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Prof. Dr. V. Shankar Ram, M.D.S., Ph.D.,
President
IDA Madras Branch

PRESIDENT'S MESSAGE

Dear Members,

Greetings from IDA Madras Branch!

IDA the premier organization of dental professionals secures the dignity and honour of its members, besides enhancing the image of the profession. Out of more than 450 local branches IDA Madras branch bear more members than any other branch.

Research is an integral part of science and dental science is not an exception. I hereby invite you all to send us well researched articles for publications along with case reports, reviews and professional experience to enrich our scientific knowledge.

My warm regards and good luck is always with dynamic editorial team pioneered by Dr. C.K. Dilip Kumar our editor. May the team continue their saga of continuous publication for the years to come.

A handwritten signature in blue ink, written in a cursive style, belonging to Prof. Dr. V. Shankar Ram, M.D.S., Ph.D. The signature is positioned above the printed name and is being written by a hand holding a pen, which is visible on the right side of the page.

Prof. Dr. V. Shankar Ram, M.D.S., Ph.D.,



Dr. H. Thamizhchelvan
Hon. Branch Secretary
IDA - Madras Branch
Hon. Secretary National CDH
IDA (Head Office)

SECRETARY'S MESSAGE

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H. Thamizhchelvan

Dr. H. Thamizhchelvan



Dr. C.K. Dilip Kumar
Editor-in-Chief
IDA - Madras Branch

LETTER FROM THE EDITOR

IDA Madras branch has done a tremendous team work with Rotary International 3232, Sri Ramachandra University and Colgate to achieve & mark a record in Asia Book of records and India book of records by bringing in 23615 people together in a single venue and making them brush together to create dental awareness among public. Our editorial team wholeheartedly wishes the entire team and organisations for their effort in achieving the milestone, which added another feather to the cap for IDA Madras branch.

"If you love life, don't waste time, for time is what life is made up of." - Bruce Lee

Yes, time is precious, to go higher in life one should utilize time to its fullest. So whatever time you get start documenting the cases that you do in your practice, colleges, etc.

The documentation will not go unproductive, it can become precious as time when you record it in history by publishing it in the journals so that your case can educate many others.

So I request all the clinicians, practitioners, students, etc to send manuscripts to our journal to make you and your time precious.

A handwritten signature in blue ink, appearing to read 'C.K. Dilip Kumar', written over a white background. The signature is fluid and cursive.

Dr. C.K. Dilip Kumar

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MIDAS -2017 ABSTRACTS OF BEST E-POSTER AND BEST PAPER

PAPER PRESENTATIONS (Continued...)

INTENTIONAL REIMPLANTATION OF ENDODONTICALLY TREATED TOOTH

T. Rajalakshmi

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Chettinad Dental College
and Research Institute
Chennai

**MIDAS Reg. No.: IDA
1126**

**Subject: ENDODONTICS
& CONSERVATIVE
DENTISTRY**

ABSTRACT:

Non-surgical retreatment and non-surgical endodontics are not always viable solutions to endodontic disease. Situations like

- Avulsed tooth presented to the clinician in appropriate time
 - Traumatized tooth
 - Tooth with anatomical limitations like -bone thickness, nerve and sinus proximity.
 - When accesses for surgical treatment is limited
- are the conditions that can be best treated by intentional replantation. The paper presentation will enlist the absolute indication and contraindications, procedure, prognosis and success rate of intentional re-implantation.

WHERE IS ORAL AND MAXILLOFACIAL SURGERY???? A QUESTIONNAIRE STUDY

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**MIDAS Reg. No.: IDA
2288**

**Subject: ORAL &
MAXILLOFACIAL
SURGERY**

ABSTRACT:

Scope of oral and maxillofacial surgery occurred in Egypt in the so called Edwin smith papyrus (2700bc). Oral and maxillofacial surgery is a specialty of dentistry, but the typical oral surgeon functions more like a hybrid between Medicine and Dentistry. The work performed by the OMFS doesn't start and end with teeth, it expands to incorporate procedure that are lifesaving, as well as those that enhance the quality of life by priority better function and aesthetics. The OMFS is a rapidly growing speciality in the priority better functions such as treatment for Trauma, Dentofacial deformities, TMJ disorders and many more completely new methods have been developed such as distraction osteogenesis, hybrid implants, tissues engineering, reconstructive surgeries, treatment for sleep apnea and facial cosmetic surgeries. In this study awareness of OMFS among the medical professionals promoters while being guardians and ambassadors for the this speciality.

