

Comparison of Magenstrasse and Mill gastroplasty and sleeve gastrectomy techniques as an experimental study on rabbits



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AIM: Bariatric surgery is an important option when life-style modification, diet, and medical treatment are inadequate in lose weight. Bariatric surgical methods have gained popularity in recent years. In this paper, we compared the Magenstrasse and Mill(M&M) technique, with performing a simpler and more physiological type of gastroplasty without implanted foreign material such as band and reservoir, to the Sleeve Gastrectomy (SG) technique. This study aimed to determine the effects of the M&M for obesity on the rabbits in comparison with the SG, which is accepted as a standard bariatric technique with creating a gastric tube.

MATERIAL AND METHODS: The study was approved by the University of Van Yuzuncu Yil Regional Committee of Ethics (Institutional Animal Care and Use Committee). 20New Zealand Rabbits underwent operations. After prestudy with 2 rabbits, the remaining 18 rabbits were divided into 2 groups; Group 1 (SG) and Group 2 (M&M).

RESULTS: Group 1 rabbits were observed to lose weight in all, while Group 2 rabbits; 2 of them died, 5 of them lost weight, 2 of them gained weight. When the pre and post-operative weight of the rabbits were compared; preoperative median weight values of 9 rabbits in Group 1 were significantly higher than postoperative values. On the other hand, there was no significant change in the mean weight of Group 2 of 7 rabbits (living up to 8weeks). The mean weight of rabbits undergoing standard SG was significantly lower than the M&M technique.

CONCLUSION: We believe that this animal experimental study, which we conducted intending to compare M&M and SG techniques, will contribute to the literature as a pilot study and determine the survey of M&M technique as a pioneer in other studies.

KEY WORDS: Bariatric surgery, Magenstrasse and Mill gastroplasty, Sleeve gastrectomy

Introduction

Obesity and overweight are defined abnormal or excessive fat accumulation that may impair health according to the World Health Organization (WHO). The imbalance

between excess calorie intake and relatively less energy expenditure causes obesity. Obesity is a growing medical and socioeconomic problem. It has morbidity and mortality risks and is a severe chronic disease consisting complex genetics and environmental causes¹.

Obesity is recognized as epidemic of the 21st century, worldwide with the prevalence of serious life-threatening diseases. Obesity is important risk factor for premature death due to type 2 diabetes mellitus (T2DM) and cardiovascular diseases (CVD) such as hypertension, stroke and coronary heart disease. Additionally this health problem affect the organs and systems of the body and cause various disorders such as gall bladder problems, certain

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cancers (endometrial, breast, prostate, colon) and non-fatal conditions including gout, sleep apnea, gastroesophageal reflux disease, osteoarthritis and infertility^{2,3}. Bariatric surgery is an important option when life-style modification, diet, and medical treatment are inadequate in lose weight⁴. Bariatric surgical methods have gained popularity in recent years such as Laparoscopic Sleeve Gastrectomy, Laparoscopic Adjustable Gastric Band, Biliopancreatic Diversion, Roux-en-Y Gastric Bypass, Mini Gastric By-pass, etc. A successful surgical technique should not only be effective in weight loss but also be safe, with minimal side effects, less metabolic sequelae and should be simply applicable. None of the procedures described to date have all of the features described above.

In this paper, we compared the Magenstrasse and Mill (M&M) technique, with performing a simpler and more physiological type of gastroplasty without implanted foreign material such as band and reservoir, to the Sleeve gastrectomy technique. While in Sleeve Gastrectomy 80% of the normal stomach is resected to produce restriction and also decrease Ghrelin levels⁵; in this new procedure, which was introduced in 1987 by Johnston et al⁶, is a bariatric technique with the only restrictive property. More than 80% of M&M applied patients report a satisfactory five year quality of life and approximately 65% Excess Weight Loss (EWL); however, in the third and fourth years, (EWL) has been reported to decrease 45%⁷.

