International Journal of Community Medicine and Public Health
Najjar HE et al. Int J Community Med Public Health. 2023 Aug;10(8):2995-2999
http://www.ijcmph.com
pISSN 2394-6032 | eISSN 2394-6040

DOI: https://dx.doi.org/10.18203/2394-6040.ijcmph20232397

Review Article

Impact of orthodontic treatment on speech and phonetics: a review

Hussam E. Najjar[1]*, Sarah Abdullah Alzaid[2], Amjad Mohammad Alasmari[3], Sultan Ali Alrashdi[4], Asim Mohammed Alqahtani[3], Samia Mussaed Alrhile[5], Saud Salman Alqahtani[6], Shorouq Shaker Aldrees[7], Ahmed Farhan Alanazi[8], Afnan Ali Alamri[9], Sama Abdullah Alotaibi[10]

[1]Department of Orthodontics, Al Thager Hospital, Jeddah, Saudi Arabia
[2]College of Dentistry, Dar Al Uloom University, Riyadh, Saudi Arabia
[3]College of Dentistry, King Khalid University, Abha, Saudi Arabia
[4]Ministry of Health, Al Qassim, Saudi Arabia
[5]Dental Department, Prince Sultan Military Medical City, Riyadh, Saudi Arabia
[6]Loran Dental Clinics, Riyadh, Saudi Arabia
[7]Dhurma General Hospital, Riyadh, Saudi Arabia
[8]College of Dentistry, Vision Colleges, Riyadh, Saudi Arabia
[9]Al Muzahmiah General Hospital, Riyadh, Saudi Arabia
[10]Specialized Clinics Centre, Sakaka, Saudi Arabia

Received: 09 June 2023
Accepted: 24 July 2023

***Correspondence:**
Dr. Hussam E. Najjar,
E-mail: hussamix@gmail.com

ABSTRACT

Orthodontic devices, including both fixed and removable devices, have the potential to impact dental anatomy, the space within the oral cavity, the displacement of the tongue, and the production of speech. The usage of fixed labial appliances may cause transient or persistent speech and phonetics changes, particularly affecting sibilant and stopped sounds. Lingual fixed appliances, while providing aesthetic advantages, can lead to difficulties in maintaining oral hygiene, pain in the tongue, and speech disturbances. Orthodontic retainers, used post-treatment, can also affect speech and phonetics by altering the oral cavity space and tongue position. Other appliances like removable appliances, palatal expanders, and prosthetic dental appliances may also disrupt speech production. Objective, semi-objective, and subjective assessments are utilized to evaluate speech disruptions induced by orthodontic devices. Patients considering orthodontic aligners should be informed about potential temporary limitations in speech production, which can be managed by removing the device when necessary. The adaptation to orthodontic treatment may vary based on individual characteristics. Orthodontists should consider these effects and communicate them to patients. This review article explores the effect of orthodontic treatment on speech and phonetics.

Keywords: Orthodontic treatment, Speech phonetics, Orthodontic appliances, Speech disturbances, Labial fixed appliances

INTRODUCTION

An increasing number of patients seek orthodontic treatment because malocclusion has a significant effect on their quality of life. The field of orthodontic appliances is continuously advancing as a result of evolving technologies. This progress is primarily driven by consumer preferences for improved aesthetics during treatment and the growing demand for faster outcomes.[1] Certain distinctive sounds, or phonemes, are produced directly by the upper and lower arches (t, d, n, l), while others are produced indirectly (s, z, f, v, th). Additionally, they serve as structural limits for the lips when the

