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Bioactive Materials for the Future of Dentistry

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Abstract: The term bioactivity is becoming more common in the fields of medicine and dentistry. Its positive implications often lead to its use in marketing dental restorative materials. However, there is some confusion surrounding the definition of the term, and concerns about its potential overuse have been raised. In response, FDI has decided to publish a Policy Statement regarding the bioactivity of dental restorative materials to clarify the term and outline some precautions for its use in advertising. The background information for this Policy Statement was gathered from current literature, primarily from the PubMed database and various online sources. Bioactive restorative materials should provide beneficial effects that are local, intended, and non-toxic, without interfering with the primary function of the material, which is to replace dental tissue. Three mechanisms of bioactivity for these materials have been identified: purely biological, a combination of biological and chemical, or strictly chemical. When the term bioactivity appears in advertisements or descriptions of dental restorative materials, it is essential to provide scientific evidence—whether from in vitro or in situ studies, and ideally from clinical trials - that outlines the mechanism of action, the duration of the effect (particularly for materials that release antibacterial agents), and the absence of significant adverse biological side effects, such as the development and spread of antimicrobial resistance. Also, it must be proven that the main goal—like fixing the shape and function of damaged or missing teeth—is not harmed. This should be backed up by data from lab tests and studies on patients.

Keywords: Bioactive material; dentistry; remineralization.

Teeth were among the first organs to have their function effectively restored using inert filling materials that are now well-known to the public, such as amalgams, polymeric resin composites, and gutta-percha. These materials have provided significant benefits to the health of millions of patients around the globe. In recent decades, there has been remarkable progress in the field of dental materials. However, dental diseases like caries and periodontitis remain very common among people of all ages [1].

Many of the practical issues and discomfort linked to dental and periodontal decay have been significantly reduced due to modern methods of restoring hard and soft dental tissues. However, the dental filling procedures we have today are still not ideal; even though amalgams offer long-term stability, they have increasingly fallen out of favor due to concerns about mercury release, risks to dental practitioners, and challenges with waste management [2].

The polymeric resin composites that have replaced traditional materials are known to promote bacterial adherence and biofilm formation [4]. In terms of current endodontic

procedures, these methods leave the refilled tooth significantly more fragile and susceptible to fractures compared to natural teeth. Additionally, while dental implants have become a common solution for complete tooth replacement, they are not without their issues. The dental implant root is directly anchored to the alveolar bone, which results in inadequate cushioning against masticatory forces and can lead to long-term problems such as marginal bone loss and peri-implantitis [3]. So, there's a clear need for new biomaterials that can not only provide mechanical support but also integrate biologically with the restored dental tissues.

These bioactive materials are expected to interact with the body's cells and the oral environment to help regenerate natural tissue and prevent future tooth decay [4]. As a result, bioactive materials are likely to become the foundation of advanced dentistry in the future. Some interesting studies have been published about improving dental resin composites and materials used for filling root canals by adding antibacterial properties [5].

These improvements aim to prevent secondary cavities and infections in root canals. Secondary cavities are a major health issue and are the main reason why many dental restorations fail. These infections happen because the dental adhesives and resin composites used today tend to encourage bacteria to stick to and grow on the restored areas [5]. Additionally, these materials tend to break down over time, causing cracks and requiring repeated treatments, which can further damage the teeth [10]. Some problems with dental restoration failure might be solved by adding substances that kill bacteria on contact, such as quaternary ammonium or tiny particles and tubes made of metal oxides , into the resin material.

This would help stop the growth of bacteria that form sticky layers on teeth. These methods have already been tried in small clinical studies, like one by Melo et al., where a special compound was mixed with dental resin to create a mouth device that could effectively reduce harmful bacteria . Another approach involves adding tiny particles of amorphous calcium phosphate, which slowly release calcium and phosphate over time, helping to rebuild tooth enamel [6].

In general, the current trend indicates that over the next ten years, there will likely be fast progress in creating and testing new, improved dental filling materials. This growth is largely driven by the dental industry's strong interest in developing new products with better features. Currently, the preferred treatment for severe dental pulp inflammation (irreversible pulpitis) involves endodontic procedures and sealing root canals with non-reactive materials like gutta-percha. However, a major issue with modern endodontic treatments is that the tooth's pulp is completely removed, losing its natural ability to maintain and mineralize the tooth. Without a functioning pulp that contains cells (odontoblasts) that produce dentin, the tooth becomes much more likely to crack or develop further problems [7].