Aim

This study aimed to determine the effects of the M&M procedure for obesity on the rabbits in comparison with the Sleeve Gastrectomy, which is accepted as a standard bariatric technique with creating a gastric tube.

Material and Methods

The study was approved by the University of Van Yuzuncu Yil Regional Committee of Ethics (Institutional Animal Care and Use Committee). Initially, the surgical option was the M&M as a vertical gastric stapling procedure, and 20 New Zealand Rabbits underwent this operation. After pre-study with two rabbits, the remaining 18 rabbits were included in the main study. 18 rabbits were given high calorie (Protein: %17; Metabolic Energy: 2700 kcal; Crude ash: %7; Crude oil: %3,17; Crude fiber: %4,5; Sodium: 0,41 mg/kg; Vit A: 12000 mg/kg; Vit D3: 3600 mg/kg; Vit E: 24 mg/kg) feed for four weeks and weight gain was achieved. Weight change is given in Table I.

As observed in Table I, all rabbits, except rabbit seven, achieved the targeted weight gain (gaining 20% more than the initial weight). The difference between pre-feed-

ing weight and four weeks post-feeding weight was statistically significant. (Wilcoxon rank test, $p < 0.001$) After gaining weight, the rabbits were randomized into two groups as standard sleeve gastrectomy group and M&M group (Group 1 and 2 respectively).

SURGICAL TECHNIQUE

18 rabbits were fasted for two days before the operation. 5 mg/kg Xylazine HCl and 50 mg/kg Ketamine HCl were used as anesthesia for the operation. The operation area of the rabbit was sterilized (Fig. 1) and a mid-line incision is made from the xiphoid down to the pubis. A shorter incision may be preferred. Scrape fine subcutaneous tissue to expose linea alba. Linea alba is isolated, using a scalpel blade, a blade incision is made parallel to the line alba⁸.

The SG involves removing a large part of the stomach to form a tube and reduce the reservoir function of the stomach. Compared with other bariatric surgical techniques, the SG appears to be an attractive technique as it theoretically offers several benefits: it is easy to perform, it preserves the pylorus, entails no anastomoses, does not imply adding any foreign body, shows no risk internal hernia, and does not prevent the exploration of digestive tract. An 8 Fr catheter was delivered orally into the stomach to guide of the incision line. Seventy-to-eighty percent of the stomachs were excised after the dissection of gastrocolic and gastrosplenic ligaments from just 0.5 cm proximal to the pylorus to the diaphragmatic crus in the SG group. Then, the inner layer was closed by continuous 5/0 polypropylene sutures, and the outer layer was closed with continuous extra mucosal sutures by 5/0 polypropylene⁹⁻¹⁰.

The M&M procedure is a form of anti-obesity operation in which a long narrow gastric tube (the Magenstrasse) is formed around an 8 Fg bougie and the stomach is stapled (Proximate Reloadable Stapler, 30 mm (TX), 3.5 mm, Blue, Ethicon Endo-Surgery, LLC Guaynabo Puerto-Rico 00969 USA) and divided from the angle of His to incisura angularis (Fig. 2, 3, 4)⁶. The excluded gastric reservoir drains through the antrum via about 1 cm wide orifice and meanwhile, the antral Mill and the pyloric sphincter are kept intact for preserve normal retro-pulsion, grinding and milling of food



Fig. 1: Pre-operative period.

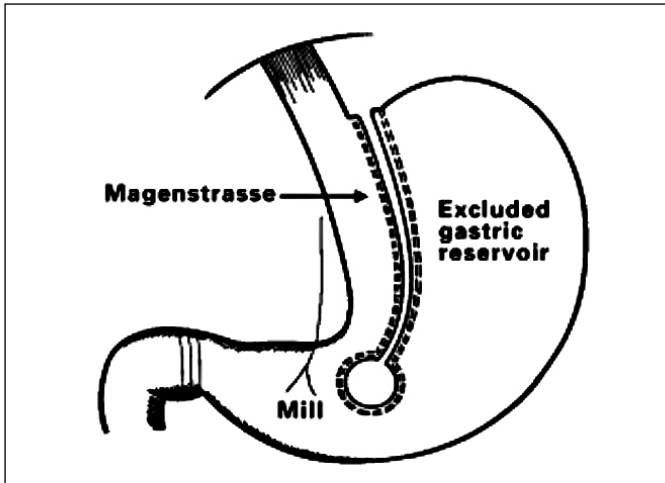


Fig. 2: Technique of Magenstrasse and Mill.

