INTERNATIONAL ANNALS OF HEALTH SCIENCES (IAHS)

Original Research

Open Access

Hybrid maxillomandibular fixation versus arch bars: a prospective clinical study of efficiency, safety, and patient outcomes

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Abstract

Background:

Mandibular fractures are commonly managed using maxillomandibular fixation (MMF) to re-establish occlusion and facilitate bone healing. Conventional Erich arch bars (EAB) are widely used; however, they are associated with prolonged application time, increased intraoperative risks such as needle-stick injuries, and compromised patient comfort. Hybrid arch bar (HAB) systems have been introduced as an alternative, aiming to enhance efficiency and overall patient experience.

Objective:

To compare the efficiency, safety, oral hygiene status, and patient comfort between hybrid arch bars and conventional Erich arch bars in the management of mandibular fractures.

Methods:

This prospective clinical study was conducted at the Department of Oral and Maxillofacial Surgery in a private hospital in Karachi from January to July 2025. A total of 60 patients requiring temporary MMF were included and randomly allocated into two groups: HAB (n = 30) and EAB (n = 30). Baseline characteristics were comparable between groups. Outcome measures included application time, intraoperative complications, postoperative occlusal stability, oral hygiene status, and patient-reported comfort assessed using a Visual Analog Scale.

Results:

The HAB group demonstrated a significantly shorter application time compared to the EAB group (18.4 ± 3.2 vs 32.7 ± 4.6 minutes; $p < 0.001$). Intraoperative complications were lower in the HAB group (10.0%) compared to EAB (23.3%; $p = 0.04$). Occlusal stability showed no significant difference between groups ($p = 0.64$). Oral hygiene was significantly better in the HAB group ($p = 0.01$), and patient comfort scores were higher (7.9 ± 1.1 vs 5.6 ± 1.4; $p < 0.001$).

Conclusion:

Hybrid arch bars offer a faster, safer, and more comfortable alternative to conventional.

Keywords: Hybrid maxilla-mandibular fixation, arch bar, mandibular fracture, IMF screws, operative time, oral hygiene, patient outcomes, prospective study.

Introduction

Mandibular fractures represent one of the most frequently encountered injuries in maxillofacial trauma, accounting for a substantial proportion of facial skeletal injuries worldwide. Due to the mandible's prominent anatomical position and functional importance, such fractures can significantly compromise occlusion, mastication, speech, and overall quality of life if not appropriately managed. Effective treatment aims not only at anatomical reduction but also at restoration of functional occlusion and early return to normal activities. In this context, maxillomandibular fixation (MMF) continues to play a pivotal role by stabilizing fracture segments, maintaining occlusal relationships, and facilitating optimal bone healing during the recovery phase (1). Among the various techniques available for MMF, traditional Erich arch bars (EABs) have long been regarded as the gold standard. Their widespread acceptance is attributed to their versatility, cost-effectiveness, and ability to provide reliable stabilization across a broad spectrum of mandibular fracture patterns. EABs allow precise control of occlusion and are particularly useful in both simple and complex fracture configurations. However, despite their clinical utility, the application of conventional arch bars is technically demanding and time-intensive, often requiring meticulous wire placement around individual teeth. This prolonged operative time increases fatigue for the surgical team and may extend anesthesia duration for patients (2).

In addition to time-related concerns, EAB placement is associated with several well-documented complications. These include an increased risk of needle-stick and wire-related injuries to the surgical

team, with glove perforation being a frequent occurrence during application. For patients, complications may include gingival trauma, periodontal damage, mucosal irritation, and challenges in maintaining adequate oral hygiene due to the presence of circum dental wires. These limitations have prompted the exploration and development of alternative MMF techniques that aim to improve both operator safety and patient comfort while maintaining effective stabilization (3).

In recent years, hybrid arch bar (HAB) systems have emerged as a promising innovation in MMF. These systems combine the principles of traditional arch bars with bone-anchored screw fixation, thereby eliminating the need for extensive circumdental wiring. By anchoring directly to the cortical bone, HAB systems allow for quicker placement and reduce manipulation around teeth and gingival tissues. This design not only enhances procedural efficiency but also minimizes the risk of soft tissue injury and occupational hazards associated with wire handling (4).

