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Bikash Desar*

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Review Article

The Impact of Protein Intake Levels on Early Postoperative Outcomes Following Impacted Mandibular Third Molar Extraction: A Pilot Study

Bikash Desar*

Department of Oral and Maxillofacial Surgery, Anandaban tertiary Hospital, Head of Department, Position-Level 11th, Nepal.

***Corresponding Author:** Bikash Desar., Department of Oral and Maxillofacial Surgery, Anandaban tertiary Hospital, Head of Department, Position-Level 11th, Nepal.

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Abstract

Background: This pilot study aimed to evaluate the effect of protein intake on early wound healing following the surgical removal of impacted mandibular third molars and to investigate its association with postoperative outcomes, including trismus, edema, pain, and oral health–related quality of life.

Methods:

Patients presenting with asymptomatic impacted mandibular third molars classified as easy or moderate difficulty according to the Pernambuco index were included. Dietary protein intake over the preceding month was assessed using a food frequency questionnaire and a 24-hour dietary recall. Early wound healing was evaluated using the Early Wound Healing Index (EHI). Trismus was assessed by measuring maximum interincisal opening, facial swelling by linear facial measurements, and pain using a visual analog scale (VAS). Oral health–related quality of life was measured using the OHIP-14 questionnaire.

Results: A total of 25 patients (16 females and 9 males), aged 19–33 years (mean 23.3 ± 2.88 years), were analyzed. No significant differences were observed between the protein intake groups with respect to age, sex, body mass index, surgical difficulty, or duration of surgery. Patients with high protein intake exhibited a significantly greater reduction in mouth opening on postoperative day 3 ($p = 0.004$). Facial swelling on day 3 was also significantly greater in the high protein intake group compared with the low and normal intake groups ($p = 0.023$), whereas pain scores on postoperative day 1 were significantly lower ($p = 0.009$). Protein intake showed a positive association with EHI scores on postoperative day 7 ($p = 0.019$), indicating improved early wound healing; however, no significant association was observed on day 1 ($p = 0.081$). No significant relationship was found between protein intake and OHIP-14 scores at any time point ($p = 0.211$, $p = 0.462$, and $p = 0.704$).

Conclusions

Higher protein intake was associated with improved early wound healing and favorable modulation of postoperative outcomes, including reduced pain severity and improved functional recovery following impacted mandibular third molar surgery. These findings highlight the potential importance of nutritional assessment and dietary support as integral components of postoperative care. Further large-scale studies are needed to confirm these results and to elucidate the underlying biological mechanisms.

Keywords: dietary assessment; dietary protein; impacted third molar; nutritional status; oral surgery; oral health–related quality of life; wound healing

Introduction

Protein is a crucial macronutrient that plays a significant role in immune function and wound healing [1]. The current recommended dietary allowance (RDA) for protein intake in healthy adults with minimal physical activity is 0.8–1.0 g/kg body weight per day. In catabolic or stress conditions, such as acute burn injuries, protein requirements may increase to approximately 1.5 g/kg body weight per day [2,3]. However, the precise amount of protein required to optimize wound healing—particularly following oral surgical procedures—remains unclear. Surgical removal of impacted mandibular third molars (SRM3s) is one of the most frequently performed procedures in oral surgery [4]. The acute inflammatory response that follows surgical trauma represents a physiological and necessary phase of the healing process. However, an exaggerated or prolonged inflammatory response may result in increased postoperative discomfort and complications. Therefore, controlling excessive inflammation is essential for optimizing surgical outcomes [5]. Delayed or impaired wound healing in the postoperative period may also negatively affect patients' quality of life (QoL) [1]. Although QoL during the recovery period after SRM3 has been widely investigated [6–8], the potential role of dietary protein intake in this context remains unclear. Previous clinical studies have evaluated the impact of nutritional status on postoperative healing in oral and maxillofacial surgery [1,9,10]. However, to the best of the authors' knowledge, no study has specifically examined the association between protein intake and early wound healing, oral health–related quality of life (OHRQoL), and postoperative outcomes following SRM3. Accordingly, this prospective observational study was designed to assess the influence of dietary protein intake on early postoperative wound healing and to explore its relationship with postoperative clinical outcomes and OHRQoL. We hypothesized that higher protein intake would be associated with enhanced wound healing and a smaller decline in OHRQoL during the recovery period.

