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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.

Keywords: *3D imaging technology, planning, performing, oral surgeries, Libya*

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 >35 Years	42.5% 57.5%	c) Years of Clinical Experience	< 10 Years 10-15 Years >15 Years	39% 32% 29%
b) Academic degree	BDS Master PhD	57% 37% 6%	d) Are you specialized in maxillofacial surgery or implantology?	Yes No	23% 77%

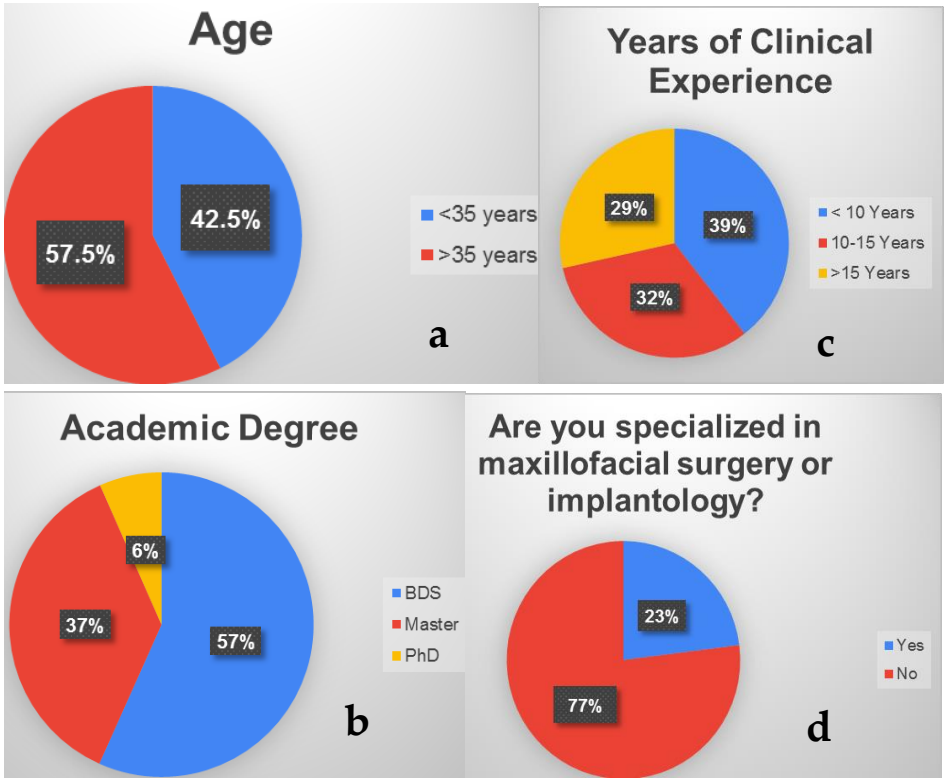

Figure 1: Charts of Participants' Categorization according to a) Age b) Academic degree c) Years of Clinical Experience d) Specialized in Surgery/Implantology.

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

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

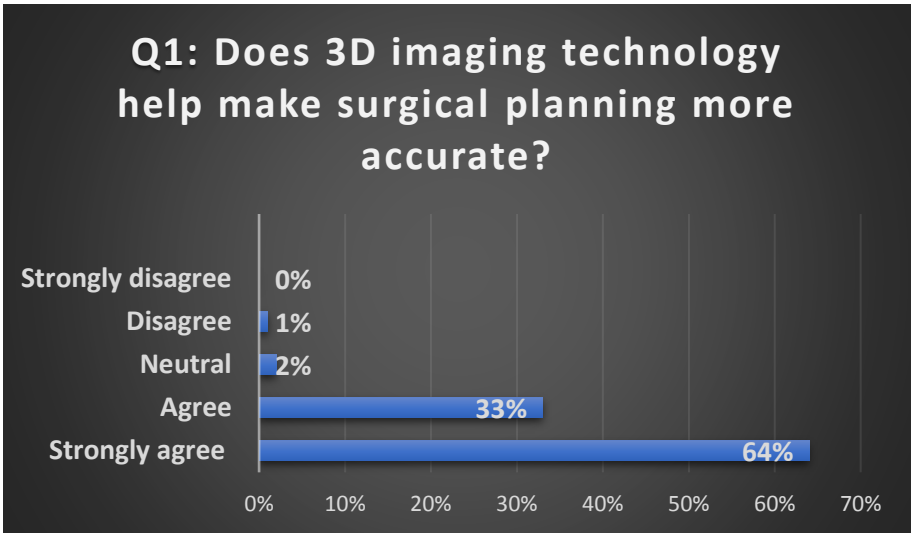

Figure 2: Bar Chart illustrating agreement percentage and degree regarding Q1.