VIRTUAL REALITY FOR DENTAL ANXIETY, A TRAIL REVIEW

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Chennai

MIDAS Reg. No.: IDA
1286

Subject: PEDODONTICS
& PREVENTIVE
DENTISTRY

ABSTRACT:

One of the most challenging aspects of dental care today is the management of patient pain. Analgesics have been the main stream solution for alleviating pain in the act. However, research in the recent times have emphasised the use interface of distraction to treat pain. Virtual reality is one such distraction technique that refers to a human computer generated environment. The patient acn navigate through beaches, forests, themeparks and other pleasant areas. Hence, the patients attention will be more or less "drained" from the real world, leaving less attention available to the real world process including painful stimuli. This paper discusses the role of virtual reality in anxiety and pain management in child and adult patients.

MASTER THE POSTURE (ERGONOMICS IN ORTHODONTICS)

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College and Hospital
Melmaruvathur

MIDAS Reg. No.: IDA
2134

Subject:
ORTHODONTICS

ABSTRACT:

Ergonomics is an applied science concerned with procedure for maximum efficiency and safety. It deals with how to formulate the work more efficient and in simplified manner. Scientist may develop musculosketel problems with proper sitting posture and movements. Orthodontics speciality needs a range of finest movements in co- ordination with vision and unsupported arm work. This increase the duration of work, in stress and strain to the muscle creating musculosketel problem. MSD referred to condition involve nerve, tendon, muscle and supporting structures of the body Ergonomics deals with the etiology in the generation of soreness and pain in dentists and correcting them by proper ergonomics and also corrective measures for proper position and handling the dental materials in orthodontic practice. Ergonomics along with regular exercise, relaxation techniques help us to combat stress increasing comfort, improving the quality of life and to extent careers.

AN INSIGHT INTO THE FORSENIC CONGNIZANCE AMONG THE ADVOCATES

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Hospital
Ramapuram, Chennai

MIDAS Reg. No.: IDA
1298

Subject:
PHARMACOLOGY

ABSTRACT:

Humans gave us crimies; law gave us justice; science gave us forensics.

AIM: The aim of this study is to assess the knowledge, awareness and perception on forensic dentistry among the Lawyers in Tamilnadu.

MATERIALS AND METHODS: A pretested questionnaire consisting of 10 questions were circulated among the lawyers of the districts salem, Chennai and Trichy which were chosen by simple random sampling. The data was collected on their years of experience. Based on their years of experience and place of practise their awareness was assessed using Chi square test and the p-value was set at 0.05

NEED FOR THE STUDY: Like the minute details of our fingers and the deoxy ribonucleic acids that codes our life are unique to each person, the denetion and its associated structuresare also idiosyncratic. Forsensic dentistry is a sector involves the relationship between both law and dentistry forensic odontology is a benediction and has helped in deciphering many ambiguous cases. Systematic collection of dental records and preservation of the same would marshal the legal officials in identification of the deceased. This presentation is an analytical study in forensic discipline of law which was done to find the cognizance among advocates and the employment of forensic odontology in medicolegal cases. A questionnaire was designed in such a way to assess the awareness of forensic dentistry among advocates and also their participation in any case which involved its use. From the results of 200 advocates who were categorized based on years of experience and place, a conclusion was arrived relating to the awareness and cases handled.

RESULTS: The study is in progress and the results are yet to be formulated.

NANO TECH - THE LIFE JACKET OF IMPLANTS!

Deeptha Mathi

Intern
Sri Venkateswara Dental
College and Hospital
Chennai

MIDAS Reg. No.: IDA
2441

Subject:
IMPLANTOLOGY

ABSTRACT:

Peri - implantitis is a destructive inflammatory affecting the soft and hard tissues surrounding the dental implants. Peri - implantitis is caused by various factors like development of biofilm on the surface of implants, trauma from occlusion, smoking etc.. Treatment modalities like scaling. SRP with plastic currettes. Flap surgery with generative Procedures and photodynamic therapy have been used to treat peri - implantitis.

Nanotechnology has been an emerging field in dentistry. Recent advances has brought in a combination of silver, titanium oxide and hydroxyapatite nanocoating application to the surface of implants. Surface coatings with nanoparticles help in the formation of an anti - surrounding bone and accelerated bone healing.



