Factors related to patients' nutritional state after orthognathic surgery

Kazuhiro Ooi[1,3], Nobuo Inoue[2], Kazuhiro Matsushita[1], Hiro-o Yamaguchi[1], Tadashi Mikoya[1], Shuichi Kawashiri[3], Kanchu Tei[1]

[1] Oral and Maxillofacial Surgery, Department of Oral Patho-biological Science, Graduate School of Dental Medicine, Hokkaido University, Kita 13 Nishi 7 Kita-ku, Sapporo, Hokkaido 060-8586, Japan

[2] Gerodontology, Department of Oral Health Science, Graduate School of Dental Medicine, Hokkaido University, Kita 13 Nishi 7 Kita-ku, Sapporo, Hokkaido 060-8586, Japan

[3] Department of Oral and Maxillofacial Surgery, Graduate School of Medical Science, Kanazawa University, 13-1 Takaramachi, Kanazawa, Ishikawa, 920-8641, Japan

Correspondence:

Kazuhiro Ooi: Oral and Maxillofacial Surgery, Department of Oral Patho-biological Science, Graduate School of Dental Medicine, Hokkaido University, Kita 13 Nishi 7 Kita-ku, Sapporo 060-8586, Japan

Tel: +81-11-706 4283; FAX: +81-11-706 4283

E-mail: ooi@den.hokudai.ac.jp

Funding: None to declare

Key words: postoperative nutritional state; orthognathic surgery; operation time

Short title: Patients' nutritional state after orthognathic surgery

Abstract

The purpose of this study was to evaluate patients' nutritional state after orthognathic surgery. The subjects were 40 female patients with dentofacial deformity aged 17-33 years who were undergoing bilateral sagittal splitting ramus osteotomy. Twenty patients were treated with intermaxillary fixation, and twenty patients were treated without intermaxillary fixation. Age and body mass index (kg/m2) were assessed as physical factors, operation time, blood loss, and amount of mandibular movement with or without intermaxillary fixation were assessed as operation stress factors, and the following laboratory data, total protein, serum albumin, total cholesterol, total lymphocytes, and cholinesterase were assessed as nutritional state factors at 1 and 2 weeks after surgery. Statistical analysis was performed for body weight loss and relationship between body weight loss and examination factors. Body weight were significantly decreased 2.3% at 1 week and 3.9% at 2 week after surgery rather than preoperation. All laboratory data except total lymphocyte were decreased at 1 week after surgery and still remained significantly decreased at 2 weeks after surgery. There was a statistically significant relationship between body weight loss at 1 week after surgery and operation time. These results indicate that long operation time caused body weight loss in orthognathic surgery.

INTRODUCTION

Nutritional management is one of the basic medical practices in the treatment of all diseases. Nutrition can affect postoperative morbidity in surgical patients[1, 2], and an insufficient food intake can decrease the therapeutic effect. In the perioperative period, poor nutrition is thought to adversely affect wound healing[3, 4] and postoperative infections[5]. Preventing deterioration of nutritional status in the perioperative period is desirable. In particular, patients following orthognathic surgery are unable to take a normal diet for 6 or 8 weeks. If postoperative intermaxillary fixation (IMF) is performed after surgery, patients have to take food by liquid diet orally or by nasogastric tube feeding until the IMF is removed. IMF is one of the modalities used before the utilization of mini-plates to stabilize and promote the healing of fractured facial bones in cases of trauma or orthognathic surgery. Weight loss has been noted as one of the major side effects of IMF in patients with mandibular fractures or orthognathic surgery[6, 7]. On the other hand, there is no significant difference in weight loss between patients with IMF and patients without IMF in the weight loss group after orthognathic surgery[8]. Eventually this may lead to impaired bone and wound healing and thus to a deteriorated overall functional recovery[9]. In the literature there is a lack of systematic documentation of the weight loss experienced by patients during the first few weeks or months or of the time required for postoperative recovery following orthognathic surgery. Thus, the perioperative period of orthognathic surgery is not good for nutrition, but the details are unknown. In addition, there no reports have investigated the factors related to nutritional status after orthognathic surgery. Therefore, knowledge about nutritional status and related factors in the early postoperative period following orthognathic surgery is important for perioperative management of orthognathic surgery.

