

## Incidence of Vitamin B1 (Thiamine) Deficiency Post Mini-Gastric Bypass: A Prospective Study

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### Abstract

**Background:** Laparoscopic Mini-Gastric Bypass is considered as a restrictive & mal-absorptive technique with excision of most of the stomach plus bypassing about 2 meters of small intestine including (duodenum and jejunum). The main complication is the Vitamins and micronutrients deficiency as Thiamine (vit. B1). These deficiencies caused by many causes as mal-absorption with Mini Gastric Bypass due to bypassing the site of thiamine absorption.

**Aim of Study:** The study aims to determine the impact of Mini-Gastric Bypass on thiamine (vit. B1) absorption and deficiency.

**Patients and Methods:** A Prospective study was included 15 patients presented for Mini-Gastric Bypass Surgery At Ain Shams Hospitals and Kafr El Sheikh General Hospital from October 2020 to October 2021. Clinical history was obtained that included demographic data, history of pre-operative vitamin deficiency and comorbid diseases.

Diagnosis of Thiamine deficiency was by measuring thiamine at 3 and 6 months postoperative. All patients had performed Mini-Gastric Bypass operation with intraoperative parameters: Bilio-Pancreatic limb of 2 meters is bypassed. Patients postoperatively were ensured for daily supplement of oral thiamine.

**Results:** The mean age of the studied group was 35 years. (55%) of them were females and (45%) males. The mean BMI was 40 kg/M2 .

No one of the study cases had thiamine deficiency preoperative, all showed normal total thiamine level (3.2-9.5ug/dl).

The results postoperative show 100% of cases show deficiency in total thiamine level 3 & 6 months postoperative.

The Mean Excess Weight Loss percentage (EWL%) shows increase in loss about 36%, 56%, 3 & 6 months postoperatively respectively.

**Conclusion:** Mini-Gastric Bypass is an effective operation in losing weight in the first postoperative months, despite of that is corresponding early significant deficiency of thiamine (Vit. B 1), one of the most important vitamins for energy and neurological integrity.

Deficiency of thiamine may show neurological deficits symptoms early in first 6 months postoperative.

**Key Words:** Thiamine deficiency – Mini-Gastric bypass.

### Introduction

AS the rate of obesity in the world continues to climb, so do the number of bariatric procedures climb. Procedures including restrictive techniques or Mal-absorptive techniques or both. In Mini-gastric bypass procedure about 2 meters including most stomach, duodenum and proximal jejunum (the site for thiamine absorption) are bypassed [1].

Vitamins and micronutrients deficiencies are very common postsurgical complications of these procedures, including Vit. B 12, Thiamine (vit. B 1), Iron & folate and others. These deficiencies caused by Post-operative hyper-emesis or Recurrent emesis, hypo-nutrition and mal-absorption with mal-absorptive techniques (e.g. Mini gastric bypass), due to alternation of normal alimentary pathway [2].

Thiamine (Vit. B 1) is one of the most important vitamins and micronutrients in our body. Vitamin B 1 enables the body to use carbohydrates as energy. It is essential for glucose metabolism, and it plays a key role in nerve, muscle, and heart function. Vitamin B 1 is a water-soluble vitamin, as are all vitamins of the B complex. Thiamine is a water-soluble vitamin that is absorbed in the proximal jejunum, up to 5mg of thiamine is absorbed through the proximal small intestines [1].

The small intestine is the place where phosphorylation of thiamine takes place for activation. So, it presents in many forms, free form, mono-phosphorylated and di-phosphorylated forms. The most active form of thiamine which act as co-enzyme for many biological processes is Thiamine

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Di-Phosphate (TPP). Most of this form in the blood found in erythrocytes and little amount only found in plasma, so the best indicator for Thiamine level is to measure TPP in whole blood [3].

Normal level of thiamine in blood is 70-180 nmol/ litre and body can't produce thiamine but can store up to 30mg in tissues for 20 days. So, daily intake should be ensured (1.2mg/dl).

The problem in diagnosis of thiamine deficiency is late diagnosis. As, mild to moderate deficiency cause non-specific symptoms as: Poor sleep, confusion, malaise, irritability and such as these symptoms are misdiagnosed with other nutritional deficiencies e.g. hypoglycemia. In Severe deficiency a severe medical conditions of low levels as beriberi and wrenicke encephalopathy are present.

Thiamine deficiency mainly diagnosed 4-6 weeks postoperative. It is diagnosed when blood level <70nmol/litre.

#### *Aim of work:*

The study aims to determine the impact of Mini-Gastric Bypass/One Anastmosis Gastric Bypass (MGB/OAGB) on thiamine (vit. B1) absorption and deficiency with exclusion of other causes of multi-vitamins and micro-nutrients deficiency as preoperative metabolic disorders related deficiency or postoperative hyperemesis or hyponutrition.

