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EFFECT OF ORTHODONTIC TREATMENT ON PHONETICS. A SCOPING REVIEW

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Abstract

Various orthodontic appliances, including fixed appliances, orthodontic retainers, and palate expanders, can potentially cause speech difficulties and can affect speech clarity. However, the impact of orthodontic equipment on speech impairments has not been thoroughly examined using an evidence-based approach. Appliances have the potential to distort the i, a, and e vowels, as well as the s, z, l, t, d, and r. While the majority of speech problems often resolve within a few weeks, the distortion of the s sound may persist for over 3 months. The objective of this study is to elucidate the scientific evidence and the processes underlying the speech impairments induced by orthodontic appliances. The study included randomized-controlled clinical trials (RCT), controlled clinical trials, and cohort studies that specifically examined the impact of orthodontic appliances on speech. The researchers performed a methodical search using electronic databases such as PubMed, Web of Science, and Scopus. The orthodontic appliances were categorized, and the specific sounds affected by them, as well as the duration of speech disturbances, were identified. The ROBINS-I tool was utilized to assess the quality of non-randomized studies, whereas the bias of RCTs was evaluated according to the guidelines outlined in the Cochrane Handbook for Systematic Reviews of Interventions. Out of the 364 articles that were reviewed, 10 studies were selected for inclusion in the study. In conclusion, it is evident. that lingual fixed appliances, palatal expanders, and Hawley retainers significantly impact speech output. The i, s, t, and d phonemes are the primary ones that are impacted.

Keywords- Speech, orthodontic treatment, phonetics

Introduction

A growing number of individuals are seeking orthodontic treatment due to the substantial impact that malocclusion has on their quality of life. The unpleasantness associated with orthodontic therapy adversely impacts patient adherence (Kang et al., 2014; Feu et al., 2010). Speech difficulty is a significant consequence of orthodontic therapy, with detrimental repercussions. In addition to the initial speech difficulties caused by malocclusion, orthodontic appliances can also result in speech disruptions due to their presence as a foreign object in the oral cavity. Orthodontic appliances commonly conform to the palate and tooth surfaces, hence influencing the tongue's mobility and the oral cavity's space. Meloa et al. (2021) and Eslamain et al. (2006) have reported

that orthodontic appliances can distort certain sounds. Furthermore, there have been reports indicating that certain orthodontic devices, including labial and lingual fixed appliances, tongue thrusts, palatal expanders, and Hawley retainers, can have an impact on the intelligibility of speech. Studying the impact of orthodontic appliances on speech is significant because it enables orthodontists to comprehend the underlying mechanisms causing speech distortions. This knowledge empowers them to provide objective guidance to patients regarding speech difficulties and find suitable solutions to address these issues. Several systematic reviews have examined the detrimental consequences of lingual and labial orthodontic treatment and found that patients with lingual appliances experienced greater speech issues (Papageorgiou et al., 2016; Long et al., 2013; Chen et al., 2018). Unfortunately, there hasn't been a full, evidence-based study of how different types of orthodontic devices, like fixed appliances, removable appliances, and orthodontic retainers, affect speech problems yet (Gandia et al., 2019; Rai et al., 2013). Hence, the purpose of this scoping review is to delineate the scientific facts and mechanisms underlying speech issues resulting from orthodontic appliances and to provide clinical guidance for practitioners and researchers.

The PICO framework was followed by the focus question: How do orthodontic appliances impact the speech performance of patients, based on participants, interventions, comparisons, outcomes, and study design (PICOS)? More precisely, the term 'participants' refers to individuals who were undergoing orthodontic or retention therapy for malocclusion. The term 'Interventions' refers to the use of orthodontic appliances, such as fixed or removable orthodontic appliances and retainers, during the course of the orthodontic or retention treatment. Neither control nor comparison were chosen. The 'outcomes' referred to the speech impairments resulting from orthodontic appliances, which encompassed altered vowels and consonants, as well as the duration of speech distortions.

Materials and Method

Study design

An electronic search was conducted in PubMed, Web of Science, and Scopus to gather relevant material. We categorized the orthodontic appliances and identified the specific sounds they affect, as well as the duration of speech disturbances. We included randomized-controlled clinical trials (RCTs), controlled clinical trials (CCTs), and cohort studies in the study after searching for relevant material. The literature search was independently conducted by two researchers (S.A. and AB) in duplicate, and any discrepancy was handled through consensus among the authors. The ROBINS-I tool was utilized to assess the quality of non-randomized studies, whereas the bias of RCTs was evaluated according to the guidelines outlined in the Cochrane Handbook for Systematic Reviews of Interventions. Meta-analysis was not possible because of the diversity in the study designs and treatment methods. Out of the 364 articles that were reviewed, only 10 studies were selected for inclusion in the study.

Search methodology (for the PubMed database). 1. Search for terms related to speech, articulation, phonetics, or pronunciation. 2 Search (Orthodontics [MeSH]) OR orthodontic appliance OR fixed labial appliance OR lingual appliance OR retainer OR removable orthodontic appliance Three search approaches, which encompassed both objective and subjective evaluations, were meticulously retrieved from the included papers.