Nutritional status was assessed by measuring body weight loss, skin fold, arm circumference and blood examination tests etc[10]. Albumin and transferrin are important in assessing nutritional state though their half-lives are relatively long (albumin 20 days and transferrin 8days), so that nutritional changes are not reflected quickly[11]. However transferrin is not investigated daily clinical practice, a strong correlation was found between transthilentin and cholinesterase level. Cholinesterase is an enzyme synthesized in the liver, is recently considered also a marker of protein energy malnutrition. Significant correlations was found between nutritional assessment scores and total cholesterol[12].

The aim of the present study was to investigate retrospectively the dentofacial deformity patients between weight loss and following factors age, body mass index (kg/m^2), operation time, blood loss, amount of mandibular movement, laboratory data and use of IMF or without IMF on postoperative body weight loss.

MATERIALS AND METHODS

Forty women with dentofacial deformity who underwent bilateral sagittal splitting ramus osteotomy (BSSRO) at Hokkaido University Hospital, Sapporo, Japan, were included in the study retrospectively. Men were not included to avoid sex-related differences because female patients who underwent bimaxillary osteotomies whose weight decreased significantly rather than men[13]. Twenty cases were treated with intermaxillary fixation (IMF) for 2 weeks after surgery, and twenty cases were treated without IMF after surgery (Table1). In all cases, there was no postoperative nausea and vomiting.

All patients consumed food of nearly 35 kcal/kg body weight from 1 day after surgery. In IMF cases, a liquid diet was taken by mouth or through a nasogastric tube until 2 weeks after surgery when the IMF was removed, and then paste or soft diet was started depending on the state. In non-IMF cases, a liquid diet was taken by mouth until 5 days after surgery, and then paste or a soft diet was started depending on the state. Caloric intake observed by registered dietitian.

Age and body mass index (BMI kg/m^2) as physical factors, IMF or without IMF, operation time, blood loss, and the amount of mandibular setback movement as operative stress factors, body weight and the following laboratory data, total protein (TP), serum albumin (ALB), total cholesterol (TC), total lymphocytes (TLCs), and cholinesterase (CHE) as nutritional state factors were assessed. These assessments were carried out three times. The first measurement was carried out before surgery (T0). The second and third, measurements were performed 1 week (T1), and 2 weeks after surgery (T2). Body weight was assessed 3 times. At these time points, assessment of all blood examination variables was repeated. BMI was calculated as actual body weight/height^2. BMI was classified as: underweight (BMI <18.5 kg/m^2); normal (BMI 18.5–25kg/m^2); overweight (BMI >25–30 kg/m^2); or obese (BMI>30 kg/m^2)[6,7] (Table 2).

Body weight loss ratio (preoperation body weight – postoperation body weight / preoperation body weight×100 (%)) at 1 and 2 weeks after surgery were statistically analyzed as indicators of the postoperative nutritional state 1 and 2 weeks after surgery. Furthermore, Liner regression analysis was performed between body weight loss ratio and physical factors or operative stress factors or nutritional laboratory factors (Prism 7 GraphPad software, Inc. USA). This work was approved by the Hokkaido University Research Ethics Committee (Ref. No. 010-0285). All patients are informed research purpose and agree to use their clinical data for this study. All methods were performed in accordance with the relevant guidelines and regulations by including a statement in the methods section to this effect.

RESULTS

Age was 25 (17-40 ± 5) mean (range ± standard deviation) years. Operation time was 188 (95-395 ± 58) minutes. BMI was 21.2 (15.1-26.5 ± 2.6) kg/m2. Blood loss was 345 (90-922 ± 193) g. Preoperative body weight was 53.1 (40.0-73.0 ± 7.7) kg. Mandibular setback movement was 6.3 (-7-17 ± 4.2) mm (Table 1Fig.1). Body weight was significantly reduced at both 1 and 2 weeks after surgery (Fig.2). Body weight were significantly decreased 2.3% at 1 week and 3.9% at 2 week after surgery rather than preoperation (Fig.1). Total protein, and serum albumin, total cholesterol and cholinesterase were significantly lower at both T1 and T2 than at T0. On the other hand, total lymphocyte was not changed significantly. (Table 3).

On Liner regression analysis, IMF or without IMF, BMI, blood loss, preoperative body weight, mandibular movement, laboratory data each does not showed significant relationships between the body weight loss. A significant relationship was only observed between body weight loss at 1 week after surgery and operation time. The statistical analysis showed that body weight decreased by 3.3% for every 30 minutes of surgery (Fig. 2).