### **Patients and Methods**

- *Type of study:* A prospective study.
- *Study setting:* Bariatric Surgery Department, Ain Shams Hospitals.
- *Study period:* 12 months.
- *Study population:* Group of 15 patients doing primary Mini-Gastric Bypass/One Anastmosis Gastric Bypass surgery.
- Selection criteria for cases:

#### *Inclusion criteria:*

Patients undergoing primary Mini-Gastric Bypass/One Anastmosis Gastric Bypass with:

- 1- Preoperative normal lab. thiamine level.
- 2- Intra-operative parameters:

Bilio-Pancreatic limb of 2 meters.

As pathway from Duodeno-jejunal junction to gastro jejunostomy will be 2 meters.

- 3- Patients with postoperative compliance on prescribed daily supplement of two tablets daily (more than 100mg daily) are taken, but if deficiency proved after first lab., 3 tabs are given daily [10].

#### *Exclusion criteria:*

- Patients with post-operative hyper-emesis complication.
- Patients with pre-operative vitamin deficiency.
- Patients with revisional bariatric surgery.
- Patients with other mal-absorptive disorders.
- Sampling method: Convenience sample.
- Sample size:
- Using PASS program (SPSS, IBM, SPSS Inc. Chicago, USA) computer package version 18, 2020.

For sample size calculation and assuming margin of equivalence (difference) extend from -5% to 15%, reference from group propor on is 5%, sample size of 15 patients in the group achieves 80% power of to equivalence with significance level ( $\alpha$ -error) 0.05.

#### • *Study procedure:*

All patients included in the study will be candidates for:

#### 1- *Clinical assessment:*

- Detailed medical and family history.
- Full clinical examination including.

#### 2- *Investigation:*

- Routine laboratory investigations (CBC, coagulation profile, liver functions, kidney functions, RBS).
- Thiamine Di-phosphate in blood.

#### 3- *Preoperatively:*

- Patients will be fully informed about the Risks and Benefits of the Procedures.
- Informed Consent will be obtained from every Patient.
- Fasting overnight (12-14 hours).
- Water can be taken as needed except 2 hours before operation.

#### 4- *Intraoperative:*

Patients will be including 15 cases managed by Mini Gastric Bypass/One Anastmosis Gastric Bypass with parameters of Bilio-pancreac of 2 meters.

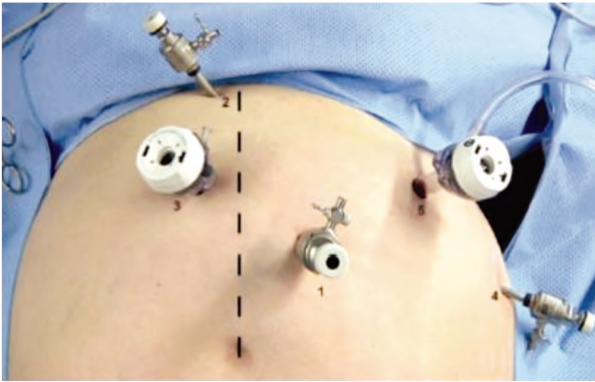


Fig. (1): Trochairs placement.

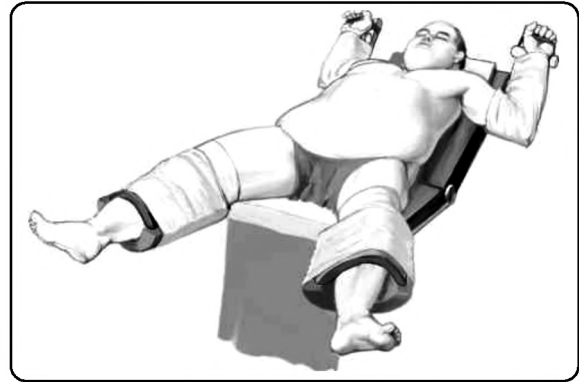
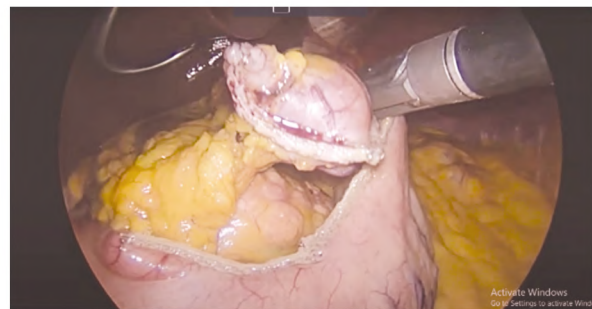
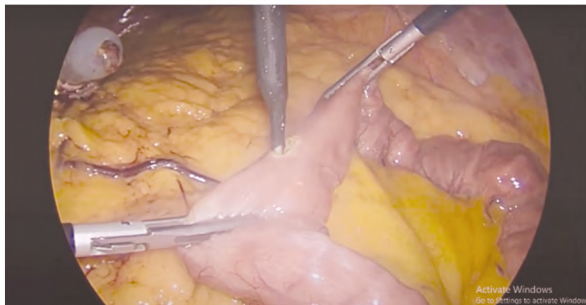


Fig. (2): Patient position.



