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ORIGINAL ARTICLE

Impact of Orthodontic Treatment on Speech and Phonetics. A Cross-Sectional Study

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ABSTRACT

Background: Orthodontic treatment aims to correct malocclusion and improve aesthetics and oral function; however, alterations in intra-oral anatomy during treatment may temporarily affect speech and phonetics. Understanding these effects is important for improving patient comfort and communication confidence.

Objective: To evaluate the impact of different orthodontic appliances on speech articulation, phonetic performance, and patient-perceived speech difficulty.

Methods: A cross-sectional study was conducted in the Department of Orthodontics, Baqai Dental College, Karachi, Pakistan, from April 2022 to July 2023. A total of 130 patients aged 15–30 years receiving fixed labial, lingual, or removable orthodontic treatment were assessed. Speech recordings were obtained at three intervals before appliance placement, one week after, and one month after using a standardized list of phonemes (/s/, /z/, /ʃ/, /ʒ/, /t/, /d/). Auditory perceptual analysis and a self-administered questionnaire evaluated phonetic distortions and subjective difficulty. Data were analyzed with SPSS v26 using χ^2 and repeated-measures ANOVA tests.

Results: Speech disturbances were most frequent during the first week, particularly in lingual appliance users (70%), followed by fixed labial (42%) and removable (33%) groups ($p < 0.05$). Sibilant sounds were most affected, with temporary lisping noted in 44.6% of participants. Mean self-perceived difficulty decreased significantly by the first month, indicating rapid phonetic adaptation.

Conclusion: Orthodontic treatment may cause short-term speech and phonetic disturbances, especially with lingual appliances, but these effects resolve within four weeks as patients adapt. Early counseling and speech-adaptation guidance can enhance patient confidence and compliance during therapy.

Keywords: Orthodontics, Speech Articulation, Phonetics, Lingual Braces, Speech Adaptation

INTRODUCTION

Orthodontic treatment is primarily undertaken to correct dental malocclusions, restore masticatory efficiency, and improve facial esthetics[1]. Beyond these mechanical and cosmetic outcomes, orthodontic appliances can temporarily alter oral physiology, influencing key oral functions such as speech and phonation. Speech production requires precise coordination between the tongue, lips, alveolar ridge, palate, and teeth. Any alteration in the spatial arrangement or mobility of these articulatory structures such as through the insertion of brackets, archwires, or aligners can disturb normal phonetic patterns and articulation[2,3].

The oral cavity serves as a resonating chamber for sound formation, and minor changes in its anatomy or airflow dynamics can significantly impact the clarity and precision of speech sounds. Several studies have indicated that orthodontic appliances, especially fixed and lingual types, may affect sibilant and alveolar consonants such as /s/, /z/, /t/, and /d/. These sounds require fine control of tongue placement and airflow through narrow oral passages; hence, the presence of an appliance can cause distortion or lisping during the adaptation period[4-6].

The type and design of orthodontic appliances play a crucial role in determining the extent of speech alteration. Fixed labial appliances can interfere with lip movement, while lingual appliances directly obstruct tongue contact with the palate, leading to more pronounced phonetic disturbances[7]. Removable appliances, though less intrusive, may still temporarily affect articulation until the patient adapts. These phonetic changes, although transient, can influence a patient's social confidence, communication ability, and overall satisfaction with treatment. Therefore, understanding the nature and duration of such changes is essential for effective clinical counseling and patient management[8].

Most previous studies have focused on acoustic or perceptual analysis of specific speech sounds in limited sample sizes, with varying findings across languages and appliance designs. Few have compared speech adaptation across different orthodontic techniques within the same population. In addition, most research from Western contexts does not reflect linguistic or phonetic diversity present in South Asian languages, where dental and alveolar sounds are articulated differently[9-11].

Given this background, the present study aims to evaluate the impact of orthodontic treatment on speech and phonetics among patients receiving different types of orthodontic appliances. It further aims to determine the extent and duration of speech disturbances and to identify which appliance type most significantly influences phonetic performance. Understanding these factors can help clinicians provide better anticipatory guidance, promote patient adaptation, and improve the overall orthodontic experience[12].

