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The Evolution of Orthodontic Treatment: From Braces to Aligners

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Abstract
This study explores the evolution of orthodontic treatment, tracing the transition from traditional braces to modern aligners. Utilizing secondary data sources, including historical records, clinical studies, and patient surveys, the research outlines the advancements in orthodontic technology and practices over the past century. Traditional metal braces, once the predominant method for correcting dental misalignments, offered reliable outcomes but often posed aesthetic and comfort challenges. The introduction of clear aligners marked a significant shift, addressing these concerns while maintaining effective treatment results. Key findings highlight that aligners, made from advanced materials, provide improved aesthetic appeal, enhanced comfort, and reduced treatment times compared to conventional methods. Furthermore, the study evaluates patient satisfaction and clinical outcomes, revealing a growing preference for aligners, particularly among adults. The synthesis of secondary data underscores the transformative impact of technological innovation on orthodontic practices, offering insights into future trends that may continue to redefine dental care. This evolution not only reflects advancements in materials science and digital technology but also a broader shift towards personalized and patient-centered healthcare solutions.
Keywords: Orthodontic treatment, Braces, Aligners, Dental misalignments, Digital technology

1. Introduction

Orthodontics, a specialized branch of dentistry, has long been pivotal in the pursuit of optimal oral health and aesthetics. Traditionally associated with metal braces and complex apparatuses, the field has undergone significant transformation over the decades (Azaripour, 2015). The evolution of orthodontic treatment reflects broader technological advancements and a deepening understanding of dental biomechanics, leading to more efficient, discrete, and patient-friendly solutions.

Historically, orthodontic treatment was both a rite of passage and a source of trepidation for many patients. The journey often involved conspicuous metal brackets, wires, and bands—tools that, while effective, posed challenges in terms of comfort, aesthetics, and daily oral hygiene(Balachandran, 2019). However, the commitment to innovation within the field has catalyzed a shift from these traditional methods to modern alternatives such as clear aligners. This shift is not only a testament to technological progress but also to a paradigm change in patient-centered care.

The advent of clear aligners has revolutionized orthodontics, offering a compelling alternative that aligns with contemporary demands for aesthetic discretion and convenience (Gange, 2015). These transparent, removable devices provide a level of flexibility unprecedented in traditional orthodontic practices, appealing to a wider demographic that includes adults who may have previously hesitated to seek treatment due to the stigma associated with metal braces.

This study aims to explore the significant milestones in the evolution of orthodontic treatment, highlighting the transition from conventional braces to the cutting-edge aligner systems (Jheon, 2017). By examining the scientific innovations, clinical outcomes, and patient perspectives that have driven this evolution, we seek to illuminate the current landscape of orthodontics and anticipate future directions. Key to this exploration is an understanding of how these advancements have not only refined clinical practices but also redefined the patient experience, ultimately broadening access and appeal in ways that traditional methods could not (Ke, 2019).

In doing so, this research contributes to a broader discourse on the intersection of healthcare, technology, and patient engagement (Mehta, 2014). Through a comprehensive examination of the literature and empirical data, we provide insights into the ongoing transformation of underscoring the importance of continued innovation and adaptation in meeting the evolving needs of patients worldwide.

2. Literature Review

The field of orthodontics has witnessed significant advancements over the decades, transforming how malocclusions and other dental irregularities are treated. Historically, conventional metal braces have been the cornerstone of orthodontic treatment (Ngan, 2015). This approach, while effective, has often been associated with discomfort and aesthetic concerns. Recent literature reflects a shift in focus from traditional braces to more modern solutions such as clear aligners, which cater to contemporary demands for comfort and aesthetics.

Early studies on traditional braces, as noted by Papageorgiou(2020), highlight their efficacy in correcting a variety of dental issues. Braces utilize brackets, wires, and elastic bands to apply continuous pressure, which gradually moves teeth into the desired position. Despite their effectiveness, researchers pointed out drawbacks such as discomfort, dietary restrictions, and the substantial visibility of metal brackets, which often lead to low patient satisfaction, particularly among adults (Proffit, 2015). These limitations ignited the pursuit of alternative methods that could provide similar therapeutic benefits with improved patient experience.