Figs. (3,4): Creating the gastric pouch by vertical dissection.



Figs. (5,6): Bypassing 2 metres from treitz ligament &amp; Anastomosis between gastric pouch and jejunum

### 5- Postoperatively:

- Broad spectrum antibiotics and PPI.
- Patients postoperatively will be ensured for the prescribed daily supplement of thiamine (oral tablets e.g. 2 tab. daily provides more than 200mg of thiamine daily).
- If deficiency is proved post 1<sup>st</sup> lab., three tabs daily was given to the patient.
- Thiamine Di-phosphate level will be measured at 3, 6 months postoperative.

*Main outcome measures:* Try to prove the effect of Mini Gastric Bypass/One Anastomosis Gastric Bypass on thiamine (Vit. B1) deficiency.

### Statistical analysis:

Patients' data were presented as frequency and percentage for categorical variables, mean and SD for numerical variables. Groups were compared by independent samples Student *t*-test and  $\chi^2$ -test for numerical and categorical data, respectively. All data and statistical analyses were handled by statistical package for the social sciences (SPSS, IBM, SPSS Inc. Chicago, USA) computer package version 18, 2020.

### Results

Among 15 cases in the study (7 males & 8 females) with mean age 35 and mean BMI 40.46, there are 9 cases which are diabetic (60%) (8 on antidiabetics & 1 on insulin) and 4 cases which are hypertensive (27%) and on antihypertensive drugs.

Table (1): Demographic data of studied cases, Anthropometric Measurements & Comorbidities.

Patients (N=15)	
Age (years)	Mean ± SD 35±11
Gender (Male/Female)	7/8 (45%)
Percentage of Male : Female	
Body Mass Index (Bmi) (Kg/M2)	Mean ± SD 40.46±6.26
Diabetic Patients	9 (60%)
Hypertensive	4 (27%)

The 15 cases in the study showing decrease in BMI (Body Mass Index) than preoperative which was a mean BMI 40.46kg/m<sup>2</sup>, showing mean BMI about 35.41kg/m<sup>2</sup>, 3 months postoperatively & mean BMI 30.2kg/m<sup>2</sup>, 6 months postoperatively as in Fig. (8).

Table (2): Mean EWL% (Excess Weight Loss, 3 & 6 months Postoperative).

	3 months postoperative	6 months postoperative
Mean EWL%	36.63±6.26	56.11±3.87
Excess Weight Loss		

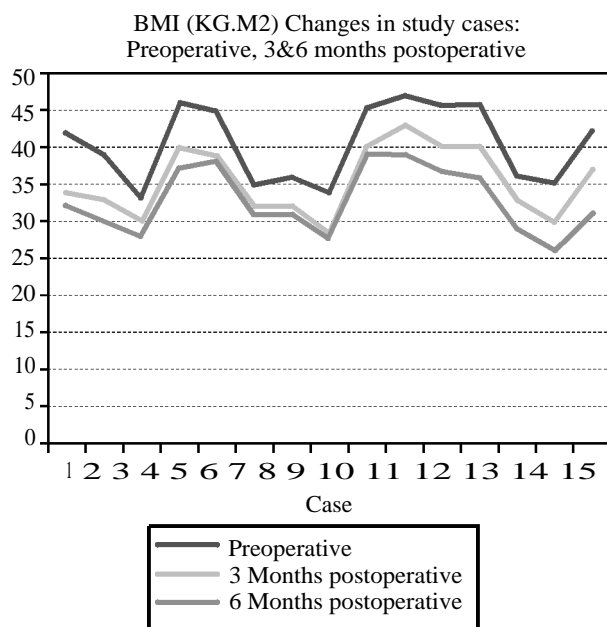


Fig. (7): Changes in BMI (Body Mass Index).

15 cases were involved in the study showing significant decrease in BMI (Body Mass Index) (KG/M2) than preoperative in all case, as shown in Figs. (3,6) months postoperative as shown in Fig. (7).

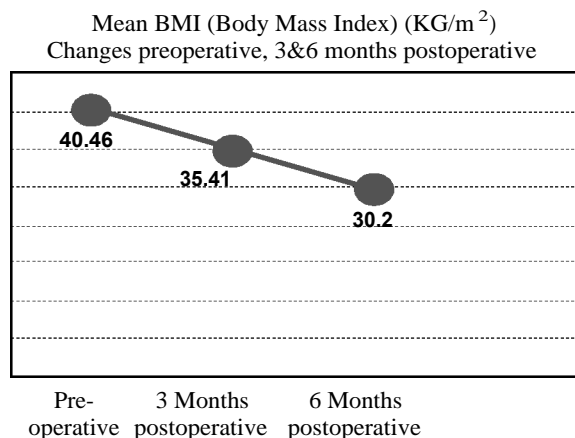


Fig. (8): Mean BMI (Body Mass Index) Changes.

