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## Journal

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## AIMS AND SCOPE

Acta Stomatologica Marisiensis is an official Journal of the George Emil Palade University of Medicine, Pharmacy, Science, and Technology of Targu Mures, Romania, and is published twice a year. Acta Stomatologica Marisiensis is an international journal dedicated to publishing high-quality peer-reviewed articles about all fields of dental medicine. The important topics covered by the journal refer to the complete, complex and interdisciplinary treatment of the patient with dental problems. This involves addressing all branches of dental medicine and does not exclude research in the field of nanomaterials, biotechnology or medical engineering.

By focusing on the publication of new documents and evidence of high quality research, Acta Stomatologica Marisiensis aims to improve research and clinical practice of dental medicine at an international level.

The journal focuses on the publication of quality medical research articles that bring new insights into dental medicine from the perspective of diagnosis and treatment methods as well as the materials used. No less important are presentations of interesting clinical cases that can bring new light into diagnosis and treatment methods or interdisciplinary therapeutic approaches or

collaborations with various fields of engineering for the development of innovative new technologies.

Acta Stomatologica Marisiensis addresses the entire community of dental specialists or related specialties at national and international level and aims to provide studies and materials for a better understanding of diseases and treatments in the sphere of dental medicine.

The Journal emphasis is primarily on original high-quality medical research but also accepts manuscripts relating to the basic sciences, review articles, systemic reviews and meta-analysis, case reports, and observational studies of all types, including randomised control trials, editorial commentary and opinions covering the entire spectrum of research in dental medicine.

The role of the Journal is to inform its readers of ideas, opinions, developments and key issues concerning dental medicine, stimulating interest, debate and discussion amongst dental medicine colleagues and those of related disciplines.

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## EDITORIAL



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**Interdisciplinarity: decision-making factor in modern dental therapy.**

Țuculina Mihaela Jana

University of Medicine and Pharmacy of Craiova, Romania.

The classic and modern methods and techniques of detection, diagnosis, and treatment of odonto-periodontal lesions need a material support, which allows obtaining restorations made correctly from a morphological and functional point of view.

The knowledge of the latest discoveries in the field, the correct acquisition of knowledge about how to use novel materials, but also of the specific indications, are indispensable elements for the practice of dentistry in the modern era. The development of theoretical ideas in close coordination with technical advancement may be the key to a competent and high-quality medical act.

An appropriate examination of the oral condition based on the patient's complaints is followed by a thorough evaluation of the odontogenic, periodontal, and radiographic signals as well as additional diagnostic components like mounted casts and pictures.

Based on the patient's vision and goals for their oral health and the evidence of prognosis of the treatment options from existing research, the final treatment plan synthesizes these factors.

Making decisions is often difficult due to the plethora of indicators, symptoms, and options [1].

The management of patients' health depends on a number of oral-systemic health interactions. Oral diseases and conditions have an impact on systemic health, as do systemic diseases and conditions [2,3].

Tooth loss, intraoral infections, and periodontal diseases are all examples of oral diseases and conditions that have been linked to poor overall health [4].

Intraoral infections can cause facial and periorbital cellulitis, which can lead to cellulitis within the facial planes of the neck, which can compromise the airway, sinusitis, and bacteremia, thus causing harm at distant sites [5].

Patients who have untreated or poorly managed oral problems such as dental decay, oral discomfort, tooth loss, loss of oral function, halitosis, and cosmetic dental health may experience social stigma, lowered self-esteem, loneliness, and depression [6].

There are numerous and intricate connections between dental health issues and overall wellness. Oral health is impacted by systemic disorders, either directly through pathological pathways or indirectly through behavioral changes brought on by illness or treatment. Systemic health is affected by changes in dental health. Losing teeth is directly related to losses in quality of life, and mortality from cardiovascular illnesses. As a result, the now-recognized link between oral health and systemic health emphasizes the necessity of many healthcare practitioners incorporating oral health care into the management of general health care [7].

One prerequisite for endocarditis is bacteremia, which is the introduction of germs into the bloodstream. Any mechanical activity on the skin or mucosae can trigger it. Both the volume and the frequency of bacteremia coming from the mouth cavity are influenced by how invasive the mechanical action is and how much the hard-soft tissue interface is inflamed. Even in those at high risk, the majority of bacteremia does not result in endocarditis. However, in high-risk patients

the likelihood of endocarditis will rise the more frequently and strongly bacteremia occurs [8].

A consultation in health care is a discussion between health care or other service professionals to seek direction and clarification, exchange pertinent data and clinical findings, notify other members of the interprofessional team of discipline-specific issues, and go over diagnosis, prognosis, treatment options, and patient management options for a specific patient. For instance, the condition of gastroesophageal reflux is linked to dental caries and tooth degradation because of recurrent exposure to acidic gastric contents. Dentinal hypersensitivity, poor aesthetics, sharp teeth that can lead to mucosal ulcerations, changes in occlusion with time, and changes in vertical dimension are all effects of erosion [9].

As members of the multidisciplinary health care team, registered dietitians provide medical nutrition therapy in an effort to treat and prevent diseases. Malnutrition may be caused by both direct and indirect links between poor dental health and nutrition, and vice versa [10].

Specialists can work together to provide screening, information, and referral to one another as part of an all-encompassing treatment plan because oral health and nutrition are mutually supportive [11].

Additionally, dentists can inform dietitians about the potential risk of dental caries posed by various liquid dietary supplements that are frequently included to increase calorie, fiber, and protein intake as well as to supply vital nutrients that could otherwise be lacking [12].

Periodontal diseases are usually associated with a systemic disease. Thus, smoking, stress, aging, chronic inflammation, and genetics are all risk or modifiable factors for both periodontal diseases and systemic conditions [13].

The prevalence of tooth loss and edentulism has been increased reportedly in the case of patients diagnosed with systemic conditions: chronic cardiovascular diseases, nephropathy, cancer, osteoporosis, and neurological diseases [14].

To allow a better treatment for patients with complex pathology multiple dental specialties need to perform together. Greater patient demands and more difficult treatment options are a result of longer life expectancies, better-quality biomaterials used in dentistry, and the quick evolution of clinical practices. In order to achieve therapeutic goals and deliver effective therapy for functional rehabilitation and cosmetic enhancement, it demands holistic management, which frequently requires doctors to collaborate in a multidisciplinary approach [15].

In terms of contemporary dentistry, endodontics, orthodontics, prosthetic dentistry, and periodontics have a close and intertwined interaction with other specialties in terms of treatment planning, procedure execution, results, achievement, and maintenance [16,17].

The dental interdisciplinary treatment is an organized cooperation between various clinicians involved in patient care. Today, it is common knowledge that no specialty can be practised in isolation because there are usually several treatment options that can increase patient satisfaction and clinical predictability for practically every case [18].

The development of an interdisciplinary approach creates a traditional link between different dental specialties that must coexist for the patient's overall health. Sharing an intimate and unbreakable bond with other dental specialties as well as with other professionals should be expressed in many parts of daily dental practice, starting with the treatment plan, procedure execution, outcome accomplishment, and long-term maintenance. Every stage of clinical dentistry is closely linked to a single goal.

In a comprehensive, interprofessional approach to patient care, the preservation and maintenance of the natural dentition in healthy conditions is of utmost importance [19,20].

**Conflict of interest:** None to declare.

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## REVIEW



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## Current status of predoctoral implant dentistry education – student’s didactic performance and self-assessment: A Systematic Review.

Disha Nagpal<sup>1</sup>, Carlos Flores-Mir<sup>1</sup>, Usama Nassar<sup>1</sup>, Liran Levin<sup>1</sup><sup>1</sup> University of Alberta, Canada

### Abstract

**Objectives:** To describe the current state of predoctoral dental implant education in terms of educational outcomes and the student’s perception of the associated curriculum. **Methods:** A database search was conducted using Medline (OVID), EMBASE, ERIC (Education Resources and Information Centre) and Web of Science electronic sources. Two reviewers thoroughly reviewed the papers in accordance with the specific selection criteria after carefully choosing the abstracts that seemed to meet the initial selection criterion for full article retrieval. **Results:** 15 articles were included, which were divided into two distinct groups: those that addressed educational outcomes and those that addressed students' perceptions. Knowledge was assessed by questionnaire surveys, and it was found that most of the students were poorly to moderately well informed. There was a positive increase in student perception after taking the implant courses. **Clinical significance:** Although predoctoral education in most dental schools across the world now includes implant dentistry as a core component, the degree of integration varies greatly. To increase the proficiency of predoctoral students around the world in performing implant treatments, it is necessary, according to this systematic review, to create a uniform, well-structured predoctoral implant curriculum and guidelines that include didactic, laboratory, preclinical, and clinical components.

**Keywords:** curriculum, dental school, dental student, dental implants, predoctoral.

### Introduction

Over the last few decades, dental implants have gained popularity as a treatment option for replacing missing teeth. Dental implant training is often regarded elective during predoctoral education [1,2]. Nevertheless, predoctoral students must have sound knowledge, and clinical expertise in implant dentistry as they will be expected to provide this treatment once they graduate [3].

In 1974, 33% of US dental schools had some level of predoctoral implant dentistry program in their curriculum [4]. This rate increased drastically to 73% in 1989 and 86% in 1993 [5]. A study of the North American dental schools’ deans, conducted in 2004 revealed that 97% of participants said the undergraduates receive some form of didactic education, and 86% said their students also obtain associated dental implants’ clinical experience. [6]. There is a wide variation in the extent of integration of implant dentistry predoctoral programs worldwide owing to the challenges like the implementation cost, patient availability, and limited curricular time [7,8].

Theoretical knowledge is a foundation for implant dentistry teaching. A sound basic knowledge would not only make the students more competent to perform a proper clinical exam for appropriate diagnosis and treatment planning but also would enhance their clinical expertise [9]. Historically, predoctoral implant training has been predominantly didactic. However, simulation training and clinical experience improves undergraduate students’ level of confidence, satisfaction, and perception of curriculum [7,10].

The ability of freshly graduated dentists to diagnose and manage implant patients by themselves is still questionable [11]. This is one of the less explored aspects of dental implant education. The available literature on these aspects is vast, discrepant, and unorganized to easily draw common conclusions. The most frequent type of the studies used to measure the educational outcomes are surveys with the aim to gauge the knowledge, attitude, and perception of dental predoctoral students towards dental implants [1,2,4,12]. There are

only a few consensus reports and opinions available about this topic [13,14,15].

This systematic review's objective was to systematically assess the state of predoctoral implant dental education in terms of the educational outcomes that result from the didactic component and how the students perceived the relevant curriculum.

### Material and methods

This preferred reporting items for systematic reviews and meta-analyses (PRISMA checklist) was followed for this study [16].

#### Protocol and Registration

A search in PROSPERO - International prospective register of systematic reviews (Centre for reviews and dissemination, University of York, York, United Kingdom)-using terms implant education and predoctoral/undergraduate curriculum was done and no registered proposal was found.

#### Information sources and search

Searches were conducted in electronic databases such Medline (OVID), EMBASE, ERIC, and Web of Science. Based on prior knowledge about the topic, selected search phrases were identified for each database. The first 100 articles found by Google Scholar's grey literature search engine were chosen. (Appendix 1).

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To find any more references that were missed during the search of the online databases, the reference lists of the chosen articles were manually checked in the end.

#### Inclusion criteria

Only those articles were included where the status of implant education was studied by means of a survey or questionnaire to the undergraduates. For student perception of the curriculum, the studies where students filled

questionnaire about the program were included.

#### Exclusion criteria

Opinion papers, consensus reports, letters, and editorials were excluded. Papers that presented only a description of the program at a school without any assessment of the students' theoretical knowledge or their perception were excluded. Surveys of postgraduate students, general dentists or specialists were not included.

Using software applications (RefWorks eCOS, ProQuest), the references were handled, and duplicate references were eliminated. There were no restrictions on the online database searches for language, study kind, year, or any other known parameters. The search was most recently revised on February 3, 2019.

The articles were screened by two reviewers (DN and LL) independently. Any disagreements were discussed until a consensus was reached. If a consensus could not be reached, the participation of a third reviewer (CFM) was solicited. From the selected studies, the following details were noted: author(s), year of publication, research methodology, region, evaluation methods, participants and response rate, survey details, and result (main reported findings related to the research question).

#### Risk of Bias (RoB) among each study

The Joanna Briggs Institute (JBI) tool for cross sectional and cohort studies (as applicable) was used to assess the methodological quality of the chosen studies. For cross sectional research, the RoB was analysed using eight distinct features, and eleven for cohort studies with answers "yes", "no", "unclear" and "not applicable". The articles were scored according to a percentage scale (0-100%) which was calculated based on the number of positive responses [17,18].

#### Risk of Bias (RoB) across included studies

According to JBI guidelines, it is recommended that a grading system be utilized to review and evaluate the reliability as well as the quality of evidence within a systematic review. Grading of Recommendations Assessment, Development, and Evaluation (GRADE) approach was designed initially for randomised controlled trials; however, there is currently no alternative evidence grading protocol for observational studies, and hence, in this study, GRADE approach was adapted, without validation, for observational studies to assess the certainty of evidence and to assign recommendations on a GRADE scale of very low, low, moderate or high [4,19].

## Results

#### Study selection

Details of the search methodology are shown in the flow diagram according to PRISMA (Figure 1) [16]. At the start, 1466 records were found. After the duplicates were removed, 821 articles were considered. 41 papers were chosen after the authors read all the titles and abstracts in phase 1. One article was chosen from Google Scholar.

In phase 2, after the full-text assessment, 15 studies were found to be appropriate. Each stage of this selection procedure was carried out individually by the writers, and any disagreements were settled by discussion and agreement. These 15 studies were further divided depending on the outcome they measured—educational outcome (7) and student perception (15) [1,2,12,20-23 1,2,7,12,20-30]. A few of these studies addressed more than one outcome.

