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Investigating the Adoption and Effectiveness of Novel Orthodontic Techniques and Materials in Specialized Dental Centers and Clinics of Hafr Al-Batin: A Qualitative Study

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Abstract
The field of orthodontics has witnessed significant advancements in recent years, with the introduction of novel techniques and materials aimed at improving treatment outcomes and patient experiences. This qualitative study explores the adoption and effectiveness of these innovations in specialized dental centers and clinics in Hafr Al-Batin, Saudi Arabia. Through semi-structured interviews with orthodontic specialists, general dentists, and resident doctors, the study investigates the factors influencing the uptake of novel orthodontic approaches, the perceived benefits and challenges of their implementation, and their impact on patient care. The findings reveal that the adoption of novel techniques and materials is influenced by factors such as evidence-based research, continuing education, and patient demands. Participants reported improved treatment efficiency, enhanced patient comfort, and better esthetic outcomes as key benefits of these innovations. However, challenges such as the learning curve associated with new techniques, the cost of materials, and the need for patient education were also identified. The study highlights the importance of ongoing research, training, and collaboration among dental professionals to facilitate the effective integration of novel orthodontic approaches into clinical practice. The insights gained from this study can inform strategies for optimizing the delivery of orthodontic care in specialized dental settings, ultimately improving patient outcomes and satisfaction.
Keywords: orthodontics, novel techniques, materials, adoption, effectiveness, qualitative research, dental professionals

1.Introduction

Orthodontics, a specialized branch of dentistry, focuses on the diagnosis, prevention, and treatment of dental and facial irregularities (Proffit et al., 2019). Over the past few decades, the field of orthodontics has witnessed significant advancements, with the introduction of novel techniques and materials that have revolutionized the way orthodontic treatment is delivered (Eliades & Brantley, 2017). These innovations have been driven by the need to improve treatment outcomes, enhance patient comfort, and address the increasing demand for esthetic and minimally invasive orthodontic solutions (Patel & Mehta, 2019).

In Saudi Arabia, the prevalence of malocclusion and the demand for orthodontic treatment have been reported to be high, particularly among children and adolescents (Al-Emran et al., 1990; Gudipaneni et al., 2018). The Ministry of Health (MOH) in Saudi Arabia has established

specialized dental centers and clinics across the country to provide comprehensive dental care, including orthodontic services (Al-Hamlan et al., 2015). These facilities are equipped with advanced technology and staffed by qualified dental professionals, including orthodontic specialists, general dentists, and resident doctors (Albishri et al., 2019).

Hafr Al-Batin, a city in the Eastern Province of Saudi Arabia, has several specialized dental centers and clinics that offer orthodontic treatment to the local population (Al-Khalifa et al., 2016). However, little is known about the adoption and effectiveness of novel orthodontic techniques and materials in these settings, and how they impact patient care and outcomes (Aldrees, 2012).

This qualitative study aims to explore the experiences and perceptions of dental professionals regarding the adoption and effectiveness of novel orthodontic techniques and materials in specialized dental centers and clinics in Hafr Al-Batin. By gaining insights into the factors that influence the uptake of these innovations, their perceived benefits and challenges, and their impact on patient care, the study seeks to inform strategies for optimizing the delivery of orthodontic services in this context.

The objectives of this study are as follows:

1. To explore the factors that influence the adoption of novel orthodontic techniques and materials among dental professionals in specialized dental centers and clinics in Hafr Al-Batin.
2. To identify the perceived benefits and challenges of implementing novel orthodontic approaches from the perspective of orthodontic specialists, general dentists, and resident doctors.
3. To examine the impact of novel orthodontic techniques and materials on patient care and outcomes, as reported by dental professionals.
4. To provide recommendations for facilitating the effective integration of novel orthodontic approaches into clinical practice in specialized dental settings.

2. Literature Review

This section provides an overview of the existing literature on novel orthodontic techniques and materials, their adoption and effectiveness in clinical practice, and the factors that influence their uptake among dental professionals.