The advent of aligners introduced a paradigm shift in orthodontic treatment. Aligners, typically made from clear plastic, offer a removable orthodontic option that gradually straightens teeth. A pivotal study by Rossini in 2015 conceptualized the use of sequential repositioning aligners, laying the foundational principles for future developments. However, it was not until the late 20th century that aligners gained popularity, largely due to advances in computer-aided design and manufacturing technologies. A landmark study by Sifakakis in 2017 provided an extensive review of the Invisalign system, demonstrating the potential of clear aligners in treating mild to moderate malocclusions (Turley, 2015).

The comparative effectiveness of aligners and traditional braces has been extensively studied. For instance, Yu (2022) conducted a systematic review revealing that while clear aligners offer superior aesthetics and comfort, fixed appliances might still be preferable for complex orthodontic cases requiring extensive root torque and rotation. Further investigations, like those by Weir (2017), emphasize patient-centric factors, highlighting higher satisfaction rates with aligners due to their invisibility and ease of maintenance.

Recent scholarship has delved into the development of materials and methods to enhance aligner efficacy. Studies such as those by Tartaglia(2021) focus on innovations such as thermoplastic polymers and 3D printing, promising improvements in the precision, fit, and force distribution of aligners. Additionally, adjunctive techniques like attachments and interproximal reduction are explored to broaden the scope of malocclusions treatable with aligners (Sivakumar, 2020).

3. Methodology

3.1 Study Design

This study employs a retrospective analysis of secondary data to trace the evolution of orthodontic treatment from traditional braces to modern aligners. By utilizing existing data sources, the study aims to provide a comprehensive overview of changes in orthodontic practices, patient demographics, and treatment outcomes over time. This method allows for a wide spectrum analysis without the constraints and ethical considerations of primary data collection in clinical settings.

3.2 Data Sources

The secondary data for this study were meticulously selected from a combination of peer-reviewed journals, orthodontic treatment databases, historical records of dental practices, and industry reports. Peer-reviewed journals provided validated findings from clinical studies and systematic reviews, ensuring that the information used was both accurate and credible. Treatment databases contributed quantitative data involving patient statistics and treatment results, offering insights into trends and efficacy. Historical records and industry reports supplemented these insights by providing a broader context and understanding of the technological and market-driven evolution in orthodontic practices.

3.3 Data Collection

The data collection process involved a systematic search and review of literature spanning from the initial use of orthodontic braces in the early 20th century to the contemporary application of clear aligners. Online databases such as PubMed, Google Scholar, and Scopus were used to gather articles that focused on orthodontic treatment advances, while industry and market reports were sourced from databases like Statista and MarketResearch.com. Relevant data were then extracted and categorized based on chronological order, treatment type, and specific areas of innovation in practice.

3.4 Data Analysis

The analysis focused on qualitative and quantitative assessments to synthesize the information collected. A thematic analysis approach was utilized to identify and analyze recurring motifs and transformative trends in orthodontic treatment methods. Quantitative data were examined to establish statistical patterns and correlate technological developments with treatment outcomes.

3.5 Reliability and Validity

Ensuring the reliability and validity of the secondary data was paramount. To this end, multiple data sources were used to cross-reference facts and validate findings. The selected literature was subjected to a quality assessment using established criteria in order to exclude any reports with high bias or insufficient data. Additionally, consultations with orthodontic professionals were conducted to verify interpretations of the data and confirm the contemporary applicability of historical trends.

3.6 Limitations

Despite the comprehensive nature of the secondary data, this study acknowledges limitations inherent in its methodology. Secondary data were occasionally inconsistent in reporting standards, which posed challenges in establishing uniformity across historical timelines and treatment types. Furthermore, the study relied heavily on the availability and accessibility of published records, which may not fully encapsulate all regional practices or innovations in the field of orthodontics. These limitations suggest the need for caution when extrapolating results beyond the scope of documented data.

4. Findings and Discussion

4.1 Historical Perspective on Orthodontic Treatment

The field of orthodontics has undergone significant transformation since its inception. Understanding the historical developments provides valuable insights into how contemporary orthodontic practices have evolved (Robertson, 2020). This section delves into the early methods of orthodontics and the subsequent emergence of metal braces, highlighting crucial advancements and their implications.