Study Population

Patients aged 18–35 years who presented to Biruni University Faculty of Dentistry between January 2023 and November 2023 with asymptomatic impacted mandibular third molars were screened for eligibility. Only teeth classified as easy or moderate difficulty according to the Pernambuco index [11] were included. Exclusion criteria comprised pregnancy or breastfeeding; systemic conditions known to impair wound healing (e.g., diabetes mellitus, severe anemia, or malignancy); immunodeficiency states (including steroid therapy); preoperative use of antimicrobial or anti-inflammatory medications; local inflammatory conditions such as pericoronitis; and smoking or other nicotine use, as these factors may adversely influence postoperative healing.

Assessment of Protein Intake

A food frequency questionnaire (FFQ) was administered to evaluate participants' dietary habits and nutritional status over the preceding month. FFQs are widely used to assess habitual dietary patterns. The questionnaire categorized the frequency of consumption of fixed food portions as follows: never or rarely; one to three times per month; once per week; two to four times per week; five to six times per week; once per day; two to three times per day; and four or more times per day [12]. The FFQ served as the primary tool for assessing habitual protein intake and enabled classification of participants according to their typical protein consumption. In addition to the FFQ, a single 24-hour dietary recall was conducted to obtain detailed information on protein intake for a specific day. The combined use of these two methods allowed for a more comprehensive evaluation of both long-term and short-term dietary intake [13,14]. Food consumption was recorded by M.S.A. using portion size models (e.g., water glass, tea glass, and tablespoon) and known net weights. When participants were unable to specify portion sizes, the Standard Recipes book [15] was consulted. Reported food and beverage amounts were converted into standardized quantities. Daily energy and nutrient intake were analyzed using the Computer-Aided Nutrition Program, Nutrition Information Systems Package Program (BEBIS), developed for use in Turkey. Protein intake was evaluated according to the recommended dietary allowance (RDA) values provided in the Nutrition Guide Specific to Turkey [16]. Participants were categorized into three groups: low protein intake (< 0.8 g/kg/day), normal protein intake (0.8–1.0 g/kg/day), and high protein intake (> 1.0 g/kg/day)

Materials and Methods

Study Population

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Assessment of Clinical Parameters

Trismus:

Trismus was evaluated by measuring the maximum interincisal distance between the mesioincisal angles of the maxillary and mandibular right central incisors during maximal mouth opening. Measurements were recorded preoperatively and repeated on postoperative days 3 and 7. Changes from baseline values were calculated to determine the degree of trismus.

Facial Swelling:

Facial swelling was assessed using a modified tape measurement technique [17], originally described by Gabka and Matsumura [18]. Measurements were obtained preoperatively and on postoperative days 3 and 7 using five anatomical landmarks: the tragus, soft tissue pogonion, lateral canthus of the eye, mandibular angle (gonion), and oral commissure. At each time point, three linear distances were recorded: tragus to oral commissure, tragus to soft tissue pogonion, and gonion to lateral canthus of the eye. The sum of these three measurements obtained preoperatively was considered the baseline value for the operated side. Postoperative swelling was calculated as the difference between the sum of the linear measurements recorded on each postoperative day and the corresponding preoperative baseline value. Postoperative pain was assessed using a 10-mm Visual Analog Scale (VAS), ranging from 0 (no pain) to 10 (worst imaginable pain), on postoperative days 1, 3, and 7. The total number of analgesic tablets consumed during the postoperative period was also recorded. Early wound healing was evaluated using the Early Wound Healing Index (EHI) [4]. The EHI assesses clinical signs of re-epithelialization (CSR), hemostasis (CSH), and inflammation (CSI) according to predefined scoring criteria. Detailed descriptions and interpretations of the EHI scores are presented in Table 1.

Assessment of Quality of Life

Oral health–related quality of life (OHRQoL) was evaluated using the Turkish version of the Oral Health Impact Profile-14 (OHIP-14)

questionnaire. OHIP-14 scores range from 0 to 56, with higher scores indicating poorer OHRQoL [19].