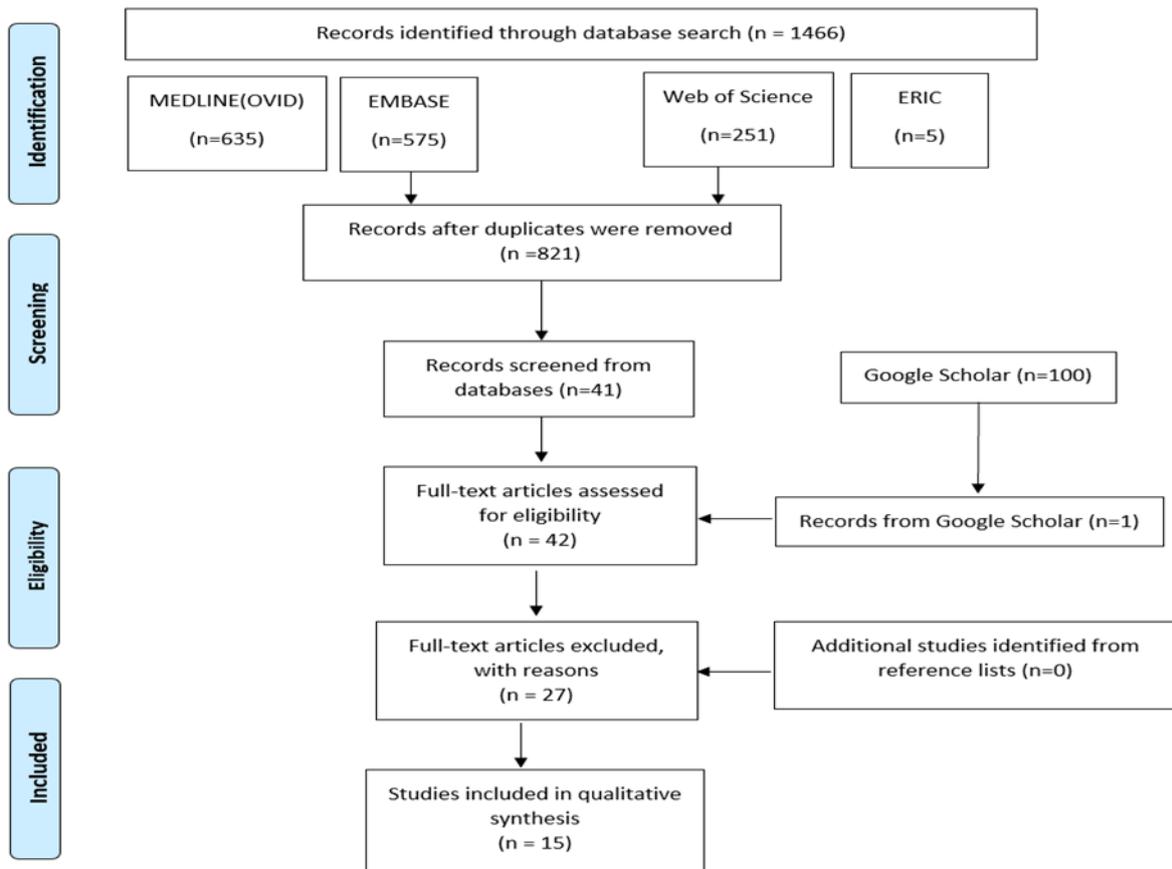


Figure 1: PRISMA 2009 Flow Diagram

### Synthesis of Results

The included studies were observational studies that had a cross sectional or cohort component, or both. All selected articles were published in English language. Sample sizes were highly variable. The response rate for most of the studies was 72%-85%. Most of the surveys were divided into knowledge, attitude, and perception outcomes. A few studies included the surveys that were validated either from a previous study with some modifications or by conducting a pilot study [2,12,21,23]. The results for different outcomes are summarised below.

#### Educational Outcome:

This is mostly measured by asking students questions to gauge their level of theoretical understanding of implants. These questions corresponded to basic questions asked by

patients like advantages, case selection, etc. [22]. The study population was the one at different levels of undergraduate training. The included studies were conducted in different parts of the world [1,2,12,22,23]. Overall, these surveys found that the participants were poorly informed [22] to moderately well informed [23] about the implants' selection and use. The majority of participants said that dental implants' key benefit was that they were additionally conservative: 55.4% [12], 59.8% [2], 54.83% [21]. Few surveys used knowledge self-assessment the participating undergraduate students before and after the implant course [1,20,21]. The implant knowledge of the students improved for two studies [1,20] but not for one [21]. Table 1 describes the major study characteristics and outcomes of the selected studies.

Table 1: Educational outcome (From Cross Sectional Surveys)

Author /Year	Type of Study	Method to Assess	Population, country, response Rate	Details of Survey	Outcome	Additional Comments
Seitz SD, 2016 <sup>20</sup>	Descriptive followed by cross sectional study	Questionnaire based survey	Of the 16 students in the selective in academic year 2014-15 at University of Texas San Antonio, United States.  15 participants finished the pre-survey, while 12 finished the post survey.	Dental students' before and after-training self-assessment of the understanding of implant and CAD/CAM, Practical skills, and Degree of comfort by rating each response from poor, average and excellent.	Before and after the course, there were statistically significant improvements in the students' self-assessed understanding, involvement in implant therapy and restoration. Only one respondent had outstanding understanding of implants prior to the survey, but this number rose to seven thereafter. From 1 before the survey to 9/10 after the survey, the CAD/CAM Knowledge Level for Diagnosis and Therapy, Intraoral Scanning, and Placement of restorations increased.	
Sánchez-Garcés MA, 2017 <sup>21</sup>	Cross sectional	Questionnaire based survey	Third and fourth years of the BDS programme at the Faculty of Dentistry at the University of Barcelona, Spain, were attended by 151 and 146 students, respectively.  107 students, 76 from the third year (Group A) and 31, from the fourth year (Group B), responded to the survey.	A survey with 11 questions was created: Basic knowledge (seven), views of training obtained (two), and potential training methods for students (2)	A higher percentage of students—more than half—thought they were ill-informed, with no statistically significant differences between the third- and fourth-year students (groups A and B, 59.81% and 61.29%), while only 19.73% and 32.25% (A and B, respectively) thought the same about their level of well-informedness.	
Chaudhary S., 2015 <sup>2</sup>	Cross sectional	Questionnaire based survey	35 dental institutions in India with 2800 students. 2041 questionnaire replies were received out of a total of 2800 that were distributed. The response rate was 72.89%. Most of the respondents were female.	A total of 15 questions that were divided into 3 parts: The sample population's demographic profile was discussed in the first section. The questions in the second segment measured the depth of knowledge regarding dental implants. The final portion of the questionnaire asked questions concerning the undergraduate dentistry students' sources of information and	When asked about their degree of knowledge regarding dental implants, 59.8% of respondents said that case selection, which is crucial for fixed partial dentures (FPD), was the biggest benefit of dental implants over surrounding healthy natural teeth. Additionally, 91.7% of the residents desired more knowledge regarding implants in their undergraduate curriculum, and 81.1% of the residents felt that they were not given enough information. 56.5% of the	

				their desire for further information.	respondents agreed that dental implants require more care and regular maintenance from the patient and dentist than do natural teeth, and that this is the most crucial factor in determining implant success.
<b>Aljohani HA, 2009<sup>22</sup></b>	Cross sectional	Questionnaire based survey	Dental students who recently graduated from King Abdulaziz University (KAU), Jeddah, Saudi Arabia. 66 /86 students responded to the questionnaire. Response rate was 76.6%	A 21 multiple-choice questionnaire. The questionnaires covered the degree of oral implantology exposure as well as some fundamental information about dental implants.	The average number of participants who accurately answered the four questions was 32.5% and 67.5%, respectively. The questionnaire revealed that recent dental graduates from KAU had a poor degree of understanding of some fundamental concepts in dental implantology. The majority of the students skipped any implant surgeries. The majority of the students (61.1%), did not have knowledge about various dental implant systems, designs, or sizes (60.6%).
<b>Chaudhary S, 2013<sup>12</sup></b>	Cross Sectional	Questionnaire based survey. The questionnaires were mailed to the participants.	Respondents were the dental interns of the state of Karnataka, India. 417 /500 interns responded with a response rate of 83.4%.	4 divisions. Demographic questions were asked in the first segment. The second portion evaluated the participants' degree of knowledge of dental implants while the third question asked about the respondents' sources of information and their perception of the need for further information	According to 12.2% of respondents, the biggest benefit of implants is that they are more aesthetically appealing than alternative tooth replacement options. However, the "conservative aspect" of dental implants was cited as the cause by the majority (55.4%). The majority of responders (56.1%) ranked case selection as the most crucial factor. The majority of respondents (56.2%) stated that they knew "moderately well" about dental implants. A slightly higher percentage (64.5%) agreed that dental implants require more upkeep and attention from the patient and dentist than do natural teeth.
<b>Sharma A, 2018<sup>23</sup></b>	Cross Sectional	Questionnaire based survey	Interns in Nepal (n=350). The response rate was high 280/350 (80%).	A previously used questionnaire from a study (Chaudhary S, 2015) <sup>2</sup> was utilised; after pilot research,	The majority of interns claimed to have a fair amount of knowledge about dental implants (50.36%); the main
					For several comments, there were significant correlations

				32% of the participants were males and 68% were females.	a little alteration to the questionnaire was made.	benefit of dental implants is that they are conservative in design (58.6%); the case selection procedure is the most crucial aspect of implant success (51.07%); and the lifespan of dental implants is 10–20 years.	with the location of the college.
<b>Homma 2015<sup>1</sup></b>	<b>S,</b>	Cross-sectional	Questionnaire based survey	5th year students (139) at Tokyo Dental College who had completed a course in oral implantology comprising lectures and practical	1) Self-assessment of level of success in achieving each course objective.2) Evaluation of practical training in Oral Implantology.3) Attitudes regarding oral implants before and after course completion.4) Overall evaluation of Oral implantology lectures and practical training. Answers to questions 1,2 and 4-yes or no	1) Over 70% (71.7+7.8%) of the students thought they had achieved the course objective.2) Results for practical training-66.6+5.8% indicated that practice was easy to complete for tracing of X ray images, incision of mucosa and wound suturing.52.8% of participants indicated difficult for computer simulation of planning of implant placement. Implant placement was considered most difficult (65.7%).	

#### Student Perception:

Most of the included studies assessed pre- and post-course change in student perception via surveys. A few studies included validated surveys based on a questionnaire from a previous study [24,26,28,30]. A positive increase from 10% to 86% in student's perception of implant education was found in some studies [1,20,24,29,30]. On the contrary, participants in other studies were not satisfied with their level of education and clinical training in implant dentistry [2,12,21, 22, 25,

27]. The participants who thought they required more information ranged from 68.21% [25] to 100% [21] of those taking the surveys. An interesting finding was that the factors like laboratory exercises [26] and clinical training [7] increased the students' confidence. 90.8% of students who received such additional training were satisfied with the program [7]. A summary of the key study characteristics and results of the selected articles is presented in Table 2.

Table 2: Student Perception

Author /Year	Type of Study	Method to Assess	Population, Country, Response Rate	Details of Survey	Outcome	Additional Comments
<b>Seitz SD, 2016<sup>20</sup></b>	Descriptive followed by cross sectional	Questionnaire based survey	Of the 16 students in the selective in academic year 2014-2015, University of Texas San Antonio, United States. 15 and 12 students participated in the pre and post survey, respectively.	Dental students' pre- and post-course assessments of their understanding of implants and CAD/CAM, as well as their practical exposure and degree of comfort choosing each answer as poor, average, and excellent. The students questioned on whether they had succeeded in achieving objectives for the select.	Statistically substantial improvements in students' self-reported knowledge, involvement in implant care, and comfort with implant restoration between pre- and post-selective responses. Dental students believed that guided surgery would be less difficult than previous techniques. However, after participating in the guided procedures, students found that it was not as simple as they had first imagined.	
<b>Jahangiri L, 2008<sup>24</sup></b>	Cross-sectional	NYUCD exit surveys for senior students, given to graduating classes annually.	Four years of senior exit surveys starting from 2005-2008	A set of inquiries asking learners' perspectives on several subjects from the curriculum. This survey included a particular question about implant dentistry.	Students who were satisfied in each year from 2005 to 2008 increased from 13%, 14.8%, 28.9% and 31.6%.	
<b>Sánchez-Garcés MA, 2017<sup>21</sup></b>	Cross sectional	Questionnaire based survey	76 of 151 and 31 of 146 in third and fourth year of BDS respectively, participated in the survey. This study was conducted at Faculty of Dentistry of University of Barcelona, Spain.	11 questions were included in a survey that was created. Basic knowledge (seven), perceptions of training obtained (two), and potential training methods for students (2)	93.54% of fourth-year students and nearly 100% of third-year students said that the material they had learned during their dental degree programme was insufficient. Both groups concurred that they had wanted to learn more during their undergraduate education (100%)	
<b>Chaudhary S., 2015<sup>2</sup></b>	Cross sectional	Questionnaire based survey	2041 internees participated from 2800 dental internees (response rate 72.89%) From 35 dental institutions in India	The questionnaire had 3 sections with 15 questions The divisions included the demographics, level of implant knowledge and the source of information of undergraduate dental students as well as their need for more information.	81.1% of the participants felt that they received an inadequate knowledge about implants and 91.7% wanted that more knowledge be provided during their undergraduate degree.	
<b>Aljohani HA, 2009<sup>22</sup></b>	Cross sectional	Questionnaire based survey	66 of 86 dental	The inquiries centered on the experience of oral	The students were not really content with their dental education and	

			students ( 76.6% response rate) of King Abdulaziz University (KAU), Jeddah, Saudi Arabia, participated in the study.	implant dentistry and some fundamental understanding of dental implants	clinical training implant. The majority of the students—52 students, or 78.8%—thought there had not been enough instruction on dental implants, while 21.2% disagreed.	
<b>Chaudhary S, 2013<sup>12</sup></b>	Cross sectional	Questionnaire based survey. The questionnaire was mailed to the colleges of the participants.	417/500 dental interns of the state of Karnataka, India, participated in this study (83.4% response rate)	The survey had 3 sections that asked about demographics, level of information about dental implants and their source of information as well as perceived need for more information.	73.3% of the participants indicated that they did not have enough information while only 26.6% reported that they had a lack of enough information. 95.7% agreed that more information about implant treatment should be provided in the undergraduate degree.	
<b>Sharma A, 2018<sup>25</sup></b>	Cross sectional	Pre used survey from Chaudhary S, 2014 <sup>16</sup>	All the undergraduate dental students (2400) of Nepal from 1st year to 5 <sup>th</sup> year excluding interns), 1700/1850 questionnaires were received. The response rate was 70.83%.	At each level of their BDS course, from the first year to the fifth year, a total of 4 questions were asked concerning their preferred knowledge sources and perceptions of the need for greater information about dental implants.	A large majority of the respondents overall concurred that they did not receive enough knowledge on implant treatment methods during their BDS degree and desired more information to be included in the curriculum. There was a substantial association of the response with the academic level.	The survey was conducted at different times of their academic year. In some colleges, it was done during the middle of their session, whereas in other colleges, it was done before their annual exams. An equal number of participants were not included at different academic levels.
<b>Sharma A, 2018<sup>23</sup></b>	Cross sectional	Survey conducted for one year (June 2016 to 2017)	Interns in Nepal (n=350). The response rate was high 280/350 (80%).  32% of the participants were males and 68% were females.	The survey was used earlier in a different research w (Chaudhary S, 2015), <sup>2</sup> a pilot study was carried out and minor modification was made in the questionnaire.	Many of the students (67.14%) felt that the BDS curriculum should include more information about implant treatment techniques since they felt that they were not given enough information. 33.21% and 48.57% of respondents, respectively, stated that they would prefer to learn more credible information regarding dental implants from implantologists who have completed a one-year certificate programme	

