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Review Article

Optimizing Patient Outcomes in Orthognathic Surgery: A Proposed Nutritional Protocol for Weight Loss Control and Bone Formation

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ABSTRACT

Objective: The primary objective of this research was to conduct a comprehensive literature review, offering an in-depth examination of the nutritional considerations associated with orthognathic surgery and suggest a perioperative nutritional protocol for enhanced recovery.

Methods: To achieve this objective, the authors rigorously examined existing literature while adhering to the guidelines outlined in PRISMA-ScR. The scope of eligible studies encompassed various types, with the exclusion of case reports and reviews. The research applied specific inclusion criteria, concentrating on the nutritional aspects relevant to perioperative and/or postoperative phases of major maxillofacial surgery.

Results: A total of 39 articles were identified that met the screening criteria. These articles were then used to generate a discussion and propose a protocol aimed at reducing body weight loss following major maxillofacial surgery and improving bone formation post-osteotomies.

Conclusions: While the realm of maxillofacial surgery sees significant advancements in other fields, there exists a noticeable gap in addressing the nutritional status of surgical patients. This oversight can potentially lead to suboptimal postoperative outcomes. Recognizing the pivotal role of nutrition in enhancing surgical results, this paper emphasizes the importance of maintaining optimal nutritional status among orthognathic surgery patients.

Keywords: Maxillofacial surgery; maxillofacial surgical procedures; treatment outcome; dietary supplements

INTRODUCTION

A diverse range of maxillofacial surgeries are conducted globally on a daily basis, encompassing procedures ranging from third molar extractions to complex maxillofacial reconstructions and orthognathic surgeries. The existing body of literature is abundant in discussions of virtual planning, [1] emerging technologies, [2] and pharmaceutical advancements [3] that contribute to enhancing the safety of surgical procedures and reducing postoperative discomfort for patients. Regrettably, there is a notable dearth of publications addressing the nutritional status of these surgical patients. This gap in research hinders a comprehensive understanding of how nutritional factors can further optimize the outcomes of maxillofacial surgeries.

Nutritional consultations, pre-operative assessments, and the consideration of mineral and vitamin supplementation often do not receive the requisite emphasis in the research and surgical community. [4] This oversight has the potential to result in suboptimal postoperative results. [5] While numerous studies have contributed valuable insights into the significance of nutrition in various surgical contexts, [6–9] there remains a notable paucity of literature dedicated to this topic in the realm of maxillofacial surgery. [10–13] Recognizing the foundational importance of staying current with developments in this area, the need for constant updates and research on this subject becomes apparent, as it is essential for achieving even more improved surgical outcomes. [14]

Main Points:

- Nutritional consultations, pre-operative assessments, and the consideration of mineral and vitamin supplementation often do not receive the requisite emphasis in the research and surgical community.
- While numerous studies have contributed valuable insights into the significance of nutrition in various surgical contexts, there remains a notable paucity of literature dedicated to this topic in the realm of maxillofacial surgery.
- Proposition of a protocol aiming on reducing body weight loss following major maxillofacial surgery and improving bone formation post-osteotomies.
- Topics such as perioperative nutritional care, weight imbalance due to involuntary loss, physical and functional evaluations, electrolytes, vitamins and bone physiology.

Hence, the primary objective of this paper is to delve into the crucial significance of maintaining an optimal nutritional status among individuals undergoing orthognathic surgery. Furthermore, the secondary aim of this paper is to put forward a comprehensive perioperative nutritional protocol tailored specifically to this patient population, with the ultimate goal of augmenting favorable surgical outcomes.

MATERIALS AND METHODS

The information presented in this article was compiled through a comprehensive examination of existing literature, following the PRISMA-ScR guidelines. [15] A specific search strategy was employed by two independent reviewers (BL and RG), who conducted searches in online databases, including PubMed, Scopus, and Web of Science (WoS). This search strategy incorporated the use of keywords such as “nutrition,” “diet,” “dietetic,” “surgery” and “maxillofacial surgery.” All types of studies related to maxillofacial surgery, except for case reports and reviews, were considered for inclusion. Additionally, a manual search of the databases was conducted to identify articles that might not have been initially captured, by reviewing the references of the included articles. There were no restrictions imposed on language or publication year.

The titles and abstracts of the search results were carefully assessed to determine their relevance to the study. Subsequently, selected articles underwent a full-text screening, during which the authors thoroughly examined and extracted pertinent data.

