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Original Research

Metabolic Consequences of Intermaxillary Fixation: A Prospective Study on Anthropometric and Biochemical Alterations in Maxillofacial Trauma

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ABSTRACT:
Aim and Objectives: To assess the metabolic alterations in patients with maxillofacial trauma undergoing intermaxillary fixation (IMF), by monitoring serial changes in serum electrolytes, cholesterol, albumin, total protein, triglycerides, and body weight. **Introduction:** Management of facial trauma involving occlusal derangement typically begins with intermaxillary fixation, followed by definitive surgical reduction and fixation of fractured segments. However, IMF significantly restricts oral intake, predisposing patients to nutritional deficiencies and delayed wound healing. This clinical study investigates the biochemical and anthropometric consequences of IMF in a cohort of 30 patients. **Materials and Methods:** This prospective cohort study was conducted on 30 patients requiring intermaxillary fixation with arch bars for the management of maxillofacial fractures. Anthropometric parameters (body weight and mid-arm circumference) and serum biochemical markers (total protein, albumin, triglycerides, sodium, potassium, and cholesterol) were recorded on the day of surgery, and subsequently at one and four weeks postoperatively. The study was carried out at the Department of Oral and Maxillofacial Surgery, Mahatma Gandhi Dental College & Hospital, Jaipur, from November 2022 to July 2024. **Results:** Statistically significant reductions were observed in body weight, mid-arm circumference, serum triglycerides, and cholesterol levels ($p < 0.01$), indicating a strong correlation between restricted dietary intake and metabolic decline during IMF. Serum sodium levels increased slightly, likely due to the administration of intravenous Ringer's lactate and dextrose saline solutions from the day of admission. Changes in serum potassium, total protein, and albumin levels were not statistically significant ($p > 0.05$). **Conclusions:** Intermaxillary fixation compromises early postoperative nutritional status, resulting in measurable loss of body mass, fat, and serum lipids. The findings suggest that integrating structured nutritional support alongside surgical management may enhance prognosis and accelerate recovery in patients undergoing IMF.
Key Words: Intermaxillary Fixation, Arch Bar, weight loss, cholesterol, triglyeride, maxillofacial trauma

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INTRODUCTION

Maxillofacial trauma constitutes a substantial proportion of emergency admissions to oral and maxillofacial surgical units globally, predominantly caused by road traffic accidents, assaults, sports injuries, and falls, with mandible fractures being the most prevalent fracture[1]. The standard protocol for managing such injuries involves restoring anatomical alignment and occlusion, typically initiated with intermaxillary fixation (IMF) or maxillomandibular fixation (MMF), followed by surgical reduction and stabilization[1]. While IMF is effective in immobilizing fractured segments, it disrupts physiology of the patient, particularly by compromising oral intake, which can initiate a cascade of metabolic and nutritional disturbances [1][2][3].

Patients recovering from minor dentoalveolar procedures typically resume a regular diet within 48 hours whereas individuals undergoing IMF due to comminuted fractures or orthognathic interventions often remain on liquid or semi-liquid diets for 4 to 6 weeks [1][4][5]. This prolonged restriction impairs nutrient availability, delaying tissue healing and promoting weight loss, muscle wasting, electrolyte imbalance, and immunity suppression [6][16]. Several studies have reported early postoperative reductions in lean body mass and serum protein levels, reflecting catabolic stress and negative nitrogen balance during this period [2][6][17].

Nutritional status is intrinsically linked to postoperative outcomes. Plasma proteins such as albumin are critical in maintaining osmotic pressure and act as carriers for hormones, drugs, and electrolytes. Hypoalbuminemia has been associated with impaired wound healing, prolonged hospitalization, and increased postoperative complications [7][16]. Similarly, sodium and potassium—essential intracellular and extracellular ions—play pivotal roles in nerve impulse transmission, cardiac rhythm, and muscle function. Imbalances in these electrolytes, often precipitated by inadequate intake or fluid shifts during fasting, can further exacerbate systemic stress [8][9][10].

Fasting and enforced dietary restriction, as encountered in IMF patients, have been shown to alter lipid metabolism significantly. Meta-analyses of Ramadan fasting and time-restricted feeding models have demonstrated reductions in total cholesterol, LDL, triglycerides, and even fasting glucose, with variations depending on baseline nutritional status and energy balance [11][12][15]. These findings underscore how dietary limitations during IMF not only induce weight loss but also disturb lipid profiles, reflecting metabolic adaptations to undernutrition [1][13][14].

