



Original Article



The Efficacy and Difficulties of Implementing a Multifaceted of Strategies to Improve Retainer Compliance

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ARTICLE INFO

Keywords:

Retainer Compliance, Behavioral Strategies, Digital Interventions, Orthodontic Retention

How to Cite:

Jumani, S. S., Shahid, R., Tanwani, V., Mehmood, T., Kumari, P., Fatima, K., & Mushtaque, S. (2025). The Efficacy and Difficulties of Implementing a Multifaceted of Strategies to Improve Retainer Compliance: Strategies to Improve Retainer Compliance. *Pakistan Journal of Health Sciences*, 6(3), 187-192. <https://doi.org/10.54393/pjhs.v6i3.2918>

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Received date: 2nd February, 2025

Acceptance date: 22nd March, 2025

Published date: 31st March, 2025

ABSTRACT

Orthodontic therapy with both permanent and removable appliances is known to be impacted by poor compliance. **Objective:** To investigate the barriers affecting orthodontic retainer compliance and to explore the effectiveness of a multifaceted approach in enhancing adherence to retainer wear. **Methods:** In this mixed-methods study, 100 patients were recruited from Jinnah Medical and Dental College, and treatments improved these patients' retainer compliance. Two groups were made control and intervention in which the control group received orthodontic treatment, and the other group received education, digital tools, and behavioral techniques. For statistical analysis descriptive statistics, logistic regression, and chi-square tests were used, and for qualitative data thematic analysis. **Results:** The self-reported adherence rates of the control group were higher (78%) as compared to the control group (52%; $p < 0.05$). The intervention group had higher retention wear adherence than the control group (78% vs. 52%, $p < 0.05$) which was further confirmed by smart monitoring (6.5 vs. 4.2 nights/week, $p = 0.03$) and orthodontists (76% vs. 50%, $p < 0.05$). The impact of digital interventions and behavioral strategies in improving retainer compliance was demonstrated by the compliance-improving techniques that ranked mobile health reminders (82%) as the most effective. **Conclusions:** A multifaceted approach, such as behavioral approaches, digital technologies, and education, considerably increased retainer compliance. Hence, orthodontic retention regimens that incorporate behavioral techniques and technology may produce improved long-term treatment results.

INTRODUCTION

After active orthodontic treatment, orthodontic retention is an essential phase that ensures the long-term stability of the improved oral alignment and occlusion. To prevent relapse, the natural tendency of teeth to return to their pre-treatment positions due to varying biological and behavioral forces retainers is crucial [1]. However, patient adherence to retainer wear is crucial for long-term stability [2]. One of the main reasons for orthodontic relapse and, consequently, the need for additional corrective treatment is non-compliance with retainers. To identify the success rate of orthodontic treatment it is essential to understand the compliance of retainers [3]. Earlier the success rate of Orthodontic treatment was evaluated based on improved

aesthetics and occlusion along with minimum changes done after treatment [4]. Nowadays the treatment comprises of patient-centered, interdisciplinary perspective as it helps to determine the quality of life of an individual. With time the criteria to evaluate the efficiency of orthodontic treatment is no longer clinical success, other factors such as self-esteem and confidence are of more importance nowadays [5]. Although great advancements have been made in the field even though both patients and doctors need to work hard to achieve optimal compliance with retainer. Several factors are associated with poor retainer adherence such as patient-related issues [6]. Hence daily routines, lifestyle choices,



