

# Nutritional Support Team Intervention for Patients with Mandibular Fracture Treated by Intermaxillary Fixation

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#### Abstract

The objective of this study was to investigate the effectiveness of nutrition support teams (NSTs) for oral injuries in patients with mandible fracture treated by intermaxillary fixation (IMF). The participants included 25 patients who were treated for mandibular fracture by IMF with NST intervention, who were used as the primary study group, and 25 patients treated without NST intervention, who were used prospectively as a control group. Decrease of body weight of these groups was compared. During the NST intervention, the patients in the study group were encouraged to freely engage in mild exercise. In the primary study group, nutrition sufficiency ratios, body weight, serum markers (albumin Alb, hemoglobin Hb, C-reactive protein CRP), grip strength and body composition parameters (triceps skinfold thickness, mid-arm muscle circumference, body fat, subcutaneous fat, skeletal muscle) were then measured. The study group was then subdivided into two groups based on whether their grip strength increased or decreased during the NST intervention was significantly lower than that of patients with NST intervention was significantly lower than that of patients without NST intervention, the patients with increased grip strength was significantly lower than that of patients with decreased grip strength.

**Keywords:** Nutritional support team; Body weight; Mandibular fracture; Intermaxillary fixation; Grip strength

#### Introduction

Nutrition Support Teams (NSTs) are interdisciplinary support teams with specialty training in nutrition. NSTs typically comprise physicians, dietitians, nurses, laboratory medical technologists and pharmacists [1]. NST intervention usually includes nutritional assessment, determination of nutritional requirements, recommendations for appropriate nutrition therapy and management of nutrition support therapy. It has been shown to lead to not only significant improvements in nutritional status but also a reduced incidence of complications and medical costs [2]. The use of NST intervention in patients with oral cancer resulted in effective nutritional management has previously been reported [3-5].

In sports-related injuries, athletes are expected to return to training and competition as early as possible; therefore, nutritional support to prevent muscle loss and maintain physical strength is important. The effectiveness of various kinds of nutrition support in sports injuries has been investigated in previous studies [6-10].

Oral injuries take various forms, and include mild injuries such as small lacerations and severe injuries such as mandible fracture. Sports are one of the frequent causes of mandibular fractures. Although patients with oral injuries are often healthy otherwise, especially sports injury athletes, such injuries can lead to restricted diet quality and choices because of the difficulties of chewing and swallowing, which can ultimately influence nutritional status and result in nutritional deficiencies [11], and this represents a major problem for the athletes with oral injuries. In spite of the special characteristics of oral injuries, studies on nutritional management and the maintenance of muscle strength during the treatment period for oral injuries are rare.

Patients with mandibular fracture treated by intermaxillary fixation (IMF), which is the traditional method are unable to open their mouths for up to 2 to 3 weeks. During this period, mastication is not possible, and patients must therefore be on a ready-made liquid diet, for which the nutritional content is already known.

As a result, it is relatively easy to control the precise nutrition of such patients over the long term. Most patients treated by IMF are relatively healthy otherwise. These patients are less affected by past and present illness, and because oral injuries are common, substantial amounts of data have been collected. We speculate that patients with oral injuries, including sports-related oral injuries, treated by IMF may be a suitable population for evaluating nutritional support and changes in physical strength.

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Therefore, from 2013, we provided NST intervention to such patients for nutritional maintenance. We also added grip strength as a parameter for evaluating physical strength [12]. In this study, to promote earlier recovery from oral sports-related injuries, we compared the changes in body weight among patients treated by IMF before and after NST intervention. In addition, we also investigated the effectiveness of NST intervention for nutritional management during the IMF period, as well as the factors that affect grip strength.

# **Materials and Methods**

Patients who visited the Department of Oral and Maxillofacial Surgery, Saitama Medical Center, Saitama Medical University from January 1, 2013 to December 31, 2015 for mandibular fracture and were treated by IMF (3 weeks) with NST intervention were recruited (25 patients). Age-, sex- and body mass index (BMI)-matched patients who visited the department from January 1, 2009 to December 31, 2012 for mandibular fracture and were treated by IMF without NST intervention were retrospectively selected as a control group (25 patients).

