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Comparison Of Hybrid Arch Bars Vs Erich's Arch Bar For Intermaxillary Fixation In Maxillofacial Trauma Patients- A Randomized Control Trial.

Author

Abstract:
Background:
Maxillofacial trauma frequently involves fractures of the mandible and midface due to the anatomical prominence of these regions. Restoration of normal occlusion and function requires accurate reduction and stable fixation of the fracture segments. Maxillomandibular fixation (MMF) remains a cornerstone in the management of such injuries. Conventionally, Erich's Arch Bars (EAB) secured with circumdental stainless-steel wiring have served as the gold standard for establishing MMF. Despite their efficacy, this method is associated with several disadvantages, including prolonged application time, risk of glove perforation and needle-stick injury, and poor oral hygiene maintenance. To overcome these limitations, Stryker introduced the Smart Lock Hybrid Arch Bar (HAB) system in 2012, which uses bone-borne locking screws rather than interdental wiring.
Aim:
This randomized controlled study aimed to compare the clinical efficiency and patient comfort between the Hybrid Arch Bar (HAB) and the conventional Erich's Arch Bar (EAB) systems in patients requiring intermaxillary fixation (IMF).
Materials and Methods:
Ten patients (aged 18-65 years) with mandibular fractures requiring IMF were randomly divided into two equal groups. Group I (EAB) underwent fixation using traditional Erich's arch bars and circumdental wires. Group II (HAB) received Smart Lock Hybrid Arch Bars fixed to the alveolar bone with self-drilling screws (6 mm in the maxilla and 8 mm in the mandible). Immobilization was maintained for 4-6 weeks. Primary outcomes included application and removal times and patient discomfort. Secondary outcomes assessed oral hygiene, soft-tissue response, stability, and injury to vital structures. Data were analyzed using SPSS (IBM, USA). Independent t-tests and Chi-square tests were applied, with $p \leq 0.05$ considered statistically significant.
Results:
The mean application time for EAB was 90.0 ± 7.9 minutes, while HAB required 41.4 ± 4.7 minutes ($p < 0.001$). The mean removal time for EAB was 44.6 ± 7.9 minutes compared with 24.6 ± 4.5 minutes for HAB ($p < 0.001$). Oral hygiene was superior in the HAB group (40% good, 60% moderate) compared to EAB (60% poor, 40% moderate), though not statistically significant ($p = 0.074$). Stability was comparable in both groups; however, one HAB patient (20%) experienced screw loosening ($p = 0.292$). Soft-tissue ingrowth occurred in 60% of HAB cases and none in the EAB group ($p = 0.038$).
Conclusion:
The Hybrid Arch Bar system offers a clinically efficient, safer, and more hygienic alternative to the conventional Erich's Arch Bar. It significantly reduces chairside time, minimizes operator fatigue and infection risk, and improves patient comfort without compromising stability. Minor complications, such as soft-tissue ingrowth, can be mitigated through meticulous technique and postoperative care.
Keywords: *Hybrid arch bar, Erich's arch bar, intermaxillary fixation, maxillofacial fractures, oral hygiene, operative time.*

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I. Introduction:

Maxillofacial region is more prone to fractures of the facial skeleton owing to its prominence, curvature, and exposure to traumatic forces. Mandibular and Midface fractures contribute significantly to maxillofacial trauma and are often associated with impaired function, altered aesthetics, and occlusal disturbances. The fundamental aim in treating such fractures is the accurate realignment of bone fragments and the establishment of stable fixation to restore normal occlusion. Depending on the type, location, and severity of the fracture, management may be achieved through either open reduction with internal fixation or closed reduction techniques.

Regardless of the approach selected, the attainment of maxillomandibular fixation (MMF) plays a critical role in ensuring stability of the occlusion during the healing phase.