A growing body of evidence supports the clinical advantages of HAB systems. Randomized controlled trials have demonstrated that HAB significantly reduces application time compared with traditional EAB while also lowering the incidence of glove perforations. Furthermore, patients treated with HAB systems have shown improved postoperative oral hygiene, likely due to reduced gingival encumbrance and easier access for cleaning. Importantly, these benefits are achieved without compromising the stability of fixation or the quality of fracture healing (5).

Similarly, studies evaluating screw-retained hybrid arch bar systems have reported markedly shorter operative durations and comparable postoperative outcomes when compared to conventional techniques. These findings suggest that HAB systems not only enhance surgical efficiency but also contribute to a safer working environment for clinicians. The reduction in intraoperative hazards, particularly needle-stick injuries, is a significant advantage in modern surgical practice where occupational safety is a priority (6).

Systematic reviews and meta-analyses further reinforce these observations by highlighting that modified MMF techniques, including HAB and other screw-based fixation systems, are consistently associated with reduced operative times and lower rates of operator-related injuries compared to traditional arch bars. These reviews indicate a clear trend toward the adoption of newer fixation modalities that align with contemporary surgical goals of efficiency, safety, and improved patient-centered outcomes (7).

In Pakistan and neighboring regions, similar efforts have been made to evaluate alternative MMF techniques within local clinical settings. Comparative studies conducted at the Armed Forces Institute of Dentistry, Rawalpindi, have demonstrated that intermaxillary fixation screws allow for faster establishment of MMF, fewer glove perforations, and improved oral hygiene when compared with Erich arch bars. These findings reflect a growing regional interest in optimizing surgical techniques to enhance both clinical outcomes and operator safety (8).

Additional regional studies have documented practical advantages of alternative fixation methods, including reduced procedure time, improved patient tolerance, and decreased incidence of procedure-related complications. However, despite these encouraging findings, most local research has focused on intermaxillary fixation screws rather than hybrid arch bar systems specifically (9).

Across South Asia and other developing regions, multicenter and comparative investigations have consistently emphasized surgical efficiency, operator safety, and patient comfort as key determinants in selecting MMF techniques. These studies collectively suggest that newer bone-anchored systems often outperform conventional arch bar wiring in terms of time efficiency and reduction of intraoperative risks, further supporting their integration into routine clinical practice (10).

Despite the growing global evidence supporting hybrid arch bar systems, there remains a relative paucity of locally generated data directly comparing HAB with traditional Erich arch bars, particularly in the Pakistani population. This gap underscores the

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Date of Receiving: 2026-02-07

Date of Revision: 2026-04-23

Date of Acceptance: 2026-04-25

DOI: https://doi.org/10.69491/vg626z79

need for region-specific research to evaluate clinical outcomes, patient experiences, and practical feasibility within local healthcare settings.

Therefore, the present study aims to compare hybrid arch bars with conventional Erich arch bars in terms of early postoperative outcomes and patient-reported experiences. By addressing this gap, the study seeks to contribute to evidence-based decision-making and support the adoption of safer, more efficient MMF techniques in mandibular fracture management.

Methodology:

This prospective clinical study was conducted at the Department of Oral and Maxillofacial Surgery, at a private hospital setting in Karachi, from January to July 2025. Sixty adult patients presenting with isolated mandibular fractures requiring temporary maxillomandibular fixation (MMF) were included. Participants were recruited using a consecutive sampling approach, enrolling all eligible patients during the study period.

Patients were randomly assigned into two equal groups (30 each) using a computer-generated random sequence, with allocation concealed through sealed opaque envelopes. Group A was managed using hybrid arch bars (HAB), while Group B received conventional Erich arch bars (EAB). All procedures were performed according to standardized protocols to ensure consistency.

Adults aged ≥18 years with fractures involving Para symphysis, body, angle, or condylar regions were included. Patients with comminuted or pathological fractures, systemic conditions affecting bone healing, significant soft tissue injuries, pregnancy, or contraindications to anesthesia were excluded. Blinding of the surgeon was not feasible due to the nature of the procedures; however, a blinded independent evaluator assessed postoperative outcomes to minimize bias.