					The response of this depends on the location of the school.	
<b>Homma S, 2015<sup>1</sup></b>	Cross sectional	Questionnaire based survey	5th yr students at Tokyo Dental College who had completed a course in oral implantology comprising lectures and practical training bet Oct 2013 and Feb 2014. Total 139. M/F 79/60	1) Self-assessment of level of success in achieving each course objective. 2) Evaluation of practical training in oral implantology 3) Attitudes regarding oral implants before and after course completion 4) Overall evaluation of Oral implantology lectures and practical training. Questions to 1,2 and 4- yes or no	Attitudes regarding oral implants before and after course completion. 10% increase in affirmative responses to the questions- Are u interested in OI treatment and Do u want to be involved in implant treatment as a dentist. 40% participant selected that they may not select implant themselves or a missing tooth after completing the program.	
<b>Yuan CC, 2011<sup>26</sup></b>	Cross sectional	Two surveys	Second year to Fourth year dental students (Class of 2009-2011). A total of 195 dental students at Chicago College of Dentistry, University of Illinois	Survey 1 was given to second year students towards the completion of pre-patient care implant curriculum in May 2009. These students were questioned about their opinions of the significance of implants education, the quality with which PCEs equipped them with care for patients, and whether these encounters may sway their upcoming plans to administer implant treatment. Third- and fourth-year students were given Survey 2. This survey evaluated students' opinions of their stress levels, skill, training, practical exposure, and productivity in addition to similar items from Survey 1.	Both the surveys had a high response rate- 95 % and 89% for Survey 1 and 2, respectively. 99% of those surveyed said implant instruction in predoctoral dentistry education was crucial or extremely crucial. Many respondents from all courses said that they intended to offer DxTP (68.9%), STI (61.2%), and IOD restorations (62.1%) following graduation. Most of the participants felt that how well they were prepared after the laboratory procedures, influenced their plan to do diagnosis and treatment planning, STI and IOD restorations.	1. Laboratory exercises (PCEs) are crucial for undergraduate implant training and preparing future dental implant therapy providers. 2. There were distinctions between male and female students in terms of how prepared they felt they were for the future. 3. Fourth year students were more stressed than third year students while doing dental implant treatment.
<b>Afshari S, 2014<sup>27</sup></b>	Cross sectional	The focus Group discussion during which the students completed a survey.	All the students participating in APIP -Nine students (100% response rate)  Chicago College of Dentistry, University of Illinois	Advanced Predoctoral Implant programme (APIP) has been developed by the College of Dentistry that gives the students the chance to putting implants for single tooth as well as overdentures for the mandible.	1. All participants agreed that the program's implant placement component was the most alluring. 2. The students claimed that because of the programme, they felt more confident recommending implants to patients. 3. The variation in the number of implant	

					procedures among the students was the program's main point of concern from the students. This was ascribed to the fact that the students had to choose their own implant patients, and externships at institutions other than the UIC College of Dentistry made it difficult for them to do so. 4. After graduating or in the future, all of the students said they will seek more training in implant dentistry through either a specialized programme or a general dental residency.	
<b>Ariani, 2013<sup>28</sup></b>	Cross sectional study	Questionnaire based survey	141/166 undergraduate students from third and fourth year at the Faculty of Dentistry, University of Indonesia participated in a questionnaire-based survey.	The survey consisted of a total of 14 multiple-choice and yes/no questions. These were divided into three sections that consisted of questions regarding Students' perspectives on implant therapy, undergraduate implant education, and students' futures with reference to implant treatment	Dental implants were thought to be the best option for missing teeth replacement in the mandibular first molar and the maxillary anterior tooth, but not in the mandible as a whole. The majority of students felt that undergraduate education did not go far enough in covering the subject of implant dentistry. They were eager to learn more and intended to include implants into their area of practice.	A national conversation over the inclusion of a thorough implant dentistry curriculum in undergraduate dental education is required.
<b>Prasad S, 2017<sup>7</sup></b>	Cross sectional	Questionnaire based survey	The group of students with only didactic training (control) participated in a survey in 2014. In 2015, the survey was given to the students with both didactic and simulation training.	78.7% of the students participated in the control group and 81.3% in the test group.	85.7% of the students in the control group, reported being satisfied with implant training compared to 90.8% of students in the test group. Restorative clinical experience increased the rate of satisfaction to almost five times among the students.	
<b>Tammerman A, 2016<sup>29</sup></b>	Cross sectional	Survey Questionnaire s assessing the students' perceptions of the educational program.	90 students at the clinical program at KU Leuven, Belgium that got the chance to insert implants received a survey following surgery A year following graduating, the participants were asked if they were working as a general dentist or started a		80% students were satisfied with the training, 60% of students would like extra course in implant dentistry after graduation. Of the 56 students, 26% declined placing implants themselves when they practice, 37 of 56 students practiced as general dentist and all of them restored implants. 7 of these 37 general	

			post graduate programme.		dentists enrolled in oral implantology course to further improve their skills.
<b>Vandeweghe S, 2014<sup>30</sup></b>	Cross sectional	Questionnaire based survey	Questionnaire on patients' perspective about their dental Status, surgical and restorative experience The questionnaire also enquired about their experience of the program.  The study was conducted at Ghent University, Belgium.	At the conclusion of the therapy, students were also required to complete a questionnaire and consider the appropriateness of complexities of the programme (RQ3). 15 statements have to be rated that range from 1 to (completely disagree) 5 (completely agree) and were prompted to evaluate five elements of the surgical experience from 1 (simple) to 5 (difficult). For analytical justifications, 4-5 were chosen at random were regarded favorable, while 1-2-3 received poor ratings.	86% participants were adequately prepared for the surgical procedure because of the theoretical instruction delivered. The topics connected with proper case selection, individual monitoring and advising during the pre-preparation and execution of the operation, as well as during the logistics achieved a score of over 75%. Approximately 40% were not persuaded that the significant preparation is necessary as a therapy plan was required. 72% considered documentation and case preparation challenging and time-consuming.

### Risk of Bias (RoB) among individual studies

A summary of the RoB assessment is presented in Table 3. The score for both the cross-sectional and cohort studies ranged between 66 to 100% implying moderate to high methodological quality (or moderate to low risk of bias). Common flaws included failing to

recognise confounding circumstances and, thus, failing to develop methods to address them. Also, there was a high variation for the question on assessing the exposure and outcome in a valid and reliable way. In most of the cases, these were self-assessed.

Table 3: JBI Critical Appraisal Checklist for Analytical Cross-Sectional Studies (Educational Outcome and Student Perception)

Ref. No.	Study	1	2	3	4	5	6	7	8	RoB
(20)	Seitz SD,2016	Y	Y	N	Y	N	N	N	Y	Mod**
(21)	Sanchez- Garces MA,2017	Y	Y	Y	Y	N	N	N	Y	Mod**
(2)	Chaudhary S,2015	Y	Y	Y	Y	N	N	Y	Y	Low*
(22)	Aljohani HA,2009	Y	Y	N	N	N	N	N	NC	High***
(12)	Chaudhary S, 2013	Y	Y	Y	Y	N	N	Y	Y	Low*
(23)	Sharma A, 2018	Y	Y	Y	Y	N	N	Y	Y	Low*
(1)	Homma S,2015	Y	Y	N	Y	N	N	N	UC	High***
(24)	Jahangiri L,2008	Y	Y	N	N	N	N	N	Y	High***
(25)	Sharma A, 2018(all Nepal)	Y	Y	Y	Y	N	N	N	Y	Mod**
(26)	Yuan JC,2011	Y	Y	Y	Y	N	N	Y	Y	Low*
(27)	Afshari S,2014	Y	Y	N	Y	N	N	N	Y	Mod**
(28)	Ariani N,2013	Y	Y	Y	Y	N	N	Y	Y	Mod**
(7)	Prasad S,2017	Y	Y	N	Y	N	N	Y	Y	Mod**
(29)	Temmerman A,2016	Y	Y	N	UC	N	N	N	Y	High***

(30)	Vandeweghe,2014	Y	Y	Y	N	N	N	Y	Y	Mod**
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Scale: 33%=High RoB and Low quality\*  
33-66% =Moderate RoB and Moderate Quality\*\*  
>66%=Low RoB and High Quality\*\*\*

### Risk of Bias (RoB) across studies

In the GRADE analysis, certainty level was found to be low. The level of certainty was graded down based on imprecision and inconsistency in the results as well as the fact that there was no standard tool used to assess the outcome. Nevertheless, the studies directly compared the knowledge level and student perception in the participants and reported the outcome. Thus, the certainty level was upgraded for the indirectness domain. As the included studies were very specific in assessing participants implant programs where the provided information was not standardized the level of certainty was also downgraded. For

these reasons for both educational outcome and student perception the certainty level was low.

### Analysis of results- Quantitative assessment

Five studies used same questionnaire [2,6,20,22,25]. Although a meta-analysis could not be done because of the lack of groups in the study, an attempt to quantify the responses of questions using common questionnaire was done by calculating and comparing the average mean for each answer (Table 4). It was found that a few studies had modified the common questionnaire by adding or eliminating a few questions.

Table 4. Average / mean of responses<sup>2,6,24,26,29</sup>

Questions on the level of Information on dental implants	Chaudhary S,2015(2)		Chaudhary S,2013(6)		Sanchez- Graces MA,2015(20)		Sharma A, 2018(22)		Sharma A, 2018(25)		AVERAGE
	2041 responses		417 responses		107 respondents		280 respondents		1700 respondents		
					3rd Yr (%n)	4th Yr (%n)					
How well informed are you about dental implants?											
Very well	8.00%	163.28	3.10%	12.92	1.31 % (1)	0	12.50%	35			53.05
Well	29.60%	604.13	18.50%	77.14	11.84 % (9)	6.45 % (2)	32.14%	90			195.5675
Moderately well	46.00%	938.36	56.80%	236.85	19.73 % (15)	32.25 % (10)	50.36%	141			335.3025
Poorly	14.80%	302.06	18.90%	78.81	59.21 % (45)	61.29 % (19)	5%	14			114.7175
Not at all	1.60%	32.65	2.60%	10.84	7.89 % (6)	0	-				16.49667
On a scale of 1–10, how difficult do you feel it is to place implants as compared with other dental procedures?											
5: average	69.80%	1424.61	68.60%	286.06	23.68 % (18)	48.38 % (15)* (p=0.012)	33	64.30%	180		480.9175
10: very difficult	25.70%	524.53	28.10%	117.77	9.21 % (7)	3.22 % (1)	8	14.60%	41		172.825
Difficult	X	X	X	X	60.52 % (46)	41.93 % (13)	59	X			59
Cannot say	X	X	X	X		6.45 % (2)	5	X			5
What do you think is the main advantage of dental implants as compared with other tooth replacement modalities											
Aesthetic	10.90%	222.46	12.20%	50.87	13.15 % (10)	3.22 % (1)	11	3.20%	9		73.3325
More conservative	59.80%	1220.51	55.40%	231.01	7.89 % (6)	54.83 % (17)	23	58.60%	164		409.63

Longevity	20.00%	408.2	30.90%	128.85	60.52 % (46)	9.67 % (3)*	49	34.60% 97			170.7625
No added advantage	4.90%	100	0.70%	2.9	6.57 % (5)	25.80 % (8)	13	1.80% 5			30.225
Do not know	4.30%	87.76	0.70%	2.9	10.52 % (8)	0	8	1.80% 5			25.915
What do you think is the most important factor for implant success?											
Case selection	65.10%	1328.69	56.10%	233.93	30.26 % (23)	41.93 % (13)	36	51.07% 143			435.405
Implant type and material	8.00%	163.28	7.70%	32.1	19.73 % (15)	9.67 % (3)	18	5.00% 14			56.845
Patient compliance	8.00%	163.28	12.70%	52.9	27.63 % (21)	35.48 % (11)	32	3.92% 11			64.795
Surgical technique	8.10%	165.32	9.60%	40.03	15.78 % (12)	0	12	4.64% 13			57.5875
Experience of operator	8.80%	179.6	12.20%	50.8	6.57 % (5)	3.22 % (1)	6	34.28% 96			83.1
Do not know	2.10%	42.86	1.70%	7.08	X	X	X	1.07% 3			17.64667
What do you tell your patient is the longevity of dental implants?											
2–5 y	4.90%	100	3.40%	14.17	0	0	0	-			38.05667
5–10 y	31.40%	640.87	36.90%	153.87	14.47 % (11)	16.12 % (5)	16	5.35% 15			206.435
10–20 y	39.80%	812.31	25.40%	105.91	61.84 % (47)	64.51 % (20)	67	57.85% 162			286.805
Lifetime	17.10%	349.01	25.20%	105.08	10.52 % (8)	3.22 % (1)	9	36.07% 101			141.0225
Do not know	6.90%	140.82	9.10%	37.9	13.15% (10)	16.12 % (5)	15	0.71% 2			48.93
Do you feel that dental implants require additional maintenance and care by the patient and dentist?											
No, are cleaned like natural teeth	29.40%	600.05	24.20%	100.9	10.52% (6)	6.45 % (2)	8	12.14% 34			185.7375
Yes, needs more care than natural teeth	56.50%	1153.16	64.50%	268.96	56.57 % (43)	64.51 % (20)	63	81.78% 229			428.53
No, needs less care than natural	7.30%	148.99	3.10%	12.92	0	0	0	3.57% 10			42.9775
Do not know	6.80%	138.78	7.90%	32.94	2.63% (2)	0	2	2.50% 7			45.18
It depends on the risks to which the patient is subject (periodontitis, diabetes, etc.)					30.26 % (23)	29.03 % (9)	32	X			32
What according to you is the cost of procuring a dental implant from an implant company?											
Rs. 6000–10,000	26.90%	549.02	25.40%	105.91			30.35	85			246.6433
Rs. 10,000–15,000	28.90%	589.84	20.90%	87.15			34.28	96			257.6633
Rs. 15,000–20,000	22.50%	459.22	18.50%	77.14			21.07	59			198.4533
Rs. 20,000–25,000	14.60%	297.98	14.10%	58.79			12.5	35			130.59
Do not know	7.10%	144.91	21.10%	87.98			1.78	5			79.29667
How much do you feel is the initial setup cost required to incorporate implant surgery into practice?											
Rs. 200,000–300,000	28.20%	575.56	14.40%	60.04			32.14%	90			241.8667
Rs. 400,000–500,000	20.30%	414.32	26.4	110.08			40.71%	114			212.8
Rs. 500,000–100,00,00	27.00%	551.07	22.30%	92.99			19.28%	54			232.6867
Rs. 100,00,00	9.00%	183.69	29.70%	123.84			7.85%	22			109.8433