and patient attitudes toward orthodontic treatment are also essential for long-term compliance. Inadequate follow-up visits, a lack of reinforcing mechanisms, and poor patient education are components of low adherence [7]. All the patient's needs can be addressed by specific strategies and proper planning. Maintaining orthodontic treatment results requires increasing patient adherence to wearing retainers. Implementing remote monitoring systems, applying behavioral reinforcement strategies, and offering thorough patient education are all components of a comprehensive strategy. Including parents or peers for support, tailoring retainer kinds to the patient's preferences, and making sure follow-up sessions are scheduled regularly are all important ways to improve compliance. Furthermore, innovations like smart retainers with compliance sensors provide unbiased wear-time tracking. Together, these diverse approaches tackle the different aspects that affect retainer adherence, which supports treatment stability over the long run [8]. Those patients who are non-compliant in wearing retainers usually suffer from more orthodontic relapse, consisting of the efficacy of the early treatment, and require more corrective measures. Hence, researchers and clinicians have investigated several methods to improve adherence because of the challenges faced by patients in retainer compliance. A multifaceted approach consists of several approaches related to education, behavior, and technology to meet the needs of patients [9, 10]. The main fundamentals to achieve sustained retainer compliance include Clinician-patient communication and follow-up care [11]. One of the emerging approaches of today's time is remote monitoring and virtual check-ins, which help in providing timely interventions whenever there is a compliance issue [12]. Orthodontic retention poses a significant challenge, particularly in the context of Pakistan, where socio-cultural and economic factors greatly influence patient compliance. Although there is a growing demand for orthodontic services, local research on retainer adherence is scarce, with the majority of studies concentrating on short-term results rather than long-term stability [5]. Research conducted internationally has shown that interventions related to behavior change, digital tools, and educating patients can effectively enhance compliance; however, these approaches need to be researched within the Pakistani context [13].

Orthodontic relapse due to poor retainer compliance remains a major challenge, compromising long-term treatment success and increasing the need for retreatment. Despite evidence that education, behavioral reinforcement, and digital tools may improve adherence, retainer non-compliance continues because of forgetfulness, social stigma, and insufficient motivation. In Pakistan, limited local research has explored long-term retainer adherence or evaluated multifaceted

interventions within socio-cultural and economic contexts. Therefore, this study aimed to identify barriers to retainer compliance and assess the effectiveness of combined educational, behavioral, and digital strategies in improving orthodontic retention outcomes. The study was conducted to fill the gaps by investigating the barriers affecting orthodontic retainer compliance and to explore the effectiveness of a multifaceted approach in enhancing adherence to retainer wear.

METHODS

In Karachi, Pakistan, Jinnah Medical and Dental College conducted a mixed-methods quasi-experimental non-randomized controlled study from April to September 2024. The ERB/JMDC/Approval# #:00006/24 was used to obtain ethical approval. A total 100 orthodontic patients were recruited in the study. The Open-Epi (Version 3.01) sample size calculator for comparing two proportions was used to determine the sample size for this quasi-experimental investigation. A 95% confidence level, 80% power, and a 1:1 allocation ratio between the control and intervention groups were among the assumptions made for the computation. The control group was projected to have a 50% adherence rate, whereas the intervention group was intended to reach an 80% adherence rate. 0.05 was used as the two-sided significance threshold. Group 1 (Control) had 50% adherence, Group 2 (Intervention) had 80% adherence, $\alpha = 0.05$, power = 80%, and a ratio of 1 were the values entered using Open-Epi's "Sample Size for Two Proportions" tool. This resulted in a minimal sample size of 90 participants, or 45 participants each group. The ultimate sample size was 100 participants, with 50 in each group, after a 10% buffer was established to accommodate for possible dropouts or non-compliance. This computation made sure the study had enough power to identify a statistically significant difference between the two groups' retainer adherence rates. Using a non-probability purposive sampling technique, the sample of 100 patients was split into two groups on the basis of their eligibility and desire to receive multiple interventions: intervention and control. The intervention group (n=50) consisted of patients who met the inclusion criteria and agreed to receive behavioral reinforcement tools, mobile health reminders, and further instruction. The control group, on the other hand, consisted of 50 individuals who also fulfilled the inclusion requirements but chose to receive simply the conventional post-orthodontic care instructions without any digital or behavioral reinforcement. The effectiveness of routine care versus enhanced assistance measures in increasing retainer compliance was assessed through a quasi-experimental comparison made possible by this division. A validated questionnaire was used to assess the compliance [14]. The qualitative method used to acquire detailed information about patients' experiences and opinions on the usage of

