

Clinicians' Awareness of Contemporary Applications of Digital Technology for Implant Dentistry

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Abstract

Digital dentistry is the new era in dental practice. However, not many clinicians are aware of the far reaching applications of digital dentistry in dental implantology which is one of the most commonly sought solutions to dental problems. Poor awareness of the contemporary applications of digital technology in implant dentistry could result in reduced reference to successful prosthodontics and dental rehabilitation. The study investigated clinicians' awareness of contemporary applications of digital technology for implant dentistry. Three research questions guided the study. The design of the study was descriptive survey. The population of the study was targeted on all clinicians in public health care facilities in Delta state and a sample of 1,600 clinicians was involved in the study. Data was collected using a closed ended questions validated by experts in public health and with a Cronbach Alpha reliability index of 0.76. Data for the study was collected by administering the instruments across group social media platforms of the health institutions in Delta North senatorial district. The analysis of data was done using weighted response average. The results of the study revealed that clinicians have low level and average level awareness of the contemporary applications of dental technology in pre-surgical preparation and procedures, fabrication of bio-active and bio-inert materials for implant dentistry and prosthodontics rehabilitation respectively. The study recommended that new digitized communication techniques should be made available for clinicians to exchange and share knowledge and ideas on dental health and implants with a wider audience of clinicians especially with those from advanced countries

Key words: Digital dentistry, technology, implants, prosthodontics, clinicians

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I. Introduction

Advances in digital technology in recent times have become enormous with wide and gainful applications even for dental practitioners. Digital dentistry is apropos in the contemporary society given the lifestyle changes in modern times that quite often result in oral and dental problems. Most dental problems can easily be prevented through regular brushing, daily flossing, eating properly and regular dental check-ups (Tammy, 2020). A good percentage of the Nigerian populace however, do not practice these essential preventive strategies. According to Bollen and Beikler (2012) 85 percent of people with persistent bad breath have dental conditions such as gingivitis, cavities, oral cancer, dry mouth and bacteria on the tongue.

Tooth decay is one of the most prevalent disease in Nigerian today owing to unhealthy oral and dental practices especially involving the consumption of sugars and/or starch. Local and average Nigerian men and women smoke or use tobacco in different ways and expose themselves to significant risk factors for periodontal disease. Little wonder the symptoms of gum diseases such as bad breath, red, swollen, tender or bleeding gum, sensitive teeth and painful chewing (Malhotra et al., 2010) are common among locals. Children and teens and sometimes adults chomp on hard foods like nuts and ice cubes, open drinks with tooth as well as use them as tools such as for peeling insulation on wire, resulting in chipped or cracked tooth. Bruxism is often overlooked and is a part of social display in some cultural dance practices among Nigerian culture.

Tooth erosion and sensitivity, toothaches and root infection that require visit to a dentist are often neglected and managed with unprofessional and dangerous strategies. In Nigeria especially in local setting, dentist have shared experience of patients who said they have done mouth wash with petrol or with camphor dissolved in kerosene with the aim to reduce tooth problems. These practices coupled with neglected dental diseases have led to many tooth loss cases with a significant percentage opting for extraction. Consequently, when these patients are enlightened by their dentist, they opt for dentures or dental implants.

Implant dentistry is fast becoming a common solution not only for serious cases of periodontal diseases, replacement of missing or broken teeth but also for aesthetic reasons. However, for developing country like Nigeria, dentists are faced with a lot of challenges amidst the lack of modern digital technology for dental implantation. Specialist dental teams in specialist centres are also not enough to meet the increasing demands. A good number of these specialist team do not however employ recent advancements in digital

dentistry with paradigm changes that relatively ensures ease of delivery treatment across all stages of dental implantation. Although, the evolution in implant dentistry is so much that it has become an important part of clinical practice, yet, the coverage of the subject in both undergraduate and postgraduate curriculum is rather slow, unstructured, limited in academic standards and training pathways (Wedad et al., 2018).