Do you think that dental implants are an acceptable solution for missing teeth in the Indian scenario?											
Yes, implants are here to stay	21.40%	436.77	31.20%	130.1	28.94 % (22)	38.70 % (12)	34	41.07% 115			178.9675
No, economic feasibility will limit its usage	57.60%	1175.61	63.50%	264.79	56.57 % (43)	38.70 % (12)	55	50.71% 142			409.35
No, too invasive for patient acceptance	14.40%	293.9	4.60%	19.18	1.31 % (1)	0	1	7.14% 20			83.52
This depends on the educational level of the patient					11.84 % (9)	16.12 % (5)	14	X			14
QUESTIONS ON SOURCE OF INFORMATION AND NEED FOR MORE INFORMATION ABOUT IMPLANTS											
Were you provided sufficient information about implant procedure during your BDS program?											
Yes	18.90%	385.74	26.60%	110.9	1,31 % (1)	6,45 % (2)	3	32.85% 92	34.70 %	590	236.328
No	81.10%	1655.25	73.30%	305.66	98,68 % (75)	93,54 % (29)	104	67.14% 188	65.30 %	1110	672.582
Would you like more information about the implant treatment procedure to be provided in the BDS curriculum?											
Yes	91.70%	1871.59	95.70%	399.06	100 % (76)	100 % (31)	107	68.21% 191	95.10 %	1617	837.13
No	8.20%	167.36	4.30%	17.93	0	0	0	31.78% 89	4.90%	83	71.458
From where would you like to get more reliable information about dental implants?											
Short-term CDE programs and workshops conducted by the implant companies (2–3 days workshops)	10.20%	208.18	27.30%	113.84	13,15 % (10)	9,67 % (3)	13	24.28% 68	22.80 %	387	158.004
1-year certificate or module - based courses conducted by colleges or trained implantologists	67.50%	1377.67	57.60%	240.19	71,05 % (54)	70,96 % (22)	76	33.21% 93	24%	408	438.972
Professional newsletters and books	10.90%	222.46	5.00%	20.85	7,89 % (6)	3,22 % (1)	7	20.00% 56	8.50%	145	90.262
Dental consultants and specialists	8.50%	173.48	7.20%	30.02	7,89 % (6)	9,67 % (3)	9	10.35% 29	40.70 %	692	186.7
Study groups and internet	3.00%	61.23	2.90%	12.09	0	0	0	12.14% 34	4%	68	35.064
From where would you like to receive training on dental implants?											
Short-term CDE programs and workshops conducted by the implant companies (2–3 d workshops)	12.50%	255.12	15.10%	62.96	3,94 % (3)	3,22 % (1)	4	12.85% 36	19.50 %	332	138.016
1-year certificate or module-based courses	52.00%	1061.32	57.90%	241.44	32,89 % (25)	19,35 % (6)	31	48.57% 136	30.20 %	513	396.552

conducted by colleges or trained implantologists											
Fellowship programs conducted by the universities	25.10%	512.29	20.40%	85.06	14,47 % (11)	6,45 % (2)	13	31.42% 88	39.20 %	667	273.07
MSc programs (full time: 1 y, part time: 2 y)	10.30%	210.22	6.00%	25.02	7,89 % (6)	0	6	7.14% 20	11.10 %	188	89.848
Specific Courses during the Degree 3 – course in Dentistry	X	X	X	X	42,10 % (31)	64,51 % (20)*	51	X	X	X	51

The averages of each response showed a generalized pattern. Most students were moderately well informed regarding dental implants, and they thought placing implants was roughly as difficult as other dental treatments (mean=480.9). The most and least important factor for implant success was case selection and operator experience, respectively. Case selection and operator experience ranked as the highest and least relevant factors for implant success, respectively. Many students (mean=409.3) believed that dental implants were not a viable option for replacing missing teeth in India and that their use would be constrained by cost. Also, most students wanted more education about implant treatment procedure.

## Discussion

Dental schools must train students due to the widespread clinical approval and rising patient demand for dental implants [31]. The theoretical knowledge serves as the base for the education in implant dentistry, as was determined at the First European Consensus Workshop on Implant Dentistry in 2008.

There is significant variation in the extent, timing, nature, and delivery of implant training in most schools [13]. Thus, leading to a great variation in student's clinical experience and perception of implant dentistry. This variety is reflected in the heterogeneity of the studies done.

A similar review was conducted by Koole and Bruyn in 2013 to explore reports on undergraduate oral implantology education,

since the ADE workshop in 2008 [10]. However, the parameters assessed in that study were different from our study. Also, the literature was reviewed from only 5 years (2008-2013) and included all publication types.

In our study, there was no such restriction of timeline for the included studies. Only survey questionnaires were included. Consensus documents, opinions, letters, or commentaries were all excluded as they had no open questions. Moreover, the surveys provided the objective assessment. It was found that different survey designs were used in different studies. Hence, arriving at a common conclusion and generalizing the results of these studies was a challenge. Five studies used similar questionnaire and hence, an attempt to quantitatively assess the responses to summarize and substantiate the results was done by calculating and comparing the means of the responses.

Most of the studies had a moderate to low risk of bias. This is mainly attributed to the lack in the study design with no identification of the confounding factors and hence, no measures to overcome those issues.

The included studies were conducted in different parts of the world. This led to an interesting finding that there is a worldwide lack of integration of implant dentistry in undergraduate education and there is a need for revising curricula. Our results agree with the studies conducted by Afsharzand et al where they found that predoctoral implant dentistry educational programs vary between European dental schools from a survey of

implant dentistry director [32]. Koole S et al, 2013 through a systematic review found that there was conflicting data on how implantology is integrated at an undergraduate level [10].

The student perception is an important indicator for further curriculum development. Most of the students felt that they were poorly to moderately well informed about the dental implants. This may be because of the limited course hours and hands on clinical experience. These results agree with the studies by Moest T and Nicolas E where the students indicated that inadequate implant education and a more thorough training was needed [33,34]. Pre- and post-course surveys showed that the students' perception and satisfaction increased after taking implant course. This difference was statistically significant in studies by Seitz SD et al, Ariani N [20,28]. Positive student perception motivated them to practice implant dentistry after graduation as assessed by Tammerman et al [29].

The level of certainty for this systematic review was considered low according to the use of an adapted GRADE criteria and our assessments, supporting the need for well-designed research to fill the knowledge gaps. There should be standard protocols and validated questionnaires so that the results can be easily derived and analyzed to make and apply worldwide, the students' perception should be studied.

At the minimum, it is a must for an undergraduate to have an adequate knowledge and understanding of the surgical and prosthetic implant procedures before they graduate [35]. Curriculum congestion is the real barrier to delivery of training at undergraduate level [3]. The fact that different specialist programs use the same patient population adds to the difficulty of the situation. Thus, where surgical training of the undergraduates negatively impacts specialized experiences, justifying it becomes challenging. [36]. To overcome these barriers, various non-traditional teaching methods can be used like online and multimedia resources, problem-

based learning, and student–teacher-centered education [3]. To avoid making the curriculum overwhelming for the students and the staff, the timings when the course would run could be altered like during the summer break [20].

## Conclusions

Based on a low-level certainty identified in this systematic review it is suggested that although predoctoral education in most dental schools across the world now includes implant dentistry as a core component, the degree of integration varies greatly.

To increase the competency of predoctoral students around the world in performing implant treatments and making related decisions, it is implied that a typical, well-designed predoctoral implant curriculum and standards that include didactic, laboratory, preclinical, and clinical components are needed.

**Conflict of interest:** None to declare.

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## REVIEW



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## Clinical outcomes of predoctoral implant dentistry education: A Systematic Review.

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### Abstract

**Objectives:** To systematically synthesize the status of predoctoral implant dental education in terms of clinical outcomes including implant success and survival of them when placed by predoctoral students.

**Materials and methods:** A thorough search was carried out up to February 2019 using Medline (OVID), EMBASE, ERIC, and Web of Science electronic databases. In addition to this, bibliographies of the potentially eligible articles were searched manually. Abstracts that seemed to satisfy the initial selection criteria were selected for the recovery of the full text. The full-text risk of bias assessment was then done, in line with the selection criteria by two reviewers. The selected articles were evaluated using the Joanna Briggs Institute (JBI) Critical Appraisal tools. The GRADE approach was adapted, but not validated, for observational studies to assess the certainty of evidence.

**Results:** Overall, 15 articles were included. Most of the reported implants were used to support mandibular overdentures or single unit implants and their survival rates were found to be generally favorable. Only a few studies also used patient satisfaction surveys which displayed overall satisfaction, suggesting that the dental implant treatment may be adequately provided in school settings.

**Clinical significance:** The success and survival of the implant's type done in an undergraduate classroom setting is indicative of the undergraduate dental implant curriculum. Based on this work, it can be concluded that the success and survival of such implants appear to be reasonable and most of the patients getting an implant at the school were satisfied.

**Keywords:** dental implant, undergraduate, predoctoral, success, survival, clinic.

### Introduction

Dental implant therapy has gained popularity over the last few years as it is highly predictable and can provide people teeth that are entirely functional. We have now arrived at a point where dental implants are frequently the preferred method of replacing missing teeth [1,2]. Over the past 40 years, research has supported the viability of osseointegrated implants as a fixed or removable prosthetic restoration alternative, primarily due to their demonstrated success in terms of appearance, durability, and longevity while posing the least biological burden on neighbouring teeth [1,2].

Predoctoral implant dentistry is taught in a variety of ways. All dental students who are active in both surgical and prosthodontic treatment planning are eligible for the implant programme at some schools, however only a select few students are permitted to participate at other schools [3]. Even though many institutions include implant dentistry in their

undergraduate curricula, there are very few studies in the dental literature about the clinical results of these programmes [3].

Despite a 73% surge in implant practitioners between 1986 and 1990, according to a 1993 survey by the American Dental Association, dentists' level of training in dental implants differed significantly [4]. Student learning regarding the application of implants has been integrated into predoctoral dental curricula at various levels. Since the 1990s, many institutions have introduced implants to predoctoral students with experiences ranging from laboratory courses to clinics [5]. An examination of US dental school graduates over a ten-year period revealed that those with predoctoral implant clinical and/or laboratory experience were considerably more likely to implement implant therapy into their practises than those without such official, practical training [4].

Historically, predoctoral implant dentistry training has been predominantly didactic in

nature. Simulation training also plays an important role to help students apply theoretical knowledge. This indeed increases their confidence in the clinics. This was supported by Prasad and Bansal, where a fivefold increase in confidence and student satisfaction was noticed with simulation training [6].

Multiple factors can be considered to determine a clinical teaching program's overall efficacy. These include gauging the effectiveness of clinical interventions in terms of implant loss or survival, patient contentment or unhappiness, and students' assessments of their own performance. Dental implant treatment in teaching institutions has been accounted to be of high caliber, although there is limited information about the complications that occur with dental implants done in predoctoral educational programs [2,7,8].

In the current systematic review, studies that assessed the clinical outcomes including the success and survival for the implants done by predoctoral students are synthesized. A comprehensive understanding of the current status and performance of implants inserted by predoctoral dental students is paramount to identify areas that should be improved.

## Material and methods

The PRISMA (Preferred Reporting Items for Systematic Reviews And Meta-Analyses) checklist was followed [9].

### Protocol and Registration

A search in PROSPERO - International prospective register of systematic reviews (Centre for reviews and dissemination, University of York, York, United Kingdom) - using terms implant education and predoctoral/undergraduate curriculum was done and no registered proposal was found.

### Information sources and search

Medline (OVID), EMBASE, ERIC, and Web of Science were the sources of information. In addition to this, bibliographies of the potentially eligible articles were also searched manually. Observational studies (cross-sectional studies, case series or controls) that assessed clinical outcomes of implants inserted by predoctoral dental students were sought.

Keywords and MeSH terms for the search were finalized depending on earlier information on the topic. Further, MeSH data in the electronic databases were also used. Google Scholar was used to conduct a search for grey literature, and the top 100 articles were chosen. [Appendix 1].

### Appendix 1: Search terms used in the study for electronic search of the databases

<b>MEDLINE 1966 to Feb3, 2019</b>	exp Education Medical, Undergraduat OR exp Curriculum/ OR Schools, Dental/OR Students, Dental/ OR exp "Internship and Residency"/OR ((dental or pre-doctoral or predoctoral or undergrad*) adj2 (school* or curricul* or student* or residen* or educat* or teach* or train* or course* or intern*)).mp. [mp=title, abstract, original title, name of substance word, subject heading word, floating sub-heading word, keyword heading word, organism supplementary concept word, protocol supplementary concept word, rare disease supplementary concept word, unique identifier, synonym] AND exp; Dental Implantation/ OR Dental Implants/ OR (implant* adj2 (endosseous or tooth or teeth or dental or dentistry or oral)).mp. [mp=title, abstract, original title, name of substance word, subject heading word, floating sub-heading word, keyword heading word, organism supplementary concept word, protocol supplementary concept word, rare disease supplementary concept word, unique identifier, synonyms]
<b>EMBASE (Excerpta Medica) 1980 to Feb3,2019</b>	using terms as in MEDLINE.
<b>ERIC (Educational Resources Information Center) 1970 to Feb3,2019</b>	Curriculum.mp, OR Dental school*.mp OR Dental Student*.mp OR (Internship and Residency).mp OR ((dental or pre-doctoral or predoctoral or undergrad*)adj2(school*or curricul*or student*or residen*or educat*or teach*or train*or course*or intern*).mp

	AND Dental implant*.mp OR (implant adj2( endosseous or tooth or teeth or dental or dentistry or oral)).mp
<b>WEB OF SCIENCE was searched till Feb3,2019</b>	TOPIC: (((((dental or pre-doctoral or predoctoral or undergrad*) NEAR/2 (school* or curricular* or student* or residen* or educat* or teach* or train* or course* or intern*)))) AND TOPIC: (((implant* )NEAR/2 (endosseous or tooth or teeth or dental or dentistry or oral))) DocType=All document types; Language=All languages;

### Selection Strategy

#### Inclusion criteria

The included articles were the ones where the clinical outcome was assessed using patient satisfaction surveys or where the success and survival of implants placed by predoctoral students were measured by questionnaire or clinical database entries.

