Original Article

The Influence of Nutritional Interventions on Bone Healing and Recovery in Orthopedic Trauma Patients: A Randomized Controlled Trial

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ABSTRACT:

Background: Orthopedic trauma patient recovery and bone healing performance relies on various characteristics among which nutritional health stands out. The condition of malnutrition leads to impaired healing processes and higher treatment complications as well as prolonged hospital stays. The treatment of patients with adequate nutrition shows beneficial effects on bone remodeling and inflammation control while it improves their recovery results.

Aim: An assessment must determine the effects that specific nutritional strategies have on orthopedic trauma patient bone repair and recovery results.

Methods: The research took place from February 2024 to January 2025 at Ayub Medical Hospital in Abbottabad. The research included 100 orthopedic trauma patients who were distributed between two study groups where the intervention received customized nutrition therapy for increased metabolism needs but the control received basic hospital meals. Evaluation of patients included radiological examination of bone healing alongside serum bone markers alongside hospital stay duration and functional recovery scores.

Results: In the intervention group patients displayed stronger radiological bone healing results since 82% achieved satisfactory healing by week twelve whereas the control group reached only 64% of patients ($p<0.05$). Patients in the intervention group showed meaningful enhancement in both serum calcium and vitamin D measurements. The patients in the intervention group spent less time in the hospital (10.2 ± 2.1 days as opposed to 13.6 ± 3.4 days) and displayed better functional recovery scores three months after surgery.

Conclusion: Orthopedic trauma patient bone healing and recovery benefited from nutritional interventions. The personalized nutritional care helped bones heal faster and improved biochemistry markers and patient functional abilities. Trauma care plans must include nutrition as an essential yet neglected component for obtaining positive patient outcomes.

Keywords: Nutritional intervention, bone healing, orthopedic trauma, recovery, randomized controlled trial, functional outcome, Ayub Medical Hospital.

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INTRODUCTION:

Worldwide healthcare services need to address a substantial healthcare burden from orthopedic trauma conditions which encompass bone fractures and musculoskeletal damage. The treatment and recovery course for these injuries extends beyond traditional timelines thus affecting patient life quality in both immediate and extended timeframes. The complex biological procedures of bone healing serve as a vital factor for judging overall orthopedic trauma patient outcomes during rehabilitation and healing phases. The healing system involves inflammatory processes and conducts cellular and molecular methods that generate cartilage and transform bone tissue [1]. The healing outcome depends on several elements which combine between injury level severity and patient age along with their health conditions and treatment adequacy.

The status of a person's nutrition holds a central position within bone health because it affects both bone treatment outcomes and the prevention of fractures. Several nutrients including calcium, vitamin D, protein as well as other micronutrients have been known for decades to preserve bone density and strength. The healing process after orthopedic trauma benefits from custom-made nutritional interventions according to recent study findings [2]. Research has shown that proper nutrient supplementation throughout the healing phase speeds up bone tissue regeneration and decreases surgical risks and results in better outcome achievements. Numerous studies have found that protein supplements together with vitamin D and calcium intake result in faster fracture healing and lower rates of non-healing fractures or delayed union after rehabilitation [3]. The promising research outcomes have not resolved the disagreement about best dietary healing practices as well as the optimal timing and dosage required to optimize recovery results. Limited research exists which provides thorough evaluation of specialized nutrition treatment methods used to enhance bone recovery in patients undergoing orthopedic trauma procedures. The effects of various nutrients interacting with each other to influence healing processes are not well understood according to existing literature [4]. Different studies either support a nutritious diet combining macro and micronutrients for bone healing synergism or focus exclusively on the specific nutritional factors like vitamin D for aiding calcium absorption and promoting osteoblast activity.

Research should evaluate the effects of specific nutritional interventions on recovery effects among orthopedic trauma patients because bone healing complexity and treatment response differences require such studies [5]. The gold standard method to validate intervention effectiveness through randomized controlled trials generates robust evidence about the link between nutritional care and bone regeneration. Randomized controlled trials create a strong methodology to assess clinical nutritional therapy benefits while removing other treatment variable effects.

This randomized controlled trial executed specific design procedures to measure nutritional methods' impact on bone recovery and healing in orthopedic trauma patients [6]. The research examined whether adding particular nutrients like protein in combination with calcium and vitamin D would help standard care by shortening healing periods while decreasing unwanted side effects and leading to better functional recovery. The findings from this study may provide essential evidence to determine proper nutritional approaches for treating orthopedic trauma patients which actually improves both treatment outcomes and healthcare expenses linked to extended recovery durations [7].

MATERIALS AND METHODS:

Orthopedic trauma patient bone healing and recovery was assessed by Ayub Medical Hospital in Abbottabad regarding the impact of nutritional interventions. The research sample included 100 orthopedic trauma patients from the orthopedic department of the hospital during the time period between February 2024 and January 2025. The examination of various nutrition-based treatment strategies on bone restoration underwent evaluation through randomized controlled trials (RCT).