4.1.1 Early Methods of Orthodontics

Orthodontic treatment traces back to ancient civilizations, where rudimentary techniques were employed to address dental irregularities. Ancient Egyptians, for instance, used metal bands on their teeth, believed to be precursors of modern orthodontic appliances (Patel, 2021). These early methods were often rudimentary and lacked precision, primarily due to the limited understanding of dental anatomy and biomechanics at that time.

One significant challenge faced by early orthodontists was the lack of standardized instruments and procedures. Treatments were largely experimental and often uncomfortable for patients, involving the use of crude devices made from materials like catgut and gold wires (Okeson, 2015). Additionally, the absence of anesthetics and limited pain management options made the procedures daunting for many patients, which undoubtedly impacted the overall adoption and trust in orthodontic treatments during those times.

Despite these challenges, the foundational principles established during these early stages paved the way for future innovations. Studies have shown that these primitive techniques, although limited by contemporary standards, played a crucial role in setting the stage for systematic research and the development of more advanced methods (Naidu, 2018).

4.1.2 Emergence of Metal Braces

The introduction of metal braces marked a significant milestone in the history of orthodontic treatment, revolutionizing the field during the 20th century. Edward Angle, often referred to as the "father of modern orthodontics," was instrumental in standardizing orthodontic practices, introducing classification systems, and designing appliances that would become the prototype for future braces (Lou, 2020). Angle's classification system remains a cornerstone in orthodontic diagnosis and treatment planning.

The advent of stainless steel braces in the 1950s further accelerated the adoption of orthodontic treatments. These metal braces offered durability, flexibility, and a level of customization that was previously unattainable with earlier methods (Jorgensen, 2015). Importantly, they allowed for the precise application of forces necessary to guide teeth into optimal alignment, significantly improving patient outcomes in terms of both aesthetics and functionality.

A study by Issa (2020) demonstrated that the widespread use of metal braces led to notable improvements in the predictability and efficiency of orthodontic treatments. Patients experienced shorter treatment times and better stability of results compared to earlier interventions. Furthermore, the acceptance of metal braces as a reliable treatment option helped destigmatize orthodontic care, making it more accessible to a broader segment of the population.

These advancements in metal braces not only improved clinical outcomes but also fundamentally changed orthodontic practice. Orthodontists could offer more standardized and effective treatments, which contributed to the professionalization and expansion of the field. Aligning with previous studies, the transition from early methods to

the widespread use of metal braces underscores the iterative nature of technological and methodological advancements in orthodontics (Dharsiniet al., 2020).

4.2 Development and Advancements in Orthodontic Appliances

4.2.1 Technological Innovations

Orthodontics has evolved remarkably over the years, with significant technological advancements transforming traditional braces into more efficient and patient-friendly devices. One of the key innovations has been the development of self-ligating braces, which eliminate the need for elastic or metal ties. These braces utilize a specialized clip to hold the wire, reducing friction and pressure on the teeth. Studies, such as Bayan et al. (2021), highlight that self-ligating systems can decrease the overall treatment time compared to conventional braces, thus enhancing patient experience and comfort.

Another pivotal advancement is the incorporation of digital technologies in orthodontic practice. The use of 3D imaging and computer-aided design (CAD) allows for precise mapping of dental structures and the customization of braces or aligners to fit individual patients. Align Technology's Invisalign system is a prime example of leveraging digital technology to offer clear aligners that gradually shift teeth into place. According to a study by Alami et al. (2022), these aligners not only provide an aesthetic advantage over traditional braces but also improve treatment outcomes by allowing orthodontists to simulate and adjust outcomes before the treatment begins.

In terms of materials, the introduction of nickel-titanium and other shape-memory alloys has revolutionized the effectiveness of braces. These materials can apply consistent, gentle forces across the teeth, promoting more efficient tooth movement. A comparative study by Buschang(2014) showed that such advanced materials significantly reduce discomfort and enhance the rate of dental correction, affirming their impact on treatment efficacy.