This study involved a critical review of publicly available electronic sources and did not entail the use of specific patient information. Consequently, it was granted exemption from institutional review board approval.

RESULTS

A total of 39 articles were identified that met the screening criteria. These articles were then used to generate a discussion and propose a protocol aimed at reducing body weight loss following major maxillofacial surgery and improving bone formation post-osteotomies. Topics such as perioperative nutritional care, weight imbalance due to involuntary loss, physical and functional evaluations, electrolytes, vitamins and bone physiology was added. This protocol was organized into a table format and is presented as Table 1.

Table 1. Optimal Nutritional values for weight loss control and bone formation

Body Mass Index (BMI)	18.5 to 24.9 kg/m^2
Calcium (Ca)	1,000 to 1,300 mg/day
Sodium (Na)	200 mg/day
Magnesium (Mg)	310 to 420 mg/day
Phosphorus (P)	700 mg/day
Potassium (K)	4,700 mg/day
Iron (Fe)	Men – 8 mg/day Women – 18mg/day
Vit. A	Men – 900 mcg/day Women – 700 mcg/day
Vit. B_{12}	Men – 2,4 mcg/day Women – 2,4 mcg/day
Vit. D	Men - 600 mcg/day Women – 600 mcg/day
Vit. C	Men - 90 mcg/day Women – 75mcg/day
Vit. K	Men – 120 mcg/day Women – 90 mcg/day
Vit. B_6	Men – 1.3mcg/day Women – 1,3 mcg/day
Vit. E	Men – 15mcg/day Women – 15 mcg/day

DISCUSSION

The correct distribution and safe administration of nutrition and metabolic support are critical matters of life and death in surgical and intensive care units. It's important to note that obese patients face increased surgical risks, as indicated by Blackbur in 2010. [16] While surgical complications often relate to the severity of the underlying disease and the specific surgical procedure, malnutrition can exacerbate various complications. Generally, patients who are well-nourished tend to handle major surgeries more successfully compared to those who are severely malnourished.

Perioperative Nutritional Care

The traditional practice of instructing patients to fast from midnight before surgery, known as "nothing by mouth" (NPO), has been phased out in many medical settings. Historically, the American Society of Anesthesiologists recommended that patients refrain from consuming solid food for 8 hours before surgery and from drinking fluids for 6 hours before anesthesia induction. This approach aimed to reduce the risk of aspiration and regurgitation. However, two Cochrane reviews have suggested that patients can safely consume fluids a few hours before surgery without increasing the risk of complications. [17, 18]

Furthermore, the use of carbohydrate-rich beverages before surgery has been shown to improve glycemic control and reduce nitrogen loss, lean body mass, and muscle strength after abdominal and colorectal surgery. [19] In emergency cases, preoperative fasting is often not possible, and surgery must be scheduled urgently, with patients treated as if their stomachs are full. [20]

For postoperative patients in critical condition admitted to the ICU, early energy intake is recommended unless it is absolutely contraindicated. [21] This practice has been associated with reduced infection rates and shorter hospital stays. [22] Additionally, using nutritionally enhanced formulas has been linked to fewer complications in surgical patients. [23]

In cases where oral feeding is not feasible or prolonged total parenteral nutrition (TPN) is expected, an enteral feeding access device should be placed during surgery. Studies are underway to evaluate the benefits of combining fish oil with nutritional therapy to enhance surgical outcomes in older adults after major surgery, with initial results showing promise in reducing systemic inflammation, lean muscle loss, and weight loss. [24]
Traditionally, patients have progressed from simple liquids to blended foods and finally to solid foods over several meals after surgery. However, there is no physiological reason to delay the introduction of solid foods once the gastrointestinal tract is functioning well and the patient is tolerating liquids. [22] Surgical patients can be transitioned to a regular diet of soft solid foods instead of being limited to a liquid-only diet.

Whenever possible, vitamin and mineral levels should be assessed through blood tests, and any deficiencies should be addressed with supplementation before surgery. In addition to maintaining a well-balanced nutritional intake before and after surgery, the potential for oral supplementation should be considered.

Weight Imbalance Due to Involuntary Loss

The term "underweight" is used to describe individuals who are 15% to 20% or more below the established weight standards.