After obtaining informed consent, eligible patients were enrolled consecutively and assigned to either the hybrid arch bar group or the conventional Erich arch bar group. Baseline data, including age, gender, fracture site, and type of mandibular fracture, were recorded using a structured data collection form.

During the surgical procedure, fixation application time was measured in minutes from the start of placement to completion of maxillomandibular fixation. Intraoperative events, including wire-stick injuries, screw loosening, or any technical difficulties, were documented by an independent observer.

Postoperatively, patients were assessed during scheduled follow-up visits for occlusal stability, oral hygiene status, and any early complications. Oral hygiene was evaluated clinically, and patient comfort and satisfaction were recorded using a standardized patient-reported assessment using visual analogue scale. Patients were asked to rate their overall comfort during the fixation period on a 10-cm horizontal line, where 0 represented no comfort (extreme discomfort) and 10 represented maximum comfort. The score marked by the patient was measured in centimeters to obtain a numerical value. This assessment was performed during follow-up visits and applied uniformly to both study groups to compare patient-reported comfort outcomes.

All collected data were entered into a secure database and prepared for statistical analysis to compare outcomes between the two fixation methods.

Statistical analysis:

Collected Data were analyzed using the Statistical Package for Social Sciences (SPSS) version 26.0. Continuous variables, including fixation application time, were expressed as mean ± standard deviation, while categorical variables such as intra operative complications, occlusal stability, oral hygiene status, and patient comfort were presented as frequencies and percentages. Comparisons between the two groups were performed using the independent *t*- test for continuous variables and the Chi-Square test for categorical variables, as appropriate. A *p*-value of less than 0.05 was considered statistically significant.

Results:

A total of 60 patients with mandibular fractures were included in the study, with 30 patients in the hybrid arch bar (HAB) group and 30 in the conventional Erich arch bar (EAB) group. The demographic characteristics and fracture distribution were comparable between the two groups. The mean fixation application time was significantly shorter in the HAB group compared to the EAB group ($p < 0.05$). Intraoperative complications, including wire-stick injuries and fixation-related technical issues, were observed more frequently in the EAB group, whereas the HAB group demonstrated a lower complication rate.

Postoperative occlusal stability was satisfactory and comparable in both groups, with no statistically significant difference observed. Patients treated with hybrid fixation showed better oral hygiene status during the fixation period compared to those with conventional arch bars. Patient-reported comfort

scores assessed using the Visual Analog Scale were significantly higher in the HAB group ($p < 0.05$).

Baseline Characteristics

A total of 60 patients were included, with 30 patients in the hybrid arch bar (HAB) group and 30 in the Erich arch bar (EAB) group. There was no statistically significant difference between the groups regarding age, gender distribution, or fracture site ($p > 0.05$), indicating comparability at baseline.

Table 1. Baseline demographic and clinical characteristics of study participants

Variable	HAB (n=30)	EAB (n=30)	*p*-value
Age (years), mean ± SD	29.6 ± 7.4	30.2 ± 6.9	0.72
Male, n (%)	22 (73.3%)	21 (70.0%)	0.78
Parasymphysis fracture, n (%)	10 (33.3%)	9 (30.0%)	0.79
Body fracture, n (%)	8 (26.7%)	9 (30.0%)	0.78
Angle fracture, n (%)	7 (23.3%)	6 (20.0%)	0.75
Condylar fracture, n (%)	5 (16.7%)	6 (20.0%)	0.74

Fixation Application Time

The mean application time was significantly shorter in the HAB group compared to the EAB group.

Table 2. Comparison of fixation application time

Group	Application time (minutes), mean ± SD	***p*-value**
HAB	18.4 ± 3.2	
EAB	32.7 ± 4.6	< 0.001

Intra operative Complications

Intra operative complications were significantly more frequent in the EAB group, particularly wire-stick injuries.

Table 3. Intra operative complications

Complication	HAB (n = 30)	EAB (n = 30)	***p*-value**
Wire-stick injury, n (%)	1 (3.3%)	7 (23.3%)	0.02
Screw loosening, n (%)	2 (6.7%)	-	-
Any complication, n (%)	3 (10.0%)	7 (23.3%)	0.04

Postoperative Occlusal Stability

Postoperative occlusion was stable in the majority of patients in both groups, with no statistically significant difference.