One of the biggest challenges in dentistry today is figuring out how to regrow a working periodontal ligament after putting in a dental implant. The PDL is a thin band of strong, flexible tissue full of collagen and blood vessels. It connects the tooth root to the surrounding jawbone and helps absorb the pressure from chewing. When a tooth is removed, the empty socket fills with dense bone, which is later used to anchor the implant. However, because the implant is directly attached to the bone, the bone ends up bearing more stress than it would with a natural tooth. Over time, this can lead to bone loss around the implant and increase the risk of infection, known as peri-implantitis [8].

The buildup of dental plaque biofilms and the ongoing inflammation linked to micro-fractures in bone due to excessive mechanical stress on the implant surface only speed up this issue. Consequently, there is a pressing need for biomaterials that can regenerate periodontal ligament-like tissue around dental implants to improve their long-term stability. The primary challenge with traditional bioscaffolds, such as those made from collagen or fibrin, is that they often promote mineralization and bone formation on the implant surface. While these scaffolds are excellent options for repairing periodontal bone defects, an effective strategy for reconstructing the periodontal ligament should

ideally involve a biomaterial that resists mineralization. Recently, we explored the potential of human Decellularized Adipose Tissue in this regard, showing that this biomaterial has a significantly lower tendency to be mineralized by osteogenic stem cells compared to other conventional scaffolds like collagen [9].

In the field of implantology, bioactive materials have been utilized as coatings to enhance the osseointegration of dental implants and improve their overall biological performance. Dental implants are typically constructed from bioinert materials such as stainless steel 316L, commercially pure titanium, its alloy Ti-6Al-4V, and cobalt–chromium alloys. Various techniques can be employed to apply bioactive coatings to the surfaces of dental implants, including enameling, sol–gel processes, electrophoresis, laser cladding, and thermal spraying. The first bioactive glass, 45S5 Bioglass, was developed around 50 years ago. Other bioactive coatings include hydroxyapatite, zirconium dioxide, titanium dioxide, and zinc oxide. The properties of these materials can be further improved by incorporating active agents for specific purposes. For example, adding silver ions to the bioactive glass structure can enhance its antibacterial properties [10].

There is a significant increase in research focused on tissue engineering and bioactive materials for dental applications. Unlike previous generations of dental materials, which were primarily selected for their inert properties and minimal adverse reactions, the next generation of dental materials is anticipated to have genuine biological effects on the surrounding oral and dental tissues, enhancing integration and functionality.

In conclusion, research in dental materials is evolving from a focus on biocompatibility to an emphasis on bioactivity. Today, the ideal dental material not only needs to be biocompatible [18], but also should exhibit biomimetic and bioactive characteristics. Various bioactive materials can be utilized in endodontics, restorative dentistry, and implantology, with the choice of the right material depending heavily on the specific application and its properties.

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Coatings for Dental Materials: How They Affect Clinical Performance

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Abstract: Contemporary dentistry embraces digital procedures and advanced biomaterials to improve patients' quality of life. As practitioners, we are encouraged to adapt in every aspect of our work, from diagnosis to the creation of prosthetics. The latest biomaterials need to be more damage-tolerant and capable of ensuring longer-lasting results. Consequently, biomimetic replacements, tissue engineering scaffolds, and even cloned teeth could represent the best options for future treatments.

Keywords: coating; ceramic; resin composite; bone healing; roughness.

Introduction

In the intraoral environment, factors such as temperature, pH, electrochemical potential, solute concentrations, and oxygen levels can directly interact with various materials. Therefore, protective layers like glazing and coatings are essential to mitigate the effects of the oral environment on these materials and ensure long-term clinical stability. Clinicians must understand the properties of these materials and how to enhance their mechanical performance in the challenging conditions of the oral cavity (1).