DISCUSSION

The evidence for nutritional support during the perioperative period has been reviewed, and recommendations have been made about when nutrition support is most useful and when it may be counterproductive[14]. Past studies paid attention mainly to the relationship between the preoperative nutritional state and postoperative complications. The importance of postoperative nutritional changes has rarely been discussed, particularly in oral and maxillofacial surgery. Nutrition affects the body's defense system in many ways. More than 60 years ago, Studley[15]reported that postoperative infection-related morbidity and mortality increased when patients lost 20% of their preoperative body weight. When 35–40% of body weight is lost, death is generally inevitable[16]. Recent studies on nutrition and wound healing focused on the relationship between specific nutrients and wound healing[17]. Nutrition directly influences the wound healing process, since malnutrition decreases anabolism and depresses immunity[18].

Animal studies have shown that 6 weeks of nutritional deficiency reduces wound strength and depresses both cellular and humoral immunity[19,20]. Clinically. these deficits are manifested by delayed healing, wound infection, and prolonged rehabilitation[21].

These indicate that nutrition is a key factor in the development of postoperative complications. Tadano[22] reported that administration of non-nutrient solutions via gastrostomy under TPN accelerated jejunal anastomotic healing in comparison with TPN alone with a fasting period, and it provided comparable effects to early enteral feeding. The mechanical loading with such stretch conditions contributed to the upregulation of de novo type I and type III collagen synthesis by rat fibroblasts derived from the gastrointestinal tract. These results indicated that nutrition is important for immunity and wound healing in animal models.

A nutrient assessment protein is used to objectively evaluate the nutritional status of an individual or group. The nutrition index used for this evaluation includes a static index and a dynamic index. The static nutrition index changes little with changes in various kinds of factors, and it reflects the average nutritional status at measurement, but it is difficult to evaluate changes in the short-term nutritional status. The dynamic nutrition index is used to monitor real-time metabolism and provides an evaluation of the nutritional status over the short term.

Biochemical indices and physical measurement indices such as body mass index (BMI), skin thickness, brachialis muscle wall, and the percent of body fat are used, and blood tests such as total serum protein, albumin, cholesterol, urinary creatinine, blood vitamins, and peripheral blood lymphocyte counts are used for a static index. Also, rapid turnover protein (RTP) with a short half-life in the blood, protein metabolism dynamics, and amino acid dynamics are used for a dynamic index. Measured values such as energy consumption, the respiratory exchange ratio at rest, and sugar availability are used elsewhere. Short retinol-binding protein (half-life t1/2 = 0.5 days) transthyretin (prealbumin: of the half-life in blood to be said to be rapid turnover protein (RTP) that is useful for an evaluation of the dynamic nutritional status in real time as a nutrient assessment protein), transferrin (t1/2 = 7th) and relatively long albumin (t1/2 = 21st) of the half-life in blood indicating the static nutritional status at the point in time are used for t1/2 = 1.9 days. In addition, C-reactive protein (t1/2 = 0.3 days) is measured as an inflammatory marker at the same time, because inflammation consumes protein.

In this study, total protein, serum albumin, total cholesterol, total lymphocytes, and serum cholinesterase were retrospectively measured. They can be used for nutrition assessment, but these indices are part of the blood examination performed normally in the perioperative period.

Serum cholinesterase (ChE) is commonly measured as a liver function test to indicate the protein synthesis ability of the liver. Therefore, ChE might be considered a marker of the effects of primary malnutrition on liver function[23] .

No changes were found in TP and ALB from 1 week to 2 weeks after surgery, but ChE increased significantly. In other words, these results showed that the nutritional status recovered in the second week after surgery. In the case of TLC, with protein energy malnutrition, it decreases, and it is used as one of the nutrition indexes expressing decreased immunocompetence. The cutoff value of TLC determining malnutrition varies among specialties, but 800-1,200/mm3 was suggested by Blackburn et al[24] as indicating moderate nutrient deficiency, with severe deficiency at under 800/mm3. According to the index, moderate or severe malnutrition would be identified using TLC in the postoperative patients targeted for this study. However, between preoperation and 1 and 2 weeks after surgery, no significant differences were found, although a significant decrease was seen on the first day after surgery. It is thought that this reflects the inflammatory reaction just after surgery. When it was reported that TLC did not correlate with transthyretin (transthyretin, TTR), and lymphocytes were assumed to be a nutrition index, it was thought that attention was necessary based on the present results.