Traditionally, Erich's arch bars (EABs) secured with circumdental stainless-steel wiring have served as the standard method for establishing MMF. While effective, this technique is not without drawbacks. Placement of the arch bar is typically time-intensive and technically demanding, with multiple circumdental ligations required. This increases the likelihood of glove perforation and needle-stick injuries, exposing surgeons and staff to potential cross-infection risks. Moreover, prolonged wiring around teeth can have unfavourable periodontal consequences, such as gingival inflammation, plaque accumulation, and difficulty maintaining adequate oral hygiene throughout the fixation period. These limitations have stimulated the development of alternative fixation methods designed to simplify the procedure and improve patient and operator safety.

In 2012, Stryker introduced the Smart Lock Hybrid Maxillomandibular Fixation (MMF) system, which represents a bone-supported alternative to conventional EABs. This system secures the arch bar to the alveolar bone using self-drilling locking screws in both the maxilla and mandible, eliminating the need for circumdental wiring. While it functions in a similar manner to traditional arch bars in achieving occlusal stabilization, several advantages have been reported.[1] These include shorter chairside times for both application and removal, decreased occupational hazards for clinicians, improved periodontal health, and relative simplicity of placement.With the increasing adoption of bone-supported arch bar systems in clinical practice, it becomes essential to critically evaluate their effectiveness compared with conventional methods. The present study seeks to compare the Smart Lock Hybrid arch bar with the traditional Erich's arch bar, focusing on the time required for placement and removal as well as patient-reported discomfort during treatment.

II. Materials And Methods

Study Population

This randomized controlled trial (RCT) was conducted in the Department of Oral and Maxillofacial Surgery between 2023 and 2024

All procedures performed in studies involving human participants were in accordance with the ethical standards of the institutional and/or national research committee and with the 1964 Helsinki Declaration and its later amendments or comparable ethical standards. The study was approved by the Institutional Ethical Committee (SRI RAMAKRISHNA HOSPITAL IRB: EC/2023/1005/CR-36).

Inclusion criteria:

Patients aged 12–65 years presenting with mandibular fractures requiring intermaxillary fixation (IMF) were considered for inclusion. (Informed consent was obtained from Parents/participants)

Exclusion criteria:

Patients with comminuted or multiple mandibular fractures, fractures with active infection, and those with significant systemic comorbidities or medically compromised status.

Study Design and Intervention

Eligible patients were randomly allocated into two groups by making the participants taking chits from a bowl. Investigator and Participants were blinded. (Double blinded study)

- Group I – Erich's Arch Bar (EAB): Conventional Erich's arch bars were secured to both maxillary and mandibular dentition using circumdental stainless-steel wires under local anaesthesia. (Figure 1)

Figure 1:GROUP 1: ERICH'S ARCH ABR INSERTION

- Group II – Hybrid Arch Bar (HAB): After preoperative imaging with CBCT/OPG to identify optimal screw positions and avoid injury to adjacent anatomical structures (e.g., tooth roots, inferior alveolar canal, maxillary sinus), the hybrid arch bar was adapted and stabilized with bone-borne self-tapping stainless-steel screws. Screws of 6 mm length were used in the maxilla, and 8 mm screws in the mandible. (FIGURE 2)

Figure 2: GROUP 2: HYBRID ARCH BAR-INSERTION

In both groups, immobilization was maintained for 4–6 weeks, following which the devices were removed under local anaesthesia.

Outcome Variables

The primary outcomes measured were:

1. Application time for placement of arch bars.
2. Removal time of the devices.
3. Patient-reported discomfort/pain during both placement and removal procedures with Visual analogue scale ranging from 1-10 with 10 being severe pain.

Secondary outcomes included:

1. Oral hygiene maintenance, and
2. Soft-tissue response (gingival/mucosal ingrowth).
3. Stability
4. Damage to Vital structures

Weekly follow-up assessments were performed until device removal. Time was calculated during removal and patients pain was assessed during removal. (Figure 3, Figure 4)

Figure 3: GROUP 1: ERICH'S ARCH BAR -HEALING AFTER REMOVAL

Figure 4:GROUP 2: HYBRID ARCH BAR: HEALING AFTER REMOVAL

Sample Size Calculation

The final sample comprised 10 patients (5 in each group). Sample size was calculated based on data reported by Hamid and Bede (2021)[10].

