



EARLY TREATMENT EFFICIENCY, COMFORT, AND PATIENT-REPORTED EXPERIENCE WITH DIFFERENT ORTHODONTIC APPLIANCE TYPES IN ADULT PATIENTS IN PESHAWAR: A MULTI-CENTER CROSS-SECTIONAL STUDY

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Abstract

Background:

Adult orthodontic treatment demand has increased in urban Pakistan. Appliance selection influences early treatment efficiency indicators and patient-reported experience. This study compared mechanical performance indicators and psychosocial outcomes among adult patients treated with different orthodontic appliances.

Methods:

This multi-center comparative cross-sectional study was conducted from December 2024 to August 2025 across four tertiary dental institutions in Peshawar. A total of 440 adult patients (18–45 years) in the active alignment phase (3–9 months) were included. Appliance-related complications were recorded at the time of clinical assessment. Pain intensity was measured using a 0–100 Numerical Rating Scale (NRS). Gingival health was assessed using the Löe and Silness Gingival Index. Psychosocial measures were evaluated using a 5-point Likert scale. One-way ANOVA and Chi-square tests were used. A p-value < 0.05 was considered statistically significant.

Results:

Clear aligners demonstrated the lowest hardware-related complication frequency (4.1%) compared to metal brackets (12.8%) and ceramic braces (34.2%) (p < 0.001). Mean pain scores were significantly lower in aligner users (21.4) compared to metal (62.5) and ceramic systems (68.3) (p < 0.001).

Gingival health scores were significantly better among aligner users ($p < 0.01$). Social confidence ratings were highest in the aligner group (93%).

Conclusion:

In this multi-center cross-sectional study, clear aligners were associated with lower complication frequency and improved early-stage patient-reported outcomes compared to fixed orthodontic appliances. Longitudinal studies are needed to determine long-term treatment efficiency.

Keywords: Orthodontic appliances, clear aligners, ceramic brackets, treatment efficiency, patient-reported outcomes, cross-sectional study.

Introduction

The demand for adult orthodontic treatment has increased globally over the past decade. Adults seek orthodontic therapy for functional improvement, aesthetics, and psychosocial benefits (1,2). Appliance selection plays a significant role in patient comfort, periodontal health, and mechanical stability.

Metal brackets remain the conventional treatment modality due to their durability and biomechanical control. Ceramic brackets provide improved aesthetics but may demonstrate higher bond failure rates (3). Clear aligners have gained popularity because of improved aesthetics and removability (4,5).

Recent studies have reported lower pain levels and improved periodontal outcomes among aligner users compared to fixed appliances (6–9). However, appliance-related complications such as bracket debonding remain common in fixed orthodontics (10).

Limited comparative data exist from Pakistan, particularly from the Peshawar region. This study aimed to evaluate early treatment efficiency indicators and patient-reported outcomes among adult orthodontic patients treated with metal brackets, ceramic braces, and clear aligners in a multi-center setting.

Materials And Methods

Study Design and Duration

This multi-center comparative cross-sectional study was conducted from December 2024 to August 2025. A point-in-time assessment was performed among adult patients within 3–9 months of treatment initiation.

Study Settings

Data were collected from Khyber College of Dentistry (KCD), Sardar Begum Dental College (SBDC), Peshawar Dental College (PDC), and Rehman College of Dentistry (RCD)

Participants

A total of 440 adult patients (18–45 years old) undergoing orthodontic treatment were included in this study using consecutive sampling.

Inclusion Criteria

- Adults aged 18–45 years
- Active orthodontic treatment (3–9 months)
- No prior orthodontic therapy

Exclusion Criteria

- Active periodontal disease
- Craniofacial anomalies
- Systemic illness affecting bone metabolism
- Poor compliance in aligner therapy

Ethical Considerations

Ethical approvals were obtained from the Institutional Review Boards of all participating institutions. Written informed consent was obtained from all participants. The study followed the Declaration of Helsinki principles.

Outcome Measures

Mechanical Performance Indicators

Recorded at assessment:

- Bracket debonding
- Bracket fracture
- Archwire displacement
- Aligner tracking errors

Gingival Health

Assessed using the Löe and Silness Gingival Index (11).

Pain Assessment

Measured using a 0–100 Numerical Rating Scale.

Psychosocial Measures

A 5-point Likert scale assessed:

- Oral hygiene difficulty
- Social confidence

Statistical Analysis

Data were analyzed using SPSS version XX. Continuous variables were expressed as mean $\pm$ SD and compared using one-way ANOVA. Categorical variables were analyzed using Chi-square test. Statistical significance was set at $p < 0.05$.