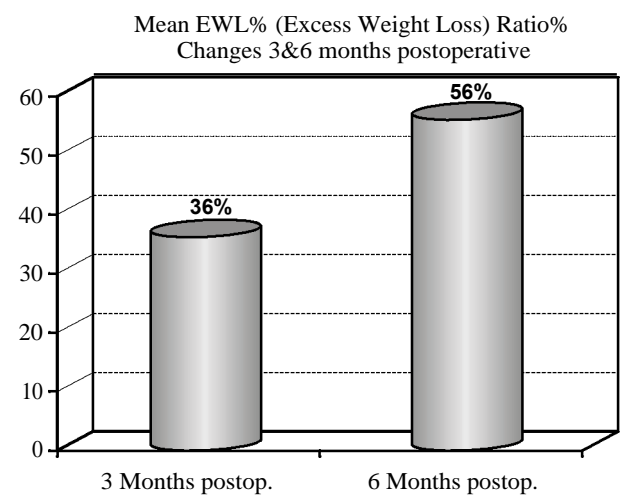


Fig. (9)

The Mean Excess Weight Loss percentage (EWL%) shows increase in loss about 36%, 3 months postoperatively & about 56%, 6 months postoperatively among the 15 cases in study.

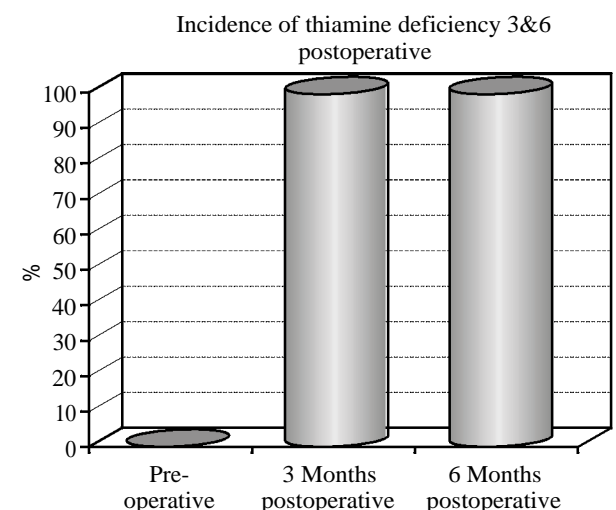


Fig. (10): Incidence of deficiency of thiamine among study cases postoperative.

Among 15 cases in this study with preoperative normal thiamine level, 100% of them showing deficiency in thiamine level 3 & 6 months postoperative inspite of compliance of daily recommended supplement.

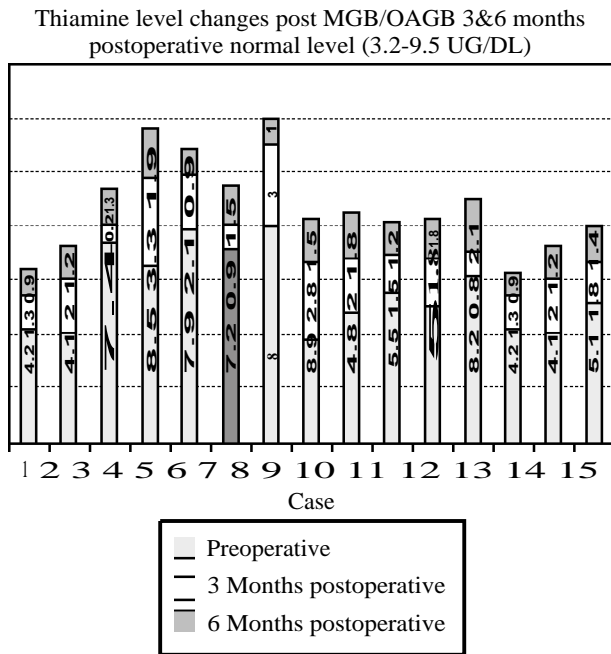


Fig. (11): Thiamine level changes (3 & 6 months postoperatively).

The figure show the decrease in thiamine level among study cases which had a preoperative normal lab. Value (3.2-9.5ug/dl), a significant decrease 3 & 6 months postoperatively among all cases of study.