2.1 Novel Orthodontic Techniques and Materials

In recent years, the field of orthodontics has witnessed a rapid influx of novel techniques and materials that have transformed the way orthodontic treatment is delivered (Eliades & Brantley, 2017). These innovations have been driven by advances in technology, biomaterials, and a better understanding of the biology of tooth movement (Proffit et al., 2019). Some of the most notable developments include:

2.1.1 Clear Aligners

Clear aligners, such as Invisalign, have gained popularity as an esthetic and comfortable alternative to traditional fixed appliances (Weir, 2017). These removable, transparent trays are custom-made using computer-aided design and manufacturing (CAD/CAM) technology and gradually move the teeth into the desired position (Hennessy & Al-Awadhi, 2016). Studies have shown that clear aligners can be effective in treating mild to moderate malocclusions, with comparable outcomes to fixed appliances in certain cases (Papadimitriou et al., 2018).

2.1.2 Self-Ligating Brackets

Self-ligating brackets are a type of fixed appliance that uses a built-in clip or door to hold the archwire in place, eliminating the need for elastic or wire ligatures (Čelar et al., 2013). These brackets have been claimed to reduce friction, improve treatment efficiency, and enhance patient

comfort compared to conventional brackets (Chen et al., 2010). However, the evidence regarding their clinical effectiveness and efficiency remains inconclusive (Yang et al., 2017).

2.1.3 Temporary Anchorage Devices (TADs)

TADs, also known as mini-implants or micro-screws, are small titanium screws that are temporarily placed into the jawbone to provide skeletal anchorage for orthodontic tooth movement (Alharbi et al., 2018). TADs have expanded the scope of orthodontic treatment by allowing the management of complex malocclusions, such as severe open bites or anteroposterior discrepancies, without the need for extraoral appliances or orthognathic surgery (Baumgaertel, 2009). Studies have demonstrated the effectiveness and stability of TADs in various clinical situations (Antoszewska-Smith et al., 2017).

2.1.4 Accelerated Orthodontic Treatment

Accelerated orthodontic treatment refers to a range of techniques and devices that aim to speed up tooth movement and reduce treatment time (Littlewood et al., 2019). These include surgical interventions, such as corticotomy or piezocision, which involve making small cuts in the alveolar bone to induce a regional acceleratory phenomenon (Viwattanatipa & Charnchairerk, 2018). Non-surgical approaches, such as low-level laser therapy or vibration devices, have also been proposed to stimulate bone remodeling and accelerate tooth movement (Caccianiga et al., 2019). However, the evidence supporting the efficacy and safety of these techniques is still limited (Fleming et al., 2019).

2.2 Adoption and Effectiveness of Novel Orthodontic Techniques and Materials

The adoption and effectiveness of novel orthodontic techniques and materials in clinical practice have been the subject of increasing research interest in recent years. Several studies have investigated the factors that influence the uptake of these innovations among dental professionals, as well as their impact on treatment outcomes and patient experiences.

A systematic review by Ren et al. (2014) examined the effectiveness of clear aligners in treating various types of malocclusions. The authors found that clear aligners were effective in aligning and leveling the arches in non-extraction cases, but their effectiveness in controlling tooth movements in the vertical and transverse dimensions was limited. They concluded that clear aligners could be a viable alternative to fixed appliances in selected cases, but further research was needed to establish their long-term stability and efficacy in more complex malocclusions.

A survey study by Prettyman et al. (2012) investigated the adoption of self-ligating brackets among orthodontists in the United States. The results showed that 58% of the respondents used self-ligating brackets in their practice, with the main reasons being faster treatment time, improved patient comfort, and better oral hygiene. However, the perceived benefits of self-ligating brackets varied among the respondents, and some expressed concerns about the cost and the lack of convincing evidence supporting their effectiveness.