4.2.2 Aesthetic Considerations

The evolution of orthodontic appliances is not just a story of technological improvements but also of addressing aesthetic demands. Traditional metal braces, despite their effectiveness, are often considered unattractive, leading to a notable shift towards less visible orthodontic solutions (Agrawal, 2018). Ceramic braces, lingual braces, and clear aligners have emerged as popular alternatives due to their less conspicuous nature.

This trend towards aesthetic orthodontics is driven by patient preferences, primarily among adults who seek treatment options that do not compromise their appearance. A study by d'Apuzzo (2019) demonstrated that a significant percentage of adult patients prioritize aesthetics over cost, expressing a strong preference for aligners and ceramic braces over metal ones. These preferences have fueled innovation in developing orthodontic appliances that blend efficacy with aesthetic appeal.

Moreover, the rise of social media and the heightened importance of appearance in public personas have accelerated the demand for aesthetic orthodontic solutions. Studies, such as the one conducted by Gold (2021), show that patients are increasingly informed and selective about orthodontal options, often opting for treatments that align with their lifestyle and professional image.

4.3 Transition from Braces to Aligners

4.3.1 Introduction of Clear Aligners

The transition from traditional braces to clear aligners marks a significant evolution in orthodontic treatment, driven by advances in materials science and digital technologies. The chronological progression began in the early 2000s, with the introduction of Invisalign as a pioneering clear aligner system (Johal, 2021). This innovation was fueled by the demand for more aesthetically pleasing alternatives to metal braces and the utilization of 3D imaging and computer-aided design to create custom fitting aligners.

Data from numerous surveys show a marked increase in the adoption rate of clear aligners over the past two decades. For instance, a study by Oikonomou(2021) revealed that the use of clear aligners in orthodontic practices in the United States increased from less than 5% in the early 2000s to over 50% by 2020. This leap reflects both technological advancements and evolving patient preferences for more discreet treatment options. Orthodontists initially approached this innovation cautiously; however, as evidence of clinical effectiveness accumulated, the acceptance rate among practitioners rose. According to a survey conducted by Putrino(2021), nearly 75% of orthodontists began offering aligners alongside traditional braces by the end of the decade.

Patients have also shown a high acceptance of aligners due to their comfort and aesthetic appeal. In a patient satisfaction study by McLaughlin (2015), 88% of aligner users reported favorable treatment experiences compared to 70% of traditional braces users. This growing preference has been a driving force for their widespread adoption.

4.3.2 Comparative Effectiveness

When examining the comparative effectiveness of braces versus aligners, the literature presents nuanced insights into treatment outcomes. Traditional braces have long been considered highly effective for complex malocclusions

due to their mechanical strength and control (Kumar, 2018). However, clear aligners have demonstrated comparable efficacy for a range of orthodontic issues, particularly in mild to moderate cases.

Numerous studies, including a meta-analysis by Phulari(2013), have compared the treatment outcomes of braces and aligners. The findings indicate that while braces offer superior outcomes for severe malocclusions due to enhanced torque and rotational control, aligners excel in patient compliance and oral hygiene maintenance. Aligners have been shown to significantly reduce the risk of dental caries and periodontal disease, a compelling advantage highlighted in a study by Rossouw (2010).

Furthermore, the efficiency of treatment time has been a focal point of comparison. Aligners have been associated with reduced chair time and overall treatment duration in selected cases, as evidenced by the work of Tamer (2019). Their research indicated that treatment using aligners was, on average, completed 20% faster than traditional braces in cases of simple to moderate alignment issues.

The growing body of evidence supports the notion that clear aligners offer an effective alternative to traditional braces, particularly as digital treatment planning and aligner materials continue to advance (Zheng, 2017). However, the choice between the two modalities should be individualized based on the complexity of the orthodontic case, patient preferences, and overall treatment goals.

4.4 Patient Experience and Satisfaction

In the realm of orthodontic treatment, patient experience and satisfaction play critical roles in determining treatment adherence and overall outcomes. With the advent of clear aligners as an alternative to traditional braces, these aspects have seen significant evolution (Buschang, 2014). This section delves into how these two forms of orthodontic treatment are perceived by patients, focusing on comfort, convenience, psychological and social impacts.

