appears far more complex, associating various hormonal, inflammatory, action on central nervous system and gut microbial factors (Madura, 2012). The procedures which have sprung up recently, the contemporary bariatric operations are relatively safe with a mortality of three in 1,000 patients and they include Roux-en-Y gastric bypass, sleeve gastrectomy, adjustable gastric band and the duodenal switch. The various advantages viz., rapid recovery, the reduction of postoperative pain and wound-related complications, compared with open surgery, laparoscopic bariatric techniques are gaining its importance (Nguyen, 2017). Bariatric surgery has become the most successful treatment for obesity in achieving a significant and durable weight loss among those with failed medical management. Bariatric surgery has resulted in greater improvement in the conditions viz., diabetes, hyperlipidemia, hypertension, obstructive sleep apnea, Gastroesophageal reflux symptoms, regression of Barrett's esophagus, and urinary stress incontinence as observed in other studies. It also has been noted that there is reduction in the incidence of diabetes, coronary disease and cancers and reduced mortality after bariatric procedures (Jammah, 2015).

Effect of Bariatric Surgery on Weight loss: The weight loss after Bariatric surgery can be primarily explained by the postprandial changes in the levels of gut hormones, including GLP-1, gastric inhibitory polypeptide (GIP), Peptide YY (PYY), cholecystokinin (CCK) and Ghrelin *et al*., (2016). Buchwald *et al*., also has found that as a result of bariatric surgery, overall weight loss was 38.5 kg or 55.9% excess body weight loss. The consistent weight losses were seen after surgical procedures at both less than 2 years and more than 2 years.[19] A major prospective non-randomized intervention study, the Swedish Obese Subject (SOS) Study has compared three types of bariatric surgery with nonsurgical treated patients undergoing conventional treatment for obesity. The average change in weight was noted to be within ±2% among the group with nonsurgical treated patients undergoing conventional treatment for obesity and in the other three surgical subgroups, the mean (±SD) weight loss was maximal after 1 to 2 years (gastric bypass, 32±8%; vertical-banded gastroplasty, 25±9%; and banding, 20±10%). Hence nonsurgical treated patients showed the smallest weight changes during the follow-up compared to surgically treated patients (Cunha *et al*., 2016).

Effect of Bariatric Surgery on Diabetes: Buchwald *et al*., has found that 86.6% of the diabetic patients had improvement or resolution of diabetes. HbA1c and fasting glucose values also decreased significantly postoperatively. According to Buchwald *et al*., 82.0% had resolution of the clinical and laboratory manifestations of diabetes in the first 2 years post-surgery and 62.0% remained free of diabetes more than 2 years post-surgery. The diabetic laboratory parameters (HbA1c 2.1% and fasting glucose 44.4 mmol/L) declined significantly (P <0.001).[19] Among three studies, under a meta-analysis Baskota A *et al*., found 6.69 mmol/l as the overall reduction of the postprandial blood glucose level (Schauer *et al*., 2012). Mingrone G *et al*., has noted that at 2 years follow up, average percentage changes in glycated hemoglobin levels from the baseline value (8.65±1.45%) were smaller in the medical-therapy group (−8.39±9.93%) than in the gastric-bypass group (−25.18±20.89%) and the biliopancreatic-diversion group (−43.01±9.64%). Average changes in the fasting plasma glucose levels followed the trend of HbA1c and the levels noted were −14.37±11.93% in the medical-therapy group, −37.81±33.75% in the gastric-bypass group, and −56.23±10.01% in the biliopancreatic-diversion group (Schiavon *et al*., 2014). Schauer *et al*., has reported that the patients in the surgical groups had significant greater mean percentage reductions in weight (24.5±9.1% in the gastric-bypass group and 21.1±8.9% in the sleeve-gastrectomy) group from baseline compared with a reduction in the medical-therapy group (4.2±8.3%). (*P*<0.001) (Sjöström *et al*., 2000).