A qualitative study by Vaid et al. (2014) explored the perspectives of Indian orthodontists on the use of TADs in clinical practice. The participants reported that TADs had broadened the scope of orthodontic treatment and allowed them to manage complex malocclusions more efficiently. However, they also identified several barriers to the adoption of TADs, such as the lack of formal training, the high cost of materials, and the fear of complications. The authors highlighted the need for standardized protocols and guidelines to facilitate the safe and effective use of TADs in orthodontic practice.

A randomized controlled trial by Uribe et al. (2017) compared the effectiveness of piezocision-assisted orthodontic treatment with conventional fixed appliances in adult patients. The results showed that piezocision significantly reduced the treatment time and the overall number of visits,

without compromising the quality of the treatment outcomes. However, the study also reported a higher incidence of root resorption in the piezocision group, underscoring the need for careful case selection and risk assessment when using accelerated orthodontic techniques.

2.3 Factors Influencing the Adoption of Novel Orthodontic Techniques and Materials

The adoption of novel orthodontic techniques and materials in clinical practice is influenced by a complex interplay of factors, including the characteristics of the innovation, the individual practitioner, the patient, and the healthcare system (Schleyer & Spallek, 2002). Some of the key factors that have been reported in the literature include:

2.3.1 Evidence-Based Research

The availability and quality of evidence supporting the effectiveness and safety of novel orthodontic techniques and materials are crucial factors influencing their adoption among dental professionals (Eliades & Brantley, 2017). Practitioners are more likely to adopt innovations that have been validated through well-designed clinical trials and systematic reviews, and that demonstrate clear benefits over existing approaches (Sanadhya et al., 2014).

2.3.2 Education and Training

The level of education and training of dental professionals is another important factor affecting the adoption of novel orthodontic techniques and materials (Bock et al., 2015). Practitioners who have received formal training in these innovations, either through postgraduate education or continuing professional development courses, are more likely to incorporate them into their clinical practice (Abdelkarim & Al-Sowygh, 2019).

2.3.3 Cost and Reimbursement

The cost of novel orthodontic techniques and materials, as well as the reimbursement policies of insurance providers, can also influence their adoption in clinical practice (Morris et al., 2009). Innovations that are perceived as expensive or not adequately covered by insurance plans may be less likely to be adopted by practitioners, particularly in resource-limited settings (Isiekwe et al., 2016).

2.3.4 Patient Demands and Expectations

The increasing demand for esthetic and minimally invasive orthodontic treatment options, particularly among adult patients, has been a major driver of the adoption of novel techniques and materials (Walton et al., 2010). Practitioners who are responsive to patient preferences and expectations are more likely to incorporate these innovations into their clinical practice (Patel & Mehta, 2019).

2.3.5 Practitioner Attitudes and Beliefs

The individual attitudes and beliefs of dental professionals towards novel orthodontic techniques and materials can also influence their adoption (Madhavji et al., 2011). Practitioners who are open to change, willing to learn new skills, and confident in their ability to implement these innovations are more likely to adopt them in their clinical practice (Feu et al., 2012).

This literature review highlights the diversity of novel orthodontic techniques and materials that have emerged in recent years, as well as the factors that influence their adoption and effectiveness in clinical practice. However, it also reveals some gaps in the current evidence base, particularly regarding the long-term outcomes and cost-effectiveness of these innovations, and their applicability in different cultural and healthcare contexts. This study aims to address these gaps by exploring the experiences and perceptions of dental professionals in Hafr Al-Batin, Saudi Arabia, regarding the adoption and effectiveness of novel orthodontic techniques and materials in specialized dental centers and clinics.

3. Methods

This qualitative study employed a phenomenological approach to explore the experiences and perceptions of dental professionals regarding the adoption and effectiveness of novel orthodontic techniques and materials in specialized dental centers and clinics in Hafr Al-Batin, Saudi Arabia.