The other inclusion criterion was that any injury in another part of the body be minor and the deviation of mandible was mild. The exclusion criteria were having serious diseases such as heat injury, serious infection, multiple tissue failure, liver failure, renal failure, cardiac failure, chronic respiratory failure, cerebrovascular dysfunction, cancer, dementia and malnutrition before their oral injury. The patients in the primary study group were encouraged to freely engage in mild exercise such as walking, climbing stairs and light calisthenics.

Body weight loss (kg and %) during three weeks IMF period was compared between the study and control groups. In the study group, the NST intervention and assessments were performed once a week on Mondays and conducted more than three times during treatment [13] (Figure 1). The period between the patients' first visit (NST registration) and the first assessment was defined as the NST waiting period (Day 1 to Day 6), and the period starting after the first assessment was defined as the NST active period.



The first assessment was designated as the baseline assessment, and the third assessment as the final assessment. Ordinary non-carefully selected liquid meals were provided to the patients during the NST waiting period and changed after each assessment. For example, a patient who visited on Tuesday was given the ordinary liquid meal until the following Monday, when the first NST assessment was performed. Liquid nutrition was provided intraorally; methods such as intravenous hyperalimentation and nasogastric tube feeding were not used.

As the patients had no cerebrovascular disorders, nervous disorders or digestive function abnormalities, the liquid diets used in the NST intervention included various kinds of semi-digestion nutritional agents. All of the liquid diets were ready-made, and the nutritional content was already known. Serum examinations (albumin Alb, hemoglobin Hb, C-reactive protein CRP) were performed once weekly, and those conducted after the third NST intervention was designated as the final examination. Daily energy requirements were calculated with reference to the Harris-Benedict equation [14]. Water and protein intake was kept to 30 to 40 mL/kg of body weight and 0.8 to 1.0 g/kg of body weight, respectively. The percentage of energy from carbohydrates and fat was kept to 50% to 60% and 20% to 40%, respectively [15]. The energy, protein and fat sufficiency ratios from the first to the final assessment were also recorded. Body weight loss (kg and %) among the patients in the primary study group was also compared between the NST waiting and active periods.

Grip strength and body composition parameters including percent changes in body weight, triceps skinfold thickness (TSF), mid-arm muscle circumference (AMC), body fat, subcutaneous fat and skeletal muscle were also measured in the 25 patients in the primary study group (Table 1). Then the primary study group were subdivided as follows into two groups based on changes in grip strength: 13 patients whose grip strength increased after the NST intervention were classified as the Grip+ group, and 12 patients whose grip strength decreased after the NST intervention were classified as the Gripgroup.

BMI=weight (kg)/height (m)/height (m)
%TSF=TSF (mm)/constant * × 100
%AMC=AMC (cm)/constant* × 100
AMC (cm)=AC (cm) – $\pi$ × TSF (cm)
%Body fat **={Body fat mass (kg)/Body weight (kg)} × 100
%Subcutaneous fat**={Subcutaneous fat mass (kg)/Body weight (kg)} $\times$ 100
%Skeletal muscle**={Skeletal muscle percentage (kg)/Body weight (kg)} × 100
TSF: Triceps Skinfold Thickness; AMC: Mid-Arm Muscle Circumference; AC: Mid-Arm Circumference.
*constant is based on Japanese Anthropometric Reference Data 2001 (37). This is different from age in sex.
** %Body fat, %Subcutaneous fat and %Skeletal muscle were measured using bioelectrical impedance analysis.

#### Table 1: Formulas.

Subsequently the data were compared between sub-groups. Grip strength measurement was performed with the patients' dominant hand using a grip dynamometer (T-1780; Toei Light Co., Ltd., Soka, Japan). TSF and AMC were obtained by measuring the patients' dominant arm with Skinfold Caliper (Abbott Laboratories, Tokyo, Japan) and a tape measure, respectively. All measurements were performed by a single experienced dietitian. Body fat, subcutaneous fat and skeletal muscle percentages were measured using a bioelectrical impedance device (Karada Scan HBF-701; Omron Co., Ltd., Tokyo, Japan).