#### Exclusion criteria

Studies were excluded if they were: Opinion papers, Consensus reports, Letters, Editorials. Any paper that gave only a description of a school program without any assessment of the clinical outcomes of dental implants placed by pre-doctoral students was excluded. The surveys done on postgraduate students, general dentists or specialists were precluded too.

ProQuest RefWorks was used to handle the attributes and to eliminate the replica. There was no constraint of language, a year, or any other specifics for the literature search. The exploration was conducted until February 3, 2019. Figure 1 shows the details of the search methodology (Figure 1), according to PRISMA [9].

The articles were screened by two reviewers (DN and LL) independently. Any disagreements were discussed until a consensus was reached. The participation of a third reviewer (author CFM) was requested if a consensus could not be arrived at. The details like the author(s), place(country), year of publication, research design, methodology, participants and response rate, details of the

survey, outcome (main reported findings related to the research question) were noted.

#### Risk of Bias (RoB) in individual studies

Included studies were descriptive and either had a cross-sectional component or were case series. The JBI critical evaluation method was utilised to evaluate the included studies' level of methodological quality (as applicable) [10,11].

This comprised of eight specific criteria (for cross-sectional studies) and eleven criteria (for case series). The answers to these questions were “yes”, “no”, “unclear” and “not applicable”. The articles were scored according to a percentage scale (0-100%).

#### Risk of Bias (RoB) across included studies

According to JBI guidelines, it is recommended that a grading system be utilized to review and assess the quality and certainty of evidence within a systematic review for each assessed outcome. The approach of Grading of Recommendations Assessment, Development, and Evaluation (GRADE) classifies all available data not only based on study design strengths and weaknesses but other factors as well.<sup>12</sup> As this tool was designed initially for Randomised Controlled Trials, there is currently no validated alternative evidence grading protocol for observational studies. Hence, in this study, GRADE approach was adapted, but not validated, for observational studies to assess the certainty of evidence and to assign recommendations on a GRADE scale of very low, low, moderate or high [13].

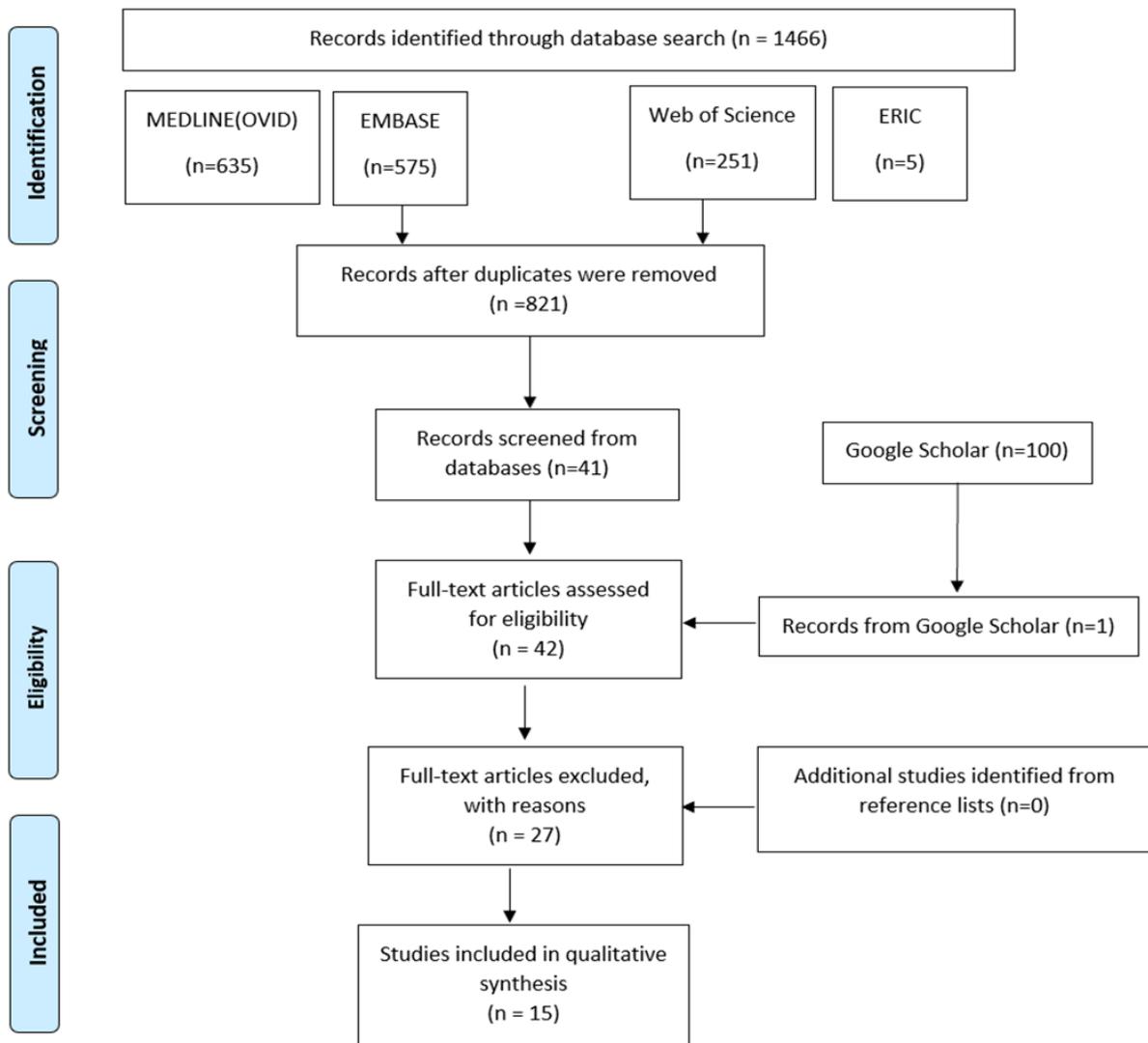


Figure 1: PRISMA 2009 Flow Diagram

## Results

### Choosing relevant studies

To start, a total of 1466 records were found. After the duplicates were removed, 821 articles were included. The authors read the headings and abstracts in the initial phase. and thus, 41 articles were selected. The grey literature contributed to only 1 article. The bibliographies of all the finalized articles were scrutinized. However, no article was found relevant. Thus, a total of 42 articles were included and their full text was read. (Stage 2). After reading the full text, only 15 articles were included in the entirety for the clinical outcome assessment.

All the stages of selecting appropriate studies were performed by all the authors

independently. In case of any disagreement, a discussion was done, and a consensus was reached. This process of selection is depicted in Figure 1, according to PRISMA guidelines [9].

### Analysis of results

Since a variety of assessment tools were used and the heterogeneity in study designs was noticed, a meta-analysis could not be done. Clinical, statistical, and methodological differences were too significant to justify a quantitative synthesis.

### Synthesis of Results

#### Search results:

The included case series studies had the data extracted from the records/databases (6

studies) and the cross-sectional ones had patient surveys including a questionnaire/telephone survey/interview (8 studies). The studies are summarized in Table 1 and 2. Implant success and survival were considered as the primary clinical outcome. However, different criteria were used to define the implant success and survival. In most of the studies 5,14,15,16 the implant survival rate was >90%.

#### Summary of studies

The clinical outcomes that were assessed included implant success and survival. Also, patient satisfaction was assessed. Kohavi D compared screw design implants from 2

manufacturers (Branemark and Taper-Lock) [4]. Two studies evaluated the failure rate of the implants over the study period as, 6.3% and 0.8%, respectively [3,17].

The results of patient satisfaction surveys showed that there was overall satisfaction with the treatment as stated by a greater number of the patients (> 80%) [18-21]. The studies by Dhaneshvar SS and Al Sabbagh included the results from both the database as well as the patient satisfaction survey [7,8]. There was a good implant success and survival rate in both studies (97% and 88%, respectively) and the majority of patients were generally satisfied with their dental implant treatment [7,8]. (Table 1)

Table 1: Clinical outcome (From Cross Sectional Surveys)

#	Author, Year	Type of Study	Student survey / Patient Satisfaction Country of Origin	No. of Patients/ Students and Years of follow up	No. and Type of implants	Implant survival and Success	Patient response / outcome
1.	Harrison P, (2009)15	Cross sectional study	Patient satisfaction survey questionnaire Ireland	100 patients randomly selected who had the surgical placement of implants in the last 5 years at Dublin Dental School and Hospital (DDSH).	Not reported	Not reported	76% of the patients stated that they were highly satisfied with their treatment whereas, 90% of patients reported themselves satisfied.
2.	Dhaneshvar SS, (2016)7	Case Series	All patients were contacted for whom implants were placed, were contacted for clinical and radiographic exam and self-reported survey arranged for those who were willing to participate. Canada	Total- 352. Completed follow up-165 for 13 years	591	97.20% Survival and 88 % Success No bone loss in 88% of the surviving implants	91.2% of the patients were very happy with how the implant restorations looked, 88% expressed great implant comfort, 92.6% expressed great satisfaction with their ability to chew, and 84.8% reported simple hygienic upkeep at implant sites.
3.	Al- Sabbagh, (2014)8	Cross sectional study	Patient interview Kentucky, United States	All patients who had their implants placement and	Total number of implants placed = 963	97% Survival rate The success rate for the	85.1% of the patients said their implants went well. 95.5% of the

				restoration done at the UKCD implant training from January to December 2000	The average number of implants placed per patient= 2.3±1.9	implants was 88 percent.	patients stated that they were overall satisfied with their implant; 96.3% were happy with the appearance of the implant; 96.1% with their surgical experience; and 96.5% thought the implants were functioning well. Only 1.8% of the implants showed mobility, and only 1.8% of the implants had chronic pain. There were 25 lost implants (2.6%).
#	Author, Year	Type of Study	Student survey / Patient Satisfaction Country of Origin	No. of Patients/ Students and Years of follow up	No. and Type of implants	Implant survival and Success	Patient response / outcome
4.	Vandeweghe, S. (2014)18	Case Series	Patient satisfaction-questionnaire/survey. Clinical outcome in terms of implant survival and crestal bone remodeling after implant placement, after 3–6 months and after 1 year. A peri-apical digital radiograph was taken and bone levels evaluated. Ghent, Belgium	27 patients	36 Implants, Tapered	The average amount of bone lost from the time of the implant surgery to the implant restoration was 1.41 mm, and it stayed the same after that. The average amount of crestal bone loss one year following the insertion of the crown was 1.43 mm.	The average satisfaction levels of more than 80 were found. Mean scores over 88% showed that patients remained happy with their care a year after getting a crown. This explains the finding that most patients (90.5%) and those who would advise the treatment to others (90.6%) would choose to get it again. Many patients (74%) expressed satisfaction with having an undergraduate treat them.
5.	Dias R, (2013)20	Cross Sectional study	The patients who received an implant-	101 patients, 6months (June	Not reported	Not Reported	27 participants in the telephone poll had issues

			retained overdenture in the undergraduate clinics at New York University, College of Dentistry, United States were contacted over phone for survey	to December of 2009)			about their care, including loosening of the implant abutment (7), a lack of stability (16), pain (2), and aesthetics (2). 79% of participants were happy with their capacity to chew, 84% were content with the comfortable prosthesis and 89% were happy with the appearance of their new prosthesis. 90% of respondents said they would advise a friend to have the same therapy, and 85% of patients said they were satisfied with the entire treatment experience.
#	Author, Year	Type of Study	Student survey / Patient Satisfaction Country of Origin	No. of Patients/ Students and Years of follow up	No. and Type of implants	Implant survival and Success	Patient response / outcome
6.	Moghadam M, (2012) <sup>21</sup>	Cross Sectional	Patient satisfaction survey New York, United States	103;100 completed survey. Telephone Calls were attempted in the months of June to Dec 2009 using the telephone numbers listed in their dental records	Not Reported	Not Reported	96 % of the patients surveyed were satisfied with their ability to chew, 91 %were satisfied with the comfort of their restoration, and 86% were satisfied with the appearance of their restoration. Additionally, 90 % of the surveyed patients who received implant-retained crowns

						were satisfied with the overall treatment experience, and 97% of them would recommend this treatment to a friend.
7.	Lee DJ,(2015)19	Cross-sectional	Patient Satisfaction survey which was given to patients 6 months after the completion of implant care. A modified OHIP-14 questionnaire was constructed consisting of 14 total questions Illinois, United States	Two Groups: 1) Implant Over denture (IOD) group had 51 patients Single Tooth Implant (STI) group had 50 patients	IOD group- 102 implants STI group- 69 implants	Not Reported Results from the IOD and STI revealed that patients were happy with their care. The OHIP-14's average score was less than 1.0, indicating that both groups' implant treatments improved patients' OHRQoL.

Table 2: Clinical outcome (Retrospective assessments)

#	Author, Year	Type of Study	Student survey / Patient Satisfaction Country of Origin	No. of Patients/ Students and Years of follow up	No. and Type of implants	Implant survival and Success
1.	Lee et al, (2011)5	Case Series	Retrospective Illinois, United States	243	371	Cumulative survival rates for the implants in both groups - 99%. 2 implants failed in each group
2..	Kroeplin, (2011)27	Case Series	Records Freiburg, Germany	51 patients for 2.5 years (between 2007 and spring 2010)	97	98.90% Success
3..	Kohavi D, (2004)4	Case Series	Patients who met the criterion from the university's database Jerusalem, Israel was included in the study		303 Screw design implant from Branemark and Taper Lock	At 24 months of follow-up, implant survival for both systems was comparable. Branemark implant failures had between stage 2 and 3 months in mandibles and after 12 months in maxillae. Mandibular failures did not occur with taper-lock implants, however maxillary failures developed before

stage 2 and after 12 months of loading.