bilabial phonemes (m, p, and b) are produced.[2] A structural abnormality may interrupt the production of consonants and result in audibility issues that make speech difficult to understand.[2] The discomfort of orthodontic treatment has a negative effect on patient compliance.[3] Speech and phonetics difficulties are recognized as a significant complication among the various negative outcomes associated with orthodontic treatment.[4] In addition to the initial speech issues brought on by malocclusion, orthodontic equipment can also create speech issues because they are a foreign body in the oral cavity. More specifically, orthodontic appliances frequently conform to the palate and tooth surfaces, influencing the tongue's mobility and altering the oral cavity's space. As a consequence, certain sounds can become distorted.[5] In addition, it has been reported that different types of orthodontic devices such as labial and lingual fixed appliances, tongue thrusts, palatal expanders, and Hawley retainers may influence speech and phonetics clarity.[2] Studying the role of orthodontic devices on speech and phonetics is valuable since it enables orthodontists to comprehend the mechanisms behind speech and phonetics distortions. This knowledge empowers them to provide objective guidance to patients regarding speech challenges and offer suitable solutions to address these issues. Doshi et al summarized the correlation between speech defect and orthodontics, which included the effect of orthodontic appliances on speech distortion, but an electronic systematic literature search was not conducted, and therefore, the included studies might be deficient.[6] Additionally, some systematic reviews focusing on the comparison of negative impacts between lingual and labial orthodontic treatment have been also conducted, and the results suggested that patients with lingual devices had more speech difficulties.[4,7] Nevertheless, as far as our current understanding goes, we have not thoroughly documented speech and phonetics challenges resulting from various kinds of orthodontic appliances such as fixed appliances, removable appliances, and orthodontic retainers.[8-10] There has been a lack of comprehensive summarization of speech and phonetics difficulties caused by different types of orthodontic appliances using an evidence-based approach. This review article will focus on impact of orthodontic treatment on speech and phonetics.

LITERATURE SEARCH

This study is based on a comprehensive literature search conducted on 4 June 2023, in the Medline, PubMed and Cochrane databases, utilizing the medical topic headings (MeSH) and a combination of all available related terms, according to the database. To prevent missing any possible research, a manual search for publications was conducted through Google Scholar, using the reference lists of the previously listed papers as a starting point. We looked for valuable information in papers that discussed the impact of orthodontic treatment on speech and phonetics. There were no restrictions on date, language, participant age, or type of publication.

DISCUSSION

The use of orthodontic appliances may adversely affect dental anatomy, space in the oral cavity, movement of the tongue and perioral musculature, and, consequently, speech and phonetics production. These changes should be considered by orthodontists and shared with patients.[11] The creation of speech sounds is affected differently by the placement of fixed labial orthodontic equipment. Some patients have a brief, unfavourable shift. In others, a more persistent change is seen over a period of two months. In approximately 40%, no change is noted.[2] The implantation of a permanent labial device affects both sibilant and stopped sounds. But sibilants, particularly /s/, are most frequently impacted. The degree of malocclusion influences how well sound production can adapt to the presence of permanent labial appliances, both right away and over time.[2]

Mechanism of speech disturbances caused by orthodontic appliances

Labial fixed appliances

In 1956, Feldman reported that the implantation of a labial fixed device may create speech problems in the short-term, but such problems should go away in a few weeks.[12] During the initial stages of usage, altered touch perception, discomfort, and tension in the articulators may result in speech abnormalities because the positioning of labial appliances might result in a direct interface between the labial brackets and the lips as well as the anterior teeth.[13] Additionally, tongue protrusion caused by the abnormality in the front area of the mouth may interfere with the articulation of the sound "s".[13] These studies' findings imply that different labial appliances can produce speech distortion for different lengths of time. This discrepancy may be due to individual differences in adaptability, which are impacted by the severity of the malocclusion and the neurological homeostasis of each person.[13] Additionally, it should be noted that a significant amount of speech distortion may be caused by lingual auxiliaries and transpalatal appliances used in conjunction with labial appliances which can be confirmed by the findings of studies conducted by Rai et al.[8]