Demographics:

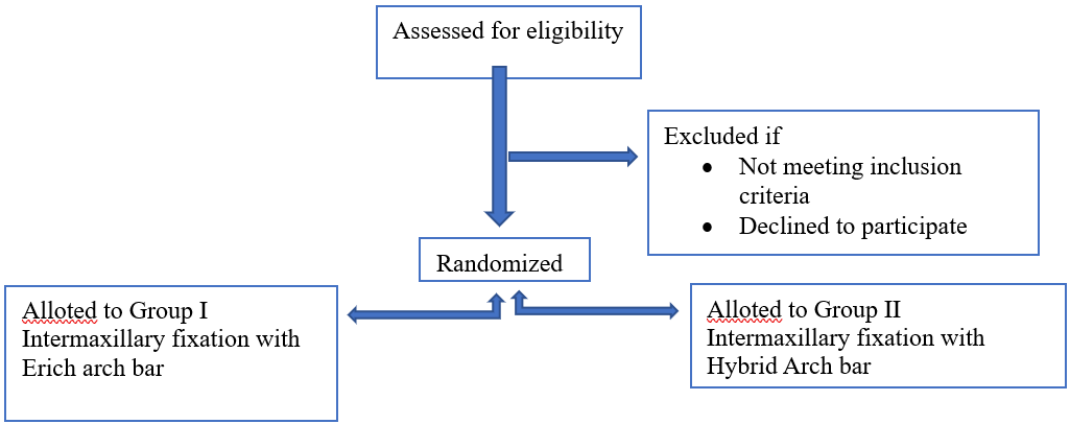
Participants Details:

S No	Patients Gender	Age	Fracture Type	Arch Bar Type
1	Male	29	Left Condyle Fracture	Eab
2	Male	38	B/L Condylar Fracture	Hybrid
3	Male	24	Left Subcondylar Fracture	Hybrid
4	Female	57	Right Subcondylar Fracture	Eab
5	Female	35	Dentoalveolar Fracture	Hybrid
6	Male	25	Bilateral Condyle+Symphysis Fracture+Right Zygomatic Fracture	Eab
7	Male	19	Bilateral Condyle # , Right Parasymphysis Fracture	Hybrid
8	Male	65	Left Condylar Fracture	Hybrid
9	Female	22	Dentoalveolar Fracture	Eab
10	Male	14	Left Mandibular Fracture	Eab

Statistical Analysis:

The data obtained was subjected to statistical analysis. The data recorded were transferred and tabulated to the computer - Windows Microsoft Excel (2007) - for the purpose of the data analysis. Statistical Package of Social Science (SPSS; IBM Chicago Inc., USA) was used for statistical analysis. The total data was subdivided and distributed meaningfully and presented as individual tables along with graphs. The significance level was fixed to be $p \leq 0.05$ for the analysis. Depending upon the nature of the data, the statistical tests were chosen. All continuous data were subjected to Kolmogorov Smirnov test for normality. It was found that the data was normally distributed and hence parametric tests of significance were used. Mean and standard deviations were established. The categorical data were analyzed with Pearson's Chi Square test. While the Time period for placement and removal among the two groups were compared with the independent t test. For all comparisons, p value of < 0.05 was considered to be statistically significant.