Thus, a significant change was found in a hematologic nutrition index after surgery for deformity of the jaw, but an improvement was confirmed at 2 weeks after surgery.

It is thought that hemoglobin is not a sensitive indicator of the nutritional state[25], but albumin and transferrin are important in assessing the nutritional state, though their half-lives are relatively long (albumin 20 days and transferrin 8 days[26]), so that nutritional changes are not reflected quickly.

Nutrients, such as vitamins A, B1, B2, C, K, and E, arginine, zinc, iron, copper, and manganese, and ω-3 fatty acids are specifically related to wound healing[27,28]. These micronutrients were not examined in this study, but it is necessary to avoid a deficiency of these micronutrients when undernutrition persists for the long term.

As a nutrition index, weight is one of the simple, easy, and important indices. Nutrition affects the body's defense system in many ways. More than 70 years ago, Studley[15] reported that postoperative infection-related morbidity and mortality increased when patients lost 20% of their preoperative body weight. When body weight loss of 35%–40% occurs, death is generally inevitable[12]. Body weight was reduced 3.5 kg in groups with complications and 2.1 kg in groups with no complications following oral and maxillofacial malignancy[25,26]. This indicates that nutrition is a key factor in the development of postoperative complications.

Worral[29] reported that there was no significant difference in weight loss or body composition changes between plated and non-plated groups at 1 week postoperatively. However, by 6 weeks postoperatively, the IMF group had lost significantly more weight (4.5 kg) than the plated group (1.1 kg). In the plated group, this weight loss resulted entirely from loss of lean body mass (77% water), whereas in the other group, it resulted from a fat loss of 1.2 kg plus a lean body mass loss of 3.3 kg (73% water). Estimated protein losses were 0.9 kg for the IMF group and 0.3 kg for the plated group. Cawood[30] reported that patients whose mandibular fractures were treated by internal fixation without IMF lost less weight and regained their preoperative weight faster than those whose fractures were treated by IMF alone. In his series of 100 cases, the plated group lost less weight (mean 3 kg) in the first postoperative week than the IMF group (mean 5 kg) and had regained their preoperative weight within 4 weeks. Antila et al[27] reported a significant decrease in mean body weight, with subsequent changes in anthropometry. Maximal mean weight loss was 6.0% ±3.8% in the control group and 3.8% ± 2.7% in the supplemental group. The impaired oral intake due to IMF does not interfere significantly with zinc status as estimated by MNC, PMNC, or serum zinc levels. The reduction in body weight and anthropometric indices in the relatively short fixation period may be clinically significant in some patients. Supplementation with a commercial formula helps to maintain the nutritional status of these patients.

In these studies, intermaxillary anchorage was shown to cause an undernutrition state. However, mention of the intake nutrient quantity in the intermaxillary anchorage group and the non-intermaxillary anchorage group was found in neither study. Generally, there are fewer calories in the fluid product than in solid food, because the fluid food is juicy. However, it is necessary to devise fluid food with a high caloric content, and to take it in to ensure nutritional requirements during intermaxillary anchorage. In these patients, 35 kcal/kg was given to both non-intermaxillary anchorage patients under the intervention of the dietitian and to intermaxillary anchorage patients. Therefore, unlike a past report, a significant weight change difference was not found between the intermaxillary anchorage group and the non-intermaxillary anchorage group. However, both groups showed body weight loss at 1 and 2 weeks after surgery compared to preoperative weight even with a nutrient dose of 35 kcal/kg. In patients following surgery for deformity of the jaw, both diet and conversation are difficult due to trismus for a certain period of time after surgery, and this is thought to be a strong stressor. Therefore, it seemed to be necessary to determine the nutrient dose taking into account these factors. In recent years, the need for intermaxillary anchorage has decreased with mini-plate fixation, but it is thought that undernutrition can be avoided by providing sufficient nutrients when intermaxillary anchorage is needed when abnormal fractures occur.