Dental ceramics are commonly used as dependable restorative materials, and the technique used for surface finishing plays a crucial role in influencing cyclic fatigue and the topography of ceramic restorations. Similarly, polished glass ceramics are sensitive to variations in load profiles, highlighting the impact of surface morphology on fatigue resistance. A notable protective effect on the chemical solubility of a glass ceramic in various pH environments can be observed when a protective coating is applied to its surface. Thus, it would be valuable to determine whether different restorative materials exhibit similar behavior or if alternative coating materials might yield different results (2).

In addition to environmental factors, surface defects can occur due to clinical and laboratory procedures, regardless of how the manufacturer processes the material. In this context, if the topographical defects created during surface treatments are filled with composite cement during the luting process, the material's strength can be enhanced. Conversely, if these defects are not fully filled with composite

cement, the fatigue performance of the ceramic restorations may suffer due to high stress concentrations within these defects during load application (3).

However, we should avoid recommending or implementing less aggressive surface treatments solely to minimize the number of material defects, as this could adversely affect the bond strength of the restoration and ultimately reduce its longevity. Therefore, the literature continues to search for a protocol that balances optimal bond strength with minimal alterations to the material structure and ensures long-term reliability (4).

The wear rate of indirect materials is influenced not just by the microstructure, but also by the application of shade characterization layers and glazing as coatings on their surfaces. Regardless of the mechanical properties of the materials, the durability of the extrinsic staining layer will be affected by the amount of glass phase present in the restorative material. Furthermore, for hybrid materials that require polymeric coatings, surface treatment is essential to enhance their longevity. However, the literature has yet to explore the wear rate and material performance following the removal of glazing and shade layers. Additionally, the superficial topography of the material or coatings, characterized by low roughness and sufficient homogeneity, may also play a role in bacterial adhesion and human cell viability. Consequently, both laboratory and clinical modifications will impact not only the mechanical properties of dental materials but also their biological responses (5).

In terms of direct restorative procedures, enhancing the dissipation of chewing load, reducing polymerization residual stress, and preventing microleakage can be achieved through the use of coatings with a functional layer. These coatings can improve the performance of restorations by altering the wettability of polymers. Polymeric biomaterials used in dental applications can also serve as coatings for both direct and indirect restorations, allowing for the deposition of nanoparticles within their structure. This method can influence the film thickness and mechanical properties of the polymeric biomaterials, leading to new applications and treatment options. When using temporary materials such as glass ionomer cements, adding a protective coating helps stop moisture from damaging the material, reduces leaks around the gums, and improves the strength of the restoration (6).

Nowadays, resin-based coatings are also used to lower water absorption, prevent the material from dissolving, and avoid color changes. This means temporary materials can last longer when necessary, making dental treatments easier for both dentists and patients. In the field of dental implants, there has been a significant increase in surface modifications and coatings using various materials and biomolecules over the past 20 years, aimed at enhancing bone interaction (7). Examples of these modifications include improvements in bone healing, osseointegration, and corrosion resistance, all of which can be achieved through appropriate coatings. Additionally, alternative processing methods such as additive manufac-

turing and technologies like microwave heating can alter the mechanical properties of modern dental materials. These advancements may even lead to the creation of smart materials and coating layers that enhance the reliability and outcomes of dental treatments (2).

Today, it's very important to choose the best biomaterials for each treatment and to carefully manage both clinical and lab settings to make sure our treatments work as well as possible. We must always think about the patient's general health. To make new materials better in terms of strength and how they interact with the body, we need to use special surface treatments and coatings. Research in dental materials should follow this method to improve the quality of the materials we use.

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Assessment of knowledge, awareness and practices toward the use of 3D technology in planning and performing oral surgeries among dentists: A cross-sectional study

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Abstract:

Background: The three-dimensional (3D) imaging technology is a contemporary technique that allows for the creation of very clear and detailed 3D pictures of teeth, jaw, and surrounding structure. In oral surgery, it leads to the enhancement of the diagnosis, planning, and implementation of oral surgical procedures. Objectives: Assessment of the knowledge, awareness and practices toward the use of 3D imaging technology in planning and performing oral surgeries among dentists in Libya. Materials and Methods: through January 2025, a cross-sectional questionnaire-based study was employed among dentists with different academic degree (BDS, Master and PhD holder) in Libya, to evaluate the awareness and use of 3D technology among oral surgeons and general dental practitioners (GDPs) utilizing Google Forms and incorporating qualitative questions. Results: Based on the questionnaire responses, it can be concluded that the feedback regarding the use of 3D technology in oral surgeries among oral surgeons and GDPs is favorable. Conclusion: Dentists have a reasonable level of awareness regarding 3D technology in the planning and execution of oral surgeries, which will improve their surgical performance.