Work Flow:



III. Results:

The present study compared the efficiency and clinical performance of the Hybrid Arch Bar (HAB) and the Erich's Arch Bar (EAB) systems in patients with maxillofacial trauma requiring intermaxillary fixation. The comparison included parameters such as time required for placement and removal, oral hygiene maintenance, stability, soft tissue ingrowth, and patient-related variables. The mean age of patients in the HAB group was 36.2 years, while in the EAB group it was 29.4 years, indicating that both groups predominantly consisted of adult trauma patients, which aligns with the typical demographic of maxillofacial fracture victims. (TABLE 1)

Variables		EAB	HYBRID
Age	N	5	5
	Mean	29.4000	36.2000
	Std. Deviation	16.3799	17.8802
	Std. Error of Mean	7.32530	7.99625
	Median	25.0000	35.0000
	Minimum	14.00	19.00
	Maximum	57.00	65.00

	Range	43.00	46.00

Table 1: ACCORDING TO AGE

Gender distribution showed that 80% of HAB patients and 60% of EAB patients were male. The difference was not statistically significant (p = 0.490), suggesting that both groups were comparable in terms of gender representation. (TABLE 2)

Variables		Groups		Pearson Chi-Square	p value
		EAB	HYBRID		
Gender	**FEMALE**	2 (40.0%)	1 (20.0%)	.476	.490
	MALE	3 (60.0%)	4 (80.0%)		

Table 2: ACCORDING TO GENDER

Both groups included a variety of fracture patterns such as condylar, symphysis, and dentoalveolar fractures. The p-value (0.433) indicated no statistically significant difference between the groups in terms of fracture type distribution, confirming that both groups were well matched in baseline fracture characteristics. (TABLE 3)

Variables		Groups		Pearson Chi-Square	p value
		EAB	HYBRID		
Fracture Type	**B/L CONDYLAR FRACTURE**	-	1 (20.0%)	8.000	.433
	BILATERAL CONDYLE #, RIGHT PARAAYMPHYSIS FRACTURE	-	1(20.0%)		
	BILATERAL CONDYLE+SYMPHYSIS	1(20.0%)	-		
	DENTOALVEOLAR FRACTURE	1(20.0%)	1(20.0%)		
	LEFT CONDYLAR FRACTURE	-	1(20.0%)		
	LEFT CONDYLE FRACTURE	1(20.0%)	-		
	LEFT MANDIBULAR FRACTURE	1(20.0%)	-		
	LEFT SUBCONDYLAR FRACTURE	-	1(20.0%)		
	RIGHT SUBCONDYLAR FRACTURE	1(20.0%)	-		

Table 3: ACCORDING TO FRACTURE TYPE

The mean time for placement of the Erich's Arch Bar was 90.0 ± 7.9 minutes, while the Hybrid Arch Bar required 41.4 ± 4.7 minutes. The mean removal time for EAB was 44.6 ± 7.9 minutes, compared to 24.6 ± 4.5 minutes for HAB. The difference in both placement and removal times between the two systems was highly statistically significant (p < 0.001). The HAB system required less than half the time for application and removal compared to the traditional EAB. This confirms its superiority in reducing chairside time, operator fatigue, and risk of needle-stick injury. (TABLE 4)

During Insertion			During Removal	
Variables	EAB	HYBRID	EAB	HYBRID
N	5	5	5	5
Mean	90.0000	41.4000	44.6000	24.6000
Std. Deviation	7.90569	4.72229	7.89303	4.56070
Std. Error of Mean	3.53553	2.11187	3.52987	2.03961
Median	90.0000	40.0000	45.0000	25.0000
Minimum	80.00	35.00	35.00	20.00
Maximum	100.00	47.00	56.00	30.00
Range	20.00	12.00	21.00	10.00

Table 4: INSERTION AND REMOVAL TIME IN MINUTES

A comparative analysis was performed between **Erich Arch Bar (EAB)** and **Hybrid Arch Bar** systems to evaluate pain experienced during insertion and removal. Mean pain scores were found to be **9.0 ± 0.71** for insertion and **7.6 ± 0.55** for removal in the **EAB group**, whereas the **Hybrid Arch Bar** group recorded lower mean pain scores of **7.0 ± 0.71** and **6.0 ± 0.71**, respectively. **Independent sample t-tests** revealed that the differences in pain scores between the two groups were statistically significant for both insertion ($t = 4.47$, $p = 0.002$) and removal ($t = 4.00$, $p = 0.004$).