Periodontal Inflammation and Infections: Systemic Implications

Ms. Rashmi ¹, Dr. Sudarsan Sabitha ², Dr. Arunmozhi Ulaganathan ³, Dr. Ramamurthy Shanmugapriya ⁴,
Dr. Rathinasamy Kadhiresan ⁵

Abstract

The emergence of PERIOMEDICINE made it explicit that a bidirectional link exists between periodontal diseases and systemic health. For more than 3000 years now, this association is being investigated. Starting from the proposal of Focal infection theory, numerous paradigm shifts have been witnessed in the periodontal science. Enormous numbers of research studies supporting the bidirectional link are documented in the literature. However similar amount of evidence against it also exists. This article gives and insight into the various forms of evidence in literature that have been documented to prove an association or causal link or otherwise between periodontal disease and systemic implication.

Key Words: Evidence, Focal infection, Periodontitis, Systemic Health.

¹ CRRI Student

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^{4,5} Reader

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Introduction

“Take care of your teeth and they’ll take care of you.”

This dictum is of unknown origin, yet the relation between oral health and general health has been inquisitive for more than 3000 years. Hippocrates, the father of medicine advocated teeth extraction as means to cure arthritis. [1]

The rise and decline of the Focal Infection Theory

In the late 19th century, it was only after the acceptance of the germ theory and principles of Bacteriology, that the role of infections as etiological agents of diseases was being recognized. Willoughby D Miller attributed oral diseases to infections and general diseases to oral diseases. [2,3,4] British surgeon William Hunter accused oral sepsis to either be the origin or deleterious catalyst of certain grave diseases. This idea gradually crystallized into the Focal Infection Theory which stated that “circumscribed foci of bacteria, localized to various parts of the body can result in myriad systemic diseases”. [5,6]

The era of focal infection began with the proselytising efforts of its most visible proponent Frank Billings, claiming to cure infections of distant organs by extraction of teeth and tonsillectomies. Though pus within the bodily compartment was considered a systemic threat, its drainage into the mouth was interpreted to be inconsequential systemically. [8,9] One school of thought concluded that dissemination of infection from the focus was prevented by the immune response – but failure of the immune components was considered in dissemination leading to systemic disease. Exclusion of focal infections was considered a rational form of therapy and unresolved cases were attributed to unrecognized foci in the internal organs. Moreover a number of poorly understood diseases were explained by the focal infection theory including psychiatric diseases. This led to a boom in tooth

extractions and tonsillectomies to such an extent that one contemporary quoted “If the craze for violent removal goes on, it will come to pass that we will have a gutless, glandless, and toothless, and I am not sure we may not have, thanks to false psychology and surgery, a witless race”. [10]

At the turn of the century, with the dawn of Bacteriology, it appeared that most, if not all diseases might be infectious in origin. In time it became clear that the theory of focal infection carried this concept to an extreme. The elegance of this theory was easy application; but, it resulted in meagre cure rates, occasional deterioration of disease and inconsistencies in experimental results. Ultimately, it was demonstrated that the science on which the theory was based was flawed. [10]

Re-emergence of focal infection theory

But in the recent years, there has been immense interest in possible associations between periodontal disease and various systemic conditions. This has led authors to adopt a cautious approach, some seeking intervention to determine causality. The inability of Epidemiology to confirm causality has been emphasized, categorizing the phenomena as a progressive invasion of local tissues distinguishing it from the former Focal Infection Theory. Others have found the scientific evidence of the theory to be slim but have conceded that it may be established by evolving science. Yet, select authors affirm the return of a modest focal theory.

Periodontal health

The oral ecosystem serves as a habitat for about more than 10¹⁴ microbes. These pose a constant threat to the defence mechanism. Moreover, the unique anatomy of the tooth which is partly exposed to the oral environment and partly rooted to the connective tissue presents as a vulnerable entity. The imbalance between the host factors and the microbial community initiates

the disease. The influence of systemic disease on the pathogenesis of periodontal destruction and vice-versa has been a topic of debate for years together necessitating the need to establish directionality. [11]