The risk of bias in the studies was evaluated. The non-randomized studies were assessed for bias and quality using the ROBINS-I method (Risk of Bias in Non-randomized Studies—of Interventions). ROBINS: I classified the studies as having either 'low','moderate','severe', 'critical', or 'unclear' risk of bias. We evaluated the bias of the randomized controlled trial (RCT) according to the guidelines outlined in the Cochrane Handbook for Systematic Reviews of Interventions.

Results

Initial searches utilizing MeSH terms and text words resulted in 364 potential research. Additionally, a 'gray' literature search yielded another 10 papers. Thirteen studies out of the 248 papers examined in this review specifically investigated the impact of orthodontic appliances on speech output. The kappa coefficient for reviewer agreement on study selection was 0.81, indicating a high level of agreement based on the Cochrane Handbook for Systematic Reviews of Interventions.

Discussion

Mechanism of speech disturbances caused by orthodontic appliances

In 1956, Feldman documented that labial fixed appliances attached to the lips could result in speech problems, which could be promptly rectified within a few weeks. Feldman observed that labial fixed appliances could cause speech problems, which could be promptly rectified within a few weeks. The positioning of labial appliances might result in direct contact between the labial brackets, lips, and front teeth. This can lead to changes in touch perception, discomfort, and tension in the muscles used for speech production. Consequently, speech abnormalities may occur during the initial phase of appliance use. In addition, the irregularity in the front part of the mouth might cause the tongue to stick out, which can impact the pronunciation of the s sound. The findings of these investigations suggest that the length of speech distortion caused by labial appliances varies (Saad et al., 2022; Runte et al., 2006). The disparity can be attributed to the varying adaptability arising from the variable severity of malocclusion and the individual neuronal equilibrium. (Rai et al., 2014).

Among the included studies, four reported a comparison of speech performance with labial and lingual orthodontic appliances, indicating that speech difficulties caused by lingual appliances were significantly more severe. Labial fixed appliances could lead to a slight impact on speech, and most of the speech recovery was reported to occur within 1 month. Vowels such as i, u, and a

and consonants such as s, t, f, and l were the primarily affected ones. The labial appliances could cause a significant decrease in the upper boundary frequency of the sound immediately after insertion. In two of the five included studies on labial appliances, Khattab et al. (2012) reported that labial appliances could cause speech disturbances lasting for more than 1 month.

Lingual fixed appliance

The practical utilization of lingual orthodontic therapy has grown since Fujita introduced lingual fixed appliances. This is mostly owing to the benefits it offers, including enhanced aesthetics, decreased risk of dental caries, and less loss of anchorage. Nevertheless, individuals utilizing lingual appliances may encounter challenges in upholding dental cleanliness, discomfort in the tongue, and disruptions in speech. Several systematic reviews have confirmed that lingual appliances cause more speech problems compared to labial appliances. Runte et al. (2001) found that tilting the upper front teeth 30° towards the roof of the mouth can influence the fricative sound. Likewise, the placement of brackets on the inner surface of the front teeth caused changes in the shape of the inner tooth surface and the area where the teeth come into contact, leading to difficulties in speaking. Hence, speech difficulties caused by lingual appliances may have a strong correlation with the design of brackets and orthodontic systems. Customized brackets with a lower profile, thinner design, and rounder hooks can minimize speech impediment and discomfort in the tongue. Tongue discomfort caused by lingual appliances can also contribute to speech distortion. Following the placement of lingual appliances, the tongue's contact area can be moved towards the roof of the mouth, causing changes in the pronunciation of certain consonant sounds, such as those produced with the tip of the tongue (alveolar sounds) and those produced with the middle part of the tongue (palatal sounds), which necessitate tongue movement. Sergl et al. (2000) found that the frequency range of noise produced by consonants could be reduced when the tongue comes into contact with new lingual appliances, resulting in a drop in the overall loudness of consonants. Additionally, the appliances' physical thickness and the gaps between the lingual brackets can result in unregulated air leakage, causing challenges in achieving a proper seal while articulating specific consonant sounds such as t, d, and j. Regarding vowels, the lingual appliances might decrease the volume of the tongue and affect the coordination of articulation during vowel production.In certain cases, speech issues might persist for over 3 months, particularly with regards to the distortion of the s sound. The vowels i, a, and o and the consonants s, t, l, r, and d were the most significantly impacted by lingual appliances. The resolution of speech distortions happened within a timeframe ranging from one week to one month, and in some cases, it took more than three months.Both Hawley retainers and vacuum-formed retainers can produce speech issues, although speech disruptions caused by Hawley retainers are more pronounced and can last for a longer duration. Hawley retainers frequently result in speech deficits affecting the sounds s, z, t, d, i, and j, whereas vacuum-formed retainers can lead to noticeable alterations in the sounds e, i, and s. In the vacuum-formed retainer group, speech aberrations resolved within 1 week, while the s sound distortion caused by Hawley retainers might persist for 3 months (Kayikci et al., 2012).