Parameter	Source	Sum of Squares	df	F-value	p-value	Interpretation
Insertion Pain	Between Groups	10.0	1	20.00	0.0021	**Significant**
	Within Groups	4.0	8	—	—	—
Removal Pain	Between Groups	6.4	1	16.00	0.0039	**Significant**

	Within Groups	3.2	8	—	—	—

Table 5: Comparison of pain during insertion and removal in both groups

In the HAB group, 40% of patients maintained *good* oral hygiene and 60% had *moderate* hygiene levels. In contrast, in the EAB group, 60% of patients demonstrated *poor* hygiene and **40%* had *moderate* hygiene. Although the difference did not reach statistical significance (p = 0.074), the trend clearly favoured the Hybrid Arch Bar, likely due to the absence of extensive interdental wiring and smoother surfaces, which facilitate better oral cleaning. (TABLE 6)

Variables		Groups		Pearson Chi-Square	p value
		EAB	HYBRID		
Hygiene	**Good**	-	2(40%)	5.200	.074
	Moderate	2(40%)	3(60%)		
	Poor	3(60%)	-		

Table 6: HYGIENE

All patients in the EAB group demonstrated adequate fixation stability (100%), while in the HAB group, one case (20%) experienced screw loosening. The difference was not statistically significant (p = 0.292). Both fixation systems provided adequate stability for fracture immobilization. The isolated case of screw loosening may be attributed to patient-related factors such as poor bone quality or systemic conditions. (TABLE 7)

Variables		Groups		Pearson Chi-Square	p value
		EAB	HYBRID		
Stability	**adequate**	5 (100%)	-	1.111	.292
	loosening of screws noted	4 (80%)	1 (20%)		

Table 7: STABILITY

Soft tissue ingrowth was absent in all EAB cases (100%), while it occurred in 60% of HAB patients. This difference was statistically significant (p = 0.038). Soft tissue ingrowth represents a specific complication associated with the Hybrid Arch Bar, particularly around unused screw slots. However, it can be minimized by bending or trimming the empty slots and maintaining regular postoperative checks. (TABLE 8)

Variables		Groups		Pearson Chi-Square	p value
		EAB	HYBRID		
Soft Tissue In Growth	**Absent**	5 (100%)	-	4.286	.038
	Present	2 (40%)	3 (60%)		

Table 8: SOFT TISSUE IN GROWTH

In both the **Erich Arch Bar (EAB)** and **Hybrid Arch Bar** groups, **no evidence of injury to vital structures** such as gingiva, tooth roots, periodontal ligament, neurovascular bundles, or adjacent soft tissues was observed during placement, fixation, or removal

Independent Samples Test										
		Levene's Test For Equality Of Variances		T-Test For Equality Of Means						
									95% Confidence Interval Of The Difference	
		F	Sig.	T	Df	Sig. (2-Tailed)	Mean Difference	Std. Error Difference	Lower	Upper
Time Taken During Insertion	Equal Variances Assumed	1.177	.310	11.801	8	.000	48.60000	4.11825	39.10329	58.09671
	Equal Variances Not Assumed			11.801	6.532	.000	48.60000	4.11825	38.71866	58.48134
During Removal	Equal Variances Assumed	.774	.405	4.906	8	.001	20.00000	4.07676	10.59897	29.40103
	Equal Variances Not Assumed			4.906	6.403	.002	20.00000	4.07676	10.17478	29.82522

Table 9: Comparitive Analysis Between Groups And The Time Period For Insertion And Removal Respectively