4.	Maalhigh-Fard A, (2008)3	Case Series	Patient records were reviewed Detroit, United States	In the elective implant dentistry programme at UDM, 70 individuals were treated.	11 Implants	Minor issues with less than 5% of patients were noted with overdentures included soft tissue irritation, porcelain fracture, gold screw fracture, and loosening of the screw. Implant failure was deemed in this study to be the presence of clinically discernible implant mobility. Ten failed implants were found in seven patients (failure rate: 6.3%).
#	Author, Year	Type of Study	Student survey / Patient Satisfaction Country of Origin	No. of Patients/ Students and Years of follow up	No. and Type of implants	Implant survival and Success
5.	Hickin P, (2017)17	Case Series	EHR of patients getting dental care at the Columbia University's graduate and undergraduate c linics between July 1, 2011, and December 31, 2014	2127 for 3 years	6,129 Straumann, Biomet 3i, Dentium, Noble Biocare	Over the course of the study, there were an average of 1.6% of patients and 0.8% of implants failing annually. Between the failed and reference cohorts, variations in the frequency distribution of various traits were studied.
6.	Prasad S, (2017)16	Case Series	Data were collected from patient records, entered in a database	1091 For 8 years (2004-2012)	1918 implants with Noble Biocare being the one that was used most often (65.0%).	A total of 96.4% of implants survived. Based on patient data, the implant survival rate was 94.6%. Age (>65 years), implant staging (two stages), and implant diameter were all statistically associated with implant failure (wide).
7..	Tammerman , (2015)14	Case Series	Implants placed in a program in Belgium No details given on how they kept record of the numbers	56 patients for 3 years	112	97.1% of implants survived after placement. After one and two years of use, the mean marginal bone loss was 0.35 mm and 0.39 mm, respectively.

8.	Cummings J, (1995)28	Case Series	Boston, United States	24 patients for 5 years	71 implants including maxillary and mandibular overdentures, fixed partial dentures, freestanding implant.	greater than 2 mm of bone loss Three of these implants showed bone loss until apex, lingually. Bone loss in Max ODs was limited to 2mm. Three patients with four implants each showed greater than 2 mm of bone loss. Bone loss did not reach the apex around any of these implants.
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### Risk of Bias (RoB) among individual studies

The answers for all applicable questions from the questionnaires for both study types ranged between 66 to 100% implying moderate to high methodological quality. Common weaknesses were that neither the confounding factors could be identified and nor the strategies to deal with them. Also, there was a

high variation for the question dealing with assessing the exposure and outcome validly and reliably. In most of the cases, these were self-assessed. Since there is a different checklist for RoB assessment for cross-sectional and case series studies, the risk of bias assessment summary is presented in two different tables. (Table 3 and 4)

Table 3: JBI critical appraisal checklist for analytical case series studies

CRITERIA	Dhaneshvar SS (2016) 7	Lee DJ (2011) 5	Kropelin BS (2011) 27	Kohavi D (2004) 4	Maalhigh-Fard (2008) 3	HickinMP (2017) 17	Prasad S (2017)16	Tammerman A (2016)14	Cummings J (1995) 28
Clear criteria for inclusion	Y	Y	Y	Y	N	Y	Y	Unclear	Unclear
A standard, reliable way of measurement of condition for all participants	Y	Y	N	N	Y	Y	Y	Y	Y
Valid methods used for identification of the condition	Y	Y	Unclear	Y	Y	Y	Y	N	Y
Consecutive inclusion of participants	Y	Y	Y	Y	Y	Y	Y	Y	Y
Complete inclusion of participants	Y	Y	Y	Y	Y	Y	Y	Y	Y
Clear reporting of the demographics of the participants in the study	Y	Y	N	Y	N	N	Y	Y	Y
Clear reporting of clinical information of the participants	Y	Y	N	Y	N	Y	Y	Y	Y
Outcomes or follow up results of cases clearly reported	Y	Y	Y	Y	Y	Y	Y	Y	Y
Clear reporting of the presenting	Y	Y	N	Y	Y	Y	Y	Y	Y

site(s)/ clinic(s) demographic information									
Statistical analysis appropriate	Y	Y	N	N	N	Y	Y	Y	Y
RoB	Low***	Low** *	Mod**	Low***	Mod**	Low***	Low***	Low***	Low***

Score: 33%=High RoB and Low quality\*; 33-66% =Moderate RoB and Moderate Quality\*\*; >66%=Low RoB and High Quality\*\*\*

Table 4: JBI Critical Appraisal Checklist for Analytical Cross-Sectional Studies

		Harrison P (2013) 15	Al- Sabbagh (2014) 8	Lee (2015) 19	Dias R (2013) 20	Moghadam M (2013) 21	Vandeweghe (2014) 18
1	Inclusion criteria clearly defined	Y	Y	Y	Y	Y	Y
2	The study subjects and the setting described in detail	Y	Y	Y	Y	Y	Y
3	The exposure measured in a valid and reliable way	N	N	Y	Unclear	Y	Y
4	Objective, standard criteria used for measurement of the condition	Y	Y	Y	Y	Y	N
5	Confounding factors identified	N	N	N	N	N	N
6	Strategies to deal with confounding factors stated	N	N	N	N	N	N
7	Outcomes measured in a valid and reliable way	N	N	N	N	N	Y
8	Appropriate statistical analysis used	N	Y	Y	N	N	Y
9	RoB	High***	Mod**	Mod**	High***	Mod**	Mod**

Score: 33%=High RoB and Low quality\*; 33-66% =Moderate RoB and Moderate Quality\*\*; >66%=Low RoB and High Quality\*\*\*

### Risk of Bias (RoB) across studies

For both the clinical outcomes assessed, that is, - Implant success and survival and patient satisfaction, the level of certainty was rated down based on imprecision and inconsistency in the results as well as the fact that there was no standard tool used to assess the outcome. The studies directly compared the success and survival rate and patient satisfaction in the participants and reported the outcome. Thus, the certainty level was upgraded for the indirectness domain. As the included studies were very specific in assessing participants in

implant programs where the provided information was not standardized the level of certainty was also downgraded. The final decision was to consider the overall certainty level of evidence as low.

### Discussion

In this era, dental implants have become an integral part of dentistry because of the archived high endurance rates and consistency, just as major advantages for patients like maintenance of subjacent healthy teeth [22].

Hence, there is a need for the predoctoral dental students to be adequately trained in implant placement and restorations so that the increase reported complications arising because of implant placements by general practitioners could be reduced. This would need resources of time and people engaged in teaching implant dentistry. It is key that part of the teaching should be about case selection and referral practices related to dental implants [23].

A study was conducted by Koole and Bruyn in 2013 to explore with a systematic approach report on undergraduate oral implantology education, since the ADEE workshop in 2008 [24]. However, the parameters assessed in that study were different from our study. Also, the literature was reviewed from only 5 years (2008-2013) and included all publication types. In our review, there is no such restriction on the timeline for the included studies. The retrospective studies from which the data was extracted came from the records/databases and/or patient survey. Consensus documents, opinions, letters, or commentaries were all excluded as they had no open questions. Moreover, the clinical databases and the survey results provided us with different assessment approaches to the clinical outcome of the implants placed by the predoctoral dental students.

It is of interest to notice that although most of the included articles had different criteria to define implant success and survival. In the study by Dhaneshvar SS, implant survival was determined by the implant being in the mouth for the existing time, irrespective of any problem associated with it [7]. In another study, Albrektsson et al criteria were used to assess the long-term success of the dental implants [5]. Eight implants were considered viable, in the study by Al- Sabbagh et al, provided the individual liked the implant presentation, function, and surgical procedure, without any pain or mobility of the implant. Prasad S, in their study, defined failure as implant being removed due to any case [16]. They measured survival time as the length of

time between the placement to being lost / till last time it was reported to be in good health.

This heterogeneity in defining the primary outcome variables in the included studies indicates that these results cannot be generalized and thus, should be interpreted with caution. This also necessitates the need to improve the study design for the studies assessing the implant success and survival to use standardized criteria for measurement of these outcomes.

Our results are well in agreement with the study done by Koole et al. [25] who found that the survival rate of dental implants (92–100%) is a significant marker of constructive treatment. Additionally, there was a lower rate of occurrence of the biological complications [25]. The results of our study of overall good patient satisfaction were in line with the study by Bonde M] et al [12]. It was found that there is a different level of integration of implants' clinical aspects in the predoctoral dental curriculum. Some are given simulation training while others are not while in a few only the restorative part is done by the predoctoral dental students whereas the surgical implant placement is done by specialists [16,22].

Generally, didactic training is given to all the students. However, certain optional projects aimed at an extra clinical experience to the chosen/interested undergraduate students are provided [24]. McAndrew et al recommended that clinical experience is essential for training in implant-supported restoration at the predoctoral level [23]. Nonetheless, it may be that this aspect is most demanding as far as economic ability and guaranteeing properly prepared teaching and support staff is concerned. To overcome this curriculum congestion, various measures have been taken like performing surgeries during the unscheduled clinical time [26].

An important area that requires assessment is the fact that recently graduate dentists should be able to distinguish between simple and complex cases by appropriate treatment planning and thus, decreasing the number of failures. Their level of awareness and actual

application of this concept in real-life settings has not been assessed yet.

A limitation of our review is the lack of a detailed quantitative assessment and hence, full comprehension of the results. Thus, there is a strong need to conduct the studies in this field with standard protocols. The efforts should be made to provide predoctoral students with suitable ground information about clinical and laboratory aspects of implants to enhance their basic competence. To make them proficient, the implant clinical program should be made a mandatory part of the curriculum. As a graduate, they should be able to distinguish between simple and complex cases.

### Conclusions

Based on a low level of certainty, evidence from this systematic review may suggest that implant placement in a undergraduate school setting has a reasonable chance of success and survival within the implant type commonly used there.

Furthermore, most of the patients getting an implant at a dental school were satisfied with the outcome. However, the level of integration of preclinical and clinical aspects is highly variable. More emphasis should be laid on gaining the knowledge for efficient treatment planning as well as manual skills for this dental treatment modality.

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## ORIGINAL RESEARCH



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## Cephalometric evaluation of adenoids and upper airway.

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### Abstract

Cephalometric analysis performed on lateral X-ray allow orthodontists to evaluate soft tissues as well. Enlargement of adenoids, changes of the position of the tongue can be diagnosed parallel with skeletal assessment.

Our purpose was to investigate the skeletal growth direction and the posterior airway depth in mouth breather patients and to underline the importance of a complex cephalometric analysis prior orthodontic treatment.

30 mouth breather patients were selected from our database (17 boys and 13 girls, age  $10.8 \pm 1.2$ ), in every case ENT examination confirmed the hypertrophy of adenoids. From the same database 30 patients with normal breathing pattern (17 boys and 13 girls, age  $11.1 \pm 0.9$ ) for the control group. For every patient, the size of the adenoids, the depth of the palate and the position of the tongue. After filtering out the outliers in GraphPad-InStat system, standard deviation ( $\pm$ SD) was calculated, descriptive analytical statistics were performed.

Statistically significant differences were recorded regarding: 1.) the distance between adenoid vegetation and the palate ( $p=0.014$ , mouth breathers mean  $9.76 \pm$  SD 3.04; control group mean  $14.38 \pm$  SD 4.41), 2.) the distance between Sella and the adenoids ( $p=0.186$ , study group mean  $33.39 \pm$  SD 4.39; control group mean  $28.38 \pm$  SD 8.91), 3.) adenoidal-nasopharyngeal ratio ( $p = 0.05$ ).

Cephalometric evaluation of adenoids revealed considerable enlargement of this in mouth-breather children, meanwhile upper airway constriction will appear in the same group. Depth of the palatum will increase when breathing pattern is modified.

**Keywords:** adenoids, upper airway, mouth breathing, cephalometric.

### Introduction

Among mouth breathing etiological factors, adenoids, as hypertrophic lymphatic tissue, are the most frequent cause [1]. By modifying the respiratory patterns, adenoids will determine changes in growth and development of skeletal structures, position of the tongue, jaws, and morphological and functional changes will occur and “adenoid face” will appear [2]. This typical arrangement of the whole face result narrow upper and lower arch, lateral cross-bite and, retrognathic and clockwise rotation of the mandible and increase lower facial height will appear [3].

The most reliable diagnostic tool for mouth breathing caused by adenoids is still a matter of debate, ENT examination methods (nasal endoscopy) seem to be a quite reliable method. To refer pediatric patients for further ENT examinations, cephalometric analysis may provide valuable information regarding upper airway obstructions [4].

During cephalometric analysis before orthodontic treatment, orthodontist should

also analyze the soft tissues, so cephalometric analysis of tonsils and adenoids can be easily included in this matter. Upper airway can be easily identified, and intraoral soft tissues (tongue, adenoids, tonsils) as well as related structures are visible on a well-executed lateral X-ray.

To be able to quantify the changes in the posterior airway and adenoids as well, many measurement methods were used. It seems so far, that Fujioka's adenoid-nasopharyngeal ratio [5] is considered one of the most reliable methods for adenoid size evaluation.

By this retrospective analysis, our purpose was to investigate whether there are any differences in the growth direction between patients with adenoids caused mouth breathing and matched controls. We also would like to describe the association between posterior airway constriction and bone development patterns, to underline the importance of a complex cephalometric analysis prior orthodontic treatment and the benefits of this

method to consider a proper etiological treatment.

### Material and methods

Our retrospective data was obtained from Department of Orthodontics, Faculty of Dental Medicine, George Emil Palade University of Medicine, Pharmacy, Science, and Technology of Târgu Mureş. 30 patients were selected from our digital database for our study, 17 boys and 13 girls, age  $10.8 \pm 1.2$ . Each studied case was mouth breather, and was referred for ENT examination, which revealed hypertrophy of adenoids. From the same database we assigned for control group, 30 patients with normal breathing pattern, 17 boys and 13 girls, age  $11.1 \pm 0.9$ . All studied individuals were referred to orthodontic treatment between March 2019 – February 2020. Approval of the Ethics Committee of the Scientific Research of our university was obtained (Decision nr. 1836/21.07.2022.), and every patient's tutor signed its' approval to conduct this study.

On each lateral X-ray, using the ImagePro-InSight computerized morphometric soft, we recorded well-defined cephalometric points to determine the size of the adenoids, the depth of the palate and the position of the tongue.

Data was collected in Excel-file for both groups, and after filtering out the outliers in GraphPad-InStat system, statistical analysis was performed.

For the measurement of nasopharyngeal lymphoid tissues, we selected three well-defined points:

1. The deepest point of the Sella (S)
2. The greatest convexity of the adenoid vegetation (A)
3. The upper posterior point of the hard palate (P).

By connecting the three above mentioned cephalometric points, we measured three linear distances:

1. SA, the distance between Sella and adenoid vegetation
2. SP, the distance between Sella and palatum
3. AP, which meant the distance between adenoid vegetation and palate.

After measuring the three above mentioned distances for every patient, adenoidal-

nasopharyngeal ratio described by Fujioka et al. was also determined. The adenoidal/nasopharyngeal (A/N) ratio was calculated by division of the distance between the maximal convexity of adenoid shadow and spheno-basio-occipital synchondrosis (A) by the distance between spheno-basio-occipital synchondrosis and posterior/superior edge of the hard palate (N) [6]. By this ratio, we divided the control group in three sub-groups and colored them differently in our Excel file:

1. Normal size adenoids (range 0.499-0.621)
2. Moderately increased adenoids (range 0.652-0.724)
3. Strongly increased adenoids (range 0.732-0.853).