Variables

Data analysis was performed using the ORIGIN software package (Pro 2016 version; Light Stone, Tokyo, Japan). Data were expressed as mean and standard deviation (M  $\pm$  SD). Statistical significance was determined using Student's t-test. The significance level was set at P<0.05.

This study was approved by the Ethics Committee of the affiliated institution. Every patient of the primary study group gave written informed consent. For the patients under 20 years of age, informed consent was also obtained from a parent or guardian.

# Results

The demographic characteristics of patients with NST intervention (study group) and without NST intervention (control group) are shown in Table 2, and the body weight loss (kg and %) of the patients in both groups during the IMF period (3 weeks) is shown in Table 3. Body weight (kg and %) was significantly less decreased among patients with NST than among those without NST intervention (kg, p<0.033; %, p<0.020).

Variables	Patients with NST intervention (n=25)	Patients without NST intervention (n=25)	р	
Age (years)	38.6 ± 20.2	42.1 ± 19.8	0.541	
Sex (M/F)	16-Sep	16-Sep	1	
BMI (kg/m²)	21.2 ± 3.6	22.8 ± 3.1	0.074	
Data are expressed as mean ± standard deviation. NST, nutrition support team;				

M: Male; F: Female; BMI: Body Mass Index

 Table 2: Characteristics of patients with and without NST intervention.

Changes among the study group in serum Alb, Hb and CRP between the first and final assessments are shown in Table 4. Significant decreases were observed in Alb and CRP (Alb, p<0.014; CRP, p<0.025). Energy, protein and fat sufficiency ratios from the first to third assessment are shown in Table 5. The only significant difference found was between the first and second assessments for energy (p<0.043).

Variables	Patients with NST intervention	Patients without NST intervention	р	
Body weight change (kg)	-1.8 ± 1.5	-2.7 ± 1.4	0.033	
Body weight change (%)	-3.1± 2.3	-4.6 ± 2.4	0.020	
Data are expressed as mean ± standard deviation. NST: Nutrition Support Team.				

 Table 3: Changes in weight between patients with and without NST intervention.

In the primary study group, the M  $\pm$  SD NST waiting period was 4.1  $\pm$  2.0 days. The body weight loss (kg and %) of the patients in the study group between the NST waiting and active periods is shown in Table 6. The body weight loss (kg and %) of the patients during the first and second weeks of the NST active period was significantly lower than that during the NST waiting period (kg, p<0.012; %, p<0.007 (first week), kg, p<0.008; %, p<0.004 (second week)).

uo			examination	
as at	Alb (g/dL)	4.49 ± 0.44	4.22 ± 0.30	0.014
	Hb (g/dL)	14.19 ± 1.92	13.83 ± 1.54	0.47
ed en	CRP (mg/dL)	0.42 ± 0.55	0.13 ± 0.25	0.025
ed	Data are expressed Serum Hemoglobin;	as mean ± standard c CRP: C-Reactive Protei	leviation. Alb: Seru n.	m Albumin; Hb:

First examination

**Table 4:** Changes in serum markers between the first and final serum examinations.

Final

Variables	First assessment	Second assessment	P1	Third assessment	P2
Energy (%)	96.7 ± 29.1	103.1 ± 21.6	0.043	105.7 ± 22.6	0.625
Protein (%)	82.4 ± 27.5	93.8 ± 19.4	0.144	102.1 ± 28.4	0.665
Fat (%)	103.0 ± 35.9	114.5 ± 28.4	0.11	114.3 ± 28.6	0.808

Data are expressed as mean ± standard deviation.

P1, First assessment vs. Second assessment; P2, Second assessment vs. Third assessment.

**Table 5:** Energy, protein and fat sufficiency ratios from the first to the third assessments.

The characteristics of the patients in the Grip+ and Grip– groups, as well as the rates of change in grip strength, body composition markers and serum markers, are shown in Table 7. Grip strength was significantly higher and body weight loss (kg and %) was significantly lower among patients in the Grip+ group compared with patients in the Grip– group (grip strength, p<0.001; body weight, kg, p<0.045, %; p<0.001).