Variables		Time Period			
		Insertion		Removal	
		Ead	Hybrid	Ead	Hybrid
Gender	**Female**	82.50 ± 3.53	47.00	41.00± 8.48	28.00
	Male	95.00±5.00	40.00±4.08	47.00±8.18	23.75±4.78
Fracture Type	**Bilateral Condyle+Symphys**	95.00	-	40.00	-
	Dentoalveolar Fracture	80.00	47.00	47.00	28.00
	Left Condyle Fracture	90.00	-	45.00	-
	Left Mandibular Fracture	100.00	-	56.00	-
	Right Subcondylar Fracture	85.00	-	35.00	-
	B/L Condylar Fracture	-	45.00	-	20.00
	Bilateral Condyle #, Right Paraaymphysis Fracture	-	35.00	-	30.00
	Left Condylar Fracture	-	40.00	-	20.00
	Left Condylar Fracture	-	40.00	-	25.00
Hygiene	**Good**	-	40.00±0.00	-	22.50±3.53
	Moderate	85.00±7.07	42.33±6.42	46.00±1.41	26.00±5.29
	Poor	93.33±7.63	-	43.66±10.96	-
Stability	**Adequate**	90.00 ±7.90	41.75±5.377	44.60±7.89	25.75±4.34
	Loosening Of Screws Noted	-	40.00	-	20.00
Soft Tissue In Growth	**Absent**	90.00±7.90	40.00±0.00	44.60±7.89	22.50±3.53
	Present	-	42.33±6.42	-	26.00±5.29

Table 10:Descriptive Analysis Of The Categorical Variables In Relation To The Time Period. (Na-Not Applicable)

IV. Discussion:

Intermaxillary fixation (IMF) has remained the **gold standard** over the years for achieving adequate immobilization of fractured bone segments, restoring occlusal harmony, and ensuring stability during the healing phase. Various techniques have been developed and modified over decades to accomplish efficient IMF. Traditional maxillofacial fixation methods relying on dentate segments include **Ivy eyelets, Risdon wiring, splints and Erich's arch bars (EAB) [2]**. However, in cases of poor periodontal health or compromised dentition, a shift has occurred toward fixation methods that gain support directly from the bone, such as **intermaxillary fixation screws [3], zip ties [4], and bondable buttons [5]**. With the availability of multiple techniques, the choice of an appropriate IMF method often remains challenging.

The conventional **Erich's arch bar**, although effective, presents several disadvantages, including prolonged chairside time, increased risk of glove perforation and needle-stick injuries, and difficulty in maintaining oral hygiene. In contrast, the **Hybrid Arch Bar (HAB)**, a screw-retained system, has emerged as a promising alternative. It is particularly useful in patients with compromised periodontal status, offering greater application and removal efficiency and improved hygiene maintenance due to the reduced use of interdental wires.

The purpose of the present study was to compare the **efficiency, patient comfort, application/removal time, and hygiene maintenance** between the Hybrid Arch Bar and Erich's Arch Bar from the patient's perspective.

In the current study, the **mean placement time** for EAB was **90 minutes**, whereas HAB required only **41.4 minutes**. Similarly, the **mean removal time** for EAB was **44.6 minutes**, compared to **24.6 minutes** for HAB. The difference between the two groups was statistically significant. These findings clearly indicate that HAB requires nearly **half the time** for both application and removal compared to EAB. Similar results were reported by **Hashemi et al. (2017) [6]**, **Brett et al. (2018) [7]**, and **Rothe et al. [8] (2020)**, who demonstrated that the HAB system significantly enhances clinical efficiency and patient comfort. Moreover, the shorter operative time also reduces operator fatigue and minimizes the risk of **needle-stick injuries**.

With respect to **oral hygiene**, patients in the HAB group demonstrated better hygiene maintenance, with **40% graded as good** and **60% as moderate**, whereas in the EAB group, **60% were graded as poor** and **40% as moderate**. Although this difference was not statistically significant, it suggests that screw-retained systems promote improved oral hygiene. These observations are consistent with those of **Harim Sankar et al. (2014) [9]** and **Saif T Hamid et al. (2022) [10]**, who concluded that reduced interdental wiring and smoother surfaces in screw-retained systems help minimize plaque accumulation, gingival inflammation, and overall oral discomfort.