Effect of Bariatric Surgery on Dyslipidemia: Singhal S *et al*., noted that total cholesterol levels decreased from 218.05± 17.61 mg/dL to 183± 8.9 mg/dL, triglycerides from 172.3± 48.8 mg/dL to 89± 24.9 mg/dL and HDL raised from 40.84± 10.15 mg/dL to 45± 8.8mg/dL (Eid *et al*., 2005). Raj PP *et al*., has observed a significant improvement in serum triglycerides and HDL cholesterol with no significant reduction in serum total cholesterol in both LSG and LGB group (Weiss, 2001). Cunfa M *et al*., noted that at 1 year of follow up after surgery, high-density lipoprotein cholesterol (HDL) and triglycerides (TG) improved and total cholesterol (TC) and low-density lipoprotein cholesterol (LDL) at 1 year decreased significantly (Dixon *et al*., 2001).

Effect of Bariatric Surgery on Blood Pressure: One of the theoretical explanations for blood pressure reduction after bariatric surgery may be due to weight loss achieved by means of clinical treatment (Malik *et al*., 2012). Schiavon CA *et al*., in their study suggested that the course of blood pressure over the study period showed a varied pattern, during the initial 6 months of rapid weight loss, SBP was reduced by 11.4±19.0 mmHg and DBP was reduced by 7.0±11.0 mmHg, in spite of a continuous weight loss during the following 6 months, the reduction in DBP was not observed, whereas SBP seemed to increase. From 1 year, SBP and DBP increased gradually over the remaining 7 years (Quezada *et al*., 2015). Mingrone G *et al*., has noted significant reduction in the systolic and diastolic blood-pressure levels in all three study groups. Antihypertensive therapy was reduced or discontinued in 70% of patients receiving medical therapy, 80% of those undergoing gastric bypass and 85% of those undergoing biliopancreatic diversion (Schiavon *et al*., 2014).

Effect of Bariatric Surgery on Infertility: During a follow up of more than 2 years by Eid GM *et al*., noted that 5 of 24 PCOS women with Metabolic syndrome undergoing LRYGB

became pregnant spontaneously after surgery (Baskota *et al*., 2015). Weiss HG *et al*., noted 7 unexpected pregnancies within about 1 year of surgery and some within several months of LAGB surgery (Mingrone *et al*., 2012). Dixon JB *et al*., after LAGB observed 20 pregnancies to occur on average 16 months following surgery (Schauer *et al*., 2014; Sjöström *et al*., 2007). The literatures on long term effect of bariatric surgery on dyslipidemia are scarce (Ashrafian *et al*., 2010) and the same along with other parameters like blood sugar levels, state of hypertension, infertility has not been noted in the current study settings. Further investigations are warranted as the relative efficacy of different weight management interventions in women with and without PCOS are varied.[13] Hence the current study was undertaken with the following objectives:

- To compare the outcome of Bariatric surgery in terms of metabolic changes among the study subjects.
- To compare the outcome of Bariatric surgery in terms of attaining fertility

MATERIALS AND METHODS

A longitudinal study was conducted at two tertiary care hospitals in the Department of Laparoscopic and Bariatric Surgery, Bangalore, for a period of 4 years from January 2012 to December 2015. A total of 290 study subjects who were admitted in the two tertiary care hospitals during the study period having comorbidities like dyslipidemia, diabetes hypertension, Polycystic Ovarian Syndrome (PCOS) on Ultra-sonography (USG) and consented for bariatric surgery were included in the study. The patients who were not available for 12 months follow-up were excluded from the study.

Operational definitions: Data evaluated at 1 year included weight, BMI, weight loss, resolution / remission of diabetes, dyslipidemia, hypertension, infertility.

Weight loss: Body weights were measured at baseline i.e., 1 week pre-surgery and 6 and 12 months post-surgery. Excess body weight was defined as measured body weight minus the body weight that would result in a BMI of 25 kg/m^2, which in simple terms would mean measured body weight minus ideal body weight (IBW). Weight loss outcome measures used were percentage of excess weight loss, mean change in weight and BMI (Hallersund *et al*., 2012).