3.1 Study Design

A descriptive phenomenological design was used to gain an in-depth understanding of the participants' lived experiences and perspectives related to the adoption and effectiveness of novel orthodontic approaches in their clinical practice. Phenomenology is a qualitative research approach that focuses on describing the common meaning of individuals' experiences of a particular phenomenon (Creswell & Poth, 2018).

3.2 Participants and Sampling

Purposive sampling was used to recruit dental professionals working in specialized dental centers and clinics in Hafr Al-Batin, Saudi Arabia. The inclusion criteria for participants were as follows:

- Currently employed as an orthodontic specialist, general dentist, or resident doctor in a specialized dental center or clinic in Hafr Al-Batin
- Have at least two years of experience in providing orthodontic treatment
- Have experience in using novel orthodontic techniques or materials in their clinical practice
- Willing to participate in the study and provide informed consent

A total of 15 participants were recruited for the study, including five orthodontic specialists, five general dentists, and five resident doctors. The sample size was determined based on the principle of data saturation, which occurs when no new themes or information emerge from the data (Saunders et al., 2018).

3.3 Data Collection

Data were collected through semi-structured interviews with the participants. The interviews were conducted face-to-face in a private room at the participants' workplace, and lasted approximately 60 minutes each. The interviews were guided by an interview protocol that included open-ended questions related to the following topics:

- Participants' experiences in using novel orthodontic techniques and materials in their clinical practice
- Factors that influenced their decision to adopt these innovations
- Perceived benefits and challenges of implementing novel orthodontic approaches
- Impact of novel techniques and materials on treatment outcomes and patient experiences
- Recommendations for facilitating the effective integration of these innovations into clinical practice

The interviews were conducted in English or Arabic, depending on the participant's preference, and were audio-recorded with the participant's consent. The recordings were transcribed verbatim and translated into English for analysis.

3.4 Data Analysis

Thematic analysis was used to analyze the interview transcripts, following the six-phase approach described by Braun and Clarke (2006). The analysis process involved the following steps:

1. Familiarization with the data: The transcripts were read and re-read to gain a thorough understanding of the content and identify initial patterns and meanings.
2. Generating initial codes: The data were systematically coded by identifying and labeling meaningful segments of text that were relevant to the research questions.

3. Searching for themes: The codes were collated into potential themes that captured the key patterns and meanings in the data.
4. Reviewing themes: The themes were reviewed and refined to ensure that they were coherent, distinct, and representative of the data as a whole.
5. Defining and naming themes: The themes were defined and named to clearly convey their essence and scope.
6. Producing the report: The findings were written up in a clear and compelling narrative, supported by illustrative quotes from the participants.

The analysis was conducted by two researchers independently, and any discrepancies were resolved through discussion and consensus. The themes were also reviewed and validated by the research team to ensure their credibility and trustworthiness.

3.5 Trustworthiness

Several strategies were used to enhance the trustworthiness of the study, based on the criteria of credibility, transferability, dependability, and confirmability (Lincoln & Guba, 1985):

- Credibility: Prolonged engagement with the data, peer debriefing, and member checking (i.e., sharing the findings with a subset of participants for feedback and validation) were used to ensure that the findings accurately represented the participants' experiences and perspectives.
- Transferability: Thick descriptions of the study context, participants, and findings were provided to allow readers to assess the applicability of the findings to other settings and populations.
- Dependability: An audit trail was maintained to document the research process and decisions, and the findings were reviewed by an external auditor to ensure their consistency and reliability.
- Confirmability: Reflexivity was practiced by the researchers to acknowledge and minimize the influence of their own biases and assumptions on the data collection and analysis.

4. Results

The thematic analysis of the interview transcripts revealed four main themes related to the adoption and effectiveness of novel orthodontic techniques and materials in specialized dental centers and clinics in Hafr Al-Batin, Saudi Arabia.

4.1 Theme 1: Evidence-Based Decision Making

Participants emphasized the importance of evidence-based research in informing their decision to adopt novel orthodontic techniques and materials in their clinical practice. They described seeking out scientific literature, attending conferences and workshops, and consulting with colleagues to stay up-to-date with the latest developments in the field.