Lingual fixed appliance

Since the introduction of lingual fixed appliances by Fujita, the clinical application of lingual orthodontic treatment has increased due to advantages such as improved aesthetics, reduced risk of caries, and smaller anchorage loss.[14] However, patients with lingual appliances may also experience difficulties in maintaining oral hygiene, pain in tongue, and speech disturbances.[13] More adult patients interested in orthodontic treatment led to the introduction of lingual fixed orthodontic appliances as an alternative to the unaesthetic appearance of conventional labial appliances. The lingual appliances'

design, production, and mechanotherapy have continuously improved, erasing part of their previous reputation for worse results, harder insertion and handling, greater lab expenses, and extended chair times. Recent claims suggest that lingual appliances may reduce white spot lesions, caries, anchoring loss, noticeability, and pressures used.[15-17] In addition, keeping up to date with the most recent evidence is increasingly challenging for clinicians.[18] When compared to labial appliances, lingual appliances cause greater levels of speech and phonetic problems, according to several systematic evaluations.[4,7,18,19] Runte et al reported that a 30° palatally pointed maxillary incisor might impact the fricative sound.[20] The morphologies of the lingual tooth surface and the second articulation zone were changed when the brackets were positioned on the lingual surface of the anterior teeth, which caused problems with speech and phonetics. Therefore, it is conceivable that the orthodontic systems and bracket designs utilised have a considerable impact on the emergence of speech problems brought on by lingual appliances. Less speech impairment and tongue pain can result from lower-profile, bespoke brackets with thinner hooks.[13] Furthermore, the discomfort experienced by the tongue due to lingual appliances is another significant factor contributing to speech and phonetics distortion. When lingual appliances are inserted, the contact area of the tongue may be pushed towards the palate, resulting in the alteration of certain consonant sounds that necessitate tongue movement, such as alveolar and palatal sounds.[13] Sinclair et al reported that the noise frequency band of consonants could be decreased as the tongue encountered unfamiliar lingual appliances, eventually reducing the overall intensity of consonants.[21] Moreover, the physical thickness of the appliances and the spaces between the lingual brackets can allow an uncontrolled escape of air, which leads to difficulties in creating a seal when pronouncing certain consonants such as /t/ /d/ and /j/. Regarding vowels, lingual appliances have the potential to decrease tongue volume and impact co-articulation when producing vowel sounds.[13]

Orthodontic retainer

An orthodontic retainer is routinely used for 6-12 months after orthodontic treatment to avoid soft and hard tissue remodeling.[13] Although the retention effect is a significant problem in the long run, practitioners should be aware that patient compliance may be significantly increased by the comfort and acceptability of the retainers. Because orthodontic retainers are foreign things that often press up against the surfaces of the teeth, lingual mucosa, and palate, they can impact the space of the oral cavity and the movement of the tongue, impairing speech and the phonetics of a number of vowels and consonants. At first, some retainer types, like the vacuum-formed retainer, enclose the biting surfaces of teeth and heighten the space between the upper and lower teeth, which distorts speech in the sound /s/.[13] Secondly, the acrylic base of retainers often covers the lingual surface of the incisors and palate, and thus, alveolar consonants such as /s/ and /t/ and palatal consonants such as /j/ can be affected. Thus, the thickness of the base plate and the degree of acrylic coverage emerge as significant factors that contribute to speech and phonetics challenges.[13] Erb et al concluded that thin retainers roughened in the anterior alveolar region could produce the lowest occurrence of speech distortions. Moreover, retainers may reduce the dimensions of the oral cavity, thus altering the vocal tract during articulation.[22] Additionally, the tongue position may retrude to a backward and low position when the tongue reaches the base plate of a retainer; this position renders a shorter vocal tract , an increase in the F1 frequency and a decrease in the F2 frequency of vowels such as the /i/ sound.[13]