Periodontal health and systemic health

Modest associations between periodontitis and some, though not all, of the diseases and conditions reviewed, is supported by published evidence. [12,13,14] Ample mechanisms have been implicated in literature signifying the bidirectional relationship between periodontitis and a range of systemic conditions establishing a causal link. Amongst these, the theory of three mechanisms put forward by The den Van Velzen et al was awarded much credibility. The theory corroborated that systemic effects could be attributed to metastatic infections, spread of bacterial toxins and immune mediated injury. [15] The above-mentioned concept was reinforced by Van Dyke, who emphasized that periodontal disease causes inflammation and the resultant bacteraemia can metastasize to different organs with production of inflammatory mediators and activation of adaptive immunity having far reaching influence on systemic health. [16] Yet, there exists a lacuna in establishing a definitive link to correlate these mechanisms aforesaid for pathogenesis of various diseases. [17-33]

Definition of disease state

There is a striking heterogeneity in the definition of Periodontitis across and within each disease condition. Moreover, not all studies met a stringent threshold for periodontitis. [17,21-26] Hence it is difficult to compare and identify size of any associations between periodontal disease and systemic diseases. In this context, the presence or absence of associations depend on the definitions adopted. Hence there is a need to conclude a consensus on the threshold to be used to define periodontitis as well as systemic diseases. [17]

Study Designs

There is a need for a paradigm shift from using cross sectional studies to longitudinal studies. This may enable the observation of disease progression and treatment results. [17,21,25,28,30]

Use of surrogate measures

Epidemiological studies predominantly did not use clinical measurements but rather surrogate measures of disease producing intriguing results. The examination of evidence based surrogate markers, do not justify the definite disease event. Studies should rather aim to analyse health outcomes. [25,27-28,31]

Test of hypotheses

In a vast majority of studies, identification of association is followed by suggestion of hypotheses which can be tested. The difficulties posed by the future study designs to investigate the hypotheses should not be underestimated. [24]

Concept of causation

The concept of causation is difficult and any given disease can be caused by more than a single mechanism and every causal mechanism involves the combined action of many component causes. The association of periodontitis with certain systemic disease cannot offer explanation or understanding of the disease. The associations in many cases may be weak but a causal link cannot be totally dismissed. The principles of disease causation and causal theory are beyond the scope of discussion. [17]

Role of shared risk factors

According to the risk factor hypothesis, periodontal diseases share a series of common risk factors with a range of systemic conditions. These may be accountable for the increased risk of systemic complications. These factors present the issue of confounding and bias. [18,24,26,29]

Applying the Bradford Hill criteria

Scientific studies reveal an association between a given factor and a health effect. This cannot be inferred to indicate that the factor causes the specific disease. Researchers are suggesting the application of the Bradford Hill (1965) criteria to establish the strength of evidence for complex conditions for infective aetiology. [17]

This necessitates the evaluation of the body of existing proof for the following:

- (a) Statistical strength of association
- (b) Consistency
- (c) Specificity
- (d) Temporal relationship
- (e) Biological gradient or dose response relationship
- (f) Biological plausibility
- (g) Coherence
- (h) Experimental reversibility
- (i) Analogy / other precedents

Evolving dynamics of systemic diseases

With the advent of predictive, preventive and personalized medicine, it has become even more relevant to integrate these concepts with periodontics. [34]

Prevention

The known methods by which periodontal disease can be prevented are more efficient than those available for

any other chronic diseases. Periodontal disease prevention employs uncomplicated procedures. But taking into consideration the high prevalence of the disease, it can be concluded that it is hardly being used. The approach of prevention has to be embraced. Neglect is the principle cause of periodontal disease. Neglect of oral health is the primitive cause; neglect of systemic health can be merely contributory. [35]

Prediction

Patients with systemic diseases should be placed at a higher risk for periodontal health deterioration and vice-versa. Though the relation between periodontal pathologies and systemic disorders is complex, status of deteriorating periodontal health can be an early indicator as well as a risk factor for a variety of multi-factorial diseases. This includes pre-term birth, a spectrum of vascular pathologies, stroke, heart and lung disease, diabetes mellitus with co-morbidities, some types of cancer, neurological disorders and several mental disorders such as depression, anxiety, anorexia, bulimia, Alzheimer's disease and so on. [34]

Personalization

The patient in question and the wide of range of other systemic contributory factors should be comprehensively analysed. Applying the concept of individual medicine - the great strength of individualized treatment is to offer a holistic and integrative approach comprising of curative, rehabilitative and preventive examination as well as treatment methods tailored for the individual. The multidimensional interaction of risk factors - both internal and external including genetic background, age, gender, environmental risk factors, lifestyle, culture and beliefs as well as social status in the overall predisposition of individuals to disease is recognized. Other aspects like development of disease, course of the disease and response to therapeutic intervention is to be considered. The fact that this varies from individual to individual is to be highlighted. [34]