Furthermore, anthropometric markers such as mid-arm circumference serve as sensitive indicators of nutritional status and muscle mass, often declining before changes in overall body weight become clinically apparent [1][8]. Reduction in mid-arm circumference reflect early muscle catabolism and are strongly correlated with suboptimal dietary intake, making them valuable adjuncts in postoperative nutritional monitoring [1][17].

Given these considerations, the present study aims to evaluate the metabolic sequelae of IMF in maxillofacial trauma patients by assessing serial changes in anthropometric and biochemical parameters. Specifically, we examine variations in body weight, mid-arm circumference, serum sodium and potassium, total protein, albumin, cholesterol, and triglycerides over a four-week period following IMF. By elucidating these changes, the study emphasizes the necessity for integrated nutritional strategies to mitigate IMF-related morbidity and optimize recovery outcomes.

STUDY DEMOGRAPHICS

This prospective study was conducted in the Department of Oral and Maxillofacial Surgery at Mahatma Gandhi Dental College & Hospital, Jaipur from November 2022 to July 2024. A total of 30 patients undergoing treatment for maxillofacial fractures were included. Of these, 27 participants (90%) were male and 3 (10%) were female, with ages ranging from 16 to 65 years (see table 1).

Table 1: Distribution of patients according to age

Age Group (Years)	Number of Patients	Percentage
11-20	6	20
21-30	10	33.33
31-40	9	30
41-50	2	6.67
51-60	1	3.33
61-70	2	6.67
TOTAL	30	100

Inclusion Criteria

- Patients with panfacial trauma
- Patients presenting with condylar, mandibular, or midface fractures with occlusal derangement
- Cases involving comminuted maxillofacial fractures
- Individuals classified as ASA I or ASA II (American Society of Anesthesiologists Physical Status Classification)

Exclusion Criteria

- Cases where intermaxillary fixation (IMF) was contraindicated or not clinically indicated
- Patients managed exclusively with open reduction and internal fixation (ORIF)
- Individuals with pre-existing malnutrition
- Pediatric patients and those with cognitive impairments or epilepsy
- Patients with chronic obstructive pulmonary disease (COPD)
- Individuals falling under ASA Class III, IV, or V

ARMAMENTARIUM AND METHODOLOGY

The essential equipment included Erich's arch bars, 24-gauge stainless steel wire, a calibrated weighing scale, flexible measuring tape for mid-arm circumference, and sterile cannulas and vacutainers for blood sampling. Biochemical analyses encompassed total protein, albumin, cholesterol, triglycerides, serum sodium, and serum potassium. All investigations were processed at the Central Laboratory of Mahatma Gandhi Hospital, Jaipur.

PROCEDURE

All patients were admitted on the day of presentation and underwent surgical intervention within the first week. Open reduction and stabilization of fractures were performed (which was followed in 4 patients in our study), followed by immobilization via intermaxillary fixation using preoperatively placed arch bars. The IMF was maintained for a period of six weeks.

Parameters Recorded

1. Body weight (kg)
2. Total cholesterol (mg/dL)
3. Triglycerides (mg/dL)
4. Serum sodium (mmol/L)
5. Serum potassium (mmol/L)
6. Total protein (g/dL)
7. Serum albumin (g/dL)
8. Mid-arm circumference (cm)

Anesthetic Protocol: Initial placement of arch bars was performed under local anesthesia (2% lidocaine with 1:200,000 epinephrine). After preoperative investigations came within normal limits, patients received IV antibiotics, analgesics, and fluids (normal saline or Ringer's lactate). Definitive fracture fixation was carried out under general anesthesia.

Postoperative Care: Patients were prescribed a high-calorie, high-protein liquid diet and were counseled to maintain adequate hydration. Nutritional support included whole milk, multivitamin supplements, B-complex capsules, and oral iron preparations. Oral hygiene was maintained through the use of soft-bristled brushes and antiseptic mouthwash.

Figure 1: Intermaxillary fixation

Anthropometric and biochemical parameters—including body weight, serum cholesterol, triglycerides, sodium, potassium, total protein, albumin, and mid-arm circumference—were systematically recorded at three time points: preoperatively, at the end of the first postoperative week, and at the fourth postoperative week. Statistical analysis of the variations between these intervals was performed using the paired Student's t-test to evaluate the significance of observed changes across the follow-up periods.

