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Computer-Guided implant surgery: A study of clinicians' attitudes and perceptions

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ABSTRACT

Background. Many methods have been utilized in placing implants orally, some free-hand and some more advanced, using software that that involves radiographs and computer algorithms so that the placement of implants is more predictable and secure. Despite the benefits, there are still few implantologisit who employ this technology. **Material and Methods.** Data was collected from dental specialists in Benghazi, Libya for an observational cross-sectional study. The modified questionnaire consisted of 30 closed-ended questions designed to investigate the clinicians' attitudes towards dental implant and compare computer-guided implant surgery with the conventional approaches. **Results.** Computer technology may impact dental practice, as shown in Tables 1–7. The results suggest that computer usage may have a positive impact on certain aspects of dental practice, especially in general dentistry. Gender may not play a significant role in the variables analyzed. The specialty analysis reveals differences in mean values for different dental fields.

Conclusion. This study's findings indicate that computer technology has the potential to significantly improve patient outcomes in dentistry practice. The study emphasize the value of computer technology in current modern dentistry, with possible advantages including increased precision, predictability, and a decrease in clinician stress

Keywords: Dental implant; Computer-guided implant surgery; Dental implant, Implant placement; Flapless implants; Implant guided surgery

Abbreviations: CGIS - computer-guided implant surgery

INTRODUCTION

Tooth loss can cause functional and aesthetic damage, lowering the patient's quality of life. There are numerous treatment options for replacing a missing tooth, but the best option is a dental implant. The primary goal of dental implant therapy is to successfully and permanently achieve the patient's desire to replace one or more missing teeth in an aesthetically pleasing and functional manner [1]. The key physiological and biophysical implant placement process, known as osseointegration, has allowed dental implant therapy to replace lost teeth successfully and predictably [2]. The main objective of dental implant therapy is to successfully and permanently fulfil the patient's desire to replace one or more missing teeth in a functional and esthetic manner.

Osseointegration is a crucial process in dental implant placement, which enables the implants to replace missing teeth by creating a direct connection between the implant surface and living bone without needing a soft-tissue barrier. This process is essential for the success of dental implants and involves both biological and biophysical factors. The previous researchers came to the conclusion that such a strong bond between the dental implant, and the bone may be used to anchor implants in the alveolar bone to support prosthetic teeth as well as to offer anchorage in other areas of the face and body [3,4].

Many methods have been utilized in placing implants orally, some free-hand and some more advanced, using software that involves radiographs and computer algorithms so that the placement of implants is more predictable and secure. Despite the benefits, there are still few implantologists who employ this technology [5]. On the other hand, computer-guided surgery offers dentists several benefits that enable them to place implants in a predictable and secure manner. Despite the benefits, there are still few implantologists who employ this technology.

The software for guided surgeries enables the dentist to visualize and alter photographs of the patient's alveolar bone and surrounding soft tissues, allowing them to plan the most accurate treatment strategy. In terms of marginal bone loss, mechanical and biological problems, and implant survival rate, both computer-guided and freehand operations produced comparable results [6].

Digital workflow for computer-guided implant surgery CGIS consists of a series of processes that culminate in the creation of a prosthetically driven, 3-dimensional virtual plan, which is then implanted into the patient's mouth by the surgical guide and protocol. Guided implant surgery is thought to be more accurate and reliable than free-handed implant surgery.

However, as errors accumulate during the digital workflow, variations in the virtual implant plan and real position are possible [7,8]. The aim of this study was to investigate the clinicians' attitudes towards dental implant treatment with computer-guided surgery approaches in Benghazi-Libya.

MATERIALS AND METHODS

Data was collected for an observational cross-sectional study from dental specialists in Benghazi, Libya. These specialists were chosen through convenience sampling and included implantologists, periodontists, oral surgeons, and prosthodontists. The data was collected using a modified version of a questionnaire designed by Lina M. Ashy et al. in 2017[2]. The questionnaire consisted of 30 closed-ended questions that were designed based on the criteria, advantages, and drawbacks of guided implant surgery (GIS) and conventional approaches found in the literature. Specialists who are knowledgeable about digital implant dentistry assessed the questionnaire to guarantee its clarity and completeness. The participants were asked for verbal consent before answering the questionnaire. The results were immediately handed over to the investigator for statistical analysis. The table below displays a questionnaire divided into 4 pages containing 30 questions. The questionnaire was written in English. The first two pages asked about gender, specialty (implantologist, periodontist, oral surgeon, prosthodontist), degree of expertise with implant placement (one hundred implants placed, 100-200 implants placed, or greater than 200 dental implants placed), interest in employing this method (interested or uninterested), and utilization of CGIS (users or non-users). These pages also included statements about various aspects of non-CGIS procedures, such as implant positioning accuracy, chairside time, and predictability of flapless surgery, staying up to date on

technological advancements, surgical stress, necessary surgical expertise, duration of treatment planning, and expense of treatment. The last two pages of the questionnaire contained similar statements but focused specifically on computer guided surgery (CGIS). Each statement prompted a yes-or-no response from the participants.