Conclusion

There is a need to use concrete and community agreed case definitions of periodontal disease status. The systematic implementation of the same is essential to decipher the relationship of periodontitis and systemic diseases. Moreover these associations are uncertain since periodontal disease is a heterogeneous mix of conditions. This issue is exaggerated by the ill-defined systemic outcomes in the target disease. A clear cut and narrower definition of diseases may enable identification of profound relationships. Shared genetic susceptibility and cross genetic susceptibility have been considered in correlating certain diseases though there is lack of substantial evidence to support this notion. This is significant as individual variation in disease experience observed clinically can be

influenced by a range of factors -genetic, epigenetic and environmental.

Moreover the systemic virulence potential of one's oral micro biome and immune response may be a completely different issue in assessing the nature of the challenge. Hence one size fits all intervention should be replaced by a more customized approach. In order to understand the associations of systemic diseases and periodontal diseases, well designed observational studies should be an integral component of future research. Longitudinal studies to assess the risk would be valuable. Further research is essential for the translation of basic research into clinical studies and practice. Such focused research modalities could go a long way in unravelling the dogma that plaques this dubious association between periodontal disease and various systemic infections.

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A Review of Robotics in Dental Implantology

Dr. Manju Natarajan¹

Abstract

Technology has become a part of everyday life, whether at home, work or just pretty much anywhere. It is so prevalent that it is hard to imagine a practical life without it. This is true in the field of Dentistry as well where technology is becoming a part of everything that a Dentist or a patient interacts with. This review article aspires to give the reader a robust overview on one part of this technology called Robotics in Dental Implantology. There are many literature articles published on computer-aided or assisted Implantology but none with a focus on robotics exclusively for a specific dental application of Implantology. This paper will give a comprehensive overview of Robotics, its role in Implantology, types of Robotics in use in Implantology thus far and its impact on Implantology.

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Key Words: Robotics, Dental Implants, Periodontitis.

Introduction

According to National Aeronautics and Space Administration (NASA), Robotics is the study of robots which are machines that can be used to do tasks either by themselves or have a person telling them what to do¹. Current Robotic technology has increased its abilities such as precision, sensing, repeatability and controls which makes it more suitable in the field of medicine². In the past, robotics was used in cleaning floors, washing equipments and delivering hot meals to patient's bed but its use has been extended to assist surgeries and surgical planning³. In Dentistry, robotics has not seen a widespread application like other fields. Some of the known dental applications of robotics are; as teaching aids for dental students to simulate real patients, dental surgery and Implantology to include image-based simulation of implant surgery and drilling. While more research and trials are being carried out to fully exploit the benefits of robots from enabling and improving accuracy of dental procedure to may be fully replacing dentists in the future, the discussion in this paper will focus on how robotics are being applied in Implantology

Role of Robotics in Implantology

Although dental implants date back to thousands of years, it wasn't a major breakthrough until the 1980s. Many medical research teams in the 1990s used interactive computer applications including hardware and software as an aid for implant planning⁴. For instance, SIM/PLANT a computer guided implant treatment was the first commercially released software in 1993 which provided the clinicians with the ability to view and interact with the CT scan data to pre-surgically place the implant body and visualize the prosthodontic implications virtually at the same time⁵. In the late 1990s, it was robotics that extended the application from pre-surgical plans into mainstream surgery through automated monitoring of surgical procedures via sensors⁴. Fast forward to 2017, a

Chinese robot dentist successfully fit implants in patient's mouth without any human involvement.

Despite Implantology being considered one of the hottest fields in Dentistry, complications due to human errors are inevitable. Damage to adjacent nerves and improper placement are the most common complications of Implant dentistry⁶. A summary of human error caused in implant surgery are:

- Damage to crown or the roots of adjacent teeth. As a result a root canal or apicoectomy is needed to repair the injured tooth roots.
- When implant surgery is done on the lower jaw, inferior alveolar nerve may get damaged which causes pain, numbness or tingling in teeth, gums, lips, tongue or chin. The same symptoms can occur when the implant is placed right on top of the nerve which causes severe pain when chewing. If the nerve damage fails to heal by itself, then the implant may have to be taken out.
- Drilling through the jawbone into the sinus cavity is another complication during implant surgery.
- Sometimes, fracture of the jaw may occur if there is not enough bone or bone density.
- Pressure and trauma of the soft tissue around or under the implant due to improper placement or size of the abutment and crown restoration which may aggravate implant complications.