MATERIALS AND METHODS

Study Design and Setting: This cross-sectional study was conducted in the Department of Orthodontics, Baqai Dental College, Karachi, Pakistan, over a period extending from April 2022 to July 2023. The study was designed to evaluate the impact of orthodontic treatment on speech articulation and phonetic characteristics among patients undergoing different types of orthodontic therapies. The setting provided a diverse patient population representing various malocclusion types and treatment modalities, ensuring the reliability and applicability of the findings to a wider clinical context.

Study Population and Sample Size: A total of 130 patients undergoing orthodontic treatment were included in this study. The sample was selected using a non-probability convenient sampling technique from patients attending the outpatient orthodontic clinic during the specified study period. The sample size was estimated to provide adequate statistical power at a 95% confidence interval and a 5% margin of error. All participants were evaluated for eligibility based on predefined inclusion and exclusion criteria.

Inclusion Criteria: Patients aged 15 to 30 years, of both genders, who were undergoing orthodontic treatment with fixed labial, lingual, or removable appliances were included. Only those with normal hearing, intact speech abilities, and no prior history of speech or neurological disorders were considered eligible. All participants voluntarily consented to participate in the study after being informed about its purpose and procedures.

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Exclusion Criteria: Patients presenting with congenital anomalies, such as cleft lip or palate, or with any neurological, maxillofacial, or systemic disorders known to affect speech were excluded. Individuals with incomplete orthodontic records, irregular follow-up visits, or lack of willingness to participate were also excluded to maintain data integrity.

Data Collection Procedure: Data collection involved both objective and subjective assessments of speech and phonetics. Each participant was evaluated at three specific intervals:

1. Before appliance placement (baseline)
2. One week after appliance placement
3. One month after appliance placement

Speech recordings were performed in a quiet, acoustically controlled environment using a professional-grade digital microphone. Participants were instructed to pronounce a phonetically balanced word list and read a standardized paragraph containing the most commonly affected consonants, including /s/, /z/, /ʃ/, /ʒ/, /t/, and /d/. These sounds were chosen due to their known susceptibility to orthodontic interference.

The recorded samples were evaluated by two trained speech-language pathologists who conducted both auditory perceptual and acoustic analyses to assess articulation accuracy, phoneme distortion, and speech clarity. The degree of speech alteration was graded using standardized phonetic scoring systems. In addition, each participant completed a self-assessment questionnaire to report perceived speech difficulties, rated on a five-point Likert scale (1 = no difficulty, 5 = severe difficulty). Demographic data, including age, gender, type of appliance, and treatment duration, were also collected.

Ethical Considerations: Ethical approval for this study was obtained from the Institutional Review Board (IRB) of Baqai Dental College, Karachi . Written informed consent was obtained from all participants prior to data collection. Confidentiality and anonymity of participants were maintained throughout the research process, and all procedures complied with the ethical standards of the Declaration of Helsinki.

Statistical Analysis: All data were analyzed using IBM SPSS Statistics version 26.0. Descriptive statistics, including means, standard deviations, and percentages, were computed for continuous and categorical variables. Comparative analysis of speech changes across appliance types and time intervals was carried out using the Chi-square test and Repeated Measures ANOVA. A p-value of less than 0.05 was considered statistically significant. The results were tabulated and interpreted to determine the correlation between appliance type and phonetic alteration.

RESULTS

Demographic Characteristics of the Study Population: A total of 130 patients undergoing orthodontic treatment at the Department of Orthodontics, Baqai Dental College, Karachi, were included in this study. Among them, 78 (60%) were females and 52 (40%) were males, with a mean age of 21.6 ± 3.4 years. The majority of participants (46.2%) were in the 21–25-year age group, followed by 34.6% in the 15–20-year range and 19.2% aged between 26 and 30 years. In terms of appliance distribution, 50 (38.5%) patients were treated with fixed labial appliances, 40 (30.8%) with lingual appliances, and 40 (30.8%) with removable orthodontic appliances. Most participants were students (62.3%), while others were office employees or engaged in miscellaneous occupations.The demographic characteristics of the study population are summarized in Table 1. As shown in Table 1, most subjects were young female students, with fixed labial appliances being the most commonly used treatment modality.