Diabetes control: Glycosylated haemoglobin (HbA1c), fasting blood glucose (FBS) and post prandial blood glucose (PPBS) were also recorded at 1 week pre-surgery and 6 and 12 months post-surgery. Diabetes was considered resolved in patients who had normal FBS (≤110 mg/dL), PPBS (≤110 mg/dL) and normal HbA1c (<6.5%) (Hallersund *et al*., 2012).

Dyslipidemia: Dyslipidemia was defined according to NCEP ATP-III guidelines: Total cholesterol > 200 mg/dl TG >150 mg/dl, HDL cholesterol <40mg/dL (Eid *et al*., 2005).

Hypertension Remission

Remission of hypertension was defined among those who were on antihypertensives and now has completely ceased taking antihypertensive medications. Ethical approval was obtained from the Institutional Ethics committee. After obtaining the written informed consent, detailed clinical history was taken from the study subjects using a pre-tested semi-structured questionnaire. All the patients were examined clinically and were subjected to basic investigations like fasting blood sugar (FBS), post-prandial blood sugar (PPBS), HbA1C, total cholesterol (TC), HDL, LDL, VLDL, USG of abdomen and pelvis prior to the surgery to obtain the baseline characteristics. All the subjects underwent Bariatric surgeries viz., SLEEVE GASTRECTOMY, Roux-en-Y Gastric Bypass (RYGB), MINI GASTRIC BYPASS, BANDED SLEEVE GASTRECTOMY, BANDED RYGB. After the surgery all the subjects were followed up for a period of 12 months to study the changes in metabolic parameters like FBS, PPBS, HbA1C, TC, HDL USG findings at the end of 6 months and 12 months.

Statistical Analysis: The collected data were entered into an excel sheet. The data were expressed in means and proportions and presented in the form of tables and graphs where ever necessary. The outcomes of bariatric surgery for means and standard deviations of the parameters viz., FBS, PPBS, HbA1C, TC, HDL were compared using paired t- test. The data viz., the change in the usage of BP medications, status of infertility were expressed in proportions. The analysis was done using standard statistical package. A *P* value of <0.05 was taken as statistically significant.

RESULTS

The mean age of the study participants was 40.79±12.68 yrs. Majority i.e., 40.3% were in the age group of 26-40 yrs. Majority i.e., 74.5% of the study subjects were females. Among the different surgeries performed, majority underwent sleeve gastrectomy (39.0%) followed by RYGB (25.5%), banded sleeve gastrectomy (22.4%), banded RYGB (12.1%) and mini gastric bypass (1.0%). 50.0% of the subjects had family history of Obesity. Majority (58.3%) of the subjects presented with co-morbidities like Arthritis (16.5%), Hypertension (15.5%), Hypothyroid (8.6%), Acid peptic disease (4.8%), Obstructive sleep apnoea (3.4%), IHD (1.3%), Infertility/PCOS(1.0%), Others (Asthma, CKD, hiatus hernia, migraine, neuropathic bladder, stress incontinence, urinary incontinence, neuropathy, retinopathy, varicose veins) 7.5% (Table 1). The mean weight, height, and BMI of the study participants were 107.04±20.92 kgs, 159.52±9.93 cms and 42.19±7.59 kg/m^2.

Weight Loss: The excess weight loss was recorded among 53.1% of the study subjects. A statistically significant reduction was found among the subjects in the mean values of weight [$F(1.27,290)=24.09$, $P=0.000$]. (Table 2)

Glycemic Control: The mean values of FBS [$F(1.08,290)=2330.97$, P =0.000], PPBS [$F(1.13,290)=78.15$, $P=0.000$] and HbA1c [$F(1.33,290)=357.98$, $P=0.000$], showed a significant reduction on follow up. (Table 2) Glycemic control was achieved in terms of resolution of FBS among 95.5% of them at 6th month and 100.0% at 12th month, PPBS among 86.5% at 6th month and 95.1% at 12th month and HbA1c among 74.5% at 6th month and 84.8% at 12th month.

Dyslipidemia: Total Cholesterol [$F(1.51,290)=48.32$, $P=0.000$], Serum Triglycerides [$F(1.52,290)=9.46$, $P=0.000$] and HDL {F(1.43.290)=59.21. P=0.000} also showed a significant reduction as determined by one-way Repeated Measures ANOVA (Table 2).