Regarding **demographic distribution**, the mean age of patients in the HAB group was **36.2 years**, compared to **29.4 years** in the EAB group, reflecting the typical age range of maxillofacial trauma victims, who are predominantly adults. Stability was achieved in all EAB cases, while one case of **screw loosening** occurred in the HAB group. According to **Kumar et al. (2020) [8]**, screw loosening may occur due to poor bone quality or excessive occlusal loading. In this study, the affected patient was **65 years old** and had **diabetes mellitus**, which may have contributed to the compromised bone quality, supporting this observation.

No cases of **tooth root injury**, **damage to vital structures**, or **maxillary sinus perforation** were reported, reflecting the effectiveness of careful preoperative planning and precise screw placement. However, a notable finding in the HAB group was **soft tissue ingrowth** in approximately **60% of patients**, particularly in empty slots. This complication occasionally required excision of the overgrown tissue during removal, causing mucosal trauma. To overcome this limitation, it was found effective to **cut or bend unused slots** away from the soft tissue immediately after fixation, which significantly reduced soft tissue entrapment and facilitated easier removal.

The limitation of the study was smaller sample size. Future researches can shed more light on ways to reduce the soft tissue ingrowth without affecting the integrity of HAB.

Overall, the findings of this study strongly support the **clinical advantages of the Hybrid Arch Bar** over the conventional Erich's Arch Bar. HAB provides **comparable stability**, while significantly **reducing operative time**, **improving hygiene maintenance**, and **enhancing patient comfort** which is consistent with previous literature [11-14]. Proper application techniques including achieving adequate torque, careful screw handling, and periodic evaluation for soft tissue ingrowth or screw loosening are essential for optimal outcomes with the HAB system.

V. Conclusion:

Within the limitations of the present study, it can be concluded that the Hybrid Arch Bar (HAB) system serves as a clinically efficient and patient-friendly alternative to the conventional Erich's Arch Bar (EAB) for achieving intermaxillary fixation. The HAB system demonstrated significantly reduced application and removal time, thereby improving overall clinical efficiency and reducing operator fatigue and the risk of needle-stick injuries.

Although both systems provided comparable stability during the fracture healing phase, the HAB group showed better oral hygiene maintenance and greater patient comfort, attributed to reduced interdental wiring and smoother hardware surfaces. Minor complications such as soft tissue ingrowth and occasional screw loosening were observed in the HAB group; however, these can be minimized with proper case selection, meticulous preoperative planning, and regular postoperative evaluation.

Overall, the Hybrid Arch Bar system offers a reliable, safe, and time-efficient alternative to traditional wiring methods, combining the advantages of rigid fixation with improved hygiene and operator convenience. Its application can therefore be recommended, especially in patients with compromised periodontal health or where shorter operative duration is desirable.

Additional Contributions:

All authors have reviewed the final version to be published and agreed to be accountable for all aspects of the work.

Disclosures:

Human subjects: Informed consent for treatment and open access publication was obtained or waived by all participants in this study. SRI RAMAKRISHNA HOSPITAL, COIMBATORE issued approval EC/ 2023 /1005 /CR-36. Research underwent an ethical committee clearance and study was begun with proper informed consents from patients for participating in the study and for publication.

Animal subjects: All authors have confirmed that this study did not involve animal subjects or tissue.

Conflicts of interest: In compliance with the ICMJE uniform disclosure form, all authors declare the following:

Payment/services info: All authors have declared that no financial support was received from any organization for the submitted work.

Financial relationships: All authors have declared that they have no financial relationships at present or within the previous three years with any organizations that might have an interest in the submitted work.

Other relationships: All authors have declared that there are no other relationships or activities that could appear to have influenced the submitted work.

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