RESULTS

The data presented in Table 1 sheds light on various aspects related to dentists, such as their demographics, specialties, experience with implant placement, awareness of computer-guided surgery, and attitudes towards its usage. The data show that the majority of dentists are aware of and interested in computer-guided implant surgery, with many having prior experience with the technology. Furthermore, the questioned dentists believe that computer-guided surgery can improve accuracy, predictability, and efficiency in implant insertion procedures.

Table 2 compares outcomes between non-computer-guided and computer-guided implant surgeries across various parameters such as accuracy, chair-side time, predictability, and cost. The results suggest that computer-guided surgery generally outperforms non-computer-guided surgery in accuracy, predictability, and clinician stress levels. However, challenges such as high treatment costs and lengthy planning times are noted with computer-guided surgery.

Table 3 presents detailed data on outcomes related to computer-guided implant surgery, including accuracy, chair-side time, predictability, and specific indications for guided surgery in different clinical scenarios. The results highlight the benefits of computer-guided surgery in terms of accuracy, predictability, and reduced clinician stress. However, challenges such as training course accessibility and steep learning curves are also identified.

The data in Table 4 displays the average values for various dental variables, categorized by computer and non-computer usage.

Table 5 presents the results of gender analysis conducted on both computer and non-computer categories using mean values and Mann-Whitney U tests.

Table 6 shows the results of specialty analysis for different dental fields about computer and non-computer usage, based on mean values and Kruskal-Wallis H tests.

Table 7 presents the implant placement data analyzed based on mean values and Kruskal-Wallis H tests for different ranges, categorized by computer and non-computer usage.

Statistical significance was determined at a significance level of p-value < 0.05 for all statistical tests.

DISCUSSION

The examination of Tables 1-7 provides a comprehensive understanding of how computer technology is transforming the field of dentistry and its impact on various dental practices. The findings indicate that the use of computer technology can significantly influence different aspects of dental specialties and implant placement procedures. Comparing our study with Ashy's[2], both studies found that computer-guided implant insertion procedures had various advantages, including reduced postoperative pain, increased accuracy, and the possibility of flapless surgery.

In a comprehensive systematic review by Hultin et al in 2012 [3], three studies were found that compared guided flapless surgery to traditional open flap surgery and reported on patient-centered outcomes. Hultin et al. reported a statistically significant reduction in patient-centered outcomes, including analgesic use, swelling, edema, hematoma, bleeding, and trismus, when flapless guided surgery was performed compared to traditional open flap surgery.

An earlier investigation, implant insertion done flapless without the use of a surgical guide can lead to bone perforation in 59.7% of patients [9], despite the current investigation revealed notable differences in average values between computer and non-computer usage across various dental specialties. In general, computer utilization had higher average values than non-computer usage, suggesting that the incorporation of computer technology may enhance certain areas of dental treatment, potentially improving efficiency, accuracy, and patient outcomes

Whereas some studies have found that surgical expertise had a minor impact on implant placement accuracy According to Van de Wiele et al. in 2014 [10] reported that only in angulation did the inexperienced group do inferior than the experienced surgeons when comparing the accuracy of implant placement between expert dental surgeons and inexperienced dental operations. As a result, the authors concluded that the primary

source of error was poor guide positioning, with surgical expertise having a minor but insignificant impact on implant placement accuracy [10]. However, on the other hand Cassetta et al., in 2017 found that the inexperienced group outperformed the expert group solely in terms of angular deviation outcomes [11].

The gender analysis in this study showed no significant variations in mean values between males and females in both the computer and non-computer groups, indicating that gender may not have a substantial impact on the variables evaluated. The specialty-specific analysis, however, revealed variations in mean values between computer and non-computer usage, suggesting that computer technology may be particularly beneficial in specific areas of dentistry. The data showed variations in mean values between computer and non-computer usage, with certain specialties exhibiting higher mean values for computer usage. This disparity implies that computer technology may be particularly advantageous in specific areas of dentistry, potentially revolutionizing how certain procedures are performed and managed.