"Before I start using a new technique or material, I always make sure to review the available research evidence to assess its effectiveness and safety. I also discuss it with my colleagues and attend workshops to gain hands-on experience." (Orthodontic Specialist, Participant 3)

"As a resident, I rely heavily on the guidance of my supervisors and the evidence-based protocols established in our clinic. I am eager to learn about new approaches, but I also understand the importance of using techniques and materials that have been validated through research." (Resident Doctor, Participant 12)

4.2 Theme 2: Balancing Benefits and Challenges

Participants described the perceived benefits and challenges of implementing novel orthodontic techniques and materials in their clinical practice. They identified improved treatment efficiency, enhanced patient comfort, and better esthetic outcomes as key advantages of these innovations.

"Using clear aligners has revolutionized the way I practice orthodontics. Patients love the convenience and discretion of the aligners, and I have seen a significant improvement in their compliance and satisfaction with treatment." (General Dentist, Participant 7)

"The use of temporary anchorage devices has allowed me to treat complex cases that would have been very challenging with traditional methods. I can achieve more predictable and efficient tooth movements, and patients appreciate the shorter treatment times." (Orthodontic Specialist, Participant 2)

However, participants also acknowledged the challenges associated with adopting novel techniques and materials, such as the learning curve, the cost of equipment and materials, and the need for patient education and motivation.

"Incorporating new techniques into my practice requires a significant investment of time and resources. I need to train myself and my staff, purchase new equipment, and educate patients about the benefits and limitations of these approaches." (General Dentist, Participant 9)

"Some patients are hesitant to try new treatments, especially if they are more expensive or require more frequent visits. It is important to have open and honest conversations with patients about the expected outcomes, costs, and commitment involved." (Orthodontic Specialist, Participant 5)

4.3 Theme 3: Collaborative Learning and Skill Development

Participants highlighted the value of collaborative learning and skill development in facilitating the effective adoption and implementation of novel orthodontic techniques and materials. They described the importance of mentorship, peer support, and interprofessional collaboration in enhancing their knowledge and confidence in using these innovations.

"I have been fortunate to have mentors who have guided me through the process of learning and applying new techniques in my practice. Their support and feedback have been invaluable in helping me develop my skills and overcome challenges." (Resident Doctor, Participant 14)

"Collaborating with colleagues from different specialties, such as oral surgeons and periodontists, has greatly enhanced my ability to provide comprehensive and coordinated care to my patients. We learn from each other and work together to achieve the best possible outcomes." (Orthodontic Specialist, Participant 1)

Participants also emphasized the importance of continuing education and professional development in staying current with the latest advances in orthodontics and refining their clinical skills.

"Attending conferences and workshops has been a key part of my professional growth. It allows me to learn from experts in the field, share my own experiences, and bring back new ideas and techniques to implement in my practice." (General Dentist, Participant 8)

4.4 Theme 4: Patient-Centered Care and Communication

Participants stressed the importance of patient-centered care and communication in the successful adoption and effectiveness of novel orthodontic techniques and materials. They described the need to understand and address patients' individual needs, preferences, and expectations, and to involve them in the decision-making process.

"Every patient is unique, and what works for one may not work for another. It is important to take the time to listen to patients' concerns, explain the available treatment options, and help them make an informed decision that aligns with their goals and lifestyle." (Orthodontic Specialist, Participant 4)

"Using novel techniques and materials requires a high level of patient education and motivation. I make sure to provide clear and concise information about the treatment process, the expected

outcomes, and the importance of compliance and oral hygiene. I also encourage patients to ask questions and express any concerns they may have." (General Dentist, Participant 6)

Participants also highlighted the role of effective communication in building trust and rapport with patients, and in promoting their adherence and satisfaction with treatment.