Other orthodontic appliances

Both orthodontic and prosthetic dental appliances can cause speech and phonetics impairments.[13] As observed with the placement of dentures, removable orthodontic appliances can also alter the intraoral space, disturbing tongue movement during speech production. The severity of the speech distortion is related to the extension of the resin base of removable appliances. Sergl and Zentner evaluated activators with considerable resin bases and wide interocclusal openings were shown to have the ability to seriously affect speech after the adoption of eight different detachable functional appliances.[23] A palatal expander is a sizable device attached to the palate that can block speech and restrict tongue mobility. The constriction and airflow characteristics of the oral cavity can also be impacted by the use of a palatal expander, which can distort certain fricative sounds.[13] Moreover, it is important to note that although the expanders have a negative effect on articulation, the patient's speech may be improved after the palatal expander is removed, probably due to the increased palatal width. In addition, tongue thrusts can cause anterior contact on the palate of the tongue during the pronunciation of consonants, which results in speech and phonetics impairments. It has been reported that Invisalign® therapy can offer aesthetically demanding patients an alternative to the lingual orthodontic treatment.[13] Nedwed et al reported showed mild speech problems occurred in 52% of Invisalign® patients. To the best of our knowledge, no linked study has evaluated speech function induced by Invisalign® therapy objectively; this calls for more relevant research.[24] A different study demonstrated that the use of Invisalign® aligners has a notable impact on speech articulation. The primary affected phonemes are the fricative alveolar consonants /s/ and /z/. If a patient perceives that their speech impairment might hinder their adherence to treatment, it is advised not to consider Invisalign® as a suitable option.[25]

Speech assessment

The evaluation of speech disturbances is a complicated process. In order to examine speech distortions, it is

common practice to employ various types of evaluations. These include semi-objective assessments carried out by speech pathologists or specialists, objective assessments using sonographic techniques, and subjective assessments made by laypeople or the patients themselves. Given that speech changes are perceptible through our auditory senses in our daily lives, it is logical and essential to incorporate semi-objective or subjective evaluations, which can be readily conducted by human evaluators. The use of objective methodology is a sophisticated technique to accurately evaluate the changes in the phonetic parameters. Based on findings from prior studies, speech disruptions identified through sonographic methodology tend to persist for a longer duration compared to those detected through semi-objective and subjective evaluations. Additionally, objective evaluation can not only verify the speech distortions reported by semi-objective and subjective evaluations but also detect some consonants such as /ʃ/, /θ/, and /f/ sounds that cannot be easily identified by human hearing. Therefore, the combination of objective, semi-objective as well as subjective methods is recommended to minimize bias during speech evaluation.[13] It is important to advise patients planning to be treated with orthodontic aligners that there will be a temporary limitation to speech production ability, which could be considered disadvantageous to people in professions that require them to speak in the public. However, such patients can be instructed to remove the device when they need to speak in public until they are better adapted. Additionally, it is important to point out that patients with other initial characteristics (age range or type of the malocclusion) might take different amounts of time to adapt to the orthodontic treatment, with fixed or removable appliances.[11]

CONCLUSION

Orthodontic treatment can have an impact on speech and phonetics. Structural malformations in the maxillary and mandibular arches can disrupt consonant production and affect speech intelligibility. The presence of orthodontic devices, including labial and lingual fixed appliances, orthodontic retainers, and other devices, can cause speech disturbances as a result of their placement within the oral cavity. The duration and severity of speech changes vary among individuals. Objective, semi-objective, and subjective evaluations are used to assess speech disturbances. Patients considering orthodontic aligners should be aware of temporary limitations in speech production. Individual adaptation to orthodontic treatment may differ based on initial characteristics. Orthodontists should inform and counsel patients about the potential speech difficulties associated with the orthodontic treatment.

Funding: No funding sources
Conflict of interest: None declared
Ethical approval: Not required