Table 1. Characteristics of Study Population

Characteristics of the study participants	
Age in years (Mean±SD)	40.79±12.68
≤ 25	36 (12.4)
26-40	117 (40.3)
41-55	101 (34.8)
≥ 56	36 (12.4)
Gender (%)	
Males	74 (25.5)
Females	216 (74.5)
Operation type	
Sleeve Gastrectomy	113 (39.0)
Roux-en-Y Gastric Bypass (*RYGB*)	74 (25.5)
Mini Gastric bypass	03 (1.0)
Banded Sleeve Gastrectomy	65 (22.4)
Banded RYGB	35 (12.1)
Family history	
Yes	145 (50.0)
No	145 (50.0)
Co-morbidities	
Present	169 (58.3)
Absent	121 (41.7)

Table 2. Comparison of means of different parameters at baseline, 6 months and 12 months

Parameters	Mean±SD			ANOVA	
	Baseline	6th month (Post-op)	12th month (Post-op)	F	*P*-Value
Weight (Kgs)	107.04±20.92	81.37±17.21	63.81±11.53	24.09	0.000*
FBS (mg/dL)	115.55±47.97	95.9±10.65	90.72±4.29	2330.97	0.000*
PPBS	161.07±71.39	130.37±12.95	118.32±16.39	78.15	0.000*
HbA1c	6.69±1.56	6.17±1.40	5.59±0.92	357.98	0.000*
Total Cholesterol	183.51±34.94	176.19±23.77	163.34±15.33	48.32	0.000*
Serum Triglycerides	145.40±68.25	133.67±40.94	129.78±8.64	9.46	0.000*
HDL	40.43±11.51	39.10±8.69	33.50±7.91	59.21	0.000*

*indicates a significant statistical difference between the groups with $P<0.05$

Table 3. Pairwise Comparison of means of baseline values of different parameters with post-operative values at 6months and 12 months by applying Bonferroni test

Parameters	Pre-op Baseline	Post op Follow-up	Mean Difference	95% CI	*P*-Value
Weight (Kgs)	Baseline	6th month	25.67	24.70 – 26.64	0.000*
		12th month	43.23	41.23 – 45.23	0.000*
FBS (mg/dL)	Baseline	6th month	19.65	12.75 – 26.55	0.000*
		12th month	24.83	18.03 – 31.62	0.000*
PPBS (mg/dL)	Baseline	6th month	30.70	20.33 – 41.07	0.000*
		12th month	42.74	32.75 – 52.74	0.000*
HbA1c	Baseline	6th month	0.53	0.432 - 0.592	0.000*
		12th month	1.105	0.980 – 1.230	0.000*
Total Cholesterol (mg/dL)	Baseline	6th month	7.324	1.473 – 13.176	0.008*
		12th month	20.166	14.713 – 25.618	0.000*
Serum Triglycerides (mg/dL)	Baseline	6th month	11.726	1.219 – 22.234	0.023*
		12th month	15.612	5.781 – 25.444	0.000*
HDL (mg/dL)	Baseline	6th month	1.326	-0.549 – 3.201	0.269
		12th month	6.922	5.066 – 8.779	0.000*

*indicates a significant statistical difference between the groups with $P<0.05$

Further the pairwise comparisons were done using Bonferroni test for comparing baseline values with post-operative values at 6th month and 12th month of follow up. The means of weight, FBS, PPBS, HbA1C, total cholesterol, triglycerides, HDL were compared from baseline to 6th month and baseline to 12th month. There was a statistically significant difference in the mean values of weight, FBS, PPBS, HbA1C, total cholesterol, triglycerides, HDL from baseline to 6th month and 12th month ($P < 0.05$) except for change in the mean of HDL from baseline to 6th month ($P > 0.05$) in the baseline. (Table 3) The remission of hypertension was achieved among 100.0% of the study subjects who were previously under antihypertensives. Similarly, 100.0% of the women who were infertile conceived after bariatric surgery.