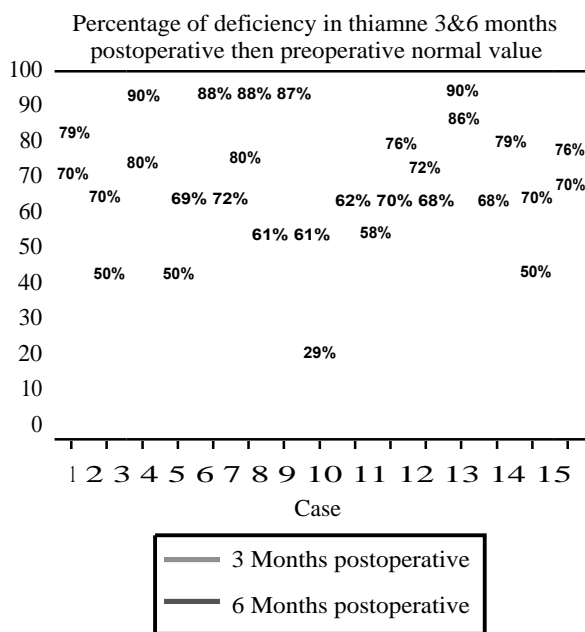


Fig. (12): Percentage of deficiency in thiamine 3 & 6 months postoperatively.

The figure shows the percent of deficiency of thiamine 3 and 6 months postoperative than the preoperative normal value among 15 cases of the study with mean deficiency about 65% in 3 months postoperative and 76% in 6 months postoperative.

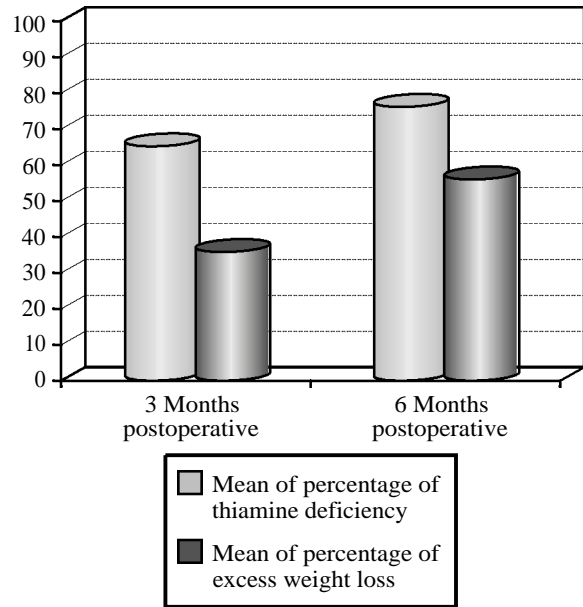


Fig. (13): Percentage of mean thiamine deficiency ratio with percentage of mean EWL (Excess Weight Loss) among study cases, 3 and 6 months postoperatively.

The figure shows the percentage of mean thiamine deficiency ratio with percentage of mean EWL (Excess Weight Loss) among study cases, 3 and 6 months postoperatively, which means that the efficacy of MGB/OAGB (Mini Gastric Bypass /One Anastmosis Gastric Bypass) in excess weight loss which is 36% and 56% in 3 and 6 months postoperative respectively, corresponding to a significant deficiency in thiamine level percentage about 65% and 76% less than preoperative normal value in 3 and 6 months postoperative respectively.

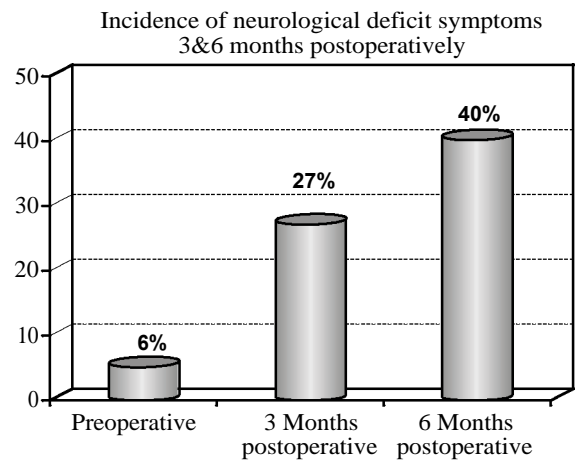


Fig. (14): Incidence of neurological deficits among cases of study.

Figure shows that about 27% (4 cases) started to complain of some neurological deficits 3 months postoperatively which weren't be complained preoperatively, while about 40% (6 cases) complained of more neurological deficit symptoms, only one case (6%) was complaining of same symptom (poor sleep) preoperatively as postoperatively.

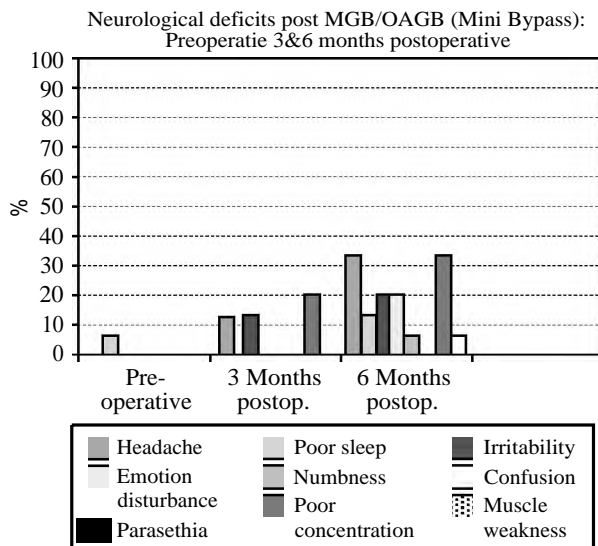


Fig. (15)