These complications arise due to the fact that the Dentist stray away from the correct location, depth and orientation of the plan while still controlling the actual drill delivery which requires extra-ordinary skills of the Dentists. Technology especially robotics or robot-assisted Implantology has been seen as a solution as it would eliminate the burden of Dentists and Patients. As mentioned earlier, while there are many technological advancements that aid Dentist in Implant surgery, this paper will focus specifically on Robotics and its application.

Robotic application in Implantology can be broadly classified into Robot-assisted Implantology and fully-autonomous Implant Robots. A Robot-guided Implantology increases accuracy and aesthetics in dental implant procedures through visual and physical guidance and a simple digital workflow⁷. A fully-autonomous implant robot on the other hand is independent under the supervision of a Dentist⁸.

Robot-guided Implantology

Robot-guided Implantology is spearheaded by Neocis, a company based in the United States of America (Miami, Florida, USA). Founded in 2009, this organization has been approved by Food and Drug Administration (FDA) to use its flagship product "Yomi" with real-world patients in a clinical setting⁹.

According to the consortium on cognitive science instruction, a robot has three basic components; sensors, effectors and control systems¹⁰. Sensors help robots gather information about the environment to guide its actions. Some of the commonly used sensors are microphones, buttons, cameras etc. An effector of the robot is the one that actually does the work. An example of effectors is robotic arms helping a surgeon pick a surgical knife. Control system also known as the brains of the robot determines the behaviour of the robot. Yomi in its simplest form consists of these three basic components.

The primary input to the robot-guided Yomi comes from a CT scan. The CT information is then fed into dynamic planning software that allows the surgeon plan the surgery accounting for key anatomical features like the nerves, sinus and adjacent teeth¹¹. This step sets the parameters of the implant surgery and establishes limits for visual and physical guidance. As shown in Figure 1, visual guidance is a real time three-dimensional graphics that provide navigation during surgery and confirms progress. Physical guidance is provided by the robotic arm (Figure 1) which guides the surgeon to position and drill till appropriate depth.

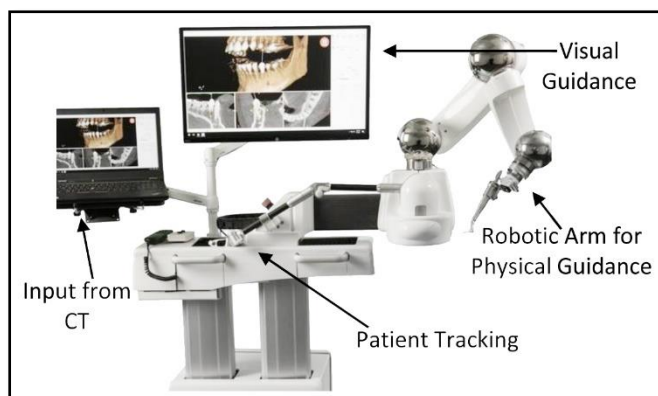


Figure 1: Yomi: Robot-Guided Implants

This collaborative robotic arm enables minimally invasive surgery which leads to faster surgery, faster recovery and less pain for the patients. The robotic arm physically constraints the surgeon's drill movement to match the plan through Haptic guidance technology. Yomi prevents any deviation from the plan with full view of the surgical site. The surgeon precisely drills into the osteotomy and is stopped when reaching the planned depth. Patient tracking throughout the surgery is done through intra-operative tracking that maintains accuracy throughout the surgery and follows the patient if they move.

Robot-guided implants like Yomi comes with its own merits and limitations. Advantages include extremely high accuracy and precision, stable and untiring repeated performance and ability to accurately process quantitative information fed into the system¹². Limitations include the fact that the judgment of the situation is limited to the data fed into the software and/or tracked by patient tracking system, supervision by an experienced Dentist is still required and the cost of the system is prohibitive¹².

Fully-Autonomous Robotic Implantology

Chinese Robot dentist made headlines in 2017, when it successfully fitted two new teeth into a woman's mouth (Figure 2)¹³. The one hour procedure resulted in implant fitted within a margin of error of 0.2-0.3mm. The artificial teeth the robot implanted were created by 3D printing which is another breakthrough technology gaining popularity among Dentists since early 2000s¹⁴.