Because being underweight often indicates an underlying health issue, it should be assessed from a clinical perspective. A low BMI (less than 18.5 kg/m2) is linked to a higher risk of mortality, especially in the elderly, compared to those with an ideal BMI (ranging from 18.5 kg/m2 to 24.9 kg/m2). [25]

Malnutrition can lead to reduced functioning of the pituitary, thyroid, gonads, and adrenal glands. Other risk factors include decreased energy levels, susceptibility to injury and infections, as well as distorted body image and other psychological challenges. Underweight or unintentional weight loss can result from various factors: (1) inadequate consumption of oral food and beverages, insufficient to meet daily activities; (2) excessive physical activity, such as compulsive sports training; (3) insufficient capacity for absorbing and metabolizing consumed food; (4) hypercatabolic diseases that raise metabolic rates and energy requirements, like cancer, HIV, or hyperthyroidism; or (5) heightened energy expenditure during psychological or emotional stress. [25]

Addressing the underlying cause of involuntary weight loss or low BMI should be the primary focus of management. Nutritional therapy and dietary adjustments can be effective when combined with treating the underlying condition. If inadequate oral food intake is the cause of underweight, activity modification and psychological counseling, if necessary, should be considered. A thorough history can help identify eating habit deficiencies. Meals should be planned and enjoyed in a relaxed manner rather than rushed. Individuals who are underweight may need encouragement to eat, even when not hungry. The key is to personalize the program with foods the individual enjoys, incorporating regular meals throughout the day. Snacks are often necessary to increase energy intake. [25]

Frequently, liquid supplements taken with or between meals are convenient, nutritious, and easy to prepare and consume. Ideally, the diet should provide approximately 30% of kilocalories from lipids, primarily from mono- or polyunsaturated sources, and at least 12% to 15% of kilocalories from protein. Encouraging the use of common vitamin and mineral supplements can also be beneficial. In addition to meeting estimated energy needs for the current weight, an additional 500 to 1,000 kilocalories per day should be planned for weight gain. This increase in intake should be gradual to prevent gastric discomfort, discouragement, electrolyte imbalances, and cardiac issues. It's advisable to consult with nutritionists to estimate energy requirements and assess a dietary plan. [25]

Physical and Functional Evaluations

Body weight can be assessed and understood through various methods, such as BMI, standard weight, and the actual measured weight. The actual body weight is the weight recorded during the examination and can be influenced by changes in an individual's fluid levels. A reduction in weight may indicate dehydration, but it could also suggest an immediate inability to meet nutritional requirements, which is a sign of potential nutritional risk. The percentage of weight loss is a strong indicator of the severity and extent of an individual's illness. Blackburn's formula from 1977 [26] is a valuable tool for calculating recent weight loss:

- Significant weight loss: A 5% decrease in weight within one month, a 7.5% decrease within three months, or a 10% decrease within six months.
- Severe weight loss: Weight loss exceeding 5% within one month, more than 7.5% within three months, or surpassing 10% within six months.

Body Mass Index

Another approach for assessing whether an adult's weight is appropriate for their height is by using the Body Mass Index (BMI) as described by Kesari and Noel in 2023. [27] BMI is determined by considering weight and height measurements and serves as an indicator of potential overnutrition or malnutrition. What sets BMI apart is its ability to account for differences in body composition by measuring adiposity and relating it to height, thus reducing the reliance on body frame size, as highlighted by Stensland and Margolis. [28] BMI exhibits the weakest correlation with body height but the strongest correlation with independent measures of body fat in adults. [29, 30] The formula for BMI calculation is as follows: BMI = Weight (kg) ÷ Height $(m)^2$.

According to established standards, an adult with a BMI below 18.5 is classified as underweight, a BMI ranging from 18.5 to 24.9 is considered within the healthy range, a BMI between 25 and 29.9 signifies overweight, and a BMI exceeding 30 indicates obesity. However, it's important to acknowledge individual variations before making definitive conclusions about the relationship between BMI and total body fat, as noted by Russell and Mueller. [31]

Electrolytes

Electrolytes are substances that, when dissolved in water, break down into ions carrying positive (cations) or negative (anions) charges. They play a vital role in numerous metabolic processes, maintaining the body's physiological functions, including osmotic balance, acid-base equilibrium, and regulating intracellular and extracellular ion concentrations.

Calcium (Ca)

Although most the body's calcium (Ca++) is stored in the skeleton, the remaining 1% serves crucial physiological functions. Approximately half of the calcium found in the intravascular compartment binds to the whey protein albumin. Consequently, when serum albumin levels are low, total calcium levels decrease due to hypoalbuminemia.