Results

Total participants:440

Metal brackets: 148

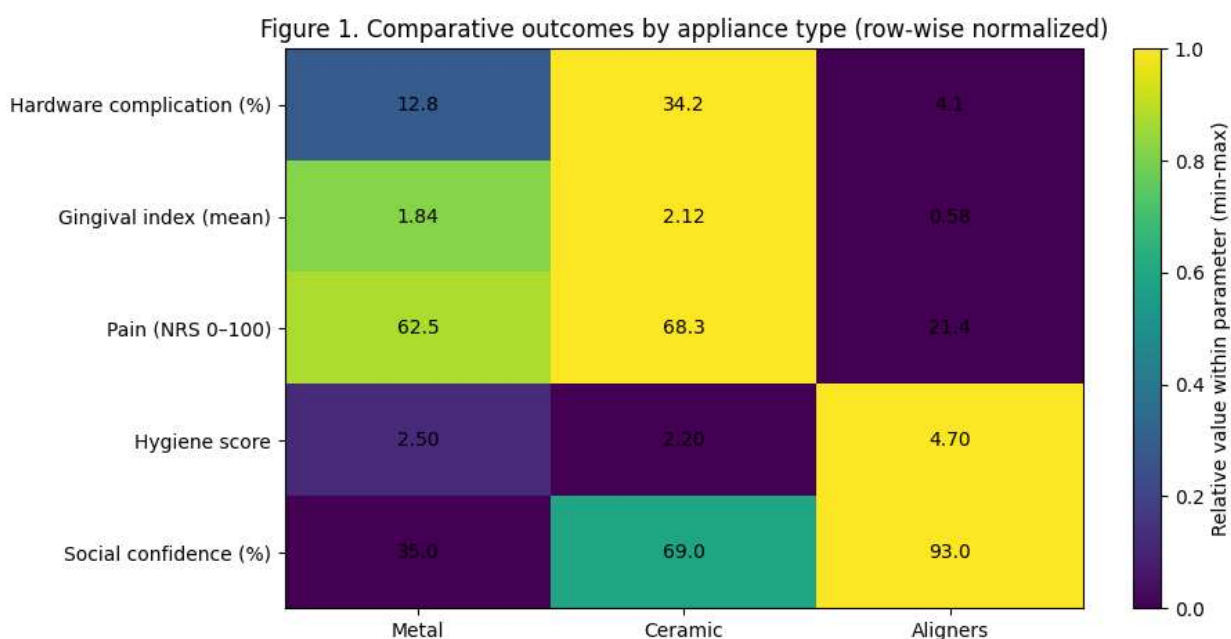
Ceramic braces: 146

Clear aligners: 146

Table 1. Early Treatment Efficiency Indicators and Patient-Reported Outcomes by Appliance Type

Parameter	Metal (n=148)	Ceramic (n=146)	Aligners (n=146)	p-value
Hardware Complication (%)	12.8	34.2	4.1	<0.001
Gingival Index (Mean $\pm$ SD)	1.84 $\pm$ X	2.12 $\pm$ X	0.58 $\pm$ X	<0.01
Pain (NRS 0–100)	62.5 $\pm$ X	68.3 $\pm$ X	21.4 $\pm$ X	<0.001

Hygiene Score (Mean $\pm$ SD)	2.5 $\pm$ X	2.2 $\pm$ X	4.7 $\pm$ X	<0.001
Social Confidence (%)	35	69	93	<0.001



This multi-center comparative cross-sectional study provides an early “snapshot” of how adult orthodontic patients in Peshawar experience three common appliance types during the active alignment phase. The main findings were consistent across four institutions. Clear aligners had the lowest point-in-time hardware complication frequency (4.1%). They also showed the lowest pain scores (mean NRS 21.4) and better gingival status (mean 0.58). Social confidence was highest with aligners (93%). Ceramic braces showed the highest complication frequency (34.2%) and the highest pain scores (mean 68.3). Metal brackets performed better than ceramic braces for complications (12.8%), but adult confidence was lowest with metal brackets (35%).

Discussion

This multi-center cross-sectional study evaluated early treatment efficiency indicators and patient-reported outcomes among adult orthodontic patients treated with metal brackets, ceramic braces, and clear aligners in Peshawar. The findings demonstrate significant differences in appliance-related complication frequency, pain perception, gingival health status, and social confidence across the three modalities during the early phase of treatment (3–9 months).