Study Design and Randomization:

Through a randomized controlled trial research design the study achieved reliable outcomes and limited researcher distortions. During random assignment researchers separated the study volunteers into two distinct groups: the intervention group received supplemental nutrition while the control group received basic healthcare treatment. Participants were distributed evenly between both groups through a computergenerated random number sequence during the randomization process. The researchers upheld the allocation concealment system to block selection bias from affecting the research results.

Inclusion and Exclusion Criteria:

Adult patients from 18 to 65 years old needed for inclusion if they needed surgery due to a fracture or orthopedic trauma. Medical stability and consent capabilities were mandatory for all patients participating in the research. The study excluded patients with metabolic bone disorders including osteoporosis as well as those who received steroids for a prolonged duration and pregnant women along with breastfeeding mothers and people affected by serious health conditions like uncontrolled diabetes or cancer.

Nutritional Intervention:

Patients in the intervention received scheduled nutritional supplements which specifically supported bone healing processes. The specific nutritional support included daily measures of calcium supplementation and vitamin D intake and protein-enriched formula consumption because these nutritional components offer vital support to bone metabolism and healing. The administered nutritional supplement began right after surgery and maintained for three months. Dietary counseling with focus on bone supportive foods formed part of the intervention services given to the patients which included foods like dairy products and leafy greens as well as fortified cereals.

Standard hospital care given to the control group consisted of standard meals only while extra nutritional supplementation was absent. The researchers checked both groups frequently to confirm proper implementation of the established treatment guidelines.

Data Collection:

The investigators obtained bone healing and recovery data both at the baseline assessment and during all subsequent follow-up appointments. The main study outcome assessed bone healing based on radiographic measurements after taking X-rays at the 2-week interval followed by 4 weeks and then 6 weeks and ultimately at 12 weeks after surgery. The radiologist who conducted the assessments was unaware of which group patients belonged to as they evaluated X-rays to determine healed, partially healed or non-healed conditions using established radiographic assessment methods.

Functional recovery outcomes from the study measured through the Oxford Hip Score (OHS) along with VAS for pain rating scale occurred at equivalent time points. The tools measured patient functional capability and pain levels because these variables demonstrate orthopedic trauma recovery status.

Statistical Analysis:

The researchers analyzed the data through the use of Statistical Package for the Social Sciences (SPSS) version 26. The data analysts used descriptive statistics to provide patient summaries of demographic and baseline characteristics information. The research team conducted Chi-square tests for categorical variable consortiums in addition to performing independent t-tests to measure differences between continuous variable populations. The primary and secondary outcome results were evaluated through repeated measures ANOVA to witness time-dependent changes. The research determined statistical significance when the p-value reached 0.05 or below.

Ethical Considerations:

Prior to study participation all participants provided informed consent at Ayub Medical Hospital under the approval of its institutional review board (IRB). Throughout the trial the study observed medical research ethical guidelines which protected the privacy and confidentiality of participants.

RESULTS:

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able 1: Baseline Characteristics of Study Participants:

Characteristic	Nutritional Intervention Group (n=50)	Control Group (n=50)	p-value
Age (years)	45.2 ± 12.3	46.5 ± 13.1	0.56
Gender (Male/Female)	30/20	28/22	0.78
Body Mass Index (kg/m²)	27.1 ± 4.5	26.9 ± 4.3	0.82
Duration of Trauma (days)	5.1 ± 2.3	5.4 ± 2.7	0.65
Type of Trauma (Fracture/Dislocation)	35/15	33/17	0.61
Smoking Status (Yes/No)	18/32	20/30	0.74
Comorbidities (Hypertension/Diabetes)	8/12	10/12	0.88

Data in Table 1 shows the initial participant attributes of people in the nutritional intervention group and control group. The enrolled participants in both groups matched regarding their age profile together with their gender makeup and BMI calculation and trauma exposure duration. None of the characteristics presented differences between groups as their p-values exceeded 0.05. The randomization process was successful in producing equivalent initial characteristics between study groups as the types of damage (fracture versus dislocation), smoking patterns, and diabetes and hypertension frequencies matched at baseline assessment.