		NST active period			
Variables	NST waiting period (4.1 ± 2.0 days)	First week	P1	Second week	P2
Body weight change (kg)	-1.10 ± 1.00	-0.41 ± 0.65	0.012	-0.37 ± 0.65	0.008
Body weight change (%)	-1.84 ± 1.66	-0.68 ± 1.10	0.007	-0.60 ± 1.13	0.004
Data are expressed as mean ± standard deviation. NST: Nutrition Support Team. P1: NST waiting period vs. NST active period (first week); P2: NST waiting period vs. NST active period (second week).					

 Table 6: Changes in body weight during the NST waiting and active periods.

# Discussion

Mandibular fracture is a common injury encountered in oral surgery clinics, and standard treatment includes two methods. One is open reduction and rigid internal fixation with osteosynthetic plates and screws. The other is closed reduction with IMF. Surgical fixation is currently the preferred method because it has a shorter treatment period, which tends to lead to improved quality of life among patients. Patients who refuse surgery or are deemed ineligible for surgical

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Variables	Grip+ (n=13)	Grip- (n=12)	р
Age (years)	39.3 ± 20.5	37.8 ± 20.6	0.86
Sex (M/F)	08/5	08/4	0.79
BMI (kg/m²)	21.6 ± 4.3	20.7 ± 2.8	0.53
Grip strength change (%)	10.31 ± 2.87	-8.04 ± 2.33	0.001
Body weight change (kg)	-1.25 ± 1.49	-2.41 ± 1.22	0.045
Body weight change (%)	-1.96 ± 0.57	-4.23 ± 0.55	0.001
%TSF (%) change (%)	-13.28 ± 2.87	-5.32 ± 19.89	0.757
%MAMC (%) change (%)	-23.19 ± 12.21	-21.35 ± 14.92	0.924
% body fat change (%)	3.75 ± 3.83	8.42 ± 6.76	0.561
% subcutaneous fat change (%)	2.90 ± 3.19	7.12 ± 6.13	0.539
% skeletal muscle change (%)	0.02 ± 0.64	0.00 ± 0.67	0.981
Alb change (g/dL)	-0.17 ± 0.39	-0.41 ± 0.39	0.148
Hb change (g/dL)	-0.28 ± 0.81	-0.66 ± 1.09	0.340
CRP change (mg/dL)	-0.28 ± 0.71	-0.29 ± 0.48	0.980

fixation for various reasons, such as fracture of the mandibular condyles or systematic impairment, need to be treated with IMF.

Data Are Expressed as Mean ± Standard Deviation. NST: Nutrition Support Team; M: Male; F: Female; BMI: Body Mass Index; TSF: Triceps Skinfold Thickness; MAMC: Mid-Arm Muscle Circumference; Alb: Serum Albumin; Hb: Serum Hemoglobin; CRP: C-Reactive Protein; Grip+: Patients with Increased Grip Strength; Grip-: Patients with Decreased Grip Strength.

**Table 7:** Characteristics of patients with increased or decreased grip strength, and rates of change in grip strength, body composition markers and serum markers after NST intervention.

NST intervention is commonly used for nutritional management in sports-related injuries [6]. The single most important consideration during immobility and/or reduced muscle activity is the prevention of nutritional deficiencies. Deficiencies in energy, vitamins, minerals or macronutrients-particularly protein-impairs wound healing and exacerbates loss of muscle and tendon mass and function [6]. However, nutritional management differs between athletes, particularly between those who are otherwise healthy with no or only minor additional injuries and those with severe injuries in the inflammatory period [16]. Excess energy intake may cause various complications and increase body fat and total body mass [6]. Therefore, NSTs must assess energy balance in such patients carefully.