Clear aligners were associated with the lowest prevalence of hardware-related complications. This observation is consistent with contemporary systematic reviews reporting reduced mechanical failures in removable aligner systems compared to fixed appliances (3,4). Fixed orthodontic appliances are subject to bond failures, bracket fractures, and archwire displacement due to continuous mechanical stress and masticatory forces (5,10). Ceramic brackets, in particular, have been reported to exhibit higher fracture rates because of their inherent material brittleness and bonding limitations (3,10). The higher complication frequency observed in the ceramic group in the present study aligns with these mechanical properties. However, due to the cross-sectional nature of this analysis, it cannot be

concluded that ceramic systems inherently result in longer treatment duration. Longitudinal survival analyses would be required to establish such relationships.

Pain perception differed significantly between appliance types. Aligners were associated with substantially lower point-in-time pain scores compared to fixed appliances. Similar findings have been reported in recent meta-analyses, which suggest that aligners generate lighter and more controlled force application during early tooth movement (6,7). Fixed appliances exert continuous force through archwire activation, which may increase inflammatory response in the periodontal ligament during initial alignment stages (21). Adult patients often report discomfort during the first few months of treatment, and appliance selection may influence this early experience (20). The lower pain scores observed among aligner users in this study may therefore reflect differences in force delivery mechanics and appliance design.

Gingival health was significantly more favorable in the aligner group compared to fixed appliance groups. Removable systems allow patients to perform routine oral hygiene measures without obstruction, which may reduce plaque accumulation and gingival inflammation (8,9). Fixed appliances create plaque-retentive niches around brackets and ligatures, which can compromise periodontal health if hygiene practices are inadequate (27). Previous cross-sectional and longitudinal studies have consistently shown increased gingival index scores among patients treated with fixed appliances compared to removable aligner therapy (8,24). The present findings are in agreement with this evidence. However, it should be noted that oral hygiene behavior varies among individuals, and cross-sectional data cannot account for pre-treatment periodontal status.

Psychosocial outcomes also differed across appliance types. Social confidence was highest among aligner users and lowest among metal bracket patients. Adult orthodontic patients frequently prioritize aesthetics and discretion in treatment (11,19). Clear aligners are less visible and removable during social or professional interactions, which may positively influence self-perception and confidence (12,29). Studies evaluating patient-reported outcome measures (PROMs) in orthodontics have demonstrated improved satisfaction and quality-of-life scores in aligner-treated adults (13,28). The high social confidence reported in the aligner group in this study aligns with these findings. However, cultural and occupational factors specific to urban Peshawar may also influence patient perception.

Ceramic braces demonstrated improved social confidence compared to metal brackets but showed the highest hardware-related complication frequency. This highlights the balance between aesthetic preference and mechanical durability. Previous investigations have suggested that while ceramic brackets improve visual appeal, their bond strength and fracture resistance may be lower than metal systems (3,10). Clinicians should therefore consider patient expectations alongside biomechanical considerations when selecting appliance type.

The concept of early treatment efficiency must be interpreted cautiously in a cross-sectional framework. In the present study, efficiency refers to point-in-time mechanical performance indicators rather than total treatment duration. Cross-sectional analysis allows evaluation of complication prevalence and patient-reported experience but does not permit inference regarding long-term outcomes or overall treatment success. Prospective cohort studies or randomized controlled trials would be required to determine whether early differences in complication frequency translate into clinically meaningful variations in total treatment time.

This study has several strengths. It included a relatively large adult sample (N=440) and was conducted across four tertiary institutions, improving generalizability within the Peshawar region. Standardized assessment tools were used for pain measurement and gingival evaluation. However, certain limitations must be acknowledged. The cross-sectional design limits causal interpretation. Self-reported psychosocial measures may introduce response bias. Treatment stage variation within the 3–9 month window may influence complication prevalence. Compliance in aligner users was not objectively verified. Additionally, severity of malocclusion was not stratified, which may influence appliance selection and mechanical outcomes.

Despite these limitations, the findings provide valuable regional data regarding adult orthodontic treatment experience in Pakistan. The results suggest that aligner therapy is associated with lower early complication frequency, reduced pain, improved periodontal health indicators, and higher perceived social confidence during the active alignment phase. However, comprehensive longitudinal research is required to determine long-term stability, treatment duration, and cost-effectiveness across appliance types.

Limitations

This study was cross-sectional. Causal relationships cannot be established. Self-reported measures may introduce response bias. Compliance in aligner users was not objectively monitored. Outcomes beyond nine months were not evaluated.

Conclusion

Clear aligners were associated with lower appliance-related complication frequency, reduced pain levels, improved gingival health, and higher social confidence compared to fixed orthodontic appliances during early treatment stages. Further longitudinal research is required to evaluate long-term treatment efficiency.

Conflict Of Interest

The authors declare no conflict of interest.

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