The incidence of pressure ulcers after gastroenterological surgery under general anesthesia[10] and wound healing in head and neck reconstructive surgery[31] were significantly related to long operation time. These reports indicate that long operation time is a risk for wound healing. In this study, long operation time was significantly related to body weight loss at 1 week after surgery. We should pay attention to wound healing and provide sufficient nutrition if operation time is long. Operative stress increases with prolongation of the operative time, and production of inflammatory cytokines and energy consumption increase, and this seems to cause weight loss. The weight loss was thought to cause delayed wound healing, and the prolongation of the operative time seemed to be closely associated with postoperative nutritional status.

We have to pay attention to weight loss occurring in the patients who came to have a long operative time in orthognathic surgery.

Author contributions

K.O. and N.I. designed most of the experiments and wrote the main manuscript text and prepared all figures and tables . K.M. and H.Y. were the primary person responsible for carrying out all experimental procedures. T.M. analyzed the data. S.K. and K.T. are the person who made the final approval of the article.

Conflict of interest

The authors declare that they have no conflicts of interest.

Role of the funding source

There was no source of funding for this research.

Ethical approval

Approval was given by Hokkaido University Hospital Ethics Committee (Ref. No 010-0285)

Patient consent

All patients are informed research purpose and agree to use their clinical data for this study.

References

1. Guo CB, Ma DQ, Zhang KH. Applicability of general nutritional status score to patients with oral and maxillofacial malignancies. *Int J Oral Maxillofac Surg* 1994; **23**:167–9.
2. Howard L, Ashley C. Nutrition in the perioperative patient. *Annu Rev Nutr* 2003; **23**:263–82.
3. Albina JE. Nutrition and wound healing. *J Parenter Enteral Nutr* 1994 ;**18**:367–76.
4. Williams JZ, Barbul A. Nutrition and wound healing. *Surg Clin North Am* 2003 ; **83**:571–96.
5. Felblinger DM. Malnutrition, infection, and sepsis in acute and chronic illness. *Crit Care Nurs Clin North Am* 2003;**15**:71–8.
6. Cawood JI, Small plate osteosynthesis of mandibular fracture. Br J Oral Maxillofac Surg 1985: 23: 77–91.
7. Hayter JP, Cawood JI. The functional case for miniplates in maxillofacial sur- gery. Int J Oral Maxillofac Surg 1993: 22: 91–96.
8. Ruslin M, Dekker H, Tuinzing DB, Forouzanfar T, Assessing the need for a protocol in monitoring weight loss and nutritional status in orthognathic surgery based on patients experiences. J Clin Exp Dent. 2017; 9 : 272-275.
9. Kuvat SV, Güven E, Hocaoqlu E, Bazaran K, Marzan G, Cura N, et al. Body fat composition and weight changes after double-jaw osteotomy. *J Craniofac Surg* 2010 ; **21**:1516-8.
10. H. ANTILA, M. SALO, V. NANTo, K. FORSSELL, M. SALONEN, O. KIRVELA. The effect of intermaxillary fixation on leukocyte zinc, serum trace elements and nutritional status of patients undergoing maxillofacial surgery Clin Nutr1993; **12**:223-229.
11. Haider M, Haider SQ. Assessment of protein-calorie malnutrition. *Clin Chem* 1984;**30**:1286–99.
12. Shao JZ, Ye MZ, Gu JF. Parenteral nutrition. Shanghai: Shanghai Science & Technology Publishing House; 1984.82.
13. Leigh J. Postoperative cart. III: Rowe KL. Ll Williams J, eds. Maxillofacial Injuries. Edinburgh: Churchill Livingstonc. 1986; 701.
14. Behbehani F, Al-Aryan H, Al-Attar A, Al-Hamad N. Perceived effectiveness and side effects of intermaxillary fixation for diet control. *Int J Oral Maxillofac Surg* 2006 ; **35** : 618-23.
15. Studley HD. Percentage of weight loss: basic indicator of surgical risk in patients with chronic peptic ulcer. *JAMA* 1936;**106**:458–60.

16. World Health Organization. Obesity. Preventing and managing the global epidemic. Report of a WHO consultation on obesity. Geneva, Switzerland : *World Health Organization*, 1998.

17. Williams JZ, Barbul A. Nutrition and wound healing. *Surg Clin North Am* 2003;**83**:571–96.

18. Chandra RK: Nutrition and immunity in elderly in the elderly: clinical significance. Nutrition Review 1995; **53**:S80 –S3.