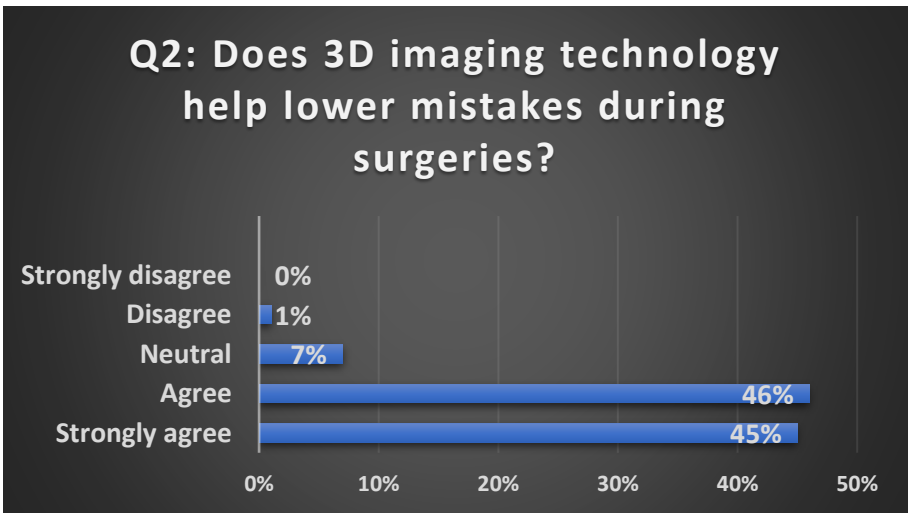

Figure 3: Bar Chart illustrating agreement percentage and degree regarding Q2.

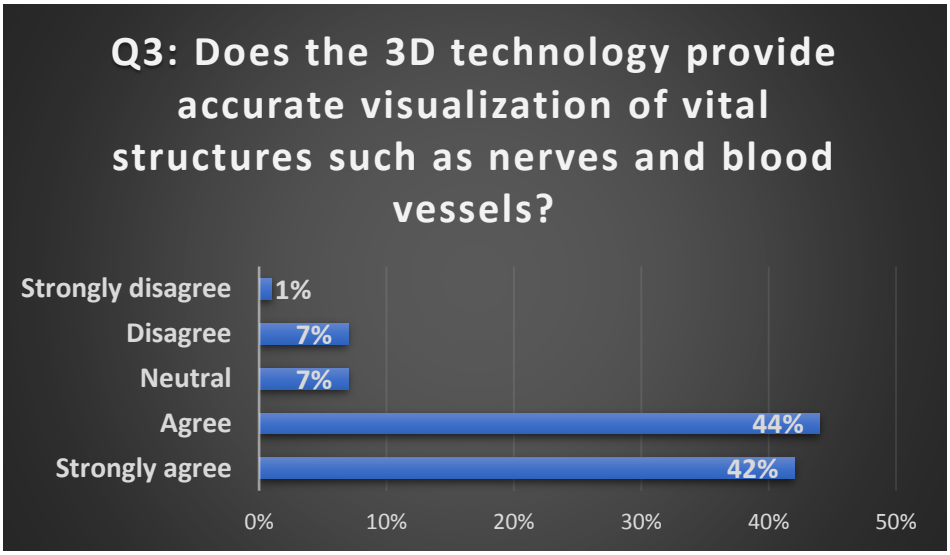

Figure 4: Bar Chart illustrating agreement percentage and degree regarding Q3.