 $\textbf{Keywords:} \ 3D \ imaging \ technology, \ planning, \ performing, \ oral \ surgeries, \ Liby a$

1. Introduction

Oral and maxillofacial surgery is a surgical specialty focused on diagnosing and managing diseases, injuries, and defects that affect both the functional and aesthetic aspects of the hard and soft tissues in the mouth, jaws, face, and neck. The time it takes to heal depends on the kind of surgery [1,2].

The applications of 3D technology are vast, spanning fields such as engineering, education, and tourism, but its impact on medicine represents a significant advancement in addressing health issues. In the medical field, 3D imaging provides incredibly detailed 3D views of teeth, jaws, and surrounding structures, delivering a level of detail that traditional 2D imaging cannot reach. Moreover, 3D models play a crucial role in diagnosing and treating various human organs [3].

Over the last decade, digital tools and 3D imaging technology have revolutionized the field of dentistry. Digital technology has become essential in dentistry, affecting everything from patient care to research, teaching, and lab tasks [4]. In oral surgery, the use of 3D imaging technology has enhanced the accuracy of treatment planning, improved the predictability of surgical outcomes, shortened operation times, and decreased overall costs. Additionally, 3D imaging technology has made surgical training more accessible, strengthened the relationship between patients and physicians, and led to better surgical results [4]. Additionally, 3D imaging technology improves surgical procedures, enhancing the quality of operations and minimizing associated risks. With 3D imaging technology, healthcare professionals can generate more detailed digital models of the jaw and teeth, allowing for more accurate diagnoses and better surgical planning [5]. This technology also aids in pre-operative planning, giving dentists a clearer idea of the potential outcomes of procedures, especially in the event of errors. Furthermore, it supports the creation of implants and prosthetics tailored to individual patient needs, ultimately increasing satisfaction with the treatment provided [6].

A significant application of 3D imaging technology today is expected to improve the planning of complex surgeries. Surgeons explain that this approach allows for a detailed visualization of the organs and structures within a patient's body. This technology helps identify the specific areas that require treatment or surgery, and it also aids in simulating surgical procedures to explore innovative solutions. By utilizing these digital models, doctors can make more informed decisions, thereby reducing potential risks and improving surgical outcomes [7]. Therefore, the diagnosis and treatment of oral and dental problems have been revolutionized by 3D imaging technology. These technologies provide an

accurate and clear representation of the oral and jaw areas, which aids in treatment planning and reduces errors. For patients, these tools enhance the ability to assess their conditions and select the most appropriate treatment options [8].

3D imaging technology represents a breakthrough in modern dentistry. It provides detailed, three-dimensional views of the mouth, encompassing teeth, bones, and gum tissue. Technologies such as Cone Beam Computed Tomography (CBCT) and 3D intraoral scanners are transforming the diagnosis and treatment of complex dental issues. CBCT scans capture multiple images of the mouth from various angles as the machine rotates around the head [9]. These images are then merged to create a comprehensive 3D model of the teeth, bones, and tissues. In comparison to traditional 2D X-rays, 3D imaging offers a significantly more accurate representation of the mouth. The added dimension enables dentists to identify details that may be hidden in 2D images, such as impacted teeth, fractured roots, or small cracks in teeth. This leads to a substantial increase in diagnostic accuracy, allowing dentists and surgeons to identify issues with greater certainty [10].

The lack of research about the knowledge, awareness, and practices toward using 3D imaging technology in planning and performing oral surgeries among Libyan dentists makes it hard to understand how this technology is effectively implemented in the dental field, especially among dental surgeons. The current research is aimed at gaining valuable insights into how well 3D imaging technology supports dentists in performing their oral surgeries. Consequently, the research question for this study was: Are Libyan dentists providing acceptable knowledge, awareness, and practices toward the use of 3D imaging technology in planning and performing oral surgeries?