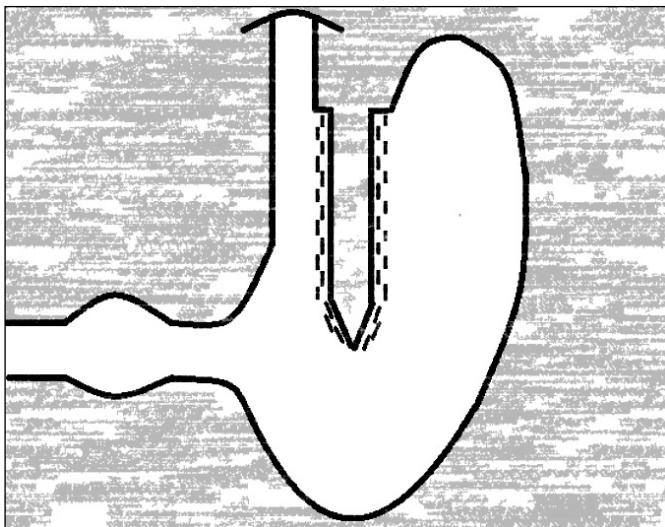


Fig. 3: The technique we applied.



Fig. 4: Magenstrasse and Mill operation.

and well-arranged gastric emptying¹². In Fig. 1, the schematic representation of Magenstrasse and Mill procedure is below.

Rabbits were followed up for two months after surgical procedures.

STATISTICAL ANALYSIS

All data were analyzed by SPSS (IBM Corp., Released 2013. IBM SPSS Statistics for Windows, Version 22.0. Armonk, NY: IBM Corp.) Program. Normality assumption was violated for all continuous variables Therefore, descriptive statistics for these variables were reported as median, minimum-maximum. Groups were compared with Paired-T test, Wilcoxon rank Test or Mann-Whitney U where appropriate. A value of 0.05 was considered to be a statistically significant level for all statistical computations and comparisons.

Results

Post-operative weight changes of rabbits were compiled in Table II.

At the end of this study, Group 1 rabbits were observed to lose weight in all, while Group 2 rabbits; 2 of them died, 5 of them lost weight, 2 of them gained weight. The weekly average weight of the rabbits according to the surgical method was found as shown in Graphic 1. When the pre and post-operative weight of the rabbits were compared; pre-operative median weight values of 9 rabbits in group 1 were significantly higher than post-operative values (Wilcoxon test, $p = 0.008$) (Fig. 1). On

TABLE I - Weight changes (gr) in rabbits after 4 weeks of feeding.

Rabbit	Beginning Weight (gr)	Weight at the end of week 4	Increase (GR)	% Increase
1	904	2212	1308	144,7
2	1030	2200	1170	113,6
3	1856	2486	630	33,9
4	660	2394	1734	262,7
5	2956	3547	591	20,0
6	468	2145	1677	358,3
7	2802	2970	168	6,0
8	1072	2778	1706	159,1
9	1022	2700	1678	164,2
10	1100	2306	1206	109,6
11	1380	2380	1000	72,5
12	792	2344	1552	196,0
13	782	2572	1790	228,9
14	1398	2540	1142	81,7
15	1296	2680	1384	106,8
16	1200	2430	1230	102,5
17	1420	2300	880	62,0
18	1260	2200	940	74,6

TABLE II - Post-operative weight changes of rabbits (gr)