Additionally, the data on implant placement revealed notable differences in mean values for various ranges of implants placed, categorized by computer and non-computer usage. These findings suggest that the technology utilized in implant placement procedures may influence the number and distribution of implants placed, underscoring the importance of technological advancements in enhancing precision and efficacy in dental implant procedures.

Moreover of this research have significant implications for dental education and training. As computer technology becomes more integrated into dental practice, it is crucial for dental schools and training programs to provide comprehensive training on these technologies to ensure that future dental professionals are equipped with the necessary skills and knowledge to capitalize on the benefits of technology in their practice.

CONCLUSION

This study highlights the possible advantages and difficulties of computer-guided implant surgery while offering insightful information on dentists' perspectives and experiences with the procedure. The findings show that most dentists are aware of computer-guided surgery, are interested in it, and believe it can increase implant insertion procedures'

efficiency, accuracy, and predictability. However, difficulties including expensive treatment cost and lengthy planning periods are also noted. The study's conclusions emphasize the value of computer technology in current modern dentistry, with possible advantages including increased precision, predictability, and a decrease in clinician stress. Accessibility issues with training courses and challenging learning curves are noted as issues that need to be resolved. The findings additionally highlight how important it is for dental training and education programs to include computer technology instruction in order to prepare upcoming dental professionals to take use of the advantages of technology in the workplace.

CONFLICT OF INTEREST

The authors declare that they have no conflicts of interest.

AUTHOR'S CONTRIBUTIONS

Ibrahim H Garoushi **(IG)** , Haneen Elsheibani **(HE)**, Osama Alzwai **(OA)**, Zainab Elbakosh **(ZE)**, Rafik alkowafi **(RA)**

1) Study design, data collection, analysis, and interpretation: **(HE),(IG)** ,**(OA),** and with support from **(ZE)**.

2) Manuscript drafting/proofreading: **(RA),(HE),(ZE), (OA),** with support from **(IG)**

3) Critical revisions: **(IG), (OA), (HE), (ZE)** and **(RA)**

4) Providing general advice on the study: **(IG), (HE), (OA),** and **(ZE)**

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Table 1: Dentists' age, expertise, implant experience, understanding of computer-guided surgery, and attitudes toward its use.

VAR	Class	N (%)
gender	male	14(82.4)
	female	3(17.6)
What is your specialty?	General dentistry	4(23.5)
	Periodontics	3(17.6)
	Oral surgery	5(29.4)
	Prosthodontics	5(29.4)
How many implants have you placed?	10-100	4(23.5)
	100-200	2(11.8)
	more than 200	11(64.7)
Have you heard of computer-guided implant surgery before?	no	0
	yes	17(100)
"Have you ever placed an implant using a computer-guided surgical stent"?	no	5(29.4)
	yes	12(70.6)
"Are you interested in computer-guided implant surgery"?	no	1(5.9)
	yes	16(94.1)
"Do you think computer-guided implant surgery can improve the accuracy and predictability of implant placement"?	no	0
	yes	17(100)
"Do you think computer-guided implant surgery can reduce the risk of implant-related complications"?	no	4(23.5)
	yes	13(76.5)
"Do you think computer-guided implant surgery can save time during the implant placement procedure"?	no	4(23.5)
	yes	13(76.5)
"Have you ever placed an implant using a computer-guided implant surgical stent"?	no	6(35.3)
	yes	11(64.7)

Table 2: Comparing non-computer-guided and computer-guided implant surgeries.

Regarding non-computer guided	Mean	S.D	Min	Max	Sum
"The implant position outcome in non-guided surgery is extremely accurate".	6.59	2.123	3	9	112
"Non-guided surgery requires little chair-side time".	5.41	2.21	2	9	92
"Flapless surgery is predictable when performed using non-guided techniques.	4.65	2.262	1	10	79
Non-guided surgery is adequate for keeping up with technology".	5.47	2.035	1	9	93
"In non-guided surgery, the clinician's intraoperative stress is low".	5.06	2.249	2	9	86
"Non-guided surgery does not require the clinician's surgical expertise".	3.88	3.389	1	10	66
"Non-guided surgery has substantial treatment costs".	3.47	2.154	1	8	59
"With non-guided surgery, treatment planning time is lengthy".	4.47	2.672	1	10	76
Total	**39**	**8.7178**	**26**	**56**	**663**

Table 3: Detailed data about computer-guided implant surgery outcomes.