2. Material and method:

Ethics statement

The Institutional Ethical Committee approval was held from the Scientific Research Ethics Committee (SREC) of the Faculty of Dentistry, University of Benghazi (Approval No.#0259). Participants were informed about the study objectives and provided their informed consent.

Study design and setting

A cross-sectional questionnaire-based study was carried out among dentists with different academic degree (BDS, Master and PhD holder) in Libya, during January 2025.

Questionnaire details

A survey was made using Google Forms and sent to dentists through email and social media platforms like WhatsApp. The online survey form had required questions to make sure no incomplete answers were allowed. The responses were collected, and the data was automatically added to an Excel sheet by Google Forms. An online survey

is created and sent to 100 people to fill out. For this purpose, the chosen survey focuses on evaluating how aware, how people see, and how they use 3D technology, like 3D imaging and printing, in oral surgeries. The survey uses a combination of questions that can be counted and analyzed with numbers, and these will be compared to more open-ended questions. These open-ended questions aim to understand more about how 3D technology is being promoted, how it's being used, and what challenges people face with it. The custom questionnaire was split into two parts: the first part gathered demographic information, while the second part contained the questions.

The samples are selected based on criteria like experience with oral surgery treatments and proficiency with 3D technology instruments. This targeted sampling approach ensures that the opinions shared, and the actual use of the technology are thoroughly researched. One advantage of the proposed online survey method is its ability to easily reach numerous practitioners across various geographical regions. To gather enough responses and ensure representation, data collection will take over a month. The study adopted a descriptive analytical approach, focusing on a target population of 100 oral surgeons and specialists who utilize 3D imaging technology. A standardized questionnaire, previously tested in a clinical setting, was employed, with questions addressing the application of the technology for accurate surgical planning, its role in identifying critical structures that, if damaged, could pose a severe risk to the patient's life, as well as its impact on patient safety and surgical outcomes.

Statistical analysis

For all categorical variables, frequencies and percentages of the responses of the survey were computed using Statistical Package for Social Sciences (SPSS, IBM, Chicago, USA) 16.0 statistical software. In this study, an analysis of opinions was conducted. The responses of the survey questions were encoded as 5, 4, 3, 2 and 1 for answers; strongly agree, agree, neutral, disagree and strongly disagree respectively. Using ranges and intervals, the mean of each questionnaire was compared to the following scale to assess which opinion the majority of responses belonged to, as follows: Strongly Disagree (1-1.79), Disagree (1.8-2.59), Neutral (2.6-3.39), Agree (3.4-4.19), and Strongly Agree (4.2-5). The coefficient of variation (standard deviation/Mean*100) was calculated for the responses of each question and the answers were ranked from the most agreeable (least coefficient of variation) to least agreeable (highest coefficient of variation).

3. Results:

Table 1 and figure 1 represent the categorization of participants according to their age, academic degree, years of clinical experience and whether they were specialized in surgery or implantology. Table 2 represents the percentage, mean, and standard deviation (S.D.) of the responses of the participants to the ten questions of the survey. Figures 2-11 are diagrammatic bar charts for the questions from 1-10, respectively. Looking at the responses from the sample, in Table 2 below, it can be deduced that the responses towards the implementation of the 3D imaging technology in oral surgeries are positive. The means of the responses for Q1-10 were 4.60, 4.36, 4.19, 4.21, 4.29, 4.11, 4.21, 4.05, 4.14, and 4.36, respectively. Since the mean of all the responses was above 4, this meant that most of the responses were either strongly agree (4.2–5) or agree (3.4–4.19).

The coefficient of variation for the responses for Q1-10 were 13.0, 16.1, 21.5, 14.3, 18.6, 19.5, 16.6, 19.8, 16.9 and 18.3 respectively. The answers were ranked from the most agreeable (least coefficient of variation) to least agreeable (highest coefficient of variation) as follows: Q1, Q4, Q2, Q7, Q9, Q10, Q5, Q6, Q8 and Q3. Thus, Q1 (Does 3D imaging technology help make surgical planning more accurate?) was the most agreeable, while Q3 (Does the 3D technology provide accurate visualization of vital structures such as nerves and blood vessels?) was the least agreeable.