In healthy adults, typical serum total calcium levels range from approximately 8.5 to 10.5 mg/dL, while normal ionized calcium levels range from 4.5 to 5.5 mEq/L. Changes in acid-base balance can inversely affect ionized calcium levels; an increase in whey pH causes calcium to bind to proteins, leading to decreased ionized calcium levels, whereas a decrease in pH has the opposite effect. Given calcium's critical roles in cardiac, nervous system, and musculoskeletal function, both hypocalcemia and hypercalcemia can pose life-threatening risks. Calcium levels are carefully regulated, with the actions of vitamin D and phosphorus playing significant roles. Vitamin D promotes calcium absorption in the GI tract, while phosphorus inhibits it.

In normal diet, dairy products serve as the primary source of calcium, along with some green vegetables, nuts, canned fish containing bones, and tofu enriched with calcium. Many food products are fortified with additional calcium by manufacturers. The recommended daily calcium intake varies from 1,000 to 1,300 mg, depending on age and gender, with an upper limit estimated at around 2,500 mg per day. [32]

Sodium (Na)

Serves as the primary cation within the extracellular fluid, playing a pivotal role in regulating extracellular volume and plasma. The normal serum concentration of sodium falls within the range of 136 to 145 mEq/L. Sodium also holds significance in neuromuscular function and the maintenance of acid-base balance. The preservation of serum sodium levels is of utmost importance, as severe hyponatremia can result in seizures, coma, and even fatalities. Contrary to common belief, sweat is hypotonic and contains relatively small quantities of sodium. The export of sodium from cells acts as the driving force for facilitating the transport of glucose, amino acids, and other nutrients into the cells.

The precise minimum dietary sodium requirements remain uncertain but are estimated to be quite low, at approximately 200 mg per day. The Dietary Reference Intakes (DRI) sets an upper limit of 2.3 grams of sodium daily or 5.8 grams of sodium chloride (common table salt) daily, considering the potential association of sodium with hypertension, as noted by Chobanian. [33] The primary source of sodium is sodium chloride, with approximately 40% of its weight comprising sodium. Protein-based foods naturally contain more sodium than vegetables and grains, while fruits contain minimal or negligible amounts of sodium. [32].

Magnesium (Mg)

The human body contains approximately 24 grams of magnesium, making it the second most abundant intracellular cation. Roughly half of the body's magnesium is stored in bone tissues, while another 45% is in soft tissues. Only 1% of the body's magnesium is found in the extracellular fluid. [34] Normal serum magnesium levels typically fall within the range of 1.7 to 2.5 mEq/L, with approximately 70% of serum magnesium existing in a free or ionized form, while the remainder is bound to proteins and remains inactive. Magnesium (Mg++) serves as a critical cofactor in numerous enzymatic reactions within the body. It plays a significant role in bone metabolism, as well as in the proper functioning of the central nervous system and cardiovascular system.

The consumption of magnesium and potassium, along with an increased intake of fruits and vegetables, has been linked to a more alkaline status, which has a beneficial impact on bone health. Consuming fortified mineral water can serve as a convenient and cost-effective method to reduce the risk of osteoporosis [35].

Magnesium is present in a wide variety of foods, making it unlikely for healthy individuals to experience isolated magnesium deficiencies. Highly processed foods generally contain lower levels of magnesium, whereas green leafy vegetables, legumes, and whole grains are rich sources. The recommended daily intake of magnesium varies between 310 to

420 mg, depending on age and gender [32].

Phosphorus (P)

Plays a crucial role in the intracellular fluid, and its contribution to adenosine triphosphate (ATP) is indispensable for energy metabolism. Additionally, phosphorus is vital in bone metabolism, with approximately 80% of the body's phosphorus content residing in the bones. Normal serum phosphorus levels typically fall within the range of 2.4 to 4.6 mg/dL. Due to its critical role in energy production, severe hypophosphatemia can pose a life-threatening situation.

Phosphorus is primarily present in animal-derived products such as meats and milk, while certain types of dried beans also serve as good sources. The recommended daily intake of phosphorus varies, approximately around 700 mg per day, depending on age and gender. There's an upper limit of 3,500 to 4,000 mg, as outlined by the Institute of Medicine [32].

Potassium (K)

Is the primary cation found within intracellular fluid, and present in smaller quantities in the extracellular fluid. Normal serum potassium levels typically range from 3.5 to 5.0 mEq/L. Potassium, in conjunction with sodium, plays a vital role in maintaining proper water balance, osmotic equilibrium, and acid-base balance. It is also essential, along with calcium, for regulating neuromuscular activity. Sodium and potassium concentrations are pivotal in determining membrane potentials in nerves and muscles.