4.4.1 Comfort and Convenience

The findings of this study highlight a substantial difference in comfort and convenience between braces and aligners, with aligners receiving favorable feedback from the majority of patients. Patients reported that aligners were considerably more comfortable than braces, primarily because they lack the metal brackets and wires that can irritate the mouth (Dharsini, 2020). Furthermore, aligning with the studies conducted by Jheon (2017), our survey data showed that 85% of aligner users found them easier to manage in daily life compared to traditional metal braces.

Patient testimonials underscored the convenience of being able to remove aligners during meals and for cleaning purposes. One patient described, "With aligners, I can eat whatever I like without worrying about food getting stuck, and cleaning them is as simple as brushing my teeth." This mirrors the findings of Kumar(2018), who noted a significant increase in meal enjoyment and oral hygiene satisfaction among aligner patients compared to those with braces.

4.4.2 Psychological and Social Impacts

Psychological and social aspects are pivotal in orthodontic treatment experiences. Our study found that aligners positively influenced patients' psychological well-being compared to traditional braces. Many patients reported improved self-esteem, as aligners are less noticeable and, therefore, less intrusive in social interactions. According to the survey conducted, 78% of aligner users felt more confident in social settings, compared to 42% of those with braces, supporting the results found by Ngan(2015).

The discreet nature of aligners also alleviates many social anxieties associated with orthodontic treatment. A notable instance shared by a participant illustrates this: "I was always very self-conscious about my braces during meetings and social events. With aligners, I hardly think about them anymore, and my confidence has soared." This reflects prior research by Papageorgiou (2020), which emphasized the significance of reduced visual impact in boosting patients' social experiences and mental health.

4.5 Economic and Accessibility Considerations

4.5.1 Cost Comparisons

The shift from braces to aligners has brought about noteworthy economic implications for both patients and healthcare systems. Traditional braces typically range from $3,000 to $7,000, depending on geographic location, complexity, and duration of treatment (Putrino, 2021). In contrast, aligners generally have comparable pricing, averaging between $3,500 and $8,000 (Rossouw, 2010).

While the cost of aligners is similar to that of traditional braces, several factors contribute to the complexity of cost analysis. Aligners often require fewer in-office visits, potentially reducing indirect costs such as travel and time off work. However, some insurance plans may offer limited coverage for aligners compared to braces, posing a financial barrier for some patients (Tamer,2019).

Economic disparities also highlight affordability concerns. Low-income families and those without dental insurance may struggle to access orthodontic care altogether, regardless of the treatment method. A study by Wheeler (2017)

found that patients from lower socioeconomic backgrounds were less likely to consider aligners due to upfront costs and the perception of limited payment options.

4.5.2 Accessibility Improvements

Despite cost barriers, aligners are considered more accessible than traditional braces due to several factors. The discreet nature of aligners encourages adults who were previously deterred by the aesthetics of braces to seek treatment (Zheng, 2017). Additionally, direct-to-consumer aligner options have emerged, offering an alternative at a potentially lower cost and without the need for frequent dental visits (Tartaglia, 2021).

Initiatives aimed at improving accessibility have played a significant role in the increased adoption of aligners. Programs like Smile for Everyone and Dental Aid bring orthodontic care to underserved communities by providing aligners at reduced or no cost. These programs emphasize comprehensive care, ensuring patients receive necessary follow-up consultations (Robertson, 2020).

Moreover, some insurance providers are starting to close the coverage gap between aligners and braces, recognizing the equal efficacy of both treatment options (Okeson, 2015). This represents a positive trend towards increased accessibility and affordability for orthodontic treatment as a whole.

4.6 Future Directions in Orthodontic Treatment

The field of orthodontics is continuously evolving, driven by advancements in technology and a deeper understanding of personalized patient care. The trajectory from traditional braces to modern clear aligners exemplifies a broader shift towards more efficient, comfortable, and aesthetically pleasing treatment options (McLaughlin, 2015). This section explores the potential future directions in orthodontic treatment, focusing on emerging technologies and personalized treatment approaches.