Table 4. Postoperative occlusal stability

Occlusal status	HAB (n = 30)	EAB (n = 30)	***p*-value**
Stable occlusion, n (%)	28 (93.3%)	27 (90.0%)	0.64
Minor discrepancy, n (%)	2 (6.7%)	3 (10.0%)	

Oral Hygiene Status

Patients in the HAB group demonstrated significantly better oral hygiene during the fixation period.

Table 5. Oral hygiene assessment

Oral hygiene status	HAB (n = 30)	EAB (n = 30)	***p*-value**
Good	20 (66.7%)	9 (30.0%)	
Fair	8 (26.7%)	12 (40.0%)	
Poor	2 (6.7%)	2 (6.7%)	0.01

Patient-Reported Comfort (VAS)

VAS comfort scores were significantly higher in the HAB group.

Table 6. Patient-reported comfort using VAS

Group	VAS score (0–10), mean ± SD	***p*-value**
HAB	7.9 ± 1.1	
EAB	5.6 ± 1.4	< 0.001

Independent *t*-tests revealed a statistically significant reduction in fixation application time in the HAB group compared to the EAB group ($t = -13.1$, $p < 0.001$). VAS comfort scores were also significantly higher in the HAB group ($t = 7.02$, $p < 0.001$). Chi-square analysis demonstrated a significantly higher rate of intraoperative complications in the EAB group ($\chi^2 = 4.2$, $p = 0.04$), while no significant difference was observed in postoperative occlusal stability between groups ($\chi^2 = 0.22$, $p = 0.64$). A *p*-value of < 0.05 was considered statistically significant.

Figure 1: Comparison of mean fixation application time between HAB and EAB groups

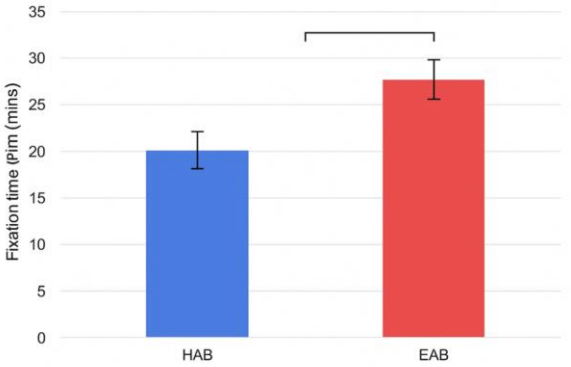
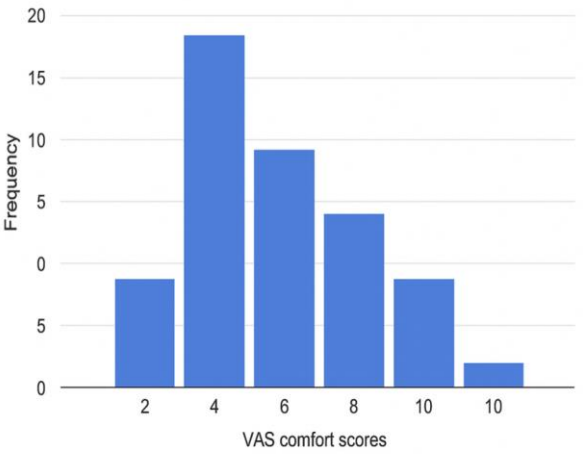


Figure 2: Distribution of patient-reported VAS comfort scores



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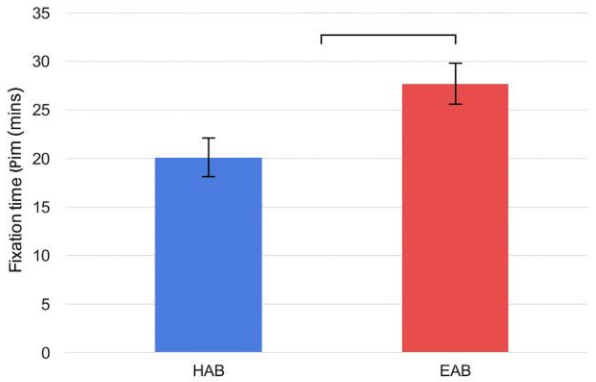

Overall, hybrid maxillomandibular fixation demonstrated superior efficiency and patient-centered outcomes while maintaining equivalent clinical stability when compared to conventional Erich arch bar fixation.