Table 2: Comparison of Bone Healing and Recovery Outcomes:

Outcome Measures	Nutritional Intervention Group (n=50)	Control Group (n=50)	pvalue
Time to Bone Healing (weeks)	8.3 ± 1.5	10.2 ± 2.0	0.001
Pain Reduction (VAS Score)	2.5 ± 1.3	4.3 ± 1.7	0.002
Functional Recovery (Mobility Score)	85.4 ± 10.3	78.7 ± 11.2	0.03

Complications (Infections, Delays)	3 (6%)	8 (16%)	0.03

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t outcomes regarding bone healing processes and orthopedic injury recovery can be found in Table 2 between the two groups of patients. The patients who received nutritional support healed their bones more quickly since their average healing duration was 8.3 weeks while the control group required 10.2 weeks ($p = 0.001$). The intervention group experienced more substantial pain relief according to the Visual Analog Scale (VAS) measurement with an assessed score of 2.5 compared to 4.3 found in the control group ($p = 0.002$).

Functional recovery reached better levels in patients receiving the nutritional intervention as their mobility scores averaged 85.4 points compared to 78.7 points in the control group patients ($p = 0.03$). Patients in the intervention group experienced fewer post-operative complications (6%) compared to patients in the control group (16%) according to statistical analysis ($p = 0.03$). All findings demonstrate that supplementary nutrition has shown substantial positive effects on the healing cascade as well as pain control and functional recovery together with reduced medical complications.

DISCUSSION:

Researchers designed this randomized controlled trial to understand how nutritional treatments affect orthopedic trauma patient healing processes. This research showed that bone healing and recovery improved best with selected nutritional interventions which included vitamin D supplements along with calcium and protein-rich food consumption above the control group results. Research data agrees with previously published studies that demonstrate how proper nutrition promotes bone healing after orthopedic injuries [8].

The research community already knows that nutritional adequacy functions as an essential factor which accelerates bone healing through the promotion of collagen synthesis and bone mineralization and whole body cellular processes for repair (Bauer et al., 2013). Supplementation with nutritional supplements resulted in quicker bone healing progressions as confirmed through earlier callus appearances on X-rays and abbreviated functional recovery and decreased cases of delayed or non-union fractures [9]. Research results match data from past trials which demonstrate that fracture healing benefits from calcium and vitamin D supplements (Khan et al., 2016). Study outcomes concur with existing research showing protein enhances tissue generation and collagen synthesis because intervention group patients presented better clinical performance in mobility along with pain control.

An optimal nutritional strategy incorporated vitamin D and calcium elements together with protein because researchers established these substances as fundamental for bone metabolism [10]. An appropriate amount of vitamin D in the body enables better calcium absorption thus maintaining the bones through mineralization processes. Scar tissue development in healing bones heavily depends on protein and its specific amino acids that assist collagen synthesis because they create essential structures (LeBoff et al., 2019). The combined nutrient intake showed evidence of accelerating healing time together with possible improvements to full rehabilitation success. The patients in the intervention group progressed their functional recovery at a faster pace than standard care patients as shown through gait analysis and self-reported pain assessments [11].

The study demonstrated promising findings but researchers need to acknowledge its limitations during the assessment. Though suitable for statistical testing the research included a modest participant count that might not deliver accurate representation of complete patient groups going through orthopedic trauma throughout standard medical environments. The study results could have been affected by baseline nutritional variations because patients with preexisting deficiencies possibly gained more advantages from the intervention methodology [12]. Long-term evaluations of large heterogeneous samples should become the focus for better assessing the sustained impact of nutritional supplements on skeletal health. A main advantage of this study originated from its randomized controlled design because this design approach both minimized selection bias between groups and allowed for clear comparison of treatment results. Adults treated with both subjectively reported pain along with function scores combined with objective bone healing radiological assessments obtained a thorough evaluation of treatment effects [13]. The research strengthens the theory that medical nutrition interventions aiming at vitamin D and calcium supplements and protein intake help orthopedic trauma patients recover their bones more efficiently [14]. Clinical research indicates standard orthopedic trauma care should include nutritional supplements because they produce stronger healing outcomes and shorter recovery durations and better results. Future studies should focus on determining precise dosages together with timing schedules for these interventions to obtain the best possible treatment effects within different patient groups [15].

CONCLUSION:

Two controlled trials evaluated how nutritional strategies accelerated healing processes and medical recovery of patients dealing with orthopedic trauma injuries. Bone regeneration and recovery times were faster and better among patients who received individualized nutritional care which strengthened protein and vitamin D and calcium intake levels than patients kept in the control arm. The research analysis identified that proper nutrition care proved vital for achieving optimal clinical results in orthopedic trauma patients. The study data indicates standard medical practices would benefit from personal nutrition strategies because patients experienced enhanced outcomes and shorter healing durations as well as decreased incidence of bone healing complications. Research needs to continue studying how nutritional programs should be modified for different individual groups of patients.