Table 1: Categorization of Participants

Description	Response	Percentage	Description	Response	Percentage
a) Age	<35 Years	42.5%	c) Years of Clinical Experi-	< 10 Years 10-15	39%
	>35 Years	57.5%	ence	Years	32%
				>15 Years	29%
b) Academic	BDS	57%	d) Are you specialized in	Yes	23%
degree	Master	37%	maxillofacial surgery or im-	No	77%
	PhD	6%	plantology?		

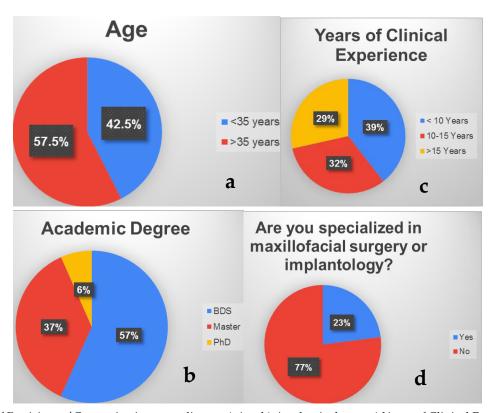


Figure 1: Charts of Participants' Categorization according to a) Age b) Academic degree c) Years of Clinical Experience d) Specialized in Surgery/Implantology.

Table 2: Responses, Percentage, mean of the Questionnaire

Survey Question Number	Responses	Percentage	Mean	S.D.	Coefficient
					of Variation
Q1: Does 3D imaging technology help make	- Strongly agree	64%	4.60	0.6	13.0
surgical planning more accurate?	- Agree	33%			
	- Neutral	2%			
	- Disagree	1%			
	- Strongly disagree	0%			
Q2: Does 3D imaging technology help lower	- Strongly agree	45%	4.36	0.7	16.1
mistakes during surgeries?	- Agree	46%			
	- Neutral	7%			
	- Disagree	1%			
	- Strongly disagree	0%			
Q3: Does the 3D technology provide accurate	- Strongly agree	42%	4.19	0.9	21.5
visualization of vital structures such as	- Agree	44%			
nerves and blood vessels?	- Neutral	7%			
	- Disagree	7%			
	- Strongly disagree	1%			
Q4: Does 3D imaging technology help decide	- Strongly agree	33%	4.21	0.6	14.3
the best way to do surgery?	- Agree	57%			
	- Neutral	10%			
	- Disagree	1%			
	- Strongly disagree	0%			
Q5: Does the 3D technology contribute to im-	- Strongly agree	46%	4.29	0.8	18.6
proving patient safety during complex sur-	- Agree	43%			
geries?	- Neutral	7%			
	- Disagree	5%			
	- Strongly disagree	0%			
Q6: Does the use of 3D imaging decrease the	- Strongly agree	36%	4.11	0.8	19.5
required time for surgical planning?	- Agree	44%			
	- Neutral	16%			
	- Disagree	3%			
	- Strongly disagree	1%			
Q7: Does using 3D imaging technology make	- Strongly agree	37%	4.21	0.7	16.6
surgeons feel more confident when perform-	- Agree	49%			
ing surgeries?	- Neutral	13%			
	- Disagree	2%			
	- Strongly disagree	0%			

Q8: Does the 3D technology allow for cus-	- Strongly agree	30%	4.05	0.8	19.8
tomized surgical plans for each patient based	- Agree	51%			
on their condition?	- Neutral	15%			
	- Disagree	3%			
	- Strongly disagree	1%			
Q9: Does utilizing 3D imaging contribute to	- Strongly agree	32%	4.14	0.7	16.9
better surgical outcomes overall?	- Agree	53%			
	- Neutral	13%			
	- Disagree	3%			
	- Strongly disagree	0%			
Q10: Do you consider the use of 3D imaging	- Strongly agree	50%	4.36	0.8	18.3
technology essential in complex surgical pro-	- Agree	40%			
cedures?	- Neutral	8%			
	- Disagree	2%			
	- Strongly disagree	1%			

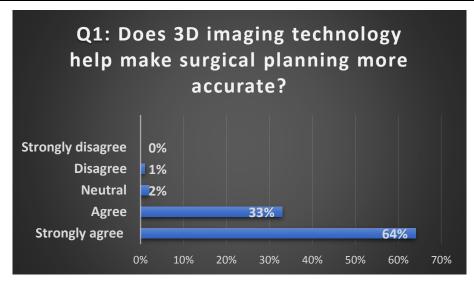


Figure 2: Bar Chart illustrating agreement percentage and degree regarding Q1.