Dental implants surgery comes with a lot of challenges beginning from patient assessment and examination of medical records, treatment planning, implant placement and integration success, restorative treatment and maintenance phases (Bozini et al., 2011). Wedad et al. (2018) clearly pointed out in their review that the success or failure of implants depends on the health of the patient, drugs for osseointegration and health of tissues in the mouth. The review further noted that such issues as: the amount of stress that will be put on the implant, fixture during normal function and planning the position and number of implants must be evaluated. The whole process of dental implant is a complex clinical procedure with prolonged procedure time because of the many steps before and after implantation. The patients' compliance, the type of implant, pre-surgical consideration, available bone length or mesiodistal dimension of edentulous space, spacing requirement and buccolingual bone width, ridge mapping, preiodental health, crown height space, restorative and endodontic status, absolute, relative and local contraindications are all significant in the prognosis of the treatment (Wedad et al., 2018). It is clear therefore, that for a developing country like Nigeria, the place of digital technology to ease the delivery process in dental implantation is indispensable.

Dental restorations conducted with digital assistance have become coming in the contemporary society especially for advance countries like USA. Most dental companies have access to CAD/CAM procedures, either in the dental practice, the dental laboratory or in the form of production centres (Beuer, Schweiger & Edelhoff, 2008). With its many benefits, Beuer et al. pointed out that dentist who will be confronted with these techniques future, require certain basic knowledge if they are to benefit from these new procedures. Digitized dentistry improves medical diagnosis, precision of consequent treatment, cost-effectiveness and procedure time for dental implantation. Thus, digital dentistry is the new era in dental practice (Sakr et al., 2017). Sakr et al. asserted that with the fast evolution of digital technology, the dentist needs to be updated with the array of developments. However, there is the need to first ascertain the awareness of clinicians of the applications of digital dentistry in general dental practice and specifically prosthodontics.

The necessity of this awareness evaluation for clinicians in developing countries like Nigeria and Delta state in particular is its role in providing effectual practical education and training of dentists and dental students. It will provide an analysis for accurate level of integration of digital dentistry in the curriculum of dental students and the areas in dental implantation that can be introduced as novelties in clinics. The need for digital dentistry applications awareness evaluation was also driven by the importance of establishing a gap in the practice of implant dentistry compared to advancement via digitization, thereby, formulating the basis for the training and retraining of dental practitioners.

Purpose of the Study

The purpose of the study was to assess clinicians' awareness of contemporary applications of digital technology for implant dentistry. Specifically, the study sought to assess clinicians' awareness of the contemporary application of digital dentistry in:

1. Laboratory/clinical procedures for implant dentistry
2. Production of high-performance biocompatible materials for restorative dentistry
3. General prosthodontics

Research Questions

The following research questions guided the study.

1. What is the level of clinicians' awareness of the contemporary applications of digital dentistry in the laboratory/clinical procedures for implant dentistry?
2. To what extent are clinicians aware of the contemporary applications of digital dentistry in the production of high-performance biocompatible materials for restorative dentistry?
3. What is the awareness level of clinicians of the contemporary applications of digital technology in prosthodontic rehabilitation?

II. Method

The study adopted the descriptive survey design. Descriptive Survey design aims at collecting data on, and describing in a systematic manner the characteristics, features or facts about a given population using a sample considered representative of the entire population (Nworgu, 2015). The study was carried out in Delta State, Nigeria. It is situated in the region known as the South-South geo-political zone. There are three senatorial districts in Delta State namely, Delta South, Delta North and Delta Central senatorial districts. The population of the study was targeted all the clinicians in public health institutions in Delta state. The sample for

the study was 1,600 clinicians. The sample size was obtained using a multistage procedure. First, random sampling was used (balloting without replacement) to select one senatorial district in Delta State- Delta North senatorial district. Secondly, strata of Federal Medical Centre, State General Hospitals, Primary Health Care Centres and Nursing home and Maternities were created. In each stratum except for Federal Medical Centre which is the major tertiary health care centre in the senatorial, health care centres were selected at random.

The instrument for data collection was a closed-ended questionnaire developed by the researcher. The questionnaire title Clinicians' Awareness of Contemporary Applications of Digital Dentistry in Implant Dentistry had two sections namely A and B. Sections A generated information on the respondents' biography and Section B was designed to generate information on clinicians awareness of the contemporary applications of digital dentistry in implant dentistry. The 30-item instrument had four response options: Very Much Aware (WMA), Aware (A), Unaware (UW) and Very Much Unaware (VMU) on which the clinicians rated their level of awareness of stated contemporary applications of digital dentistry.