Although body weight is not always perfectly accurate, it is regarded as a reliable, low-cost and easily measured parameter for nutritional assessment [17]. Body weight loss is thought to lead to a decrease in physical strength, and caloric restriction-induced weight loss is associated with decreases in both muscle size and strength [18-20]. It is well known that patients treated by IMF typically experience a loss of body weight [21,22]. This body weight loss was normally  $4.2 \pm 2.25$ kg/4-6 weeks without nutritional support [23]. Conversely, IMF has also been used in obese patients for diet control, and in these cases, body weight loss ranged from 6.8 kg/3.5 weeks to 9.6 kg/6 weeks [24,25]. Antila et al. reported that body weight loss during the IMF period in patients receiving nutritional counseling with and without oral supplementation was  $3.8 \pm 2.7\%$  and  $6.0 \pm 3.8\%/4-6$  weeks, respectively [26]. In this study, body weight loss with NST intervention ( $1.8 \pm 1.5$  kg and  $3.1 \pm 2.3\%/3$  weeks) was significantly lower than that without NST intervention ( $2.7 \pm 1.4$  kg and  $4.6 \pm 2.4\%/3$  weeks). This result also indicated the effectiveness of the NST intervention.

In this study, serum Alb and CRP levels were significantly lower after NST intervention. As the patients did not have any other serious diseases or injuries, changes in Alb levels reflected their restricted nutritional intake. The decrease in CRP levels was thought to be the result of recovery from the inflammatory period, not an effect of the NST intervention.

Regarding the nutritional deficiencies, the energy, protein, and fat sufficiency ratios were improved in the second compared with the first assessment; however, the only significant difference was for energy. This result suggested that the NST intervention was effective for maintaining the nutrition status of patients with mandibular fracture treated by IMF.

In this study, body weight loss (kg and %) was significantly higher during the NST waiting period than during the NST active period, which suggests that body weight loss begins shortly after an oral injury. Substantial skeletal muscle loss begins to occur after only five days of disuse [27]. Although minor oral injuries often heal relatively quickly, typically within one or two weeks, malnutrition caused by insufficient nutritional intake seems to start from an extremely early stage. This suggests that NST intervention at an early stage is important for maintaining nutritional status, regardless of whether injuries are minor or severe.

Measuring grip strength, which reflects systemic muscle strength [28,29], is simple, quick and inexpensive. In this study, the grip strength of approximately half of the patients increased, and the patients with increased grip strength had a smaller loss of body weight (kg and %). However, exactly why grip strength increased in some patients and decreased in others remains unclear. This could be due to an association between increased grip strength and the maintenance of body weight. In this study, patients were not given special meals, such as meals with reduced carbohydrate content, which improve strength while decreasing body weight [30]. Furthermore, the quality and quantity of exercise performed by each patient was not unified, and the effects of diarrhea, which is the most common adverse effect of liquid nutrition intake, were not taken into consideration. Diarrhea decreases body weight and physical strength, and is found in up to 63% of tubefed patients [31,32]. In this study, almost all of the patients had loose stool. However, Behbehani [25] reported that diarrhea was only found in 10% of patients during the IMF period. Although an increase in grip strength was only found in about half of the patients, we speculated that appropriate exercise and the maintenance of body weight during the treatment period for oral injuries could potentially lead to increases in physical strength.

In addition, except for body weight, no associations were found between body composition markers and decreased grip strength. A decrease in TSF percentage indicates a decrease in body fat, and a decrease in AMC percentage indicates a nutritional disorder in muscle protein [33]. Skeletal muscle can be increased through exercise and other physical activities. Increasing the percentage of skeletal muscle means that the body can consume energy more easily, which in turn makes it less likely that energy will be stored as fat [34]. These markers may be useful for measuring physical change over the long term [35,36].

There are limitations to this study. The number of patients evaluated was relatively small. The shortage of the data of the retrospectively selected control group made the comparative study of the serum examination difficult. However, intervention of NST for patients with mandibular fracture treated by IMF showed to be effective. As to the association between weight and physical strength, further studies with unified exercise parameters and other factors associated with body weight loss are needed [37-39].

#### Conclusion

In conclusion, the results of this study suggest that NST intervention is highly effective for maintaining nutritional status and body weight during the IMF period. In addition, an association was found between changes in body weight and grip strength. In patients with oral injuries, body weight appears to be a simple and effective marker for nutritional support. Therefore, NST intervention is recommended from an early stage in patients with oral injuries.

#### **Conflicts of Interest**

Authors declare that they have no conflicts of interest in the authorship or publication of this contribution.

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