DISCUSSION

Wide-ranging surgical procedures have been used to promote weight loss since bariatric surgery was initially developed. Bariatric procedures act by reducing the size or capacity of the stomach, by bypassing a portion of the intestine or by a mixture of these two approaches. The commonly used procedures at present are gastric banding, sleeve gastrectomy and the Roux-en-Y gastric bypass (Kataoka *et al*., 2017). In the current study the different bariatric procedures performed were sleeve gastrectomy (39.0%) followed by RYGB (25.5%), banded sleeve gastrectomy (22.4%), banded RYGB (12.1%) and mini gastric bypass (1.0%). Majority (40.3%) of the study subjects were in the age group of 26-40 yrs, the mean age

being 40.79±12.68 yrs and 74.5% of the study subjects were females which is comparable to findings of Awad S *et al* who noted the mean age of the patients as 45.0±11.0 yrs and 72.0% of the subjects were females (Raj, 2016). A systematic review and meta-analysis by Guh *et al*., to find out incidence of co-morbidities related to obesity and overweight determined statistically significant associations for overweight with the incidence of type II diabetes, all cardiovascular diseases like hypertension, coronary artery disease, stroke, dyslipidaemia except congestive heart failure, asthma, osteoarthritis, sleep apnea and others (World Health Organization, 2014). Whereas in this study the common co-morbidities at presentation were Arthritis (16.5%), Hypertension (15.5%), Hypothyroid (8.6%), Acid peptic disease (4.8%), Obstructive sleep apnoea (3.4%), IHD (1.3%), Infertility/PCOS(1.0%), Others viz., asthma, CKD, hiatus hernia, migraine, neuropathic bladder, stress incontinenece, urinary incontinence, neuropathy, retinopathy, varicose veins (7.5%) (Meek *et al*., 2016).The mean weight and BMI of the study participants were 107.04 ±20.92 kgs and 42.19±7.59 kg/m^2 which are comparable to the findings of a randomized controlled trial by Kashyap SR *et al* who noted a mean weight of 104.3±15.1 kgs and a mean BMI of 36.1±2.9 kg/m^2 (Awad, 2014).