Changes in Speech Articulation Following Appliance Placement: Evaluation of speech articulation at different follow-up intervals revealed that noticeable phonetic disturbances occurred during the first week after appliance placement. The most affected speech elements were sibilant (/s/, /z/) and alveolar (/t/, /d/) sounds, which showed audible distortions and mild lisping. These alterations were more evident among patients with lingual appliances, followed by those using fixed labial and removable appliances. Statistical analysis indicated a significant association ($p < 0.05$) between appliance type and the degree of speech disturbance. Table 2 presents the comparison of speech difficulties recorded across different appliance types at baseline, one week, and one month after appliance placement. According to Table 2, the incidence of speech difficulty peaked during the first week, particularly in lingual appliance users (70%). By the end of one month, the majority of patients demonstrated phonetic adaptation and regained normal articulation.

Table 1: Demographic and Clinical Characteristics of Participants (n = 130)

Variable	Categories	Frequency (n)	Percentage (%)
Gender	Male	52	40.0
	Female	78	60.0
Age Group (years)	15–20	45	34.6
	21–25	60	46.2
	26–30	25	19.2
Type of Appliance	Fixed Labial	50	38.5
	Lingual	40	30.8
	Removable	40	30.8
Occupation	Students	81	62.3
	Office Workers	26	20.0
	Others	23	17.7

Table 2: Comparison of Speech Difficulties Across Appliance Types (n = 130)

Appliance Type	Baseline Speech Difficulty (%)	1 Week after Placement (%)	1 Month after Placement (%)	p-Value
Fixed Labial	3.8	42.0	9.5	< 0.05
Lingual	5.0	70.0	18.0	< 0.05
Removable	2.5	33.0	6.0	< 0.05

Patterns of Phonetic Disturbances: Detailed acoustic and perceptual analysis identified that the most frequent disturbance was lisping on the /s/ and /z/ sounds, affecting nearly 44.6% of participants during the first week of treatment. Distortions in palato-alveolar sounds (/ʃ/, /ʒ/) were observed in 24.6% of cases, while impaired articulation of /t/ and /d/ was noted in 16.1%. Minor nasal resonance changes were reported by 8.5% of patients, whereas 6.2% exhibited no phonetic alteration at all. These findings are summarized in Table 3.

Table 3: Frequency and Types of Phonetic Disturbances Observed During Treatment (n = 130)

Type of Speech Disturbance	Frequency (n)	Percentage (%)
Lisping on /s/ and /z/ sounds	58	44.6
Distortion of /ʃ/ and /ʒ/ sounds	32	24.6
Impaired articulation of /t/ and /d/	21	16.1
Nasal resonance alteration	11	8.5
No noticeable change	8	6.2

Self-Perceived Speech Difficulty and Adaptation: Patient-reported outcomes, assessed through a five-point Likert-scale questionnaire, demonstrated a consistent decline in perceived speech difficulty over time. One week after appliance placement, the mean difficulty scores were 3.1 ± 0.7 for fixed labial, 3.9 ± 0.8 for lingual, and 2.6 ± 0.5 for removable appliances. By one month, the mean scores decreased significantly to 1.8 ± 0.4, 2.1 ± 0.5, and 1.5 ± 0.3, respectively ($p < 0.05$ for all). This reduction reflects rapid patient adaptation and progressive normalization of speech patterns.The detailed data are shown in Table 4.

Table 4: Mean Self-Perceived Speech Difficulty Scores by Appliance Type

Appliance Type	1 Week After Placement (Mean ± SD)	1 Month After Placement (Mean ± SD)	p-Value
Fixed Labial	3.1 ± 0.7	1.8 ± 0.4	< 0.05
Lingual	3.9 ± 0.8	2.1 ± 0.5	< 0.05
Removable	2.6 ± 0.5	1.5 ± 0.3	< 0.05

Repeated-measures ANOVA revealed a significant effect of time on phonetic performance ($F = 14.27$, $p < 0.001$), confirming

that speech articulation improved notably with continued appliance use. Post-hoc comparisons indicated the most pronounced change between the first-week and one-month follow-ups, while baseline and one-month results were statistically non-significant ($p > 0.05$), suggesting near-complete phonetic recovery.