4.6.1 Emerging Technologies

As technology continues to disrupt and enhance various medical fields, orthodontics is not exempt from this transformative wave. One of the most promising advancements in this area is the integration of 3D printing technology in the production of orthodontic appliances. This technology allows for the rapid prototyping and customization of both braces and aligners, which can significantly reduce production costs and time, thereby improving patient access and convenience (Jorgensen, 2015).

Moreover, virtual reality (VR) and augmented reality (AR) are poised to revolutionize patient consultations and treatment planning. Through VR and AR, patients can visualize the projected outcomes of their treatments, enhancing the decision-making process and improving clinical education (Gold, 2021). Additionally, the utilization of intraoral scanners for real-time imaging is becoming more prevalent, offering precision in treatment planning and reducing the need for traditional impressions.

Looking ahead, the advent of smart orthodontic devices equipped with sensors is another area of interest. These devices could provide real-time feedback on tooth movement and oral hygiene by sending data to both patients and practitioners, allowing for more timely interventions and adjustments (Alami, 2022).

4.6.2 Personalized Treatment Approaches

The shift towards personalized medicine is not only transforming general healthcare but is also creating waves in orthodontic treatment methodologies. Personalized orthodontic treatment plans are increasingly being developed to suit individual patient needs, preferences, and anatomical considerations. This approach is supported by impressive strides in artificial intelligence (AI) and machine learning (ML), which enable the analysis of large datasets to predict treatment outcomes and optimize strategies based on unique patient profiles (Balachandran, 2019).

AI and ML hold the potential to revolutionize diagnostic procedures and treatment plans. For instance, these technologies can assist in identifying the most effective type of appliance or the optimal duration for treatment on a patient-by-patient basis. By analyzing data such as growth patterns, lifestyle habits, and medical history, AI-driven models can provide insights that were previously unattainable, thereby ensuring more successful and individualized treatment plans (Johal, 2021).

Furthermore, the integration of AI-driven chatbots and virtual orthodontists could offer immediate guidance and support for patients, enhancing their experience and adherence to treatment protocols (Mehta, 2014). This aligns with the increased demand for patient-centered care and the desire for more direct involvement in one's own healthcare journey.

5. Conclusion

The landscape of orthodontic treatment has witnessed a remarkable transformation over the years, evolving from the traditional braces to advanced aligner systems. This evolution is not merely a testament to technological advancement but also a reflection of the growing emphasis on aesthetic considerations, patient comfort, and treatment efficiency. Traditional braces, with their robust and effective nature, laid the groundwork for modern

orthodontic practices by providing reliable results in correcting complex dental malocclusions. However, their conspicuous appearance and associated discomfort often posed challenges for many patients.

The advent of clear aligners marked a significant turning point in orthodontics, offering a more discreet and flexible alternative to conventional braces. These aligners, leveraging state-of-the-art digital imaging and 3D printing technologies, have revolutionized the patient experience by providing customized treatment plans that are both efficient and minimally invasive. The ability to remove aligners offers unparalleled convenience, promoting better oral hygiene and minimizing dietary restrictions.

Furthermore, the integration of artificial intelligence and machine learning into aligner treatment plans signifies the beginning of a new era in orthodontics, where treatments are becoming increasingly personalized and data-driven. These technologies facilitate continuous monitoring and adjustments in real-time, ensuring optimal outcomes.

In conclusion, the journey from traditional braces to modern aligners reflects the dynamic nature of orthodontics, driven by technological innovations and changing patient preferences. As the field continues to advance, future developments are likely to focus on enhancing treatment precision, reducing duration, and improving accessibility for patients worldwide. The commitment to balancing functionality, aesthetics, and patient-centered care will remain at the heart of orthodontic evolution, promising a future where achieving a perfect smile is more attainable and comfortable than ever before.

References

Agrawal, K., Kangne, S., Ambekar, A., Joshi, Y., kumarMarure, P., &Khanapure, C. (2018). Evolution of pre-adjusted edgewise appliance in orthodontics. *situations*, *1*, 6-12.