The initial draft of the instrument, the objectives of the study, the research questions and hypotheses were given to three experts: staff from Human Kinetics/Health Education Department, NnamdiAzikiwe University, Awka and one College of Health Sciences, Delta State University, Abraka and one Dentist from Federal Medical Centre Asaba, Delta State for validation. They were requested to vet the items for appropriateness and unambiguity. All the corrections, suggestion and recommendation were effected in the final draft of the instrument. The reliability of the instrument was established using Cronbach Alpha(Nworgu, 2015). The instrument was administered once to 10 clinicians in public health establishments in Anambra state. The data collected were collated and the reliability computed using Cronbach Alpha. The analysis of the obtained data yielded a coefficient of internal consistency of 0.76.

The researcher accessed group social-media platforms for each health care facility included in the study. On the permission of the group administrators, copies of the questionnaire were sent to each group chat platforms via Whatsapp and Telegram-x. The questionnaire was resent to the same platforms for a period of three months every week to enable those who did not login to the media for any reason, respond to the questionnaire whenever they log in. Complete response patterns for each respondent was received immediately on submission and accessed via google doc's forms. Only 92.88% (1,486) of the instrument was retrieved and used in the study.

Data generated from the study were analyzed using item by item analysis, item mean and standard deviation (SD).

$$\bar{x} = \frac{\sum x}{\sum f}$$

Where \bar{x} = item mean

\sum = Sum of

f = frequency of weights of response for an item (Scores: 4, 3, 2, 1)

x = response score

$$SD = \sqrt{\frac{\sum f(x - \bar{x})^2}{N}}$$

Where \sum = Sum of

f = frequency of weights of response for an item (Scores: 4, 3, 2, 1)

x = response score

\bar{x} = item mean

N = Total number of respondents

$$\text{Grand Mean} = \frac{\sum \text{Item means } (\bar{x})}{\text{Number of items}}$$

The cut-off mean was 2.50. Any item with mean equal to or above the cut off mean was considered known (aware). Items with mean below the cut-off mean were unknown (unaware). To determine the extent of awareness, the average of the entire item mean was computed and decisions taken as follows: 2.49 and below was low level awareness, 2.50 – 3.49 was average level awareness whereas 3.50 above was high awareness.

III. Results

Research Question 1: What is the level of clinicians' awareness of the contemporary applications of digital dentistry in the pre-surgical consideration and laboratory/clinical procedures for implant dentistry?

Table 1: Clinicians' Awareness of Contemporary Applications of Digital Dentistry in Pre-Surgical Considerations and Laboratory/Clinical Procedures for Implant Dentistry

S/N	Items	\bar{x}	SD	Decision
1	Use of stereolithographic templates in virtual planning for onward transfer to the surgical procedure	2.42	1.02	Unaware
2	Use of digital technology for periodontal examinations	2.73	0.83	Aware
3	Use of Cone-Beam Computer Tomography (CBCT) for examination of anatomical structures	2.53	1.72	Aware
4	Use of computer guided prosthetic planning to obtain diagnostic models by mean of optical scanners	1.94	1.83	Unaware
5	CAD-CAM (computer-aided design/computer-aided manufacturing) technology for virtually plan and design of future prosthesis by direct scanning of the intraoral arch	2.18	1.22	Unaware
6	Using CBCT data for design of surgical guide	1.32	1.09	Unaware
7	Guided perforation according to data on bone availability, determined position and angulation of dental implant(s)	2.10	1.28	Unaware
8	Minimal invasive procedure by means of flapless technique	2.38	0.93	Unaware
9	Panoramic images reconstructed from 3D CBCT data using focal troughs and incisor guide planes measured by jaw movement analyzer	2.41	0.34	Unaware
10	Use of digital technology for flexible and improved record keeping	3.21	0.29	Unaware
11	Immediate viewing of highly desirable image of implant procedure and post-placement to detect defect	2.93	0.62	Aware
	Grand mean	2.38		Low

Table 1 shows that items 2, 3 and 11 have item mean above the cut-off mean while all other items are below the cut-off mean. This implies that clinicians are aware of the use of digital technology for periodontal examinations, of Cone-Beam Computer Tomography (CBCT) for examination of anatomical structures and immediate viewing of highly desirable image of implant procedure and post-placement to detect defect. The grand mean shows that clinicians have low level awareness of the contemporary applications of digital dentistry in the pre-surgical consideration and laboratory/clinical procedures for implant dentistry.