Additional orthodontic devices

Both orthodontic and prosthetic dental equipment can cause speech problems. Similar to the effects seen with dentures, removable orthodontic appliances can also modify the space inside the mouth, which can disrupt the movement of the tongue during the production of speech. The size of the resin base of detachable appliances directly correlates with the degree of speech distortion. In their study, Sergl and Zentner. (2000) examined the reception of eight distinct varieties of removable functional appliances. They discovered that an activator including a substantial resin base and a wide interocclusal aperture had the potential to cause significant speech problems. Likewise, a palatal expander is a sizable device that is positioned on the palate. It can be obstructive and restrict the movement of the tongue. The utilization of a palatal expander might influence the narrowing and airflow characteristics of the mouth, leading to the alteration of some fricative consonants. Furthermore, once the palatal expander is eliminated, the patient's speech may experience enhancement likely due to the augmented palatal width (Stevens et al., 2011). Furthermore, tongue thrusts can lead to the tongue making contact with the front part of the palate while pronouncing consonants, leading to speech difficulties. According to reports, Invisalign® therapy provides an option for lingual orthodontic treatment for patients who have high aesthetic standards. Nedwed et al. (2005) found that 52% of patients using Invisalign® encountered mild speech difficulties.

Evaluation of speech abilities.

Assessing speech impairment is a complex procedure. Routine investigations of speech distortions can be carried out through objective assessments employing sonographic techniques, semi-objective evaluations conducted by speech pathologists or specialists, and subjective evaluations performed by laypersons or patients themselves. Since our auditory senses detect speech changes in our daily lives, it is both logical and essential for humans to conduct semi-objective or subjective evaluations. Utilizing objective methodology is an advanced way of precisely assessing alterations in phonetic characteristics. Based on the findings of prior research, the sonographic method reveals speech problems that persist for a longer duration compared to semi-objective and subjective evaluations (Arreghini et al., 2018; De Felippe et al., 2010). Furthermore, objective evaluation serves the purpose of not only confirming the speech distortions detected through semi-objective and subjective evaluations but also detecting certain consonant sounds like o and f that are not easily discernible by human auditory perception (Araujo et al., 2011; Melo et al., 2021). Hence, it is advisable to employ a blend of objective, semi-objective, and subjective approaches to mitigate prejudice when assessing speeches. Out of the 10 studies analyzed, only 3 utilized a combination of objective, semi-objective, and subjective evaluations. Additionally, five studies did not employ objective methods to assess the affected sounds and phonetic parameters. The variation in the approaches used to assess speech in the research included could lead to detection bias, thereby affecting the extent of the reported effects. Furthermore, studies that solely rely on subjective evaluations may lead to misinterpretations due to variations in individual expertise and professional knowledge.

Limitations

The primary limitations of this scoping review were the low level of evidence grading and the presence of heterogeneity. Due to a scarcity of randomized controlled trials (RCTs), the majority of the studies included in the analysis were non-randomized. Out of the 7 non-randomized studies considered, 5 were identified as having a significant risk of bias, either serious or critical, because of confounding factors and biased measurement of outcomes. Out of the three randomized controlled trials (RCTs) that were looked at, two had an unclear risk of bias because it wasn't clear how the random sequences were made or how the allocations were kept secret. Furthermore, it was hard to separate the same impacted sound and phonetic measurements from the clinical results across all the studies because the evaluation methods and sounds used were so different. Given that the majority of the studies conducted monitored patients for a duration of 3 months or less, it is important to acknowledge that the findings of this review may mostly reflect short-term impacts. This scoping review provides orthodontists with valuable insights into the speech challenges caused by orthodontic appliances. It also helps them understand the underlying mechanisms behind these speech distortions. With this knowledge, orthodontists can effectively advise their patients on the specific sounds that may be affected and the expected duration of these speech difficulties based on the type of appliance used. Nevertheless, it is important to acknowledge that the quality of the evidence in this study is quite low, and there are inherent limitations in this systematic assessment. Additional rigorous randomized controlled trials (RCTs) with increased sample numbers and extended follow-up durations (exceeding 3 months) are required.

Conclusion

Speech issues can arise from the use of many orthodontic appliances, including labial and lingual fixed appliances, palatal expanders, and orthodontic retainers. Lingual appliances caused more severe speech impairments compared to labial appliances, while Hawley retainers induced more apparent speech disruption than vacuum-formed retainers. The bulk of damaged sounds consisted of the i vowels and the s, t, and d consonants. While the majority of speech problems often resolve within a few weeks, the distortion of the s sound resulting from lingual fixed appliances and Hawley retainers may last for over 3 months. Given the constraints of this systematic review, it is advisable to use caution when interpreting the data. To establish a reliable comparison between various orthodontic equipment, it is imperative to conduct additional high-quality randomized controlled trials (RCTs) with larger sample numbers and longer follow-up periods.

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