This fully-autonomous surgery by a Robot being the first of its kind, it involved a lot of planning and multiple Dentists supervision. The dental staff fitted position orientation equipment to the patient and the robot was programmed to move into the correct position to carry out the surgery in a pre-determined movements, angle and depth needed to fit the new teeth. The robot adjusted its positions in-line with patient's own movement. The functioning, process and set up is very similar to Robot-guided Implantology discussed above with the exception that in an ideal implementation a fully-autonomous robot will require minimal to zero Dentist involvement.

This fully autonomous Robot took four years to develop jointly by the Stomatological Hospital, based in Xian, and the robot institute at Beihang University in Beijing¹³. The technology is still in its infancy in a demonstration stage when compared to Robot-guided technology which Neocis (maker of Yomi) claims that the units are being sold to Dentists in the USA. Nevertheless the achievement is significant and has set a high bar for Implant technologies being developed.



Figure 1: Robot Dentist fitting two teeth into a women's mouth in China

Impact of Robotics in Implantology

While technology is catching up in Dentistry in comparison to other medical field, Robotics is fairly a very new term in dentistry. Hence, mainstream deployment of Robotics is very limited and so are its evidences in a clinical setting. However, a literature scan for the evidences for success of robotics returned limited scholarly review, so the search was expanded to include robotics and computer-assisted studies which hopefully establishes the building blocks in the evaluation of Robotics in Implantology.

A phantom experiment of image-guided robotics for dental implantation concluded that the system accuracy is comparable to other similar systems for dental implantation with a Fiducial Registration Error (FRE) and Target Registration Error (TRE) values recorded as less than 0.30 mm and 1.42 ± 0.7 mm¹⁵. FRE is a common measure which is the root-mean square error in fiducial alignment between image space and physical space. The estimate of FRE error is an indication of the accuracy of the system's ability to provide guidance to surgical targets for a given case¹⁶. TRE is the measure of displacement of actual probe from the target in a guidance system¹⁷.

In another study of analysis of all of the major data sources including unpublished data in the internet, computer-assisted/-guided/-aided Implantology has been found to overcome the errors encountered during implant osteotomies and positioning precisely¹⁸. In a meta-regression analysis of 2,827 studies to summarize the accuracy and clinical performance of computer assisted implant systems, the mean error was estimated at 0.74 mm (max value of 4.5 mm) at the entry point in the bone and 0.85 mm (max of 7.1 mm) at the apex.

In a clinical study of 102 patients involving 250 implants in armed forces dental clinic in Germany, the patients were treated with a system that allows transfer of virtual planning of implant positions using

cone beam CT data to surgical guide template. The results concluded that in all cases critical anatomical structures were protected and no complications were detected in postoperative panoramic radiographs¹⁹. A flapless surgery plan was realized in 58.1% of the 250 implants¹⁹.

These literatures conclude promising evidences in robotics and many building blocks of robotics such as the computer-assisted Implantology. But, a more mainstream implementation and wider population study should lead to more robotics dominance in Implantology.

Conclusion

In general Robotics and technology lags in Dentistry compared to the pace of technological adoption curve in other major job markets such as industrial and information technology. Dental Implantology however has seen a remarkable adoption of technology evolving from computer-aided surgical planning to fully autonomous. This could be attributed in part to the complexity and human induced errors involved in Implant surgery especially damages caused to adjacent nerves and improper placement of implants. Robotics has seen its application in the automation of either a portion or all of the implant surgical process in a Dental office. Robotics-guided Implantology, that is partial automation of implant procedure, is more advanced from a technology maturity stand-point. The Dentist is still in control of the process and it minimizes patients' burden. Fully-autonomous robotic Implantology has sure gained interest but the technology is still in its infancy and it is expected to stay that way for the foreseeable future. Irrespective of the type of robotics, the benefits seen in error reduction and in minimizing patient burden will outweigh the cost associated with this technology for some of the developed economies such as US and Europe. According to the Oxford university study, the job of a Dentist is one of the top 10 jobs that a robot will never replace with only a 0.4% of a chance of automation²⁰. This paper did find evidences that could push the limits of the validity of this study by a tiny bit. Whether the risk is seen to the profession or not, the entire dental community can agree to the fact that Robotics will surely have a positive impact on Patients.

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