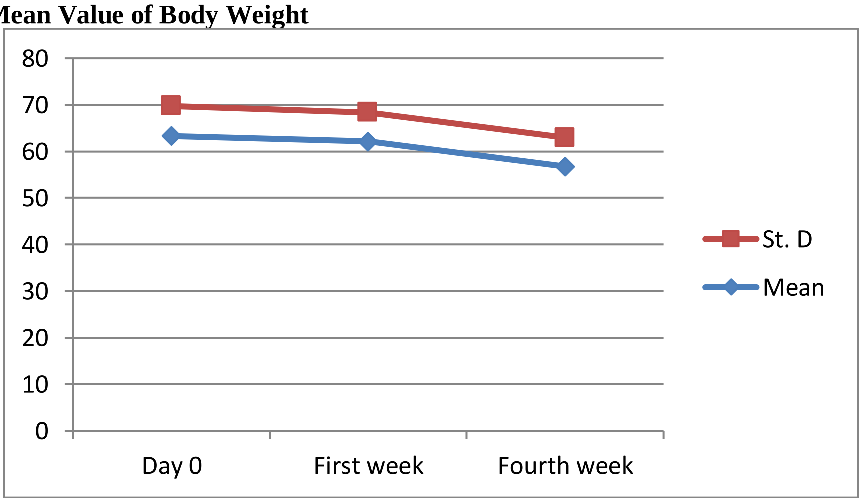
OBSERVATIONS AND RESULTS

The present study revealed statistically and clinically significant trends in anthropometric and biochemical parameters among patients undergoing intermaxillary fixation (IMF) over a four-week postoperative period.

Body Weight

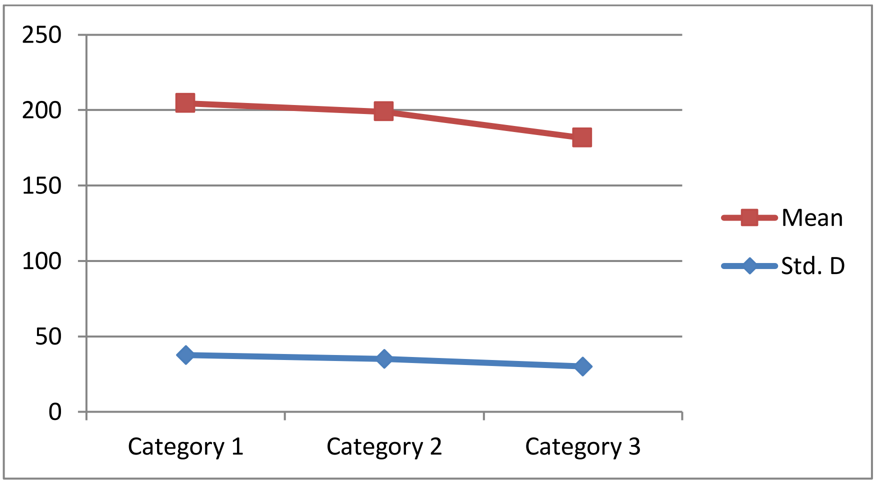
A continuous and significant reduction in mean body weight was recorded across all follow-up intervals. From the preoperative baseline to the end of the first postoperative week, the decrease was highly significant ($p < 0.01$). This trend persisted through the fourth postoperative week ($p < 0.01$), indicating progressive weight loss attributed to restricted oral intake and altered metabolic demands. (Graph 1)