Pre-Operative Weight	Surgical Method Applied	Weight After 8 Weeks	Weight Change	Change %
2212	1	1958	-254	-11,5
2200	1	1910	-290	-13,2
2394	1	2034	-360	-15,0
3547	1	3130	-417	-11,8
2778	1	2020	-758	-27,3
2572	1	2290	-282	-11,0
2540	1	1930	-610	-24,0
2680	1	2120	-560	-20,9
2200	1	1690	-510	-23,2
2486	2	2304	-182	-7,3
2145	2	2100	-45	-2,1
2970	2	2960	-10	-0,3
2700	2	EX at first week		
2306	2	2528	222	9,6
2380	2	EX	-	-
2344	2	2602	258	11,0
2430	2	2350	-80	-3,3
2300	2	2294	-6	-0,3

1; Standard gastric tube surgery, 2; Stomach protective gastric tube surgery

TABLE III - Comparison of preoperative and postoperative mean weights according to the surgical method

	Group 1	Group 2	P (Mann-Whitney U)
Pre-operative weight-gr(min-max)	2540, (2200-3547)	2344, (2145-2970)	0,666
Weight after 8 weeks-gr(min-max)	2020, (1690-3130)	2350, (2100-2960)	0,016

the other hand, there was no significant change in the mean weight of Group 2 of 7 rabbits (living up to 8 weeks) (Paired-T test, $p = 0.724$).

As observed in Table III there was no significant difference between the mean weights of the rabbits in both groups before surgery. Post-operatively at the end of the 8th week, the mean weight of rabbits undergoing standard SG was significantly lower than the M&M technique.

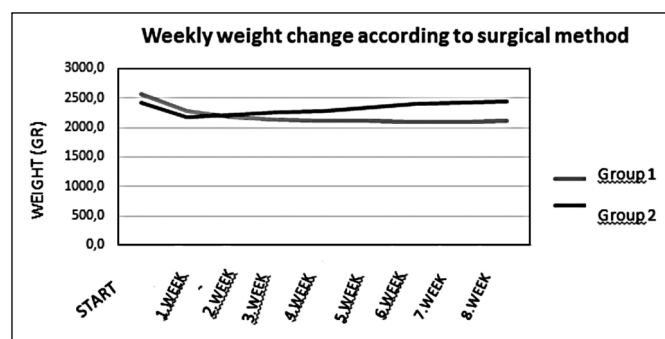
Discussion

The main methods of bariatric surgery have focused on reducing the volume of stomach to the make ingestion of large amounts of food impossible. In combination with gastric reduction, methods that incorporate techniques to further reduce the absorption of food have

produced greater weight loss^{13,14}. The M&M technique is the simplest and most physiological gastroplasty ever described. In this procedure, many of the complications of vertical banded gastroplasty, adjustable banding, and gastric bypass are avoided. It is safe, has few side-effects and leads to major and durable weight losses, similar to those produced by other types of gastroplasty. The M&M technique, in other words, "incomplete Sleeve", offers potential advantages compared to a SG. The preservation of the greater curvature may be useful in the repair of a fistula or a stricture at the level of the gastric tube, which in the case of a sleeve can lead to repeated stent placement or gastrectomy with esophagojejunal anastomosis^{15,16}.

Johnston et al. 17 reported a series of 100 patients operated between 1992-1998 with a mean pre-operative BMI of 46.3 kg/m². Their mortality was 0%, and major complications occurred in 4% of patients. Mean weight loss was 38 kg equivalent to 60% of excess weight, obtained within 1 year of operation and maintained for 3 years¹⁸. Although the clinical results were successful with its advantages, the result of our experimental study was not effective. The results are not satisfactory, either depending on the metabolism or the anatomical differences of rabbits. In our study, high mortality and low efficacy may be due to the separation of a single stapler and large curvature without using a circular stapler in the antrum.