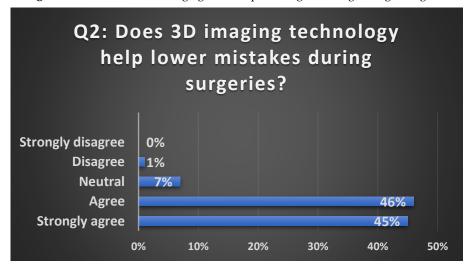


Figure 3: Bar Chart illustrating agreement percentage and degree regarding Q2.

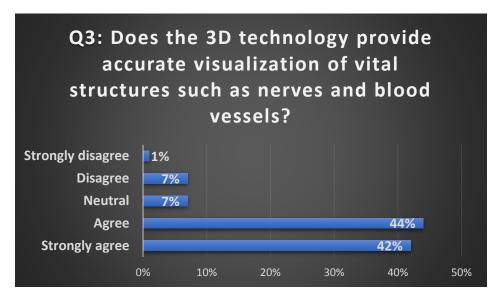


Figure 4: Bar Chart illustrating agreement percentage and degree regarding Q3.

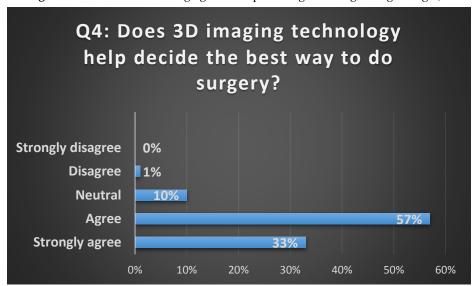


Figure 5: Bar Chart illustrating agreement percentage and degree regarding Q4.

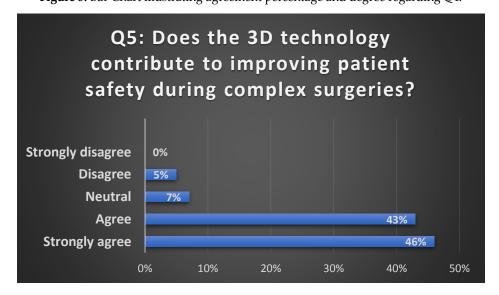


Figure 6: Bar Chart illustrating agreement percentage and degree regarding Q5.

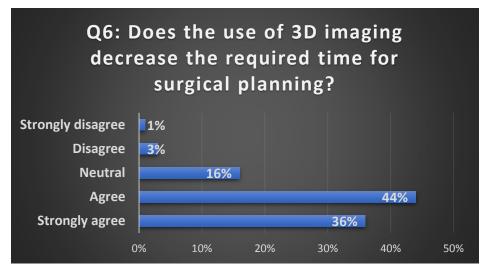


Figure 7: Bar Chart illustrating agreement percentage and degree regarding Q6.

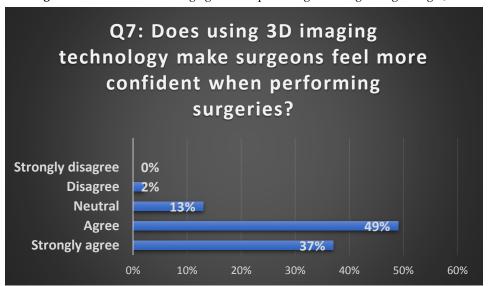


Figure 8: Bar Chart illustrating agreement percentage and degree regarding Q7.