REFERENCES

1. Malik OH, McMullin A, Waring DT. Invisible orthodontics part 1: invisalign. Dental Update. 2013;40(3):203-15.
2. Paley JS, Cisneros GJ, Nicolay OF, LeBlanc EM. Effects of fixed labial orthodontic appliances on speech sound production. Angle orthodontist. 2016;86(3):462-7.
3. Feu D, de Oliveira BH, de Oliveira Almeida MA, Kiyak HA, Miguel JA. Oral health-related quality of life and orthodontic treatment seeking. Am J Orthodont Dentofacial Orthop. 2010;138(2):152-9.
4. Papageorgiou SN, Gölz L, Jäger A, Eliades T, Bourauel C. Lingual vs. labial fixed orthodontic appliances: systematic review and meta-analysis of treatment effects. Eur J Oral Sci. 2016;124(2):105-18.
5. Haydar B, Karabulut G, Ozkan S, Aksoy AU, Ciğer S. Effects of retainers on the articulation of speech. Am J Orthodont Dentofacial Orthop. 1996;110(5):535-40.
6. Doshi UH, Bhad-Patil WA. Speech defect and orthodontics: a contemporary review. Orthodont. 2011;12(4):340-53.
7. Ata-Ali F, Ata-Ali J, Ferrer-Molina M, Cobo T, De Carlos F, Cobo J. Adverse effects of lingual and buccal orthodontic techniques: A systematic review and meta-analysis. Am J Orthodont Dentofacial Orthop. 2016;149(6):820-9.
8. Rai AK, Rozario JE, Ganeshkar SV. Comparison of speech performance in labial and lingual orthodontic patients: A prospective study. Dental Res J. 2014;11(6):663-75.
9. Araújo EA, Andrade I, Jr, Brito Gde M, Guerra L, Horta MC. Perception of discomfort during orthodontic treatment with tongue spurs. Orthodontics. 2011;12(3):260-7.
10. Wan J, Wang T, Pei X, Wan Q, Feng W, Chen J. Speech effects of Hawley and vacuum-formed retainers by acoustic analysis: A single-center randomized controlled trial. Angle Orthodontist. 2017;87(2):286-92.
11. Damasceno Melo PE, Bocato JR, De Castro Ferreira Conti AC. Effects of orthodontic treatment with aligners and fixed appliances on speech. Angle Orthodontist. 2021;91(6):711-7.
12. Feldman EW. Speech articulation problems associated with placement of orthodontic appliances. J Speech Hearing Disorders. 1956;21(1):34-8.
13. Chen J, Wan J, You L. Speech and orthodontic appliances: a systematic literature review. Eur J Orthodont. 2018;40(1):29-36.
14. Fujita K. New orthodontic treatment with lingual bracket mushroom arch wire appliance. Am J Orthodont. 1979;76(6):657-75.
15. McDonald F, Cobourne M. Adult orthodontics: perils and pitfalls. Progress Orthodont. 2007;8(2):308-13.
16. Lawson RB. Extraction treatment in lingual orthodontics. J Orthodont. 2013;40(1):S38-48.

17. Dalessandri D. Reduction in incidence of white spot lesions with lingual appliances. Am J Orthodont Dentofacial Orthoped. 2016;149(1):7-8.
18. Afrashtehfar KI. Evidence regarding lingual fixed orthodontic appliances' therapeutic and adverse effects is insufficient. Evidence-Based Dentistr. 2016;17(2):54-5.
19. Long H, Zhou Y, Pyakurel U. Comparison of adverse effects between lingual and labial orthodontic treatment. Angle Orthodont. 2013;83(6):1066-73.
20. Runte C, Lawerino M, Dirksen D, Bollmann F, Lamprecht-Dinnesen A, Seifert E. The influence of maxillary central incisor position in complete dentures on /s/ sound production. J Prosthet Dentistr. 2001;85(5):485-95.
21. Sinclair PM, Cannito MF, Goates LJ, Solomos LF, Alexander CM. Patient responses to lingual appliances. J Clin Orthodont. 1986;20(6):396-404.
22. Erb DP. Speech effects of the maxillary retainer. Angle Orthodontist. 1967;37(4):298-303.
23. Sergl HG, Zentner A. A comparative assessment of acceptance of different types of functional appliances. Eur J Orthodont. 1998;20(5):517-24.
24. Nedwed V, Miethke RR. Motivation, acceptance and problems of invisalign patients. J Orofacial Orthop. 2005;66(2):162-73.
25. Pogal-Sussman-Gandia CB, Tabbaa S, Al-Jewair T. Effects of Invisalign® treatment on speech articulation. Int Orthodont. 2019;17(3):513-8.

Cite this article as: Najjar HE, Alzaid SA, Alasmari AM, Alrashdi SA, Alqahtani AM, Alrhile SM et al. Impact of orthodontic treatment on speech and phonetics: a review. Int J Community Med Public Health 2023;10:2995-9.