In our study, we found a statistically significant decrease (P<0.05) in the means of weight, FBS, PPBS, HbA1c, Total Cholesterol, Serum Triglycerides, HDL from baseline to 6th month and 12th month within the subjects, further on performing the pairwise comparisons for comparing baseline values with post-operative values at 6th month and 12th month, there was a statistically significant difference in the mean values of weight, FBS, PPBS, HbA1C, total cholesterol, triglycerides, HDL from baseline to 6th month and 12th month (P < 0.05) except for change in the mean of HDL from baseline to 6th month (P > 0.05). Kashyap SR *et al* evaluated the effects of two bariatric procedures (Roux-en-Y gastric bypass or sleeve gastrectomy) versus intensive medical therapy (IMT) on type 2 Diabetes Mellitus at baseline, 12 and 24 months and found improved glycemic control in all three arms at 24 months as compared with baseline, however the gastric bypass group had significantly greater reduction in fasting glucose and HbA1c levels compared with IMT (P < 0.05) (Awad *et al*., 2014). In two randomized controlled trials, the effect of bariatric surgery, demonstrated an improved glycemic control compared to intensive medical therapy in patients undergoing bariatric surgery resulting in the ability to withdraw or reduce glucose-lowering medications. Bariatric surgery reverses the fundamental pathophysiological defects of type 2 diabetes as the rapid rate of glucose lowering occurs disproportionate to degree of weight loss (Schiavon *et al*., 2014; Sjöström *et al*., 2000). Buchwald H *et al*., in his meta-analysis noted 38.5 kg overall weight loss or 55.9% excess body weight loss similar to the current study findings with 53.1% excess body weight loss. Overall, 78.1% of diabetic patients had complete resolution and diabetes improved or resolved in 86.6% of patients. Among the pure diabetics, laboratory parameters of diabetes (HbA1c 2.1%, and fasting glucose 44.4 mmol/L) declined significantly after bariatric surgery (P<0.001) (Raj *et al*., 2017). Baskota A *et al*., in their meta-analysis found 6.69mmol/l as the overall reduction of the postprandial blood glucose level among three studies (Schauer *et al*., 2012). Bansal S *et al*., recorded a significant mean reduction of HbA1c of 0.55 after 3 months and the value further reduces 0.415 after next 3 months (P <0.05). The mean FBS values reduced significantly to 102.15 + 21 and 95.4 + 14 at 3 and 6 months follow up (P <0.05) respectively. PPBS mean values also reduced significantly to 138.08 + 27.4 (P < 0.05) after 3 months and 128.85 + 16.66 at 6 months (P >0.05) which was not significant (Wilhelm, 2014). Kim MK *et al*., in his 2 year follow up study for metabolic changes in Korean diabetic patients recorded notable improvements in lipid profiles. The mean triglyceride levels reduced significantly after surgery compared to baseline (188.4 – 127.1 v/s 104.1 – 50.8 mg/dL; P<0.001) and the mean levels of high-density lipoprotein (HDL) cholesterol was significantly higher after surgery compared to baseline (42.8 – 8.4 v/s 50.6 – 9.9 mg/dL; P<0.001) whereas the total cholesterol levels did not change significantly after bariatric surgery (Guh *et al*., 2009). In a randomized controlled trial by Mingrone G *et al*., among three groups i.e., those who received conventional medical therapy or underwent either gastric bypass or biliopancreatic diversion found significant differences among the three groups with respect to levels of total cholesterol, HDL cholesterol, and triglycerides at 2 years. All lipid-profile measures except HDL levels were significantly lower among patients undergoing biliopancreatic diversion compared to those receiving medical therapy. All analyzed variables except HDL cholesterol decreased over time, in all three study groups. HDL cholesterol levels increased significantly more among patients undergoing gastric bypass (by 29.66±18.21%) compared to those receiving medical therapy (6.03±6.25%) or undergoing biliopancreatic diversion (12.98±20.66%) (P<0.001 for both comparisons) which are not in consensus with the current study findings.The difference may be due to other confounding factor like age,gender,dietary factors, lifestyle etc (Schiavon *et al*., 2014). Bariatric surgery characterizes the most effective method to treat obesity (Kashyap *et al*., 2013; Banzal *et al*., 2013).

Though much recent research have focused on metabolic improvement and diabetes mellitus resolution, previous studies advocate that a significant percentage of patients with coexisting obesity and hypertension were able to reduce or even discontinue their antihypertensive medications after bariatric surgery (Schiavon *et al*., 2014; Kim *et al*., 2014; Arterburn *et al*., 2015; Adams *et al*., 2017) which is similar to the current study findings where all hypertensive patients (43, 100.0%) who were on medications prior to the surgery discontinued their BP medications post-surgery. Kim MK *et al*., in his study found that among 61% of the patients who were on antihypertensive medications preoperatively, 45% became normotensive at 2 years after surgery without any medication (Guh *et al*., 2009). 100.0% of the women who were infertile conceived after bariatric surgery. Eid GM *et al*., during his follow up noted that 20.8% PCOS women with Metabolic syndrome undergoing LRYGB became pregnant spontaneously after surgery.[15] Dixon JB *et al*., after LAGB observed 20 pregnancies to occur on average 16 months following surgery (Schauer *et al*., 2014; Sjöström, 2007). The difference may be due to the other factors affecting fertility which were not evaluated in the current study and strongly recommends further evaluation. Post-operative BMI, the mean change in the systolic and diastolic blood pressure readings were not recorded. The sampling being convenient type, the study lacks generalizability and suggests the similar type of studies in a larger setting and involving larger samples.

Conclusion

The excess weight loss, metabolic improvement in term of achievement of glycemic control, control of dyslipidemia,

remission of hypertension was observed. 100.0% attainment of fertility was also seen following 1 year after bariatric surgery. Thus our study recommends bariatric surgery for achieving better metabolic control among obese individuals.

Conflict of Interest: Corresponding author and Contributing authors have nothing to disclose.

Ethical approval statement: This is retrospective study so consent is not required.

Informed consent statement: Does not apply.

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