Surgical Protocol

All surgeries were performed by two experienced surgeons, O.S. and A.V., under inferior alveolar nerve block and buccal infiltration anesthesia using 40 mg/mL articaine HCl with 0.012 mg/mL epinephrine HCl (Ultracaine D-S Forte 2 mL/Ampul; Sanofi Aventis). A full-thickness triangular flap with a mesial vertical releasing incision at the mandibular second molar was raised to provide adequate surgical exposure [20]. Osteotomy, and odontotomy when necessary, was performed using a high-speed surgical handpiece (NSK Surgic Pro, Japan) at 40,000 rpm with a 1.6 mm round bur under copious sterile saline irrigation. Following tooth extraction, the socket was curetted and irrigated with sterile saline. The flap was then repositioned and sutured with 3/0 silk sutures (Dogsan). Postoperative medications included Augmentin 1 g (875 mg amoxicillin + 125 mg clavulanic acid) administered orally twice daily for 7 days, Parol 500 mg (paracetamol) as needed with a maximum of four doses per day, and Kloroben mouth rinse (0.12% chlorhexidine). Postoperative care included the use of Kloroben mouth rinse containing 0.12% chlorhexidine gluconate and 0.15% benzidamine hydrochloride, administered three times daily for one week. Patients were provided with standard postoperative instructions: bite on sterile gauze for the first 30 minutes, apply intermittent ice packs (10 minutes on, 10 minutes off) during the first six hours, and maintain oral hygiene by brushing teeth twice daily. Mouth rinsing was advised to begin 24 hours after surgery. Patients were also instructed to avoid foods with small grains or particulate texture for one week to prevent adherence to sutures or the surgical site. Sutures were removed during the follow-up visit on postoperative day 7.

Statistical Analysis

A priori power analysis was performed using G*Power version 3.1.9.4, which indicated that a minimum sample size of 25 participants was required to achieve 80% power, assuming an effect size of 0.5897 and a standard deviation of 0.97 for wound healing, at a significance level of $\alpha = 0.05$. Given the prospective design and short follow-up period, the risk of patient dropout was considered minimal, and no adjustment for attrition was made. The study continued until the target sample size with complete data sets was achieved. All statistical analyses were conducted using IBM SPSS Statistics version 22.0. Data were summarized using descriptive statistics. Group comparisons were performed using Student's t-test or the Mann–Whitney U test, as appropriate. Repeated-measures ANOVA with post hoc Bonferroni correction and the Friedman test with post hoc Wilcoxon signed-rank test were used to analyze changes over time. Categorical data were analyzed using the chi-square test. Statistical significance was set at $p < 0.05$.

Results

A total of 25 patients (16 females and 9 males) aged 19–33 years (mean 23.3 ± 2.88 years) were included in the analysis. There were no significant differences between the protein intake groups with respect to age, sex, body mass index (BMI), surgical difficulty, or duration of the operation. Detailed demographic and clinical characteristics of the study population are summarized in Table 2.

Parameter	Description	Points
CSR	Visible distance between incision margins	0
	Incision margins in contact	3
	Merged incision margins	6
CSH	Bleeding at the incision margins	0
	Presence of fibrin on the incision margins	1
	Absence of fibrin on the incision margins	2
CSI	Redness involving more than 50% of the incision length and/or significant swelling	0
	Redness involving less than 50% of the incision length	1
	Absence of redness along the incision length	2
In the presence of suppuration, the EHI score was recorded as 0		

Table 1: Early wound healing index scoring.

		n	%
Gender	Female	16	64
	Male	9	36
BMI (kg/m^2)	Underweight	2	8
	Normal weight	15	60
	Overweight	7	28
	Obese	1	4
Surgical Difficulty	Easy	6	24
	Medium	19	76
Operation Duration	10–19 min	8	32
	20–29 min	7	28
	>30 min	10	40
Protein Intake	Low	10	40
	Normal	6	24
	High	9	36

Table 2: Description of the subjects.

	Time	Min-Max	Mean ± sd	P
Trismus (mm)	Day 3	30−0	12.52±10.21	0.001*
	Day 7	27−0	6.68±8.06	
Facial swelling (mm)	Day 3	0–10	2.1±2.95	0.001*
	Day 7	0-17.5	1.7±4.66	
Pain	Day 1	0–10	3.88±3.36	0.001*
	Day 3	0–10	3.2±3.1	
	Day 7	0–8	1.28±2.34	
Early Healing Index	Day 1	0–9	5.04±2.05	0.001*
	Day 7	4–10	8.56±1.83	
	Day 14	10–10	10±0	
OHIP-14	Preop	0–44	13.2±10.63	0.004*
	Day 3	3–40	20.88±10.16	
	Day 7	1–29	13.36±9.21	

Table 3 Comparison of preoperative and postoperative parameters. *$p<0.05$.