Graph No. 1: Mean Value of Body Weight



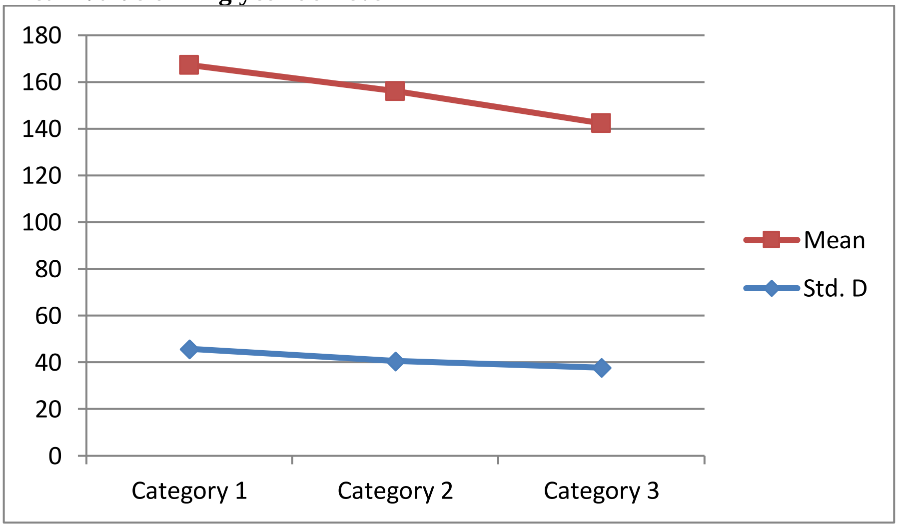
Serum Cholesterol
Serum cholesterol levels exhibited a significant downward trend. A moderate reduction was noted between the preoperative phase and the first postoperative week ($p < 0.05$), followed by a more substantial decline by the fourth week ($p < 0.01$). This reflects a consistent hypolipidemic effect associated with prolonged dietary limitations. (Graph 2)

Graph No. 2: Mean Value of Cholesterol Level



Serum Triglycerides
A pattern similar to cholesterol was observed in triglyceride levels, with a statistically significant reduction noted between the preoperative baseline and the first postoperative week ($p < 0.05$). A further marked decline was seen by the fourth week ($p < 0.01$), suggesting sustained mobilization of lipid stores in response to caloric deficit. (Graph 3)

Graph No. 3: Mean Value of Triglyceride Level



Serum Sodium
No statistically significant changes were observed in serum sodium concentrations across the three measured time points ($p > 0.05$). This relative stability is likely due to consistent perioperative fluid management using isotonic intravenous solutions (normal saline and Ringer's lactate), which maintained sodium homeostasis.

Serum Potassium
Serum potassium levels remained stable from the preoperative measurement to the end of the first week ($p > 0.05$). However, a statistically significant decrease was noted between the first and fourth weeks ($p < 0.01$), indicating a delayed depletion possibly related to prolonged dietary insufficiency and intracellular potassium shifts.

Total Serum Protein
Total protein levels demonstrated no statistically significant variation during the observation period ($p > 0.05$), indicating preservation of overall protein status, potentially due to supplementation and dietary counseling provided throughout the treatment phase.

Serum Albumin

A statistically significant reduction in serum albumin levels was detected in the first postoperative week ($p < 0.05$). By the fourth week, however, levels approached baseline values ($p > 0.05$), suggesting a transient decrease consistent with acute postoperative stress rather than sustained malnutrition.

Mid-Arm Circumference (MAC)

Mid-arm circumference, a surrogate marker for muscle mass and nutritional status, showed a statistically significant decline ($p < 0.01$), particularly evident between the first and fourth postoperative weeks. This underscores its value as an early and sensitive indicator of nutritional deterioration during IMF.

Table 2: Results

Parameter	Mean +/- SD		
	DAY 0	1ST WEEK	4TH WEEK
Weight	63.30 +/- 1.17	62.10 +/- 1.15	56.7 +/- 1.13
Cholesterol	166.93 +/- 6.86	163.86 +/- 6.43	151.46 +/- 5.49
Triglyceride	121.46 +/- 8.36	115.60 +/- 7.39	104.60 +/- 6.88
Sodium	134.86 +/- 0.64	134.00 +/- 0.55	133.76 +/- 0.64
Potassium	4.25 +/- 0.07	4.16 +/- 0.08	3.93 +/- 0.04
Protein	6.83 +/- 0.13	6.19 +/- 0.10	7.08 +/- 0.13
Albumin	3.97 +/- 0.11	4.05 +/- 0.10	4.20 +/- 0.11
Mid-arm circumference	26.37 +/- 2.32	26.28 +/- 2.43	24.61 +/- 1.97

DISCUSSION

The findings of this study underscore the significant metabolic and nutritional challenges faced by patients undergoing intermaxillary fixation (IMF) for maxillofacial trauma. The observed progressive decline in body weight, serum cholesterol, triglycerides, and mid-arm circumference (MAC) over the four-week IMF period aligns with the physiological responses to enforced hypocaloric states. Such conditions prompt the body to utilize glycogen stores initially, followed by lipolysis and eventual protein catabolism to meet energy demands [14].