Discussion:

The present study demonstrates that hybrid arch bar (HAB) fixation offers clear advantages over conventional Erich arch bars (EAB) in several key aspects of maxillomandibular fixation (MMF). A significantly shorter application time was observed with HAB, highlighting its superior procedural efficiency

. This reduction can be attributed to the screw-retained design, which eliminates the need for time-consuming circumdental wiring. Shorter operative duration not only streamlines surgical workflow but may also reduce anesthesia exposure, an important consideration in trauma care (1–3).

In addition to improved efficiency, the HAB group exhibited fewer intraoperative complications, particularly a lower incidence of wire-stick injuries. This finding reflects the inherent safety advantage of minimizing wire manipulation during fixation. Conventional arch bars, which rely heavily on stainless-steel wiring, expose surgeons to a higher risk of sharps injuries and glove perforations. The reduced complication rate observed in this study supports the growing emphasis on operator safety in surgical practice (4–6).

Despite these differences, postoperative occlusal stability was comparable between the two groups, indicating that HAB provides fixation strength equivalent to traditional methods. Maintenance of stable occlusion is a critical outcome in mandibular fracture management, and the findings suggest that improved efficiency and safety with HAB do not compromise clinical effectiveness (7–9).

Oral hygiene status was significantly better among patients treated with hybrid fixation. The absence of extensive wiring around teeth and gingival margins facilitates easier cleaning and reduces plaque accumulation. Improved oral hygiene is particularly important during the fixation period, as it may decrease the risk of gingival inflammation, periodontal complications, and secondary infections (10–12).

Patient-reported comfort was also higher in the HAB group, reflecting reduced soft tissue irritation and improved overall tolerance. Conventional arch bars are often associated with mucosal trauma and discomfort due to their bulk and wire components. In contrast, the smoother and less intrusive design of hybrid systems appears to enhance patient experience, an increasingly important factor in treatment selection (13–15).

These findings are consistent with previous studies that have reported shorter application times and improved safety profiles with hybrid and screw-based MMF techniques (1,4,5). Similarly, multiple investigations have demonstrated reduced rates of

intraoperative injuries and better oral hygiene outcomes with HAB compared to conventional arch bars (6,10,13). Systematic reviews and meta-analyses further support these observations, concluding that modified fixation systems offer advantages in efficiency, operator safety, and patient comfort without compromising stability (8,14–16).

Regional studies, particularly from Pakistan and neighboring countries, have largely focused on intermaxillary fixation screws and have reported comparable improvements in operative efficiency and patient tolerance (5,11,17). However, direct comparisons involving hybrid arch bar systems remain limited in local settings. The present study therefore adds meaningful regional data, supporting the feasibility and benefits of HAB in routine clinical practice.

Overall, the findings reinforce the evolving trend toward adopting newer MMF techniques that prioritize efficiency, safety, and patient-centered outcomes. Hybrid arch bar systems represent a practical and effective alternative to conventional methods, particularly in settings were reducing operative time and minimizing complications are essential.

Conclusion:

Hybrid maxillo-mandibular fixation showed superior efficiency and patient-centered outcomes compared to conventional Erich arch bars, including shorter application time, fewer intra operative complications, improved oral hygiene, and greater patient comfort, while providing comparable postoperative occlusal stability. These findings, consistent with recent national and international evidence, indicate that hybrid arch bars are a safe, effective, and patient-friendly alternative for mandibular fracture management. Their routine use may improve surgical workflow and patient outcomes in busy maxillofacial units, although larger studies with longer follow-up are recommended confirming long-term benefits.

Limitations:

Despite its strengths, this study has certain limitations. The sample size was relatively modest, and long-term outcomes such as periodontal health and late complications were not evaluated. Future multicenter studies with larger sample sizes and extended follow-up periods are recommended to further substantiate the long-term benefits of hybrid fixation systems.

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Conflict of interest: Author declares no conflict of interest.
Funding Disclosure: Nil

Author's Contribution:
Dr. Faizan Abdul Hussain Lakhdhir: Conception and designing work, drafting
Dr. Muhammad Ahmed Noor: Data collection