		Protein intake			
	Time	Low	Normal	High	p
Trismus (mm)	Day 3	13.2±9.15[ab]	6.17±5.85[a]	16±12.36[b]	0.004*
	Day 7	5.5±7.07	3.83±5.85	9.89±9.88	0.255
Facial swelling (mm)	Day 3	1.75±3.34[a]	1.67±3.03[a]	2.78±2.64[b]	0.023*
	Day 7	0.75±4.26	0±0	3.89±6.01	0.58
Pain	Day 1	4.1±3.36[a]	4±3.35[a]	3.6±3.01[b]	0.009*
(VAS -	Day 3	3.9±3.1	2.17±3.49	3.1±2.85	0.208
10 mm)	Day 7	1.3±2.34	2±3.16	0.8±1.39	0.849
Analgesic consumption (Total)	-	7.1±7.12[a]	13+9.19[b]	8.4±8.47[a]	<0.001*
EHI	Day 1	4.3±2.05	5.29±1.86	6.2+1.93	0.081
	Day 7	7.7±1.83[a]	8.14±1.61[ab]	9.8±1.71[b]	0.019*
OHIP-14	Preop	12.9±10.63	11.71±10.54	12.7±11.08	0.211
	Day 3	20.3±10.16	21.57±10.93	20.2±9.95	0.462
	Day 7	13±9.21	12.43±9.74	11.9±10.09	0.704

Discussion

Malnutrition is a well-established risk factor that can negatively influence wound healing [21]. Despite extensive research on postoperative recovery following surgical removal of impacted mandibular third molars (SRM3), few studies have specifically investigated the role of dietary protein intake in this context. This study aimed to evaluate the effect of protein consumption on early wound healing, as well as on postoperative outcomes such as trismus, facial swelling, and pain. Our findings suggest that higher protein intake is associated with improved early wound healing, as reflected by higher EHI scores on postoperative day 7. Additionally, protein intake appeared to modulate postoperative outcomes: patients with higher protein intake experienced lower pain scores on day 1, although they showed greater trismus and facial swelling on day 3. These results indicate that while early inflammatory responses (manifested as swelling and limited mouth opening) may be more pronounced in patients with higher protein intake, overall wound healing is enhanced in the first week postoperatively. No significant relationship was observed between protein intake and OHRQoL (OHIP-14 scores), suggesting that short-term variations in protein consumption may not substantially impact patients' perceived oral health-related quality of life during the first week of recovery. Gender differences were noted on day 7, with females showing improved OHRQoL compared with males, while surgical variables such as difficulty level and operation duration did not significantly influence postoperative outcomes. These findings underscore the potential importance of nutritional assessment and dietary support as part of postoperative care in oral surgery. Few clinical studies have specifically explored the relationship between protein intake and wound healing in oral and maxillofacial surgery, and most of these have been observational, consistent with our findings. For example, Laimer et al. reported that better nutritional status was associated with improved wound healing in patients with medication-related osteonecrosis of the jaw (MRONJ) undergoing intraoral soft tissue closure [9]. Similarly, Dodington et al. observed enhanced healing outcomes with higher protein intake following nonsurgical periodontal therapy [1]. Lee et al. conducted the first interventional study examining the effects of nutritional supplementation on healing after periodontal surgery, reporting improvements in early periodontal wound repair [10]. In our study, a significant positive correlation was observed between protein intake and Early Wound Healing Index (EHI) scores on postoperative day 7, suggesting that greater protein consumption may accelerate early wound healing, particularly during the inflammatory and early proliferative phases. No significant correlation was observed on day 1, and by day 14, all patients had achieved maximum EHI scores, rendering further assessment unnecessary. Surgical trauma disrupts protein metabolism, leading to rapid mobilization of amino acids from skeletal muscle. Some studies suggest that muscle protein breakdown provides essential precursors for wound protein synthesis, yet this catabolic-anabolic interplay may sometimes delay healing [22]. Conversely, reduced lean body mass has been shown to impair immune function and prolong wound repair [21,23,24]. Anabolic steroids have been reported to accelerate wound healing [25]. Gore et al. highlighted the phenomenon of net muscle protein catabolism alongside net wound protein anabolism following trauma, challenging the assumption that amino acids released from muscle are insufficient for tissue repair. These findings collectively

emphasize the critical role of adequate protein intake in supporting early postoperative healing after oral surgical procedures