Carmichael et al.¹⁸ reported that the M&M procedure is an effective anti-obesity procedure in which achieves acceptable weight loss with preservation of normal gastric emptying mechanisms, with the result that side-effects such as vomiting, dumping, diarrhea, and nutritional deficiencies are prevented¹⁸. Although there are studies that do not disturb gastric emptying, we consider the following issues in our study. The rabbit feeds frequently up to 30 times per day of 2-8 g of food over 4-6 minute periods. The stomach will normally contain a mixture of food, hair, and fluid even after 24 hours of fasting. In this study, 18 rabbits were fasted for two days before the operation. However, that was not enough. When an incision was performed the stomach was full, therefore, the stomach must be emptied. Because of the gastric emptying of the rabbit is late, the



Graphic.1: Weekly weight change in Group 1 and 2.

operation of sleeve gastrectomy is partially difficult. For stomach surgeries, rabbits should be ensure nutritional supplement three or four days before the surgery, then fasted for 18 h preoperatively. Vassallo et al.¹⁹ adopted the procedure in their study, involving the prolongation of the Magenstrasse to 3-4 cm proximal to the pylorus combined with pyloroplasty, confers to this restrictive intervention some characteristics similar to gastric bypass, i.e. rapid transit of the alimentary bolus in the mill and a scarce reflux in the gastric fundus, with possible effects on the entero-endocrine system and consequent loss of interest in food^{20,21}.

In this experimental study, which investigated the effect of a M&M method on weight loss according to a standard method, it was found that weight loss was achieved with the standard method and weight was not lost with M&M technique. Moreover, two rabbits died in the M&M technique, while all rabbits survived in the standard SG method. In M&M, the large curvature of the stomach is left in place. Since the connection between the tube and the large curvature remains open, it can be considered that the food also accumulates here, which hinders the restrictive function. Furthermore, the cause of death of the subjects can be attributed to the impaired blood flow of the large curvature.

Conclusion

Unavoidable defects are common to most studies of obesity, however, they nevertheless underline the need for more protracted studies and unbiased, prospective comparison with the current alternative operations. We believe that this animal experimental study, which we conducted intending to compare M&M and standard techniques, will contribute to the literature as a pilot study and determine the survey of M&M technique as a pioneer in other studies.

Riassunto

La chirurgia bariatrica è un'opzione importante quando la modifica dello stile di vita, la dieta e il trattamento medico sono inefficienti per una perdita di peso. I metodi chirurgici bariatrici hanno guadagnato popolarità negli ultimi anni. In questo articolo, abbiamo confrontato la tecnica Magenstrasse e Mill (M&M), con l'esecuzione di un tipo più semplice e più fisiologico di gastroplastica senza materiale estraneo impiantato (bendaggio e reservoir), con la tecnica della sleeve gastrectomia (SG). Questo studio mirava a determinare la effetti dell'M & M per l'obesità sui conigli rispetto all' SG, che è accettato come una tecnica bariatrica standard con la creazione di un tubo gastrico.

MATERIALI E METODI: Lo studio è stato approvato dal Comitato regionale di etica dell'Università di Van

Yuzuncu Yıl (Comitato istituzionale per la cura e l'uso degli animali). 20 New Zealand conigli sono stati sottoposti a operazioni. Dopo un pre-studio su due conigli, i 18 rimanenti sono stati divisi in 2 gruppi; Gruppo 1 (SG) e Gruppo2 (M&M).

RISULTATI: Su tutti i conigli del Gruppo 1 è stata osservata una perdita di peso, mentre tra i conigli del Gruppo 2, 2 sono morti, 5 hanno perso peso, e 2 hanno guadagnato peso. Al confronto del peso pre e post-operatorio, il peso medio preoperatorio di 9 conigli nel Gruppo 1 era significativamente più alto dei valori postoperatori. Per contro non si è verificato alcun cambiamento significativo nel peso medio del Gruppo 2 di 7 conigli (vissuti fino a 8 settimane). Il peso medio dei conigli sottoposti a SG standard è risultato significativamente inferiore rispetto a quelli operati con la tecnica M&M.

Si ritiene che questo studio sperimentale sugli animali, eseguito per confrontare le tecniche di M&M e SG, potrà contribuire alla letteratura come studio di riferimento, e determinerà l'indicazione della tecnica di M&M come riferimento in altri studi.

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