Among 15 cases of study, only 1 case (6%) complained of repeated headache and poor sleep preoperative, 3 months postoperative 4 cases (27%) started to complain of some neurological deficits, not complained preoperatively as: Headache, irritability and poor concentra on & while, 6 months postoperative, about 6 cases (40%) complained of neurological deficits as: Headache (33%), irritability (20%) and poor concentration (33%), in addition to numbness (6%), poor sleep (12%) and muscle weakness (6%).

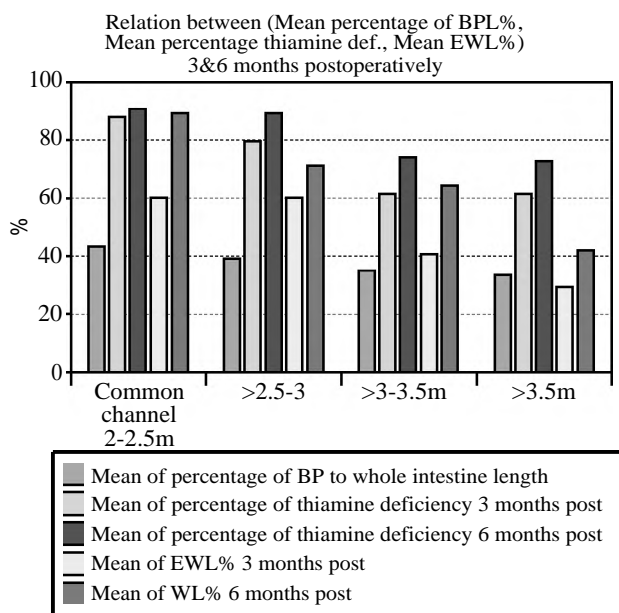


Fig. (16)

As shown in Fig. (16):

The mean deficiency percentage of thiamine among these groups was calculated, also the mean percentage of EWL% (Excess Weight Loss) and the data represented in diagrams trying to show if there is a relation between length of common channel after the bypass affect the percentage of deficiency of thiamine and the weight loss, results show:

- 1<sup>st</sup> group, 1 case, with common channel of 2.5 metres, showing mean deficiency of thiamine, 88% (3 months postop.) and 92% (6 months postop.) less than preoperative normal level.

This case show excellent EWL% about 60% (3 months postop.) and 90% (6 months postop.).

- 2<sup>nd</sup> group, 2 cases (2.5-3 metres), with common channel of 2.8 & 3 metres, showing mean deficiency of thiamine, 80% (3 months postop.) and 86% (6 months postop.) less than preoperative normal level.

These cases show WL% about 58% (3 months postop.) and 72% (6 months postop.).

- 3<sup>rd</sup> group, 3 cases (3-3.5 metres), with common channel of 3.2 & 3.2 & 3.4 metres, showing mean deficiency of thiamine, 62% (3 months postop.) and 75% (6 months postop.) less than preoperative normal level.

These cases show WL% about 42% (3 months postop.) and 64% (6 months postop.).

- 4<sup>th</sup> group, 9 cases (>3.5 metres), with common channel of 3.8 4.2 metres, showing mean deficiency of thiamine , 62% (3 months postop.) and 70% (6 months postop.) less than preoperative normal level.

These cases show EWL% about 28% (3 months postop.) and 42% (6 months postop.).

### Discussion

Laparoscopic Mini-Gastric Bypass/One Anastomosis Gastric Bypass includes excision of most of the stomach plus bypassing about 2 meters of small intestine including (duodenum and jejunum) which is the site of absorption of thiamine (Vit. B1) [1].

15 patients presented for Mini-Gastric Bypass /One Anastomosis Gastric Bypass with measuring the thiamine level 3 & 6 months postoperative with daily supplement of vit. B1 (Thiamine), with exclusion of cases with repeated vomiting or preoperative deficiency, trying to detect the effect of the operation on absorption of thiamine.

After the first few months (3&6) months post-operative, with daily supplement of vitamin, all the cases (100%) show significant thiamine deficiency than the preoperative normal level.

In spite of increasing of daily recommended dose of thiamine after <sup>1st</sup> 3 months, still the level of thiamine continues to decrease, with no complain of repeated vomiting or diarrhea which mainly indicates the significant effect of MGB/OAGB operation on thiamine absorption by bypassing the main site of absorption (proximal jejunum).

Although, After these 6 months postoperative almost all cases show significant weight loss.

This shows the corresponding significant effect of mini-gastric bypass MGB/OAGB on weight loss in first months postoperative, with the significant early decrease of the thiamine level postoperative.