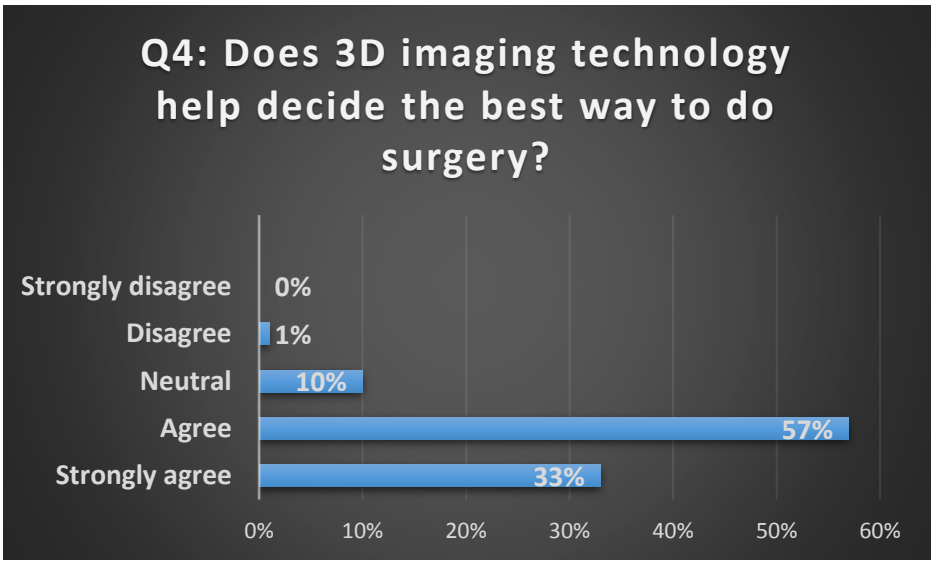

Figure 5: Bar Chart illustrating agreement percentage and degree regarding Q4.

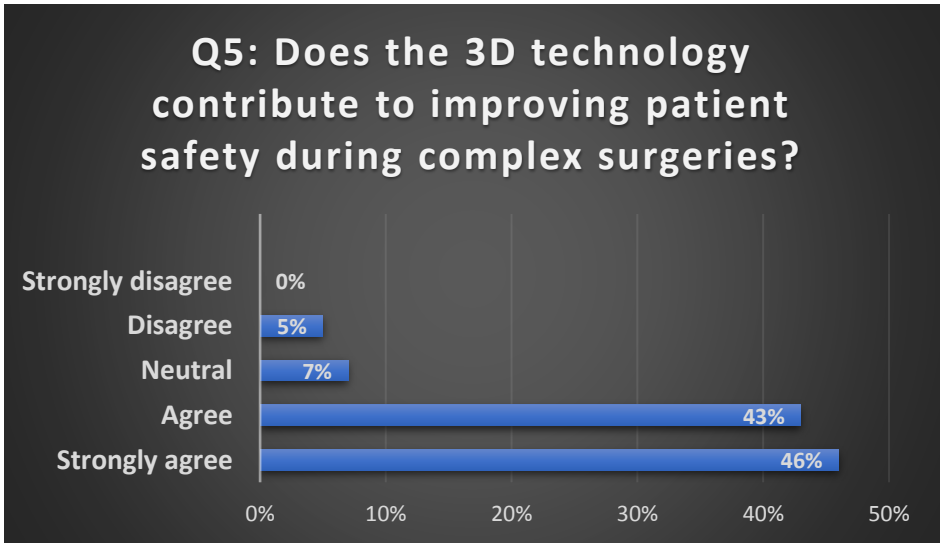

Figure 6: Bar Chart illustrating agreement percentage and degree regarding Q5.