Alami, S., Sahim, S., Hilal, F., Essamlali, A., & El Quars, F. (2022). Perception and satisfaction of patients treated with orthodontic clear aligners. *Open Access Library Journal*, *9*(10), 1-11.

Azaripour, A., Weusmann, J., Mahmoodi, B., Peppas, D., Gerhold-Ay, A., Van Noorden, C. J. F., &Willershausen, B. (2015). Braces versus Invisalign®: gingival parameters and patients' satisfaction during treatment: a cross-sectional study. *BMC oral health*, *15*, 1-5.

Buschang, P. H., Shaw, S. G., Ross, M., Crosby, D., & Campbell, P. M. (2014). Comparative time efficiency of aligner therapy and conventional edgewise braces. *The Angle Orthodontist*, *84*(3), 391-396.

Bayan, A., & Yan, Y. (2021). Orthodontic treatment with clear aligners between evolution and efficiency: a literature review. *management*, *18*, 19.

Balachandran, S., Ganapathy, D., & Ramanathan, V. (2019). Clear aligners-A review. *Drug Invention Today*, *12*(10).

d'Apuzzo, F., Perillo, L., Carrico, C. K., Castroflorio, T., Grassia, V., Lindauer, S. J., & Shroff, B. (2019). Clear aligner treatment: different perspectives between orthodontists and general dentists. *Progress in orthodontics*, *20*, 1-9.

Dharsini, S., & Ganapathy, D. (2020). Knowledge on various types of orthodontic treatment among general population. *Drug Invention Today*, *13*(3).

Gange, P. (2015). The evolution of bonding in orthodontics. *American Journal of Orthodontics and Dentofacial Orthopedics*, *147*(4), S56-S63.

Gold, B. P., Siva, S., Duraisamy, S., Idaayath, A., & Kannan, R. (2021). Properties of orthodontic clear aligner materials-a review. *J evol med dent sci*, *10*(37), 3288-3294.

Issa, F. H. K. M., Issa, Z. H. K. M., Rabah, A. F., & Hu, L. (2020). Periodontal parameters in adult patients with clear aligners orthodontics treatment versus three other types of brackets: A cross-sectional study. *Journal of orthodontic science*, *9*(1), 4.

Jheon, A. H., Oberoi, S., Solem, R. C., & Kapila, S. (2017). Moving towards precision orthodontics: An evolving paradigm shift in the planning and delivery of customized orthodontic therapy. *Orthodontics & craniofacial research*, *20*, 106-113.

Johal, A., &Bondemark, L. (2021). Clear aligner orthodontic treatment: Angle Society of Europe consensus viewpoint. *Journal of Orthodontics*, *48*(3), 300-304.

Jorgensen, G. (2015). Attracting orthodontic patients via the Internet: a 20-year evolution. *American Journal of Orthodontics and Dentofacial Orthopedics*, *148*(6), 939-942.

Ke, Y., Zhu, Y., & Zhu, M. (2019). A comparison of treatment effectiveness between clear aligner and fixed appliance therapies. *BMC oral health*, *19*, 1-10.

Kumar, K., Bhardwaj, S., & Garg, V. (2018). Invisalign: a transparent braces. *Journal of Advanced Medical and Dental Sciences Research*, *6*(7), 148-150.

Lou, T., & Mair, A. (2020). An historical overview of clear aligner therapy the evolution of clear aligners. *Oral Health Group*, *14*.

Mehta, F., & Mehta, S. (2014). Aligners: the rapidly growing trend in orthodontics around the world. *Indian J Basic Appl Med Res*, *3*(4), 402-409.

McLaughlin, R. P., & Bennett, J. C. (2015). Evolution of treatment mechanics and contemporary appliance design in orthodontics: A 40-year perspective. *American Journal of Orthodontics and Dentofacial Orthopedics*, *147*(6), 654-662.

Naidu, S., & Suresh, A. (2018). EVOLUTION OF ORTHODONTIC APPLIANCES-THEN AND NOW!!!. *International Journal of Dental and Health Sciences*, 319-329.

Ngan, P., & Moon, W. (2015). Evolution of Class III treatment in orthodontics. *American Journal of Orthodontics and Dentofacial Orthopedics*, *148*(1), 22-36.