To measure the depth of the palatum, we first had to determine the base of the maxilla, marked by a line defined by the spina nasalis anterior (SpNant) and the spina nasalis posterior (SpNpost). The second line was the one which was traced between the enamel-cementum junction of the upper central incisor and the same junction of the upper first permanent molar (ICV-M6). A P' perpendicular was traced between the two lines at the level of the first and second bicuspid interdental contact point (maximum palatum concavity), which would show the depth of the palate.

The position of the tongue was measured using a triangle defined by Bibby and Preston [7]. The three points required to define a triangle are:

1. C3, which is the lowest point of the third cervical vertebra.
2. H (Hyoidale) which is the uppermost, foremost point of the body of the lingual bone.
3. RGN (Retrognathion) which is the lowest posterior point of the symphysis.

Furthermore, the perpendicular drawn from the H point to the line C3-RGN gives the position of the tongue in the vertical plane and was marked by H' [8].

To evaluate the position of the tongue to the mandible, we traced a perpendicular (H'') from the uppermost point of the hyoid bone to the base of the mandible.

After recording the points, the linear measurements were done using the ImagePro-

Insight soft, and data was collected in separate Excel files for study and control group. The

measurements applied in our study can be found in Figure 1.

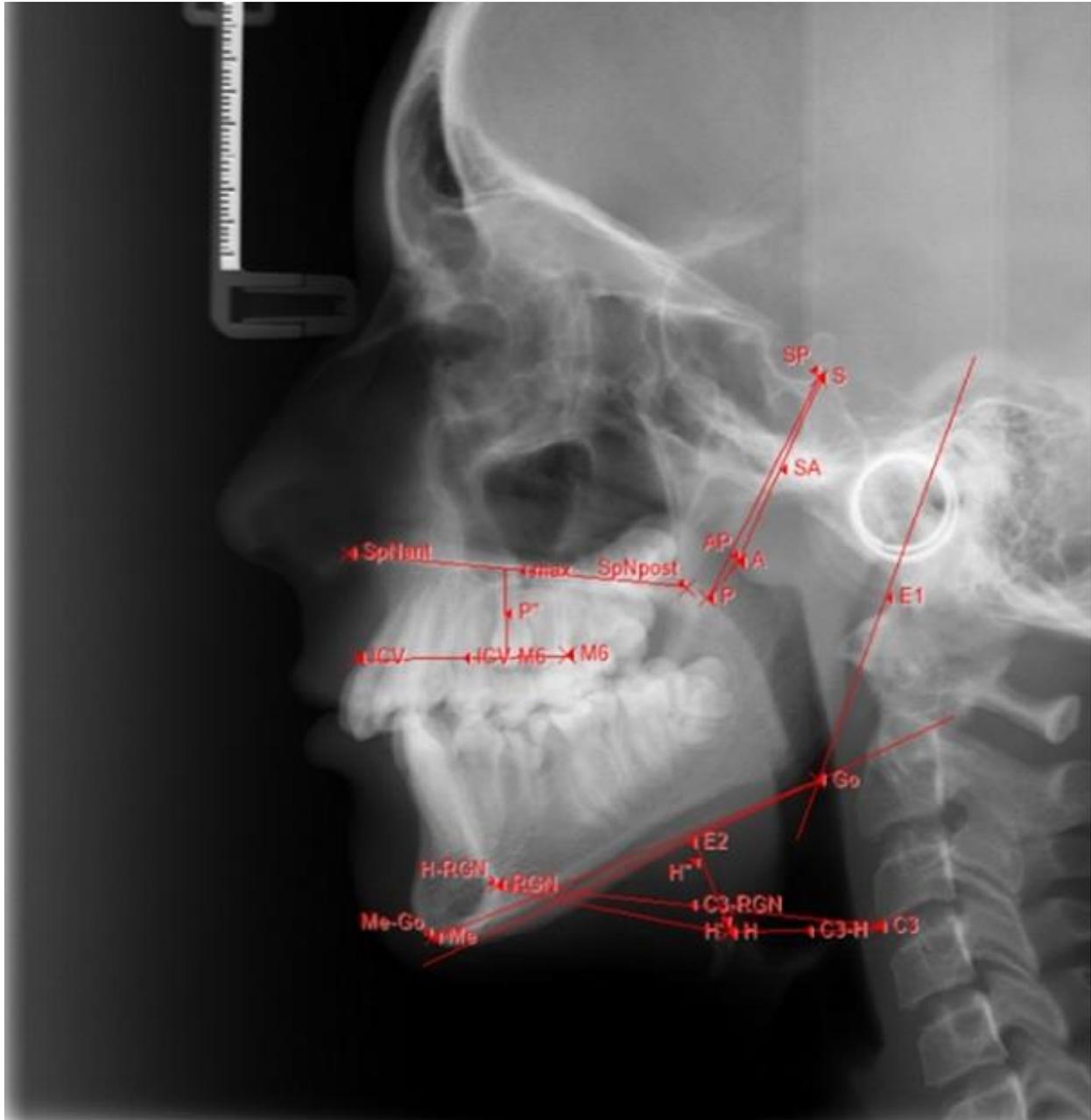


Figure 1. Measurements applied in our study

#### Statistical analysis

First, outliers were filtered out for both groups, using the Grubbs Test. Descriptive statistics was performed (GraphPad-InStat) mean values, standard deviation ( $\pm$ SD), and minimum and maximum values for each group were defined. Using the Kolmogorov-Smirnov normality study, we found the normal distribution of the values according to the Gaussian curve. This was followed by analytical statistics, during which we searched

for significant differences between the two groups using an unparallelled T-test ( $p < 0.05$ ).

#### Results

When adenoids have been measured, several values differed significantly regarding the size of adenoid vegetation. When measuring the distance between adenoid vegetation and the palate (AP), this value was significantly lower in mouth breathers (mean

9.76 ± SD 3.04) compared to the control group (mean 14.38 ± SD 4.41). When analyzing the distance between Sella and the adenoids (SA), the data of the study group (mean 33.39 ± SD 4.39) were significantly higher ( $p = 0.001$ ) compared to the control group (mean 28.38 ± SD 8.91). Examining the distance between Sella and the posterior point of the palate, we found no significant difference ( $p = 1.31$ ) between the values measured in the mouth breathers (mean 42.64 ± SD 2.66) and those found in the control group (mean 39.38 ± SD 7.69).

Examining Fujioka's ratio, we found a significant difference between the two groups ( $p = 0.05$ ). All patients selected in the study group (mean value for A/N ratio 0.78 ± SD 0.79) had strongly increased adenoid vegetation by Fujioka classification (mean 0.726 ± SD 0.1007). The 0.65 ± SD 0.14 mean found in the control group corresponded to the slightly increased adenoid vegetation group (mean 0.680 ± SD 0.1028).

Examination of the depth of the palate, denoted by P', revealed a statistically significant difference between the two groups ( $p = 0.18$ ): control group – mean 11.58 ± SD 2.48., study group - mean 13.94 ± SD 3.05.

By comparison of the values of ICV-M6 line for the two groups significant difference was found ( $p = 0.0001$ ): study group - mean 36.01 ± SD 1.51, control group - mean 30.15 ± SD 3.36.

Examining the base of the maxilla (SpNant-SpNpost), we found no significant difference between the mean value of 53.26 ± SD 5.11 measured in the mouth breather group and the mean value of 54.81 ± SD 6.61 measured in the control group.

No significant differences have been found between the two groups in the assessment of the tongue position. The distances between the points taken to determine the position of the hyoid bone did not give significant differences. H'' distance had the mean value of 11.45 ± SD 6.72 for mouth breathers and 13.34 ± SD 4.94 for the control group ( $p = 3.35$ ). The mean value for the C3-RGN distance in the study group was 63.97 ± SD 10.4, and for the control group was 62.90 ± SD 8.24 ( $p = 7.45$ ).

The position of the tongue in the vertical plane was defined by the H' distance. The mean value obtained for oral breathers was 3.4 ± SD 2.32, and the mean value for the control group was 4.45 ± SD 2.67 ( $p = 2.43$ ).

The mean distance between C3-H points was 27.64 ± SD 4.08 in the mouth breather group and 27.94 ± SD 5.29 in the control group ( $p = 8.85$ ). Also, the mean value of the lengths of the lines determined by H-RGN was 38.93 ± SD 10.39 in children with oral breathing, and the mean value measured for the control group was 36.48 ± SD 4.77 ( $p = 3.36$ ).

Limitation of the study

Regarding the number of included cases, analysis of more cases should be performed.

## Discussions

Many studies aimed to reveal the usefulness of lateral cephalometric analysis as diagnostic tools for the detection of upper airway obstruction due to adenoid hypertrophy [9], but scientific literature seems to be diverse and controversial [10].

When comparing radiological and endoscopic evaluation of the adenoids, both radiographic measurements and nasal endoscopy findings correlate well with the findings of the intra-operative mirror nasopharyngeal exam [11].

Studies, which consider lateral neck X-ray as not so reliable diagnostic tool for adenoid hypertrophy, reveal that while A/N ratio on lateral neck X-ray frequently correlates with adenoid size, lateral neck films can be influenced by patient positioning and involve radiation exposure [12].

Two out of the three methods of adenoid assessment tools are available for orthodontists as well. Clinical signs (rhinorrea, mouth breathing or sleep disorders) can be noticed during clinical examination, lateral cephalometric analysis can reveal the presence of this lymphatic tissue conglomerate and if both examinations are positive, children should be referred for complex ENT examination [13].

Although no universal guidelines for assessing adenoidal enlargement and upper airway obstruction have been established, the

meta-analysis performed by Duan et al. to assess the diagnostic accuracy of a lateral cephalogram for adenoid hypertrophy concluded, that this type of radiological investigation exhibits a very good diagnostic accuracy for the diagnosis of adenoid hypertrophy and posterior upper airway obstruction [14].

Our purpose was to encourage more complex cephalometric analysis prior orthodontic treatment, so where the doubt of adenoids and subsequent mouth breathing occurs, ENT examination should be performed. The age of the analyzed cases was around mixed dentition, and, in some cases, endoscopic examination can be difficult for children at this age.

Guided by these evidence-based findings, we conducted a geometric morphometric study, with no mathematical formulae available, this is the reason why we selected according to the availability of the records, and we selected a minimum of 30 specimen/group [15]. We selected patients referred for orthodontic treatment for 12 months period because of the epidemiological situation during the pandemic, when the ENT diagnosis was difficult to proceed. Morphological measurements conducted in this study describe orthodontic patients, therefore results should be interpreted in this regard, and they should not be applied to the general population.

Upper airway constriction revealed by the AP and SA linear distance measurement as well as Fujioka's A/N ratio showed significant differences between mouth breathers and control group. Our findings revealed enlarged adenoids in the study group and agree with the results of many other studies [16, 17].

Measurements tend to describe palatal morphological changes in mouth breathing cases described a deeper anterior palatum and sagittally elongated upper arch. As oral breathing is the most important etiological factor for constricted maxilla and upper arch, the fact that we were able to describe these alveolar and dental adaptations, concord with several studies [18].

On the contrary, several studies in the literature over the years have demonstrated that there is no regular association between oral

respiration and increased palatal depth [2, 19, 20].

According to our results, during mouth breathing and because of the soft tissue adaptation to this kind of breathing pattern, the perimeter of the upper arch will change, the sagittal elongation is the reflection of upper incisor protrusion [21].

The measurement of the distance defined by us (ICV-M6), traced between the enamel-cementum junction of the upper central incisor and upper first molar, showed a markedly higher value in the mouth-breathing group (mean  $36.01 \pm SD 1.15$ ,  $p = 0.0001$ ). This significant difference shows the backward and downward rotation of the maxilla, and the steep occlusal plane, as compensatory modifications of growth in mouth-breathing children [22].

Due to modified breathing pattern, the hard palatum length will not change, but the vertical and anteroposterior position of the tongue and its relationship to airway size may be more important than soft palate size [23, 24].

## Conclusions

Cephalometric evaluation of adenoids revealed considerable enlargement of this in mouth-breather children, meanwhile upper airway constriction will appear in the same group. Depth of the palatum will increase when breathing pattern is modified, but there is no statistical difference regarding the position of the tongue and lingual bone, when results were compared with normal breathing pattern.

**Conflict of interest:** None to declare.

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## ORIGINAL RESEARCH



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## The hematogenous marrow tolerance when being in direct contact with the titanium implant.

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### Abstract

Introduction: The titanium implant represents a foreign body for the organism in which it is inserted, and it will never be accepted as an intrinsic structure. However, research has shown that it is very well supported both by soft and hard tissues, including here the limitrophe implant tissues. Aim of the study: The aim of this study was to test the tolerability towards the titanium implant inserted in direct contact with the hematogenous marrow. Material and methods: Titanium implants with the length of 10 mm and the diameter of 2 mm were inserted in the diaphysis of the femora bone of 10 male rabbits with the age of 10 months. At these particular dimensions, the implant exceeded the depth of the bone wall with more than half its length, taking direct contact with the hematogenous marrow from the marrow channel. Results: Seven days after the implants insertion, the histologic examination revealed the fact that the hematogenous marrow had a very good lenience towards the titanium implant, meaning that it did not lead to any immunological rejection reactions, nor to pathological processes or the tendency of proliferation of unwanted tissues like conjunctive fibrous tissue. In these conditions, the pre-implantation reparatory processes fully benefited of the hematogenous marrow support, which, not being altered in any way, offered cells and stimulant factors, of the same intensity, throughout the entire experimental period. Conclusions: The high tolerance of the hematogenous marrow to the titanium implant assures special conditions for the peri-implantation reparatory processes which take place at a speed that cannot be competed against by other stimulant modalities. This stimulant modality of reparatory processes cannot be applied in all situations, but only when working on healthy bones that contain hematogenous marrow, therefore the practical applicability relates especially to the dental interventions of implant prosthesis.

**Keywords:** hematogenous marrow, titanium implant, bone proliferation.

### Introduction

Throughout our lives, we suffer injuries resulted from accidents or surgical interventions, which are remediated through the lesion healing process, due to the remarkable potential of the human body to repair itself. The healing and lesion repair processes imply the recruitment and proliferation of cells capable of re-establishing the original structure and function of the tissues. An important source of such cells is the bone hematogenous marrow, and studies show its implication in the healing process after injuries, bleeding or diseases [1].