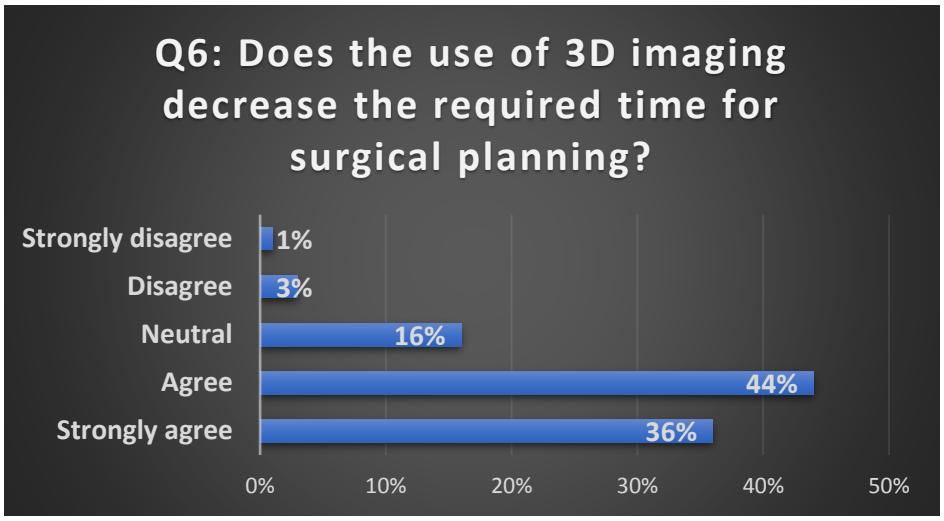

Figure 7: Bar Chart illustrating agreement percentage and degree regarding Q6.

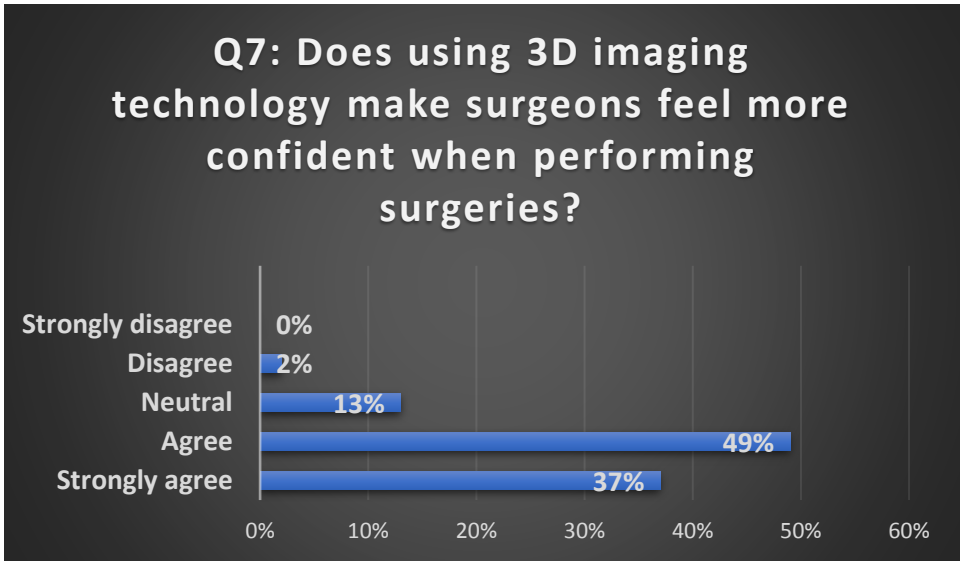

Figure 8: Bar Chart illustrating agreement percentage and degree regarding Q7.

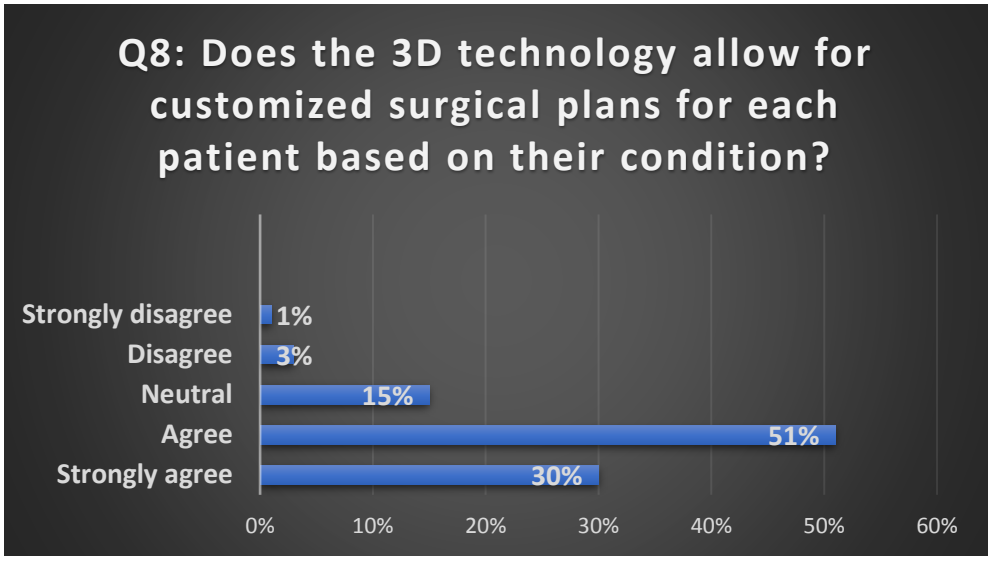

Figure 9: Bar Chart illustrating agreement percentage and degree regarding Q8.