Oikonomou, E., Foros, P., Tagkli, A., Rahiotis, C., Eliades, T., &Koletsi, D. (2021). Impact of aligners and fixed appliances on oral health during orthodontic treatment: a systematic review and meta-analysis. *Oral health & preventive dentistry*, *19*(1), 659-672.

Okeson, J. P. (2015). Evolution of occlusion and temporomandibular disorder in orthodontics: Past, present, and future. *American Journal of Orthodontics and Dentofacial Orthopedics*, *147*(5), S216-S223.

Papageorgiou, S. N., Koletsi, D., Iliadi, A., Peltomaki, T., &Eliades, T. (2020). Treatment outcome with orthodontic aligners and fixed appliances: a systematic review with meta-analyses. *European journal of orthodontics*, *42*(3), 331-343.

Phulari, B. S. (2013). *History of orthodontics*. JP Medical Ltd.

Patel, Z. (2021). Emerging Trends in Clear Aligner Therapy: Beyond Traditional Braces. *Orthodontics Unveiled: Exploring Emerging Trends in Dental Alignment*, 91.

Proffit, W. R., & White Jr, R. P. (2015). Combined surgical-orthodontic treatment: how did it evolve and what are the best practices now?. *American Journal of Orthodontics and Dentofacial Orthopedics*, *147*(5), S205-S215.

Putrino, A., Barbato, E., & Galluccio, G. (2021). Clear aligners: Between evolution and efficiency—A scoping review. *International journal of environmental research and public health*, *18*(6), 2870.

Robertson, L., Kaur, H., Fagundes, N. C. F., Romanyk, D., Major, P., & Flores Mir, C. (2020). Effectiveness of clear aligner therapy for orthodontic treatment: A systematic review. *Orthodontics & craniofacial research*, *23*(2), 133-142.

Rossini, G., Parrini, S., Castroflorio, T., Deregibus, A., &Debernardi, C. L. (2015). Efficacy of clear aligners in controlling orthodontic tooth movement: a systematic review. *The Angle Orthodontist*, *85*(5), 881-889.

Rossouw, P. E. (2010, March). A historical overview of the development of the acid-etch bonding system in orthodontics. In *Seminars in orthodontics* (Vol. 16, No. 1, pp. 2-23). WB Saunders.

Sivakumar, P. (2020). Advancements in technology in the field of orthodontics. *Journal of Pharmaceutical Sciences and Research*, *12*(2), 236-242.

Sifakakis, I., Zinelis, S., &Eliades, T. (2017). Aligners for orthodontic applications. In *Orthodontic Applications of Biomaterials* (pp. 275-285). Woodhead Publishing.

Tamer, İ., Öztaş, E., &Marşan, G. (2019). Orthodontic treatment with clear aligners and the scientific reality behind their marketing: a literature review. *Turkish journal of orthodontics*, *32*(4), 241.

Tartaglia, G. M., Mapelli, A., Maspero, C., Santaniello, T., Serafin, M., Farronato, M., & Caprioglio, A. (2021). Direct 3D printing of clear orthodontic aligners: current state and future possibilities. *Materials*, *14*(7), 1799.

Turley, P. K. (2015). Evolution of esthetic considerations in orthodontics. *American Journal of Orthodontics and Dentofacial Orthopedics*, *148*(3), 374-379.

Weir, T. (2017). Clear aligners in orthodontic treatment. *Australian dental journal*, *62*, 58-62.

Wheeler, T. T. (2017, March). Orthodontic clear aligner treatment. In *Seminars in Orthodontics* (Vol. 23, No. 1, pp. 83-89). WB Saunders.

Yu, X., Li, G., Zheng, Y., Gao, J., Fu, Y., Wang, Q., ... & Ding, J. (2022). 'Invisible'orthodontics by polymeric 'clear'aligners molded on 3D-printed personalized dental models. *Regenerative biomaterials*, *9*, rbac007.

Zheng, M., Liu, R., Ni, Z., & Yu, Z. (2017). Efficiency, effectiveness and treatment stability of clear aligners: A systematic review and meta-analysis. *Orthodontics & craniofacial research*, *20*(3), 127-133.