The reductions in serum cholesterol and triglyceride levels observed in this cohort are consistent with adaptive metabolic responses to caloric restriction.

Similar lipid profile alterations have been documented during fasting periods, such as Ramadan, where significant decreases in lipid concentrations were noted [11]. While these changes might suggest improved lipid metabolism, in the context of trauma patients, they may reflect inadequate energy intake, potentially compromising the healing process.

The transient yet statistically significant decrease in serum albumin levels during the first postoperative week highlights the body's acute-phase response to surgical trauma and nutritional stress. Albumin, a negative acute-phase reactant, typically decreases during inflammatory states, and its reduction may indicate early protein catabolism [18]. Although total protein levels remained within normal ranges, the potential for subclinical protein malnutrition cannot be dismissed, especially in the absence of more sensitive markers such as prealbumin or transferrin.

Electrolyte levels, specifically sodium and potassium, remained relatively stable throughout the study period, likely due to effective perioperative fluid management. This stability is crucial, as electrolyte imbalances can have significant clinical implications, particularly in patients with restricted oral intake.

The significant decline in MAC observed in this study serves as an important anthropometric indicator of muscle mass and nutritional status. Reductions in MAC have been associated with acute malnutrition and correlate strongly with losses in lean body mass, particularly in hospitalized or immobilized patients [8]. Regular monitoring of MAC can provide early insights into nutritional deterioration, allowing for timely interventions.

From a clinical perspective, the metabolic and nutritional disruptions identified in this study have profound implications for patient outcomes. Hypocaloric states and micronutrient deficiencies are known to impair immune function, delay fibroblast proliferation, compromise collagen synthesis, and reduce osteoblastic activity—all of which are integral to efficient fracture healing and soft tissue repair [19]. Suboptimal nutrition has been associated with increased infection rates, delayed union of fractures, and extended hospital stays in orthopedic and head-and-neck trauma settings [20].

Given these findings, it is imperative that IMF protocols incorporate structured, individualized nutritional support plans. This includes energy-dense liquid diets providing adequate caloric and protein intake, micronutrient fortification, and regular monitoring of anthropometric and biochemical markers. Early engagement of dietitians as part of a multidisciplinary maxillofacial care team can significantly mitigate the adverse metabolic consequences of IMF and improve clinical outcomes [16].

CONCLUSION

This study underscores the significant metabolic impact of intermaxillary fixation (IMF) in patients undergoing treatment for maxillofacial trauma. The findings demonstrate a marked reduction in body weight, serum cholesterol, and triglyceride levels during the fixation period, establishing a direct correlation between impaired oral intake and nutritional deterioration. These results align with prior literature that highlights the catabolic state induced by prolonged fasting or caloric restriction, which adversely affects lipid metabolism, protein conservation, and healing capacity [15,12].

Although total serum protein and albumin levels remained within acceptable clinical ranges over the four-week period, the transient drop in albumin observed during the initial postoperative phase suggests an acute inflammatory or stress response rather than sustained malnutrition. Similar patterns have been reported in surgical and critically ill populations, where hypoalbuminemia is often a surrogate for physiological stress rather than protein-energy malnutrition [7,18].

Electrolyte homeostasis, particularly sodium and potassium levels, remained largely unaffected, likely due to the consistent administration of intravenous fluids. This reinforces the importance of perioperative fluid management in preventing electrolyte imbalances in patients with compromised oral intake [5].

Anthropometric indicators, particularly mid-arm circumference (MAC), proved to be reliable early markers of nutritional decline. The observed reduction in MAC during the IMF period aligns with contemporary research identifying muscle wasting as an early and sensitive measure of catabolic stress and inadequate nutrient assimilation in immobilized or critically restricted patients [8].

The findings of this study advocate for a multidisciplinary approach to the management of IMF patients, wherein surgical stabilization is complemented by proactive nutritional support. Incorporating individualized dietary plans—including high-protein, high-calorie liquid nutrition—along with continuous monitoring of anthropometric and biochemical indices, may help mitigate the adverse metabolic consequences of IMF. Such interventions are pivotal for optimizing patient recovery, minimizing postoperative complications, and enhancing long-term functional outcomes [16,6].

In conclusion, IMF—while clinically indispensable for fracture stabilization—poses significant challenges to metabolic stability. Integrating surgical care with evidence-based nutritional protocols should be recognized as a critical component of holistic patient management in oral and maxillofacial trauma.

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