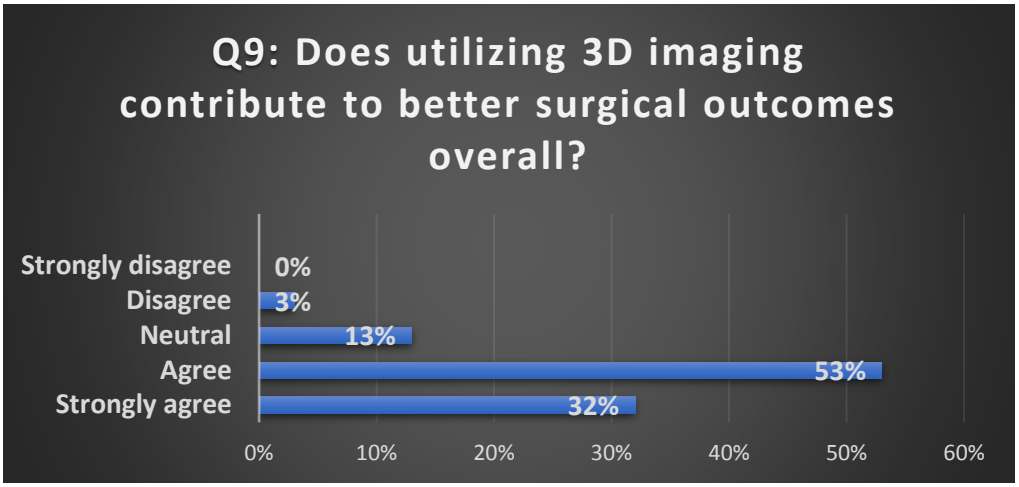

Figure 10: Bar Chart illustrating agreement percentage and degree regarding Q9.

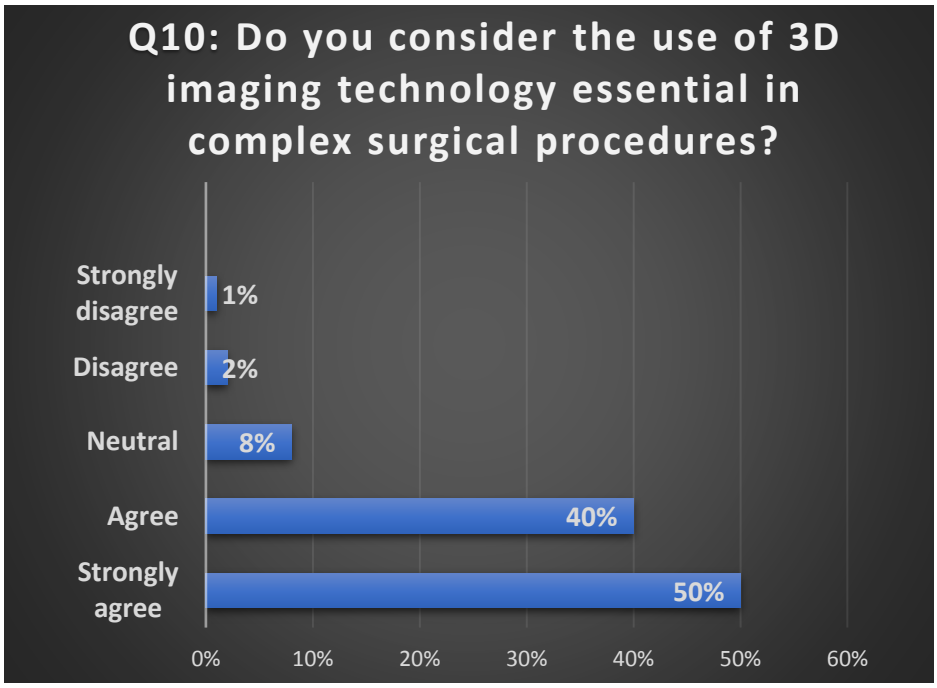

Figure 11: Bar Chart illustrating agreement percentage and degree regarding Q10.

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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