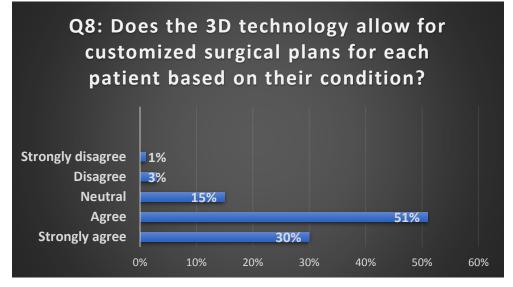


Figure 9: Bar Chart illustrating agreement percentage and degree regarding Q8.

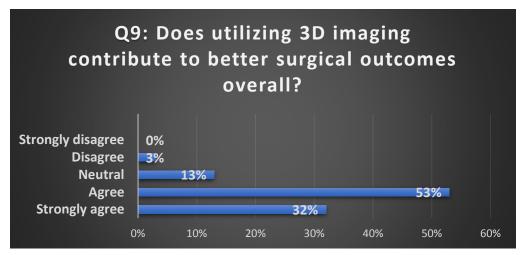


Figure 10: Bar Chart illustrating agreement percentage and degree regarding Q9.

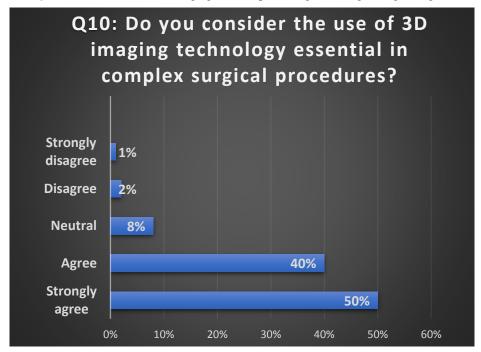


Figure 11: Bar Chart illustrating agreement percentage and degree regarding Q10.

4. Discussion:

The current research provides an assessment of how 3D imaging technology improves the planning, execution, and results of oral surgeries. These technologies can enhance precision, reduce complications, and accelerate recovery times, but their impacts need thorough evaluation. Understanding the role of 3D technology in oral surgery is crucial because of its significant benefits, such as enhanced surgical planning. 3D imaging provides detailed and accurate views of the oral and maxillofacial anatomy, allowing surgeons to plan procedures with greater precision and decrease the chances of mistakes during surgery. Furthermore, by clearly identifying important structures like nerves and blood vessels, 3D imaging technology boosts patient safety by helping to avoid accidental injuries during complex operations [11].

This technology has various applications, including oral and maxillofacial surgery, prosthodontics, and oral implantology. It presents numerous advantages and holds significant promise for the future [12]. The current study evaluates the knowledge, awareness, and practices toward using 3D technology in planning and performing oral surgeries among dentists in Libya.

Based on the responses shown in Table 2, the feedback regarding the use of 3D imaging technology in oral surgeries is largely positive. Among all the collected statements, the question regarding the potential of 3D imaging technology to enhance the accuracy of surgical planning (Q1) received the highest mean value of 4.6. This suggests that all the participants interviewed understanding the use of this technology in complex surgeries as crucial for precise planning.

Additional data gathered from the questionnaire (Q2 and Q10) regarding the effectiveness of 3D imaging technology in minimizing errors during surgeries, as well as its importance in complex surgical procedures, yielded a high mean value of 4.36. This clearly indicates the positive impact that this technology has brought.

Most of the responses either strongly agree or agree, which denotes the high awareness of the participants about the efficiency of 3D technology in oral and maxillofacial surgery. The statements that received the least satisfaction regarding strong agreement and agreement were (Q6, Q8, and Q9): "Does the use of 3D imaging decrease the required time for surgical planning?", " Does the 3D technology allow for customized surgical plans for each patient based on their condition?", and " Does utilizing 3D imaging contribute to better surgical outcomes overall?". Finally, the results of our study were consistent with other studies conducted in other countries and dental specialties [13–15].

In conclusion, the study shows that 3D imaging technology is a useful tool for improving the planning and performance of oral surgery. It helps reduce problems after surgery, ensures patient safety, and leads to better results. However, some participants disagreed about whether the technology saves time during the planning stage. Overall, the importance of this technology, especially for complex procedures, is clear. The dental surgery field should use and improve this technology to maximize its benefits, particularly in increasing efficiency and achieving better outcomes. It is recommended to conduct further research to enhance the efficiency and precision of the plans.

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