retainers was a semi-structured interview guide. Personal experiences with retainers, difficulties with everyday wear, feedback on educational sessions, digital aids like mobile reminders, and behavioral reinforcement techniques were among the main topics covered in the handbook. It also asked for recommendations on how to increase compliance. The interview was divided into sections that addressed firsthand experiences, motivation and comprehension of the significance of retention, obstacles to regular usage, comments on the treatments, and the function of peer or family support networks. The interviews were done by trained researchers and lasted between 20 and 30 minutes each. All of the sessions were audio recorded. In order to assure reliability and depth of interpretation, the data were subjected to independent coding by two researchers and then cross-validated using theme analysis in NVivo software. Ethical considerations, such as ensuring patient confidentiality and obtaining informed consent, were strictly maintained. Patients who had received orthodontic treatment, were wearing removable retainers, were willing to participate in follow-ups, and had access to a smartphone for digital interventions were included in the study. The patients ranged in age from 18 to 60. Individuals having a history of noncompliance, fixed retainers, cognitive impairments, or Temporomandibular Joint Disorders (TMDs) were excluded. Self-reported adherence diaries, surveys, semi-structured interviews, orthodontist evaluations, and smart retainer monitoring were all used in the data collection process. While the control group received conventional post-orthodontic care instructions, the intervention group received instructional seminars, mobile health reminders, and systematic habit-tracking. To improve the survey instruments and evaluate the precision of the smart monitoring system, a pilot study was carried out. Patients' experiences with retainer compliance, difficulties encountered, and opinions of digital solutions were all covered in the interview guide. Descriptive statistics, logistic regression, chi-square tests, and normality assessments (Shapiro-Wilk test) were all part of the quantitative study. The effectiveness of the intervention was assessed using effect sizes and Confidence Intervals (Cis).

RESULTS

There were 100 patients in the study, 50 in the intervention group and 50 in the control group. The participants' mean age was 22.5 ± 3.2 years, and 60% of them were female. As indicated in Table 1, the baseline characteristics of both groups, including age, gender, educational achievement, and the type of initial orthodontic treatment, were comparable (p > 0.05).

Table 1: Demographic Details of Participants (n=200)

Variables	Intervention Group Mean ± SD/ Frequency (%)	Control Group Mean ± SD/ Frequency (%)	Total Mean ± SD/ Frequency (%)	p-Value
Present	22.8 ± 3.1	22.3 ± 3.3	22.5 ± 3.2	0.52
Gender				
Male	20 (40%)	20 (40%)	40 (40%)	1.00
Female	30 (60%)	30 (60%)	60 (60%)	1.00
Level of Education				
High School	12 (24%)	14 (28%)	26 (26%)	0.67
Undergraduate	24 (48%)	22 (44%)	46 (46%)	0.72
Postgraduate	14 (28%)	14 (28%)	28 (28%)	1.00
Types of Orthodontic Treatment				
Fixed Braces	35 (70%)	33 (66%)	68 (68%)	0.68
Clear Aligners	15 (30%)	17 (34%)	32 (32%)	0.71
Type of Retention				
Hawley Retainer	20 (40%)	22 (44%)	42 (42%)	0.69
Essix Retainer	30 (60%)	28 (56%)	58 (58%)	0.73

The Shapiro-Wilk test was used to determine whether age and smart retainer adherence were normal continuous variables before the use of parametric testing. The findings supported the use of logistic regression and t-tests for additional analysis since they showed a normal distribution (p > 0.05). The intervention group showed noticeably better retainer compliance than the control group. Compared to 52% (95% CI: 38.8–65.0) in the control group, the intervention group's self-reported adherence rates were 78% (95% CI: 66.2–87.0) (p < 0.05, effect size: Cohen's d = 0.65, moderate effect). A statistically significant improvement in adherence is confirmed by these results as shown in table 2.

Table 2: Outcomes of Adherence (n=100)

Variables	Intervention Group Frequency (%) /Mean ± SD	Control Group Frequency (%) /Mean ± SD	p-Value
Adherence reported by self	39 (78%)	26 (52%)	<0.05
Orthodontist-confirmed adherence	38 (76%)	25 (50%)	<0.05
Smart retainer monitoring (Average nights per week)	6.5 ± 1.2	4.2 ± 1.5	0.03

The most common barriers were social stigma (35%), forgetfulness (30%), and ignorance (40%). Other challenges were losing retainers (15%), lacking motivation (20%), and having trouble speaking (22%). Even though the majority of comparisons were not significant (p > 0.05), more significant differences might have been found with a larger sample size. The intervention group did, however, have significantly lower levels of social stigma (p = 0.03) and lack of motivation (p = 0.04) as shown in Table 3.