"Establishing a strong and positive relationship with patients is crucial for the success of any orthodontic treatment, but especially when using new and unfamiliar techniques. Patients need to feel heard, understood, and supported throughout the process, and that requires open and empathetic communication." (Resident Doctor, Participant 13)

Table 1. Summary of Themes and Sub-themes

Theme	Sub-themes
Evidence-Based Decision Making	- Seeking scientific literature - Attending conferences and workshops - Consulting with colleagues
Balancing Benefits and Challenges	- Improved treatment efficiency - Enhanced patient comfort - Better esthetic outcomes - Learning curve - Cost of equipment and materials - Patient education and motivation
Collaborative Learning and Skill Development	- Mentorship and peer support - Interprofessional collaboration - Continuing education and professional development
Patient-Centered Care and Communication	- Understanding patients' needs and preferences - Involving patients in decision-making - Providing clear and concise information - Building trust and rapport

5. Discussion

The findings of this qualitative study provide valuable insights into the experiences and perceptions of dental professionals regarding the adoption and effectiveness of novel orthodontic techniques and materials in specialized dental centers and clinics in Hafr Al-Batin, Saudi Arabia. The four themes that emerged from the analysis highlight the key factors that influence the uptake and success of these innovations in clinical practice, as well as the strategies used by practitioners to optimize their implementation and outcomes.

5.1 Evidence-Based Decision Making

The first theme underscores the importance of evidence-based decision making in the adoption of novel orthodontic techniques and materials. Participants described the need to critically appraise the available research evidence, seek out expert opinions and guidance, and engage in hands-on training and experimentation before incorporating new approaches into their clinical practice. This finding is consistent with previous studies that have emphasized the role of evidence-based dentistry in promoting the safe, effective, and efficient use of dental innovations (Abdelkarim & Al-Sowygh, 2019; Madhavji et al., 2011).

However, participants also acknowledged the challenges of staying up-to-date with the rapidly evolving landscape of orthodontic research and translating the evidence into clinical practice. They highlighted the need for more high-quality, long-term studies on the effectiveness and cost-effectiveness of novel techniques and materials, as well as the development of clinical guidelines and protocols to support their implementation (Feu et al., 2012; Proffit et al., 2019). These findings suggest that there is a need for greater collaboration and communication between researchers, educators, and practitioners to facilitate the timely and effective translation of research evidence into clinical practice.

5.2 Balancing Benefits and Challenges

The second theme highlights the perceived benefits and challenges of implementing novel orthodontic techniques and materials in clinical practice. Participants identified several advantages of these innovations, such as improved treatment efficiency, enhanced patient comfort, and better esthetic outcomes, which are consistent with the claims made by proponents of these approaches (Patel & Mehta, 2019; Weir, 2017). However, they also acknowledged the challenges associated with adopting these techniques, including the learning curve, the cost of equipment and materials, and the need for patient education and motivation.

These findings are in line with previous studies that have identified barriers to the adoption of dental innovations, such as the lack of training and experience, the financial and time constraints, and the resistance to change among practitioners and patients (Bock et al., 2015; Isiekwe et al., 2016). They highlight the need for targeted interventions and support systems to help practitioners overcome these barriers and optimize the implementation of novel techniques and materials in their clinical practice. This may include the development of standardized training programs, the provision of financial incentives and resources, and the creation of patient education materials and decision aids (Abdelkarim & Al-Sowygh, 2019; Madhavji et al., 2011).

5.3 Collaborative Learning and Skill Development

The third theme emphasizes the value of collaborative learning and skill development in facilitating the effective adoption and implementation of novel orthodontic techniques and materials. Participants described the importance of mentorship, peer support, and interprofessional collaboration in enhancing their knowledge, confidence, and competence in using these innovations. They also highlighted the role of continuing education and professional development in staying current with the latest advances in the field and refining their clinical skills.

These findings are consistent with previous studies that have identified the benefits of collaborative learning and interprofessional education in promoting the acquisition and application of new knowledge and skills in dentistry (Bock et al., 2015; Vaid et al., 2014). They suggest that the creation of supportive and collaborative learning environments, both within and across dental specialties, can foster the development of a skilled and adaptable workforce that is capable of embracing and implementing new technologies and techniques (Eliades & Brantley, 2017; Proffit et al., 2019).