*Comparing the results with other studies' results for other operations:*

About (25.7%) (27 of 147 case) had thiamine deficiency post sleeve gastrectomy, this was recorded by a retrospective chart review was performed on 147 bariatric patients between 18- and 65-years old who underwent Vertical Sleeve Gastrectomy between April 2011 and February 2015

[4].

Another retrospective review of identified data was examined that included whole blood thiamine measured from consecutive patients from April 2018 to June 2019 (n=346).

Overall, while 35 patients (10%) were with thiamine deficiency with concentrations <70nM . On the average, these patients were of similar age and were all undergoing primary procedures (50% Roux-En-y gastric bypass, 50% sleeve gastrectomy)

[5].

*For causes of the deficiency:*

The most common causes known to be the cause of thiamine deficiency are:

Postoperative vomiting and improper compliance for the postoperative vitamin supplements [6,7].

*In our study:* We exclude the patients with postoperative vomiting and ensure the compliance of patients for daily supplement of oral tablets providing 100-200mg daily.

We want to show the effect on absorption of thiamine after bypassing most of jejunum in the operation (Site of absorption).

*Our results also show no post-operative vomiting:*

*Other studies:* Show that patients undergoing gastric bypass surgery Roux-en-Y, another cause of vitamin B 1 deficiency is bypass of the duodenum, which is the main site of its absorption, and bacterial overgrowth. It is recommended that all patients should be screened for thiamine deficiency before bariatric surgery and supplemented with vitamin B1 after surgery [8].

*Neurological deficits post thiamine deficiency:*

Vitamin B 1 deficiency can cause functional and morphological changes in the nervous system. With long-term thiamine deficiency in the body, beriberi can develop.

There is no specific concentration of thiamine at which symptoms of its deficiency will appear, so it is important to remember about the symptoms of beriberi when diagnosing a patient's ailments.

Also, mild deficiency or early stages of deficiency shows non-specific symptoms as poor concentration, poor sleep, poor memory or loss concentration or parasethia [9].

In our study clinical sheet was done following-up cases for any new neurological deficits not complained preoperative especially after confirming laboratory thiamine deficiency trying to early predict the clinical insult for the deficiency:

About 27% of cases (4 cases) show neurological deficits 3 months postoperatively, while 40% of cases (6 cases) show neurological deficits 6 months postoperatively.

*The main neurological symptoms complained by the cases were:*

Headache, Poor concentration, Irritability, Emotion disturbance, Poor sleep, Numbness and Muscle weakness were the main complains of the cases.

Also, 2 cases (12%) complained of cardiovascular symptoms mainly palpitation.

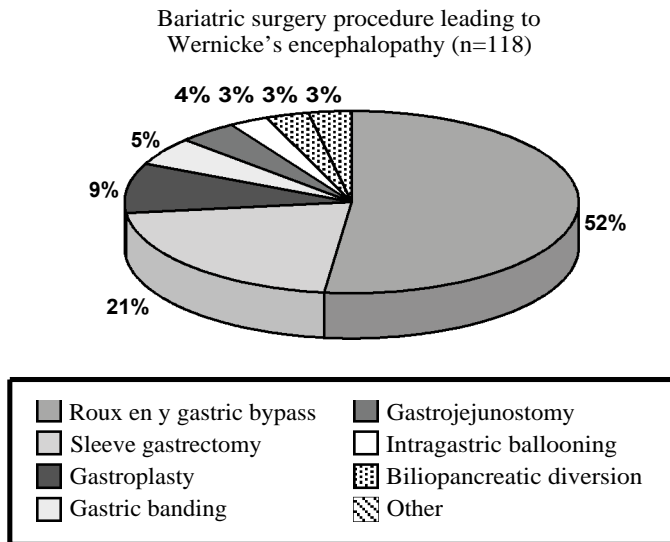
All the manifestations were mild to moderate manifestations, recently complained postoperatively, not complained preoperative.

N.B. Hypoglycemia, anemia and vit. B12 post-operative are confounding factor that may be the cause of neurological deficits [11].

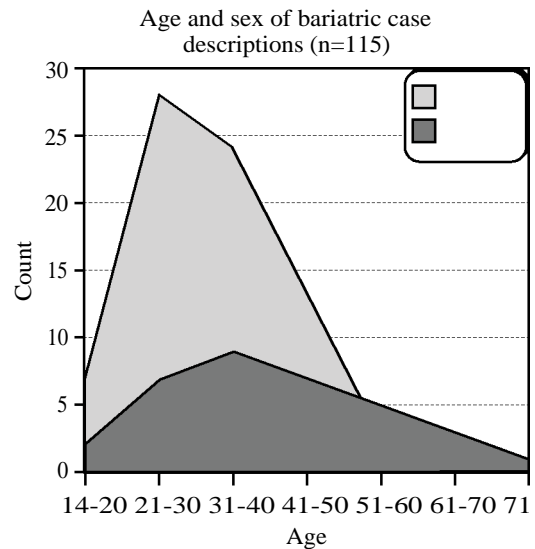
But, In our study, out of the 15 cases, the 6 cases (40%) who showed neurological deficits 6 months postoperative, had only thiamine deficiency,

with no case showed any other confounding factor like hypoglycemia or anemia or vit. B 12 deficiency.