19. Rubcrg I.. Role of nutrition in wound healing. *Surg Clin Korth Am* 1984; 64: 721.

20. Law DK. Dudrick SJ. Abdou XI. The eflects of dietary protein depletion on immunocompetence. Ann Surg 1974; **179**: 168.

21. Leigh J. Postoperative cart. III: Rowe KL. Ll Williams J, eds. Maxillofacial Injuries. Edinburgh: Churchill Livingstonc. 1986; 701.

22. Sosuke Tadano, Hideo Terashima, Junya Fukuzawa, Ryota Matsuo, Osamu Ikeda, and Nobuhiro Ohkohchi, Early Postoperative Oral Intake Accelerates Upper Gastrointestinal Anastomotic Healing in the Rat Model. *Journal of Surgical Research* 2011;**169**: 202–208.

23. Montagnese C1, Scalfi L, Signorini A, De Filippo E, Pasanisi F, Contaldo FInt J Eat Disord. Cholinesterase and other serum liver enzymes in underweight outpatients with eating disorders.2007; **40** :746-50.

24. Blackburn GL, Bistrian BR, Maini BS, et al : Nutritional and metabolic assessment of the hospitalized patient. *J Parenter Enteral Nutr* 1977; **1** : 11－22.

25. Bozzetti F. Effects of artificial nutrition on the nutritional status of cancer patients. *J Parenter Enteral Nutr* 1989;**13**:406–20.

26. Haider M, Haider SQ. Assessment of protein-calorie malnutrition. *Clin Chem* 1984;**30**:1286–99.

27. Albina JE. Nutrition and wound healing. *J Parenter Enteral Nutr* 1994;**18**:367–76.

28. Williams JZ, Barbul A. Nutrition and wound healing. *Surg Clin North Am* 2003;**83**:571–96.

29. S. F. Worrall : Changes in weight and body composition after orthognathic surgery and jaw fractures: a comparison of miniplates and intermaxillary fixation. *Br J Oral Maxillofac Surg* 1994; **32**: 289-292.

30. Cawood JI. Small plate osteosvnthesis of mandibular fractures. *Br J Oral Maxillofac Surg* 1985; **23**: 77.

31. Sayoko Kanno, Noriko Kanzaki, Miwa Suzuki, Masako Taki, Hisako Honma and Shunichi Ishii : Analysis of pressure ulcers after gastroenterological surgery under general anethsia *Jpn J PU* 2006; **8**: 172-176.

Table1. Clinical background of the DD female patients

Characteristics	DD patients (n=40)
IMF / without IMF	20 / 20
age (years)	25 (17-40 ± 5)
BMI (kg/m^2)	21.2 (15.1-26.5 ± 2.6)
operation time (min)	188 (95-395 ± 58)
blood loss (g)	345 (90-922 ± 193)
preoperative body weight (kg)	53.1 (40.0-73.0 ± 7.7)
mandibular setback movement (mm)	6.3 (-7-17 ± 4.2)

Data are number or mean (range ± SD)
DD : Dentofacial Deformity
BMI : body mass index (kg/m^2)

Table 2. Examination factors

category	factors
physical factors	age, BMI
operative stress factors	IMF or without IMF operation time (min) blood loss (g) mandibular setback movement (mm)
nutritional state factors	body weight (kg) laboratory data total protein (TP) serum albumin (ALB) total cholesterol (TCHO) total lymphocyte (TLC) cholinesterase (CHE)

BMI : body mass index (kg/m^2)
IMF : intermaxillary fixation

Table 3. Postoperative changes of laboratory data

	T0	T1	T2	P value
total protein (g/dl)	7.3 (0.6)	7.0 (0.6)	7.0 (0.5)	0.0027**
		-4.5 (7.0)	-3.7 (6.9)	
serum albumin (g/dl)	4.6 (0.3)	4.3 (0.4)	4.3 (0.4)	<0.0001**
		-6.5 (8.1)	-4.7 (8.0)	
total cholesterol (mg/dl)	172.8 (32.4)	166.5 (27.9)	166.5 (27.9)	0.015*
		-2.2 (15.0)	9.2 (18.8)	
total lymphocyte (n/μl)	2089 (596)	2079 (540)	2079 (540)	0.9048
		3.8 (29.3)	3.4 (43.9)	
cholinesterase (IU/l)	271.4 (58.1)	233.9 (49.6)	233.9 (49.6)	<0.0001**
		-9.6 (13.2)	-8.1(11.8)	