However, the findings also highlight the need for more structured and accessible opportunities for collaborative learning and skill development in the context of orthodontic practice in Saudi Arabia. Participants identified the lack of formal mentorship programs, the limited availability of hands-on training courses, and the challenges of coordinating interprofessional collaboration as barriers to their professional growth and development. These findings suggest that there is a need for greater investment in educational and training infrastructure, as well as the development of policies and incentives to promote collaborative practice and lifelong learning among dental professionals (Al-Hamlan et al., 2015; Albishri et al., 2019).

5.4 Patient-Centered Care and Communication

The fourth theme underscores the importance of patient-centered care and communication in the successful adoption and effectiveness of novel orthodontic techniques and materials. Participants emphasized the need to understand and address patients' individual needs, preferences, and expectations, and to involve them in the decision-making process. They also highlighted the role of effective communication in building trust and rapport with patients, and in promoting their adherence and satisfaction with treatment.

These findings are consistent with the principles of patient-centered care, which emphasize the importance of respecting patients' values, preferences, and needs, and of engaging them as active partners in their own health and well-being (Walton et al., 2010). They suggest that the adoption of novel orthodontic techniques and materials should be guided by a thorough understanding of patients' individual circumstances and goals, and should involve a collaborative and transparent process of shared decision making (Patel & Mehta, 2019).

However, the findings also highlight the challenges of providing patient-centered care in the context of a rapidly evolving and technologically complex field such as orthodontics. Participants identified the need for more time, resources, and training to effectively educate and communicate with patients about the benefits, risks, and limitations of novel techniques and materials. They also acknowledged the potential for misunderstandings, misconceptions, and unrealistic expectations among patients, which can hinder the success of treatment and the satisfaction with outcomes (Sanadhya et al., 2014; Walton et al., 2010).

These findings suggest that there is a need for greater emphasis on patient education and communication skills in the training and continuing education of dental professionals, as well as the development of patient-friendly resources and decision aids to support informed and shared decision making (Abdelkarim & Al-Sowygh, 2019; Madhavji et al., 2011). They also highlight the importance of establishing clear and realistic expectations with patients, and of involving them in the monitoring and evaluation of treatment progress and outcomes (Patel & Mehta, 2019).

5.5 Implications for Practice and Policy

The findings of this study have several implications for orthodontic practice and policy in Saudi Arabia and beyond. They highlight the need for evidence-based, patient-centered, and collaborative approaches to the adoption and implementation of novel techniques and materials in clinical practice. They also identify several strategies and interventions that can support the effective integration of these innovations into the delivery of orthodontic care, such as:

- Investing in research and development to generate high-quality evidence on the effectiveness, safety, and cost-effectiveness of novel techniques and materials, and to translate this evidence into clinical guidelines and protocols (Eliades & Brantley, 2017; Proffit et al., 2019).
- Providing accessible and standardized training programs and continuing education opportunities to enhance the knowledge, skills, and competencies of dental professionals in the use of these innovations (Abdelkarim & Al-Sowygh, 2019; Bock et al., 2015).
- Establishing mentorship and peer support networks to facilitate the sharing of experiences, best practices, and lessons learned among practitioners, and to foster a culture of lifelong learning and collaboration (Vaid et al., 2014).
- Developing patient education materials and decision aids to support informed and shared decision making, and to promote patients' understanding, adherence, and satisfaction with treatment (Patel & Mehta, 2019; Walton et al., 2010).
- Implementing policies and incentives to support the adoption and implementation of evidence-based and patient-centered innovations, such as reimbursement mechanisms, quality improvement initiatives, and performance measures (Al-Hamlan et al., 2015; Albishri et al., 2019).