A study was done for 118 patients performed bariatric surgeries at 2018 and show deficiency in



thiamine with symptoms of wernickes encephalopathy, about 52% of them was a deficiency post REYB, 21% were post Sleeve gastrectomy, 9% were post gastric band and the remaining was a deficiency post BPD and gastroplasty [12].



The length of common channel remained after the bypass show a significant effect on the weight loss after operation, with proportional changes in percentage of the deficiency of vitamin.

As the common channel length increases, with fixed bypassed limb 2 meters (The percentage of bypassed BPL to whole intestine length decreases), this was corresponding to decrease in the mean percentage of deficiency in thiamine with also a significant decrease in the mean percentage of Excess weight loss EWL%.

In the follow-up 3 & 6 months postoperatively.

**Conclusion:**

Mini-Gastric Bypass/One Anastomosis Gastric Bypass is a very effective operation in losing weight in the first postoperative months, despite of that is corresponding early significant deficiency of thiamine (Vit. B1), one of the most important vitamins for energy and neurological integrity.

Mini-gastric bypass mainly has a direct effect on thiamine absorption leading to progressive deficiency inspite of increasing oral supplement.

Deficiency of thiamine may show neurological deficits symptoms early in first 6 months postoperative.

The common channel length after the bypass has a noticeable inversely proportional effect on Excess Weight Loss and percentage of deficiency of thiamine.

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## نقص فيتامين الثيامين ب ١ بعد عملية تحويل المعدة المصغرة : دراسة اترايبية مستقبلية

المقدمة: إجراء عملية تحويل المسار المصغرة، يتم تجاوز ٢ متر تقريباً بما في ذلك معظم المعدة والاثنى عشر والصائم القريب (موقع امتصاص الثيامين). يعتبر نقص الفيتامينات كالثيامين من المضاعفات الشائعة بعد الجراحة لسوء الامتصاص بسبب تناوب المسار الغذائي الطبيعي. يمتص الثيامين في الصائم والأمعاء الدقيقة القريبة. المستوى الطبيعي للثيامين في الدم هو ٧٠-١٨٠ ن مول/لتر ولا يستطيع الجسم إنتاج الثيامين.

الهدف من هذه الدراسة: تهدف الدراسة إلى تحديد تأثير تجاوز المعدة الصغيرة على امتصاص الثيامين (فيتامين ب١) ونقصه مع استبعاد الأسباب الأخرى للنقص كاضطرابات التمثيل الغذائي قبل الجراحة ذات الصلة بالنقص أو فرط نشاط ما بعد الجراحة أو نقص التغذية.

الأدوات وطرق البحث ومعايير الاشتمال والاستبعاد: دراسة مستقبلية، تمت في قسم جراحة السمنة في مستشفيات جامعة عين شمس على المرضى الذين يخضعون للعملية لأول مرة مع مستوى طبيعي للثيامين قبل العملية. يستبعد المرضى الذين يعانون من نقص الفيتامينات قبل الجراحة. يتم قبل الجراحة قياس نسبة الثيامين، إبلاغ المرضى بشكل كامل عن مخاطرها وفوائدها، وأخذ الموافقة. كما يتم قياس مستوى الثيامين ثنائى الفوسفات بعد ٣ و ٦ شهراً من الجراحة.

النتائج: كانت النتائج الرئيسية لهذه الدراسة كما يلي، كان متوسط عمر المجموعة المدروسة ٣٥ عاماً (٥٥٪) إناث و ٤٥٪ ذكور ومتوسط مؤشر كتلة الجسم ٤٠ كجم/م<sup>٢</sup>. كما أن لم تكن أى حالة من حالات الدراسة تعاني نقص الثيامين الكلى الطبيعي (٣.٢-٩.٥ ميكروغرام/ديسيلتر)

أجرى جميع المرضى عملية تحويل مسار المعدة المصغرة مع تجاوز مترين من الأمعاء الدقيقة لذلك يتم تجاوز موقع امتصاص الثيامين.

سيتم ضمان المرضى بعد الجراحة للمكمل اليومي الموصوف للثيامين كأقراس فمويه تظهر النتائج أن ١٠٠٪ من الحالات تظهر نقصاً في إجمالي مستوى للثيامين ٣ و ٦ شهور بعد العملية الإثبات تقوم عملية تحويل المسار المصغر بحدوث نقص في امتصاص فيتامين ب ١ أو الثيامين ونقص نسبته في الجسم مما قد يؤدي لحدوث وظهور بعض الأعراض للخلل العصبي.