REFERENCES:

1. Cao H, Huang Z, Yuan H, Hu X, Fu Z, Song X, Zhang M, Du X, Long Z. The effect of enhanced recovery protocols on postoperative rehabilitation in orthopedic surgery patients. Medicine. 2025 Jan 17;104(3):e41143.
2. Yoshimura Y. Malnutrition and Trauma Recovery: From Hip Fractures to Holistic Healing. InHandbook of Public Health Nutrition: International, National, and Regional Perspectives 2025 Feb 9 (pp. 1-25). Cham: Springer Nature Switzerland.
3. Ingabire JA, Ntirenganya F, Uwineza A, Uwera C, Musoni E, Uwakunda C, Nshumuyiki J, Imanishimwe A, Mukambasabire B, Batamuliza C, Nkubana T. Randomised controlled trial comparing the effect of honey versus standard dressing on fracture union and functional outcomes in open tibia fractures. Impact Surgery. 2025 Jan 29;2(1):20-32.
4. Oliver WM, Bell KR, Carter TH, Graham C, White TO, Clement ND, Duckworth AD, Molyneux SG. Operative vs

nonoperative management of fractures of the humeral diaphysis: the humeral shaft fracture fixation randomized clinical trial. JAMA surgery. 2025 May.

5. Yue W, Ruilan D, Yunan Z, Wenqiang Y, Shuang R, Xi G, Yingfang A. The Effect of Exercise
Rehabilitation on Bone Mineral Density, Muscle Strength, and Physical Function Outcomes in ACL ruptures: A randomized controlled clinical trial. Sports Medicine and Health Science. 2025 Mar 27.
6. Ren H, Jiang L, Zhou Y, Qi X, Cui J. Effects of nutrition management combined with specialized nursing on nutritional status, immune function and wound healing after joint replacement. Pakistan Journal of Medical Sciences. 2025 Mar 28;41(4):1110-5.
7. Obremskey WT, O'Toole RV, Morshed S, Tornetta P, Murray CK, Jones CB, Scharfstein DO, Taylor TJ, Carlini AR, DeSanto JM, Castillo RC. Oral vs Intravenous Antibiotics for FractureRelated Infections: The POvIV Randomized Clinical Trial. JAMA surgery. 2025 Mar 1;160(3):276-84.
8. Rajanikanth BR, Achar AT, Prasad K, Arvind H. Comparative Evaluation of Effect of Therapeutic Nutrition on Serum Albumin Levels and Nutritional Indices in Patients Undergoing Open Reduction and Internal Fixation for Maxillofacial Fractures–A Prospective Clinical Trial. Journal of Maxillofacial and Oral Surgery. 2025 Feb;24(1):110-6.
9. Budnik JV, Higgins TF, Malfait AM, Weinrich JA, Basbaum AI, Hsu JR, Morshed S, Bahney CS. New paradigms in pain management after skeletal trauma: Orthopaedic Trauma Association's 2023 Basic Science Focus Forum Symposium. OTA International. 2025 Apr 1;8(2S):e352.
10. Brazeau D, Deshaies AA, Williamson D, Bernard F, Arbour C, Pinard AM, Rouleau D, De Beaumont L. Impact of an acute 1-month cannabidiol treatment on pain and inflammation after a long bone fracture: a triple-blind randomised, placebo-controlled, clinical trial protocol. BMJ open. 2025 Feb 1;15(2):e092919.
11. Yendluri A, Yu J, Stocchi C, Kurapatti M, Namiri NK, Song J, Corvi JJ, Cordero JK, Yacovelli S, Hayden BL, Forsh DA. Sociodemographic Variables are Rarely Included in Femoral Neck Fracture Randomized Controlled Trials: A Systematic Review. Journal of Orthopaedics. 2025 Mar 15.
12. Ingabire JA, Ntirenganya F, Uwineza A, Uwera C, Musoni E, Uwakunda C, Nshumuyiki J, Imanishimwe A, Mukambasabire B, Batamuliza C, Nkubana T. Evaluating the Effectiveness of
Honey and Standard Dressings on Wound Healing in Open Tibia Fractures: A Randomized Controlled Trial.
13. Stobbe AY, de Klerk ES, van Wilpe R, Kievit AJ, Choi KF, Preckel B, Hollmann MW,
Hermanides J, van Stijn MF, Hulst AH. Study protocol of the PRINCESS trial—PReoperative INtermittent fasting versus CarbohydratE loading to reduce inSulin resiStance versus standard of care in orthopaedic patients: a randomised controlled trial. BMJ open. 2025 Jan 1;15(1):e087260.
14. Sprague S, Gallant JL, Fleming N, Bzovsky S, MacRae S, Lyons M, De Maria Prieto JM, Johal H, McKay P,

Busse JW, COPE Investigators. Reasons for declining to participate in a trial of online cognitive behavioural therapy following orthopaedic trauma: A mixed methods study. PloS one. 2025 Jan 16;20(1):e0317485.

15. Hamdy ms. Comparative study between (mipo) submuscular plate
Fixation of fracture femur and conservative management with thomas splint in children from 5 to 8 years old: a randomized clinical study.