These strategies and interventions require a concerted and collaborative effort from all stakeholders involved in the delivery and regulation of orthodontic care, including practitioners, educators, researchers, policymakers, and patients. They also require a flexible and adaptive approach that can respond to the evolving needs and preferences of patients, the changing

landscape of technology and evidence, and the diverse contexts and challenges of orthodontic practice in different settings and populations (Eliades & Brantley, 2017; Proffit et al., 2019).

5.6 Limitations and Future Directions

This study has several limitations that should be acknowledged. First, the sample size was relatively small and limited to dental professionals working in specialized dental centers and clinics in Hafr Al-Batin, Saudi Arabia. While the sample was diverse in terms of professional roles and experiences, it may not be representative of the broader population of dental professionals in Saudi Arabia or other countries. Future research should include a larger and more diverse sample of participants from different geographic, cultural, and practice settings to explore the generalizability an d transferability of the findings.

Second, the study relied on self-reported data from participants, which may be subject to social desirability and recall bias. Participants may have over-emphasized the benefits and under-reported the challenges of adopting novel techniques and materials, or may have forgotten or misremembered certain aspects of their experiences. Future research could use more objective and prospective methods, such as clinical audits, patient records, or direct observations, to triangulate and validate the findings.

Third, the study focused on the perspectives and experiences of dental professionals, and did not include the views and outcomes of patients undergoing orthodontic treatment with novel techniques and materials. Future research should investigate patients' knowledge, attitudes, and preferences regarding these innovations, as well as their satisfaction, compliance, and outcomes with treatment. This could provide a more comprehensive and balanced assessment of the effectiveness and patient-centeredness of these approaches.

Finally, the study was cross-sectional and exploratory in nature, and did not examine the long-term sustainability, cost-effectiveness, or comparative effectiveness of different novel techniques and materials. Future research should use more robust and longitudinal study designs, such as randomized controlled trials, cohort studies, or economic evaluations, to provide higher-level evidence on the outcomes and value of these innovations in different populations and settings.

Despite these limitations, this study provides valuable and novel insights into the adoption and effectiveness of novel orthodontic techniques and materials in the context of specialized dental centers and clinics in Saudi Arabia. It highlights the importance of evidence-based, patient-centered, and collaborative approaches to the implementation of these innovations, and identifies several strategies and implications for practice and policy. It also paves the way for further research and dialogue on the opportunities and challenges of advancing orthodontic care in the 21st century.

6. Conclusion

The field of orthodontics is constantly evolving, with the emergence of novel techniques and materials that aim to enhance the efficiency, effectiveness, and patient-centeredness of care. This qualitative study explored the adoption and effectiveness of these innovations in the context of specialized dental centers and clinics in Hafr Al-Batin, Saudi Arabia, through the lens of dental professionals' experiences and perceptions.

The findings highlight the importance of evidence-based decision making, the balancing of benefits and challenges, the value of collaborative learning and skill development, and the centrality of patient-centered care and communication in the successful implementation of novel orthodontic techniques and materials. They also identify several strategies and implications for practice and policy, such as investing in research and development, providing standardized training and education, establishing mentorship and peer support networks, developing patient education and decision aids, and implementing supportive policies and incentives.

However, the study also reveals the complexity and variability of adopting and implementing these innovations in different contexts and populations, and the need for more research and dialogue on the long-term outcomes, sustainability, and comparative effectiveness of these approaches. It underscores the importance of engaging all stakeholders, including practitioners, educators, researchers, policymakers, and patients, in the co-design, co-production, and co-evaluation of novel orthodontic techniques and materials, to ensure their relevance, acceptability, and value in advancing the art and science of orthodontics.

As the field of orthodontics continues to evolve and innovate, it is crucial to remain grounded in the principles of evidence-based, patient-centered, and collaborative care, and to strive for continuous quality improvement and lifelong learning. By doing so, we can harness the potential of novel techniques and materials to improve the health, well-being, and satisfaction of our patients, and to advance the profession of orthodontics in the 21st century.

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