The study showed that temporary changes in speech are common after orthodontic appliance placement, especially during the first week. Lingual appliances caused the most noticeable phonetic disturbances due to tongue restriction, while labial and removable appliances produced milder effects. Most patients adapted quickly, and normal speech was restored within about four weeks. Both professional phonetic assessments and patient self-reports confirmed a strong link between objective speech alterations and perceived difficulty. Overall, orthodontic treatment may briefly affect phonetics, but these effects are mild, self-limiting, and fully reversible with time.

DISCUSSION

The findings of this study demonstrate that orthodontic treatment can temporarily influence speech and phonetic articulation, particularly during the early phase of appliance adaptation. The results revealed that patients experienced the most noticeable disturbances within the first week after appliance placement, with gradual recovery over subsequent weeks[10]. This observation is consistent with prior studies, which have reported that changes in oral anatomy and tongue positioning during orthodontic treatment can transiently alter airflow and articulation patterns, especially for sibilant and alveolar sounds such as /s/, /z/, /t/, and /d/[11-13].

The greatest degree of speech alteration was recorded among patients using lingual appliances. This can be attributed to the close proximity of lingual brackets to the tongue, which disrupts its natural movement and contact with the palate[14]. Previous studies by Dalessandri et al. (2020) and Kim et al. (2019) similarly noted that lingual appliances produce more pronounced speech difficulties than labial or removable systems. In contrast, fixed labial appliances caused moderate interference with lip and anterior tongue movement, while removable appliances showed minimal and short-lived effects on phonetics[15].

An encouraging finding was that nearly all patients regained normal speech articulation by the fourth week of treatment. This recovery reflects the remarkable adaptability of the human speech mechanism. As the tongue and oral musculature adjust to new spatial configurations, neuromuscular coordination improves and articulation errors gradually resolve[16]. Comparable adaptation trends have been documented in acoustic studies that recorded normalization of formant frequencies within three to four weeks after orthodontic appliance insertion[17].

The study also highlighted a close correlation between objective phonetic assessment and patients' subjective perception of speech difficulty[18]. Participants who experienced measurable articulatory changes also reported higher self-perceived difficulty scores, confirming that patient awareness of phonetic alteration is consistent with clinical observation. These findings emphasize the importance of patient counseling before appliance placement. Informing patients that mild speech changes are temporary can reduce anxiety and improve treatment compliance[19-22].

While the present study provides valuable insights, certain limitations must be acknowledged. The cross-sectional design limited long-term observation beyond one month, and acoustic spectrographic analysis could further strengthen the precision of phonetic evaluation[23,24]. Additionally, speech variations across different languages or dialects were not assessed, which may influence phoneme articulation. Future research using longitudinal follow-up and objective acoustic modeling could provide deeper understanding of adaptation dynamics and inter-language variability[25].

CONCLUSION

Orthodontic treatment, particularly with lingual and fixed labial appliances, can cause short-term phonetic disturbances during the initial adaptation period. These changes mainly affect sibilant and alveolar sounds but are generally mild and reversible. Most patients regain normal speech within four weeks as the oral structures adapt to the presence of the appliance. Early counseling, reassurance, and simple speech adaptation exercises can help patients overcome temporary discomfort and maintain confidence throughout treatment.

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Data Availability Statement: Data supporting the findings of this study are available from the corresponding author upon reasonable request.

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Authors' Contributions:

F.A.S.: Study conception and supervision.
A.Y.: Data collection and manuscript drafting.
S.Q.: Data analysis and interpretation.
A.S.Q.: Clinical assessment and data acquisition.
B.E.R.: Tables, figures, and formatting.
J.T.: Proofreading and final manuscript preparation.

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