Research Question 2: To what extent are clinicians aware of the contemporary applications of digital dentistry in the production of high-performance biocompatible materials for restorative dentistry?

Table 2: Clinicians Awareness of Contemporary Applications of Digital Dentistry in the Production of High-Performance Biocompatible and Bio-inert Materials for Restorative Dentistry

S/N	Items	\bar{x}	SD	Decision
1	Digitized surgical stent fabrication	2.23	1.22	Unaware
2	Crown fabrication for implant requiring ridge lap to mask the exposed implant head and abutment collar	2.84	0.21	Aware
3	Laser digitization of dental casts for evaluation of the accuracy of the adopted cast formation technique	2.11	1.24	Unaware
4	Finite element analysis (FEA)	2.19	0.33	Unaware
5	CAD/CAM technology in the fabrication of dental prostheses and denture	2.62	0.47	Aware
6	Digitized testing of materials including tensile strength, compression fatigue, rheology and structure	2.14	0.17	Unaware
7	Adjustment of bridge constructions saving materials in milling time	1.92	1.31	Unaware
8	Fabrication through prototyping	2.62	0.91	Aware
9	Generative production method using laser sintering devices	2.06	0.63	Unaware
	Grand mean	2.30		Very low

Table 2 shows that items 2, 5 and 8 have item mean above the cut-off mean while all other items are below the cut-off mean. This implies that clinicians are aware of the contemporary application of digital dentistry for crown fabrication for implant requiring ridge lap to mask the exposed implant head and abutment collar, CAD/CAM technology in the fabrication of dental prostheses and denture and fabrication through prototyping. The grand mean shows that clinicians have very low level awareness of contemporary applications of digital dentistry in the production of high-performance biocompatible and bio-inert materials for restorative dentistry.

Research Question 3: What is the awareness level of clinicians of the contemporary applications of digital technology in prosthodontic rehabilitation?

Table 3: Clinicians' Awareness of Contemporary Applications of Digital Technology in Prosthodontic Rehabilitation

S/N	Items	\bar{x}	SD	Decision
1	Insufficient space beneath the fully bone anchored prosthesis	2.18	1.11	Unaware
2	Occlusal overload	2.84	0.21	Aware
3	Jaw fracture and temporomandibular joint disorders	2.33	2.01	Aware
4	Abutment penetration into a sinus, nasal cavity or through inferior border of	2.86	1.28	Unaware

	the mandible			
5	Loss of recovery and loss of supporting tissues	2.51	0.31	Aware
6	Incorrect fixture placement	2.63	0.74	Aware
7	Damaged hex nut on top of fixture	2.77	0.73	Aware
8	Poor air-flow pattern with high-water design	2.73	0.46	Aware
9	Fractured abutment screw	2.64	0.88	Aware
10	Plaque/Calculus formation and periodontal problems	2.59	0.64	Aware
	Grand mean	2.61		Average

Table 3 shows that except for items 1 and 4, all other items in the Table have item mean above the cut-off mean. This implies that clinicians are aware of the contemporary application of digital dentistry for occlusal overload, jaw fracture and temporomandibular joint disorders, loss of recovery and loss of supporting tissues, incorrect fixture placement, damaged hex nut on top of fixture, poor air-flow pattern with high-water design, fractured abutment screw, plaque/calculus formation and periodontal problems. The grand mean shows that clinicians have average level awareness of contemporary applications of digital dentistry in prosthodontic rehabilitation.

IV. Discussion

The applications of digital dentistry have indeed started a new age in dental practice and have significantly improved the outcome of dental implant surgeries. However, the major setback in the application of digital technology is that there is the problem of awareness and education of clinicians. More so, only a few school and college of health science have incorporated the new field of dental technology into their curriculum. Clinicians who are unaware of the novel discoveries and application in digital technology especially as it applies to implant dentistry may become a hitch to the instalment and practice of these advancements in clinics.