Generally, potassium-rich foods include fruits, vegetables, fresh meat, and dairy products. The recommended daily potassium intake for adults is 4,700 mg/day, and no upper limit has been established. Inadequate potassium intake has been linked to conditions such as systemic arterial hypertension and cardiac arrhythmias, as indicated by the Institute of Medicine [32].

Bone Physiology

Bone tissue functions as a repository for calcium and various minerals required by other body tissues. Calcium homeostasis is the process of maintaining a consistent serum calcium concentration. In situations where the dietary intake is insufficient, the body heavily relies on this reservoir of calcium stored in bone tissue. Additionally, bone tissue is dynamic, undergoing continuous changes through a process of bone turnover, which includes modeling the skeleton during early growth and remodeling once skeletal development (height gain) is completed. Vitamin D collaborates with parathyroid hormone (PTH) to enhance the release of calcium from bone tissue, thus regulating blood calcium levels. Vitamin D primarily derives from the interaction between sunlight and skin precursors, and secondarily, from dietary sources [36].

When the resorption and formation phases are in balance, the amount of bone tissue at the end of the formation phase matches that at the start of the resorption phase. This remodeling process benefits the skeleton by renewing bone without causing microfractures. However, when dietary calcium intake is insufficient, osteoclastic resorption becomes relatively higher than osteoblast formation due to consistently elevated PTH levels in the bloodstream. This results in the removal of significant amounts of bone tissue that is not typically completely replaced [36].

Vitamins

Vitamins are essential micronutrients that play a crucial role in various biochemical processes within the body, including metabolism, immune function, and cell growth. They are vital for maintaining overall health and preventing deficiencies that can lead to a range of health issues, emphasizing their fundamental importance in supporting human well-being. Lower levels of vitamin C are related to higher analgesics consumption. [16] Vitamin D should be strongly assessed and supplemented since a high deficiency can be found globally. [5] Vitamin B12 is strongly associated with neurosensory disturbances recovery. [17,18] Vitamin A, iron, and generic supplements [12,13,19] also could be very useful in case of minerals/vitamins blood tests are not available.

CONCLUSION

In conclusion, while the realm of maxillofacial surgery sees significant advancements in virtual planning, emerging technologies, and pharmaceutical innovations, there exists a noticeable gap in addressing the nutritional status of surgical patients. This oversight can potentially lead to suboptimal postoperative outcomes. Recognizing the pivotal role of nutrition in enhancing surgical results, this paper emphasizes the importance of maintaining optimal nutritional status among orthognathic surgery patients. Additionally, a comprehensive perioperative nutritional protocol tailored to this patient population is proposed, aiming to reduce body weight loss post-surgery and improve bone formation. Constant research and updates in this domain are imperative for achieving further improvements in surgical outcomes.

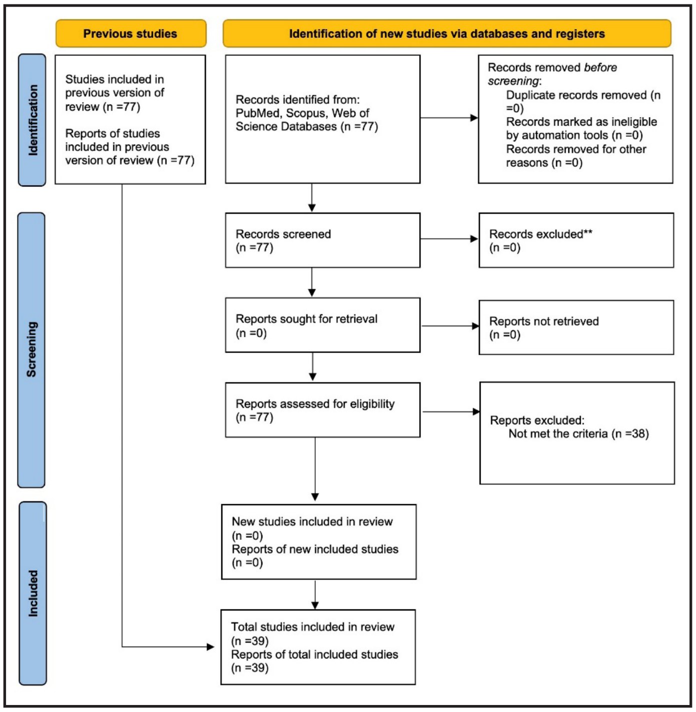

Figure 1. Flowchart of the included articles.

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