Regarding computer guided	Mean	S.D	Min	Max	Sum

"The outcome of implant placement during guided surgery is extremely accurate".	8.18	1.741	3	10	139
"The amount of time spent at the operating table during guided surgery is minimal".	7.82	1.468	5	10	133
"Flapless surgery is predictable when performed with guided technology".	8.59	1.372	6	10	146
"Guided surgery effectively keeps up with technological advancements".	8.06	1.519	5	10	137
"Intraoperative stress for clinicians is reduced with guided surgery".	7.12	1.728	4	10	121
"With guided surgery, the surgeon's surgical skills are not required".	6.06	2.926	1	10	103
"Guided surgery has a significant treatment cost".	7.59	2.32	1	10	129
"Treatment planning takes a long time when using guided surgery".	6.65	2.827	1	10	113
"Training classes for guided surgery are inaccessible".	4.82	2.628	1	8	82
"For guided surgery, planning software is inaccessible".	5.18	2.007	1	9	88
"For guided surgery, learning curve is steep".	5.59	1.698	1	8	95
"For guided surgery, communication with production centers is inconvenient".	5.41	2.293	1	10	92
"Guided surgery is indicated in single anterior edentulous gap situations".	5.71	3.424	1	10	97
"Guided surgery is indicated in single posterior edentulous gap situations".	6.65	3.334	1	10	113
"Guided surgery is indicated in extended anterior edentulous gap situations".	7.71	1.724	5	10	131
"Guided surgery is indicated in extended posterior edentulous gap situations".	7.82	2.007	4	10	133
"Guided surgery is indicated in completely edentulous situations".	8.41	1.938	5	10	143
Total	**117.3529**	**16.06215**	**92**	**143**	**1995**

Table 4: The average values for different specialties in dentistry

Average variables	Regarding non-computer	Regarding computer
General dentistry	42.5	122.5

Periodontics	38	119.667
Oral surgery	41	116.6
Prosthodontics	34.8	112.6

Table 5: The connection between gender and computer usage.

Gender	N	Mean Rank	Mann-Whitney U	Z	P_value
male	14	9.04	20.5	-0.063	0.953

Regarding non-computer	female	3	8.83			
Regarding computer	male	14	8.86	19	-0.25	0.859
	female	3	9.67			

Table 6: The connection between specialty and computer usage.

VAR	What is your specialty?	N	Mean Rank	$Kruskal-WallisH$	$d.f$	P_value
Regarding non-computer	General Dentistry	4	10.25	1.352	3	0.717
	Periodontics	3	9			
	Oral surgery	5	10.1			
	Prosthodontics	5	6.9			
Regarding computer	General Dentistry	4	10.75	1.042	3	0.791
	Periodontics	3	9.67			
	Oral surgery	5	8.8			
	Prosthodontics	5	7.4			

Table 7: The connection between implant placement data and computer usage.

	How many implants have you placed?	N	Mean Rank	$Kruskal-WallisH$	$d.f$	P_value

Regarding non-computer	10-100	4	11.63	1.463	2	0.481
	100-200	2	7.5			
	more than 200	11	8.32			
Regarding computer	10-100	4	7.5	0.681	2	0.711
	100-200	2	11			
	more than 200	11	9.18			

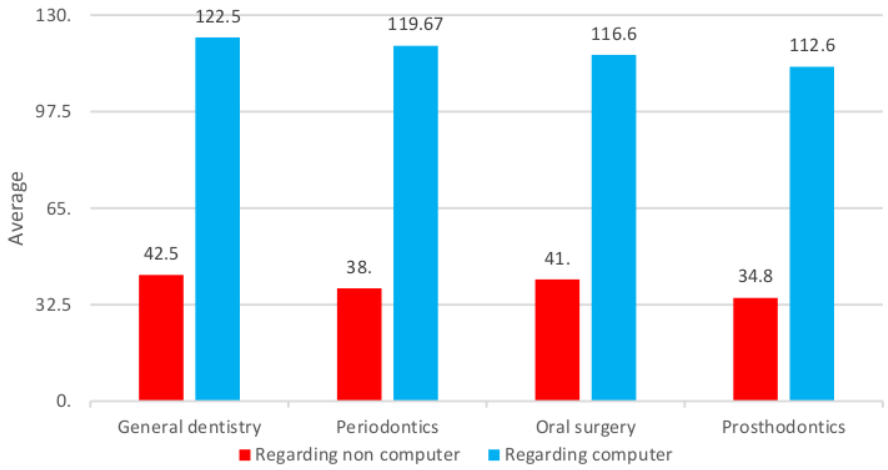

Figure 1: A bar chart illustrating the average values for various specialties in dentistry.