T0 : preoperation
T1 : 1 week after orthognathic surgery
T2 : 2 week after orthognathic surgery

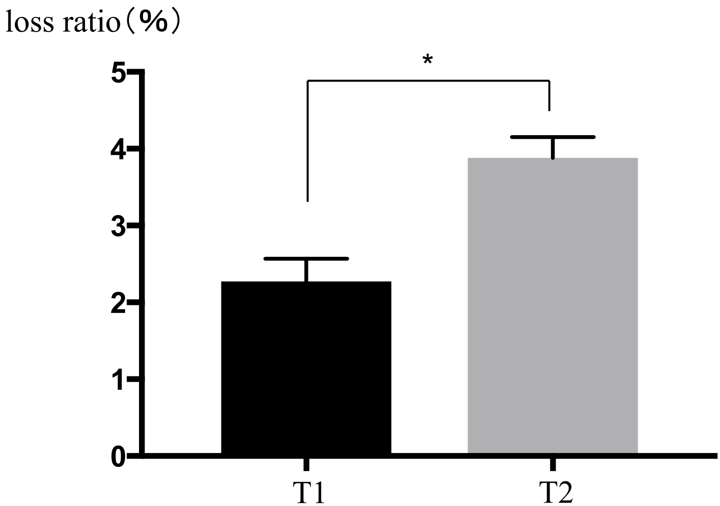
Upper / Lower : value / changes ratio from T0
Data are mean (S.D.)
*P<0.05, **P<0.01 Friedman test

Table 4. Relationship between examination factors and body weight loss

	T1		T2	
	r	P value	r	P value
IMF/ without IMF	0.006	0.141	0.007	0.289
age	0.048	0.174	0.002	0.083
BMI	0.001	0.868	0.001	0.947
operation time	0.117	0.031 *	0.008	0.317
blood loss	0.078	0.081	0.053	0.155
preoperative body weight	0.078	0.081	0.001	0.391
mandibular movement	0.001	0.963	0.001	0.863
total protein T1R	0.069	0.102	0.033	0.260
T2R			0.057	0.138
albumin T1R	0.094	0.055	0.041	0.210
T2R			0.001	0.858
total cholesterol T1R	0.016	0.448	0.096	0.052
T2R			0.041	0.209
total lymphocyte T1R	0.005	0.670	0.014	0.463
T2R			0.074	0.089
cholinesterase T1R	0.024	0.338	0.031	0.272
T2R			0.047	0.177

T1 : 1 week after orthognathic surgery
T2 : 2 week after orthognathic surgery
T1R : T0-T1 ratio
T2R : T0-T2 ratio

*p<0.05 Spearman`s test



T1 : 1 week after surgery　　*p<0.05 Mann -Whitney test
T2 : 2 week after surgery

Fig.1 Postoperative changes of body weight loss ratio

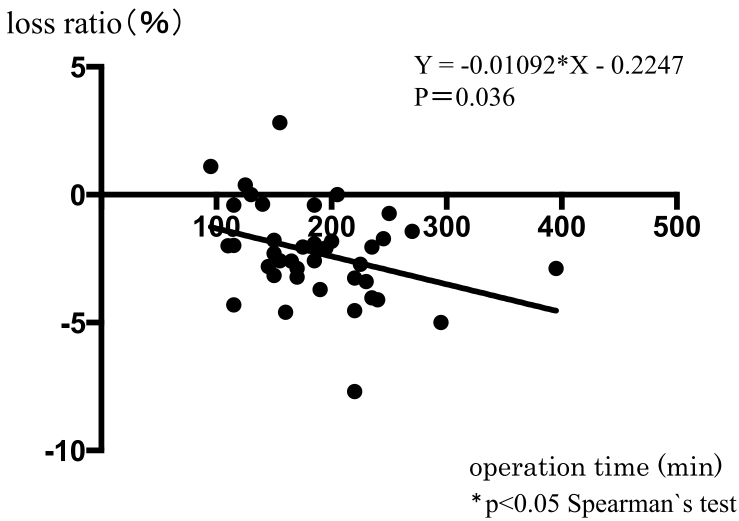


Fig.2 Change of body weight ratio at 1 week after orthognathic surgery