Discussion

Postoperative inflammation typically peaks around 72 hours after surgery, with the release of inflammatory mediators contributing to pain, edema, and restricted jaw movement [26]. In the present study, patients with high protein intake experienced the greatest reduction in mouth opening on postoperative day 3, which was statistically significant compared with the normal protein intake group. Similarly, facial swelling was most pronounced on day 3 in the high protein intake group, with significant differences relative to the other groups. These findings suggest that higher protein intake may be associated with a more robust early inflammatory response. While this may transiently increase swelling and trismus, it could support improved functional recovery in later stages of healing [27]. Conversely, pain scores on postoperative day 1 were highest in the low protein intake group, potentially reflecting individual variability in inflammatory sensitivity and the subjective nature of pain perception. Total analgesic consumption was greatest in the normal protein intake group, although this difference was not clinically significant, likely reflecting variations in pain thresholds rather than a direct nutritional effect. Collectively, these results indicate that adequate protein intake may modulate postoperative outcomes by supporting tissue recovery and mitigating pain beyond the acute inflammatory phase, highlighting the importance of nutritional optimization in SRM3 postoperative care. Previous studies have shown that postoperative complications significantly affect patients' quality of life (QoL) [6–8]. Ruvo et al. reported that delayed clinical healing was associated with reduced QoL and slower recovery of oral function [28], while Gojayeva et al. found that postoperative pain, edema, and trismus negatively impacted QoL following SRM3 [29]. In the present study, OHIP-14 scores were highest on day 3 but returned to baseline by day 7, indicating a temporary decline in oral health–related quality of life (OHRQoL). Protein intake appeared to reduce the severity of trismus and pain, emphasizing its potential role in enhancing postoperative recovery. The study also considered potential confounding variables such as gender and surgical factors. Although some evidence suggests faster cutaneous wound healing in females due to estrogen-mediated anti-inflammatory effects [30–31], mucosal healing after third molar extraction may not follow the same pattern [32–33]. Animal studies have shown that estrogen supplementation or androgen receptor blockade can accelerate wound healing [34–39]. In this study, no significant gender differences were observed in trismus, swelling, pain, or EHI scores, possibly due to the short follow-up period or subjective perception differences. However, males experienced a decrease in OHRQoL on day 7, whereas females showed improvement, potentially reflecting delayed clinical healing in males influenced by sex hormones [39]. Surgical difficulty was assessed using the Pernambuco Index, which integrates Pell & Gregory and Winter classifications along with root morphology, patient age, and BMI [44]. Although surgical difficulty and operation duration are often associated with postoperative complications [4, 45–47], no significant relationships were observed in this study, likely due to the relatively homogeneous sample (easy and medium difficulty cases). Importantly, even after controlling for gender and surgical variables, higher protein intake was associated with significantly improved early wound healing (higher EHI scores on day 7), underscoring the value of adequate protein consumption in promoting recovery. This study represents the first observational investigation of the relationship between protein intake and early wound healing after third molar surgery. However, several limitations should be acknowledged. Radiographic or histological assessments were not performed, limiting evaluation of bone healing. The short follow-up period (one week) may not capture the full trajectory of tissue repair. Dietary assessment relied on FFQ and 24-hour recall, which are subject to recall bias. The small sample size also limits generalizability, and variations in oral hygiene practices could act as confounding factors. Future studies should include larger cohorts, longer follow-up, and comprehensive assessment of both soft and hard tissue healing to further clarify the role of protein in postoperative recovery.

Conclusions

This study demonstrates a clear association between higher protein intake and improved early postoperative outcomes following impacted mandibular third molar surgery. These findings suggest that dental professionals should consider assessing patients' dietary habits preoperatively and provide guidance on adequate protein intake during the perioperative period. Simple strategies, such as encouraging protein-rich foods or short-term supplementation, may promote faster recovery, reduce pain, and enhance quality of life.

Abbreviations

SRM3: Surgical removal of impacted mandibular third molars

RDA: Recommended dietary allowance

FFQ: Food frequency questionnaire

VAS: Visual Analog Scale

EHI: Early Wound Healing Index

OHRQoL: Oral health–related quality of life

OHIP-14: Oral Health Impact Profile-14

BMI: Body mass index

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