The findings of the study revealed that clinicians have low level awareness of the contemporary applications of digital dentistry in the pre-surgical consideration and laboratory/clinical procedures for implant dentistry. A lot of factors account for implant failure. However, the most obvious sign of such failure is mobility (Palmer, 1999). There is therefore, the need for severe pre-surgical considerations as well as procedures for dental implants to ensure success. The success level due to these considerations has in recent time been improved owing to advancements in digital dentistry. Low level awareness of such the applications of digital dentistry in dental surgery among clinicians would amount to poor dental implant practices. Clinicians may still recommend the old routines and reference to prevalent procedures.

The study also revealed that clinicians have very low level awareness of contemporary applications of digital dentistry in the production of high-performance biocompatible and bio-inert materials for restorative dentistry. Dental implants have become much more common that clinicians are more likely to see patients who opt for them or who have implants supported restorations. Nevertheless, low level awareness of the applications of digital technology in the fast production of high-performance materials could reduce the number of patients who get the treatments. Beuer, Schweiger and Edelhoff (2008) noted that all components computer-aided design and computer-aided manufacturing (CAD/CAM) systems are located in the dental surgery. Fabrication of dental restorations can take place at chairside without a laboratory procedure. The digitalisation instrument is an intra-oral camera, which replaces a conventional impression in most clinical situations and this saves time and offers the patient indirectly fabricated restorations at one appointment (Beuer et al., 2008). Thus, dentist no longer have to send impressions to the laboratory where maser casts are first fabricated, a time consuming process. Also, variant forms of bio-active and bio-inert materials can be produced in less time for implant dentistry.

The study further revealed that clinicians have average level awareness of contemporary applications of digital dentistry in prosthodontic rehabilitation. Iatrogenic injuries can occur and are unpleasant events for both clinicians and patients (Ng et al., 2005).Dental implants depending on their type require varied levels of maintenance. One of the key biological and biophysical processes in predicting the success of dental implants is osseointegration. Failure to osseointegrate could lead to mobility and dentists therefore, must have to have a handy solution to all such periodontal problems. A high level of awareness of the applications of digital dentistry in solution to the post-surgical challenges of implant dentistry is required to propel clinicians to refer and recommend patients seeking prosthodontic rehabilitation and to education them. Average level of awareness among clinicians may result in patients' problem deteriorating due to poor education from their health care providers. A lot of patients seeking post-implant attention and maintenance barely have these technologies in their clinics with the clinicians lacking full knowledge of the applications of digital dentistry in situation.

V. Conclusion

The applications of digital dentistry in pre-surgical preparations, fabrication and productions of dental implant materials as well as rehabilitations and maintenance of surgical implants have come to revolutionize

dental implantology. The study establishes that there is a low level awareness among clinicians of the novel application of digital technology in implant dentistry and is a huge challenge to expected improvement in the success rates of dental implant surgery in Nigeria.

VI. Recommendations

In the light of the findings of the study, the following are recommended.

1. The government through the Ministry of Health should organise for the training of dental practitioners across the nations. The training should be implemented in strict practical terms in dental laboratory fully equipped with digital technologies and certificates issued to dentists who successfully scaled through the training.
2. Education software and videos on digital dentistry could be developed to create good sense of understanding among clinicians and dental patients to help encourages the applications and reduce dental fear and fears regarding oral health of post-dental implantology.
3. New digitized communication techniques should be made available for clinicians who availed themselves for the training to exchange and share knowledge and ideas on dental health and implants with a wider audience of clinicians especially with those from advanced countries.
4. Federal and state governments should make provisions for the instalment of new digital dental facilities and upgrade obsolete one at Federal and State health care facilities. Specialist health care facilitates where possible should be given assistance in the acquisition of such innovative technology in private institutions.
5. The curriculum for dental study in colleges of health science should be reviewed for inclusion of the study of digital dentistry for implant dentistry. In the light of the review, provision should also be made by Ministry of Education at State and Federal levels, educational administrators and stakeholders of dental digital technology in school laboratories for proper implementation whereas the curriculum for dental students is reviewed.

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