Table 3: Challenges Faced by Participants due to Compliance of Retainers(n=200)

Variables	Intervention Group Frequency (%)	Control Group Frequency (%)	Overall Frequency (%)	p-Value
Unawareness	18 (36%)	22 (44%)	40 (40%)	0.21
Habit of Forgetting	14 (28%)	16 (32%)	30 (30%)	0.45
Social Stigma	16 (32%)	19 (38%)	35 (35%)	0.37
Speech Issues	10 (20%)	12 (24%)	22 (22%)	0.41
No motivation	9 (18%)	11 (22%)	20 (20%)	0.48
Losing Retainers	7 (14%)	8 (16%)	15 (15%)	0.50

According to 82% of participants, mobile health reminders were the most successful tactic for increasing adherence. Behavioral reinforcement and instructional materials also had a significant effect. In 54% of cases, parental participation was advantageous, confirming the effectiveness of behavioral and digital treatments.

Table 4: Efficacy of Various Approaches used by Participants (n=50)

Variables	Useful for Participants	Efficacy (%)
Reminder Messages	41	82%
Educational messages	38	75%
Reinforcement of Behavior	34	68%
Involvement of family	27	54%

DISCUSSION

The current study's findings demonstrate that a multifaceted strategy significantly increases orthodontic retainer adherence. The adherence rate of the intervention group, which received behavioral reinforcement, electronic reminders, and educational support, was considerably greater (78%) than that of the control group (52%; $p < 0.05$). The results support previous research showing that behavioral strategies, electronic health treatments, and patient education can increase adherence to orthodontic retention plans [15, 16]. Mobile health reminders were identified as the most successful approach (82%), making them one of the most significant factors of compliance. This is consistent with research showing that digital interventions, such as smartphone apps and text message reminders, can improve patient compliance [17]. Online tools are successful because they may be incorporated into patients' daily routines as consistent reminders, removing forgetfulness, which this study found to be the main reason for non-adherence (30%). Additionally, behavioral reinforcement and patient education played a key role in improving compliance (68% and 75%, respectively). Long-term adherence to dental and medical treatments has been demonstrated to be enhanced by motivational interviewing and reinforcement techniques [18]. By showing that patients who received personalized involvement and reinforcement had improved retainer wear adherence, the current study bolsters this data. Hence, family member involvement also increased

compliance, highlighting the importance of social support for treatment adherence [19, 20]. More research should be conducted locally to improve adherence, even though some of these problems were lessened by the intervention techniques [21]. Several challenges were found in both groups such as stigma caused by society (35%), difficulties in speech (22%), and lack of motivation (20%). In literature, these barriers have been documented several times. Hence additional measures, such as cognitive behavioral therapy should be implemented to enhance adherence.

The main limitation of the study was the small sample size along with the single-center study. To identify whether the therapies used in this study are sustainable more longitudinal studies with extended observation periods were required. This study was limited by its small sample size, single-center design, non-randomized sampling method, and short follow-up duration, which may restrict generalizability and long-term applicability of findings. Self-reported adherence may also introduce reporting bias despite smart monitoring support. Future studies should involve larger multicenter randomized controlled trials with longer follow-up periods to assess sustainability of compliance strategies. Additionally, integrating advanced digital monitoring systems and culturally tailored behavioral interventions may further strengthen long-term orthodontic retention success.

CONCLUSIONS

A multifaceted strategy that included education, digital technologies, and behavioral methods significantly enhanced retainer compliance. In addition to improving adherence and long-term orthodontic retention outcomes, targeted therapies such as reinforcement behavior, customized patient engagement, and reminder systems can lessen barriers experienced by orthodontic patients.

Authors' Contribution

Conceptualization: SSJ

Methodology: VT, KF

Formal analysis: RS, SM

Writing and Drafting: SSJ, TM, PH, SM

Review and Editing: SSJ, TM, PH, SM

All authors approved the final manuscript and take responsibility for the integrity of the work

Conflicts of Interest

All the authors declare no conflict of interest.

Source of Funding

The author received no financial support for the research, authorship and/or publication of this article.

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