The hematogenous marrow can be found in the cavities of the long and flat bones, having the capacity of being cut and transplanted. The utility of the marrow transplant is conferred by the fact that it contains numerous adult stem cells. Even though it is very unlikely, some authors claim that the adult stem cells might

contain the same clinical potential as the embryonal stem cells, which would represent a huge advantage because it would eliminate the ethical and practical problems related to the preparation and use of the embryonal stem cells [2].

The marrow stem cells include hematopoietic stem cells, stromal marrow cells (mesenchymal stem cells) and multipotent adult cells. The hematopoietic stem cells differentiate towards different types of blood cells, whereas the stromal cells can differentiate towards adipocytes, chondrocytes, osteoblasts and other conjunctive tissue cells. Therefore, the transplant of marrow cells has the potential to contribute to the development of hematopoietic and osteogenesis cells [3]. In other words, the living cells of the bone marrow contribute to the bone development through osteogenesis.

The bone marrow contains osteoblast progenitors that can differentiate in mature

osteoblasts, that can directly contribute to the process of osteogenesis. Bone marrow suction was successfully used to improve bone regeneration; the transplanted cells initiate the development of an unmineralised bone matrix (osteoid) and they start the process of bone matrix mineralisation through accumulation of hydroxyapatite [4].

The bone marrow can be cut through suction from the stern, anterior iliac bone or posterior iliac bone. The technique of autogenous bone marrow suction and implantation does not imply major complications. The complementary procedures can be conducted as ambulatory ones with the patient under oral sedation and local anaesthesia, intra-venous sedation or general anaesthesia. Using the implantation of the suctioned marrow in the bony defects, a significant bone regeneration was obtained [3]. It must be stated that marrow suction provides the growth factors necessary for bone development, as well as angiogenesis [5].

There are a lot of advantages in using the autologous bone marrow suction for the treatment of bony defects, the mesenchymal stem cells being able to spontaneously differentiate into *in vitro* osteoblasts [6,7]. In experimental studies, it was demonstrated that the bone marrow stromal cells can form *in vivo* authentic bone, as well as the fact that they can form *in vivo* adipocytes [8]. It seems that the plasticity is more extended, meaning that some authors claim that the bone marrow contains myogenous, neurogenic and hepatogenic progenitors [9,10]. What needs to be considered is the fact that the suction method is painful for the donors, and it sometimes needs to be done under general anaesthesia and may be associated with side effects [11].

The marrow suction can be combined with different framing (collagen I, tricalcium phosphate, hydroxyapatite) in order to contribute to the acceleration of the bone healing process. From a surgeon's point of view, there are many advantages associated with the clinical application in one stage of the bone marrow concentrate. The immediate

transplantation of bone marrow concentrate can prevent complications that might appear due to the low quality of the transplanted cells, like pre-aging (telomer contraction), reduced viability or the tendency to differentiate towards other types of cells, processes that might occur in case of propagation. Moreover, for this procedure, the infection risk is relatively reduced through the deduction of the *ex vivo* period of time [12].

Following a series of cases, some authors concluded that the bone marrow suction was able to facilitate the healing of massive bone loss. The same authors point to the fact that a cost-benefit analysis should be conducted in order to see whether the application in one stage of the bone marrow suction reduces the hospitalisation period and the additional costs involving stationary or necessary personnel for the *ex-vivo* transplant [6].

Some authors claim that the administration modality influences the results, claiming that the use of a recently suctioned bone marrow is more indicated than the preparations that have gone through different procedures, which can affect parts of the transplanted cells [12].

The use of the hematogenous marrow through the bone reparatory process stimulation has been long studied, either as a recently suctioned bone, or under the form of medullary components or cultures. All the studied variants revealed the beneficial effect of the hematogenous marrow, but there is one thing which needs to be highlighted, the fact that the procedures necessary for obtaining a certain marrow product may lead to certain alterations of the more sensitive, delicate components. In other words, the marrow concentrates are very useful, but they do not have all the qualities of the marrow which was not previously exposed to certain procedures.

Some authors have even gone further and tested the osteo-inductive potential of the hematogenous marrow over a titanium implant which penetrates the marrow cavity, having direct contact with the marrow. The results obtained by them were very encouraging [13,14].

Given the fact that it was proven the important effect of the titanium implants inserted in direct contact with the hematogenous marrow over the osteointegration, we aimed at investigating the possible side effects that might occur when the titanium implant is in direct contact with the marrow channel.

### Material and methods

The materials used were titanium implants, self-drilling screw type, 5 mm in length and 2 mm in diameter (Bio Micron®-Cluj, Romania).

The biologic material was represented by 10 male rabbits, common race, aged 10 months. The study was approved by The Banat Bioethics Commission of Agricole Sciences and Veterinary Medicine "Regele Mihai I al României", no. 124/02.06.2022. The rabbits' accommodation throughout the whole experiment was made at the temperature of 20-24°C and natural light with a light-darkness cycle of approximately 12/12 hours. The food used was standardised grained fodder, and the water was fresh and unlimited.

The process of narcosis was undertaken through intramuscular administration of xylazine 5 mg/kg + ketamine 40 mg/kg (Bioveta®-Czechia), followed by the placing of a venous catheter on the external auricular venae and the animal was connected to a fluid-therapy mechanism. After 7 days, the animals were sacrificed and the area that contained the implant was cut and immediately introduced in formalin 10 % for histologic fixation (Roth®-Germany). At the end of the stabilisation period, the pieces were decalcified with trichloroacetic acid (Roth®-Germany), dehydrated with ethyl alcohol (Chemical Company®-Iasi, Romania) in progressive concentration, clarified in 1-Butanol (Roth®-Germany), included in paraffin (Roth®-Germany), sectioned at 5 micrometres and coloured using the Tricrom Goldner method (Hematoxilin, Fuchsin acid [Rubin S], Orande G, Tungstophosphoric acid hydrate, Light green yellowish, Merk®-Germany and Xylidin

Ponceau 2R - Roth®-Germany). The examining of the histologic concentrates was made using an Olympus BX41 microscope containing an image digital camera type E-330.

### Results

The histological exam revealed that the implant exceeded the endosteum, penetrating the femoral marrow cavity with three and a half spires, therefore it had initially been in direct contact with the hematogenous marrow, over more than a half its length. After 7 days, approximately half of the intra-marrow implant portion is already covered in new bone, looking like a young bone in full proliferation process and visible tendency of extending towards depth on the implant surface (figure 1).

In the progression area, what can be noticed is young conjunctive tissue with a very specific aspect which contains numerous cells, especially osteoblasts and even some very discreet lines of bone trabecula (figure 2). The aspect suggests that its evolution is directed towards a bone tissue and not towards a fibrous conjunctive tissue. Towards its final area, the implant is covered with a thin layer of young conjunctive tissue which continues without demarcation towards the hematogenous marrow of the marrow channel (figure 3).

The marrow situated next to the titanium implant contains progenitors of the sanguine figurate elements, in different stages of evolution, progenitors on all lines being highlighted (granulocyte, lymphocyte, monocyte, thrombocyte) (figure 4). These aspects suggest that the marrow situated next to the titanium implant is perfectly functional and does not react in any way to the presence of the titanium implant. Moreover, the large implant surface covered after only 7 days from the implant insertion of newly proliferated tissue, present only in the implant portion inserted in the marrow cavity, demonstrates the fact that the reparatory processes began in the endosteum area and evolved rapidly.

The high speed at which the new bone was proliferated can only partially be attributed to the endosteum, the fact that this proliferation was significantly stimulated being obvious.

This proliferation was initiated by the endosteal cells and benefitted from significant help from the hematogenous marrow, through the osteoblast progenitors and the stimulating substances present there. The stage to which the peri-implantation proliferation process evolved during a period of only 7 days from the titanium implant insertion, suggests the fact that the marrow did not react to the contact with the titanium implant as if it were a foreign body, through immunologic rejection mechanisms. If such mechanisms had been initiated, a foreign body reaction would have taken place, with the appearance of multinuclear giant cells that would try isolating and eliminating the titanium implant. Such multinucleate cells were not identified, grouped or isolated. Additionally, what needs to be mentioned is the fact that all the tissues proliferated at the interface between the implant and the area initially occupied by the hematogenous marrow, represent stages of new bone formation. The proliferation of conjunctive tissue with fibrosis tendency cannot be noticed. These aspects highlight the

fact that the hematogenous marrow develops a high tolerance towards the material out of which the implant is made (titanium), meaning that it did not activate hostile reactions to its presence, which is nevertheless a foreign body for the organism.

The acceptance of the implant by the hematogenous marrow assured the optimal conditions for the activation of the reparatory processes within a very short period of time and at very high speed.

This rapid bone proliferation could not have taken place without the direct contact of the marrow with the marrow channel, which provided both osteoblasts and stimulating factors. If the marrow did not suffer any alterations due to the direct contact with the implant, the process of osteointegration benefited from the best possible conditions and that was the standpoint for the speed at which the reparatory processes took place. From this point of view, the results are so good, that they exceed those obtained from the use of suctioned marrow or hematogenous marrow concentrates, even though the specialised literature bristle of positive results obtained after their use, in many circumstances.

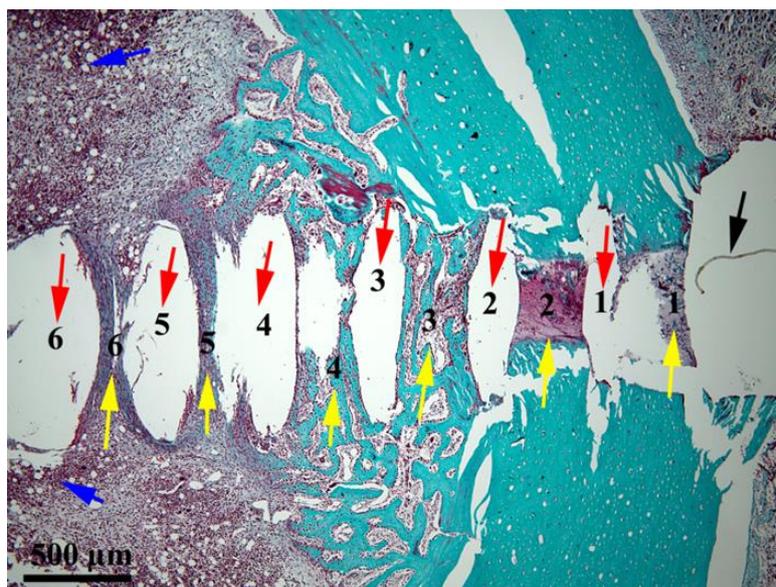


Figure 1. The aspect of the implantation area after 7 days from the implant insertion. Black arrow – the implant unthreaded screw collar; red arrow – implant spires (1-6); yellow arrow – the proliferated material in the implant socket (1-6); blue arrow – hematogenous marrow (Tricrom Goldner) 205

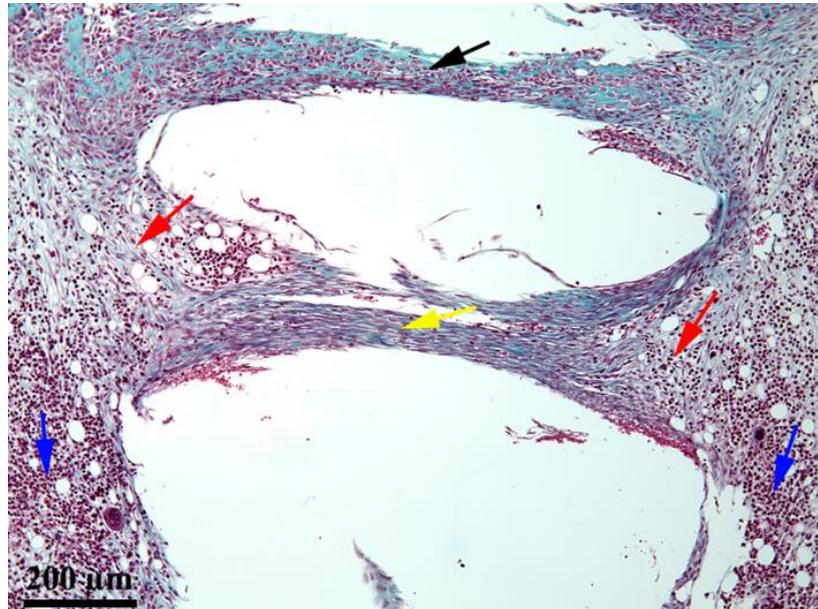


Figure 2. The interface between the 5-6 implant spires and the hematogenous marrow: black arrow – proliferated material in socket 5; yellow arrow - proliferated material in socket 6; red arrow – new conjunctive tissue proliferated on the interface; blue arrow – hematogenous marrow (Tricrom Goldner) 208

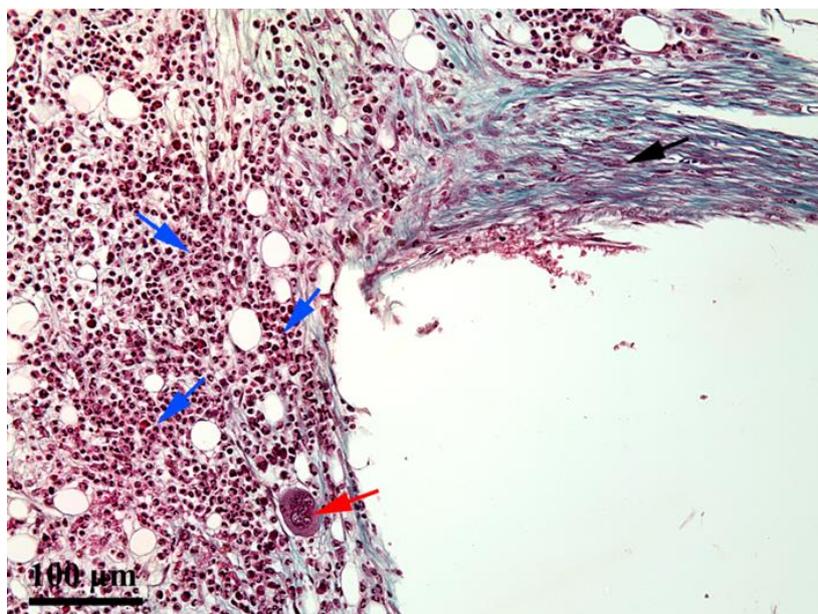


Figure 3. The interface between implant spire 6 and the hematogenous marrow – detail; black arrow – the proliferated material in socket 6; red arrow – megakaryocyte; blue arrow – progenitors of sanguine figurate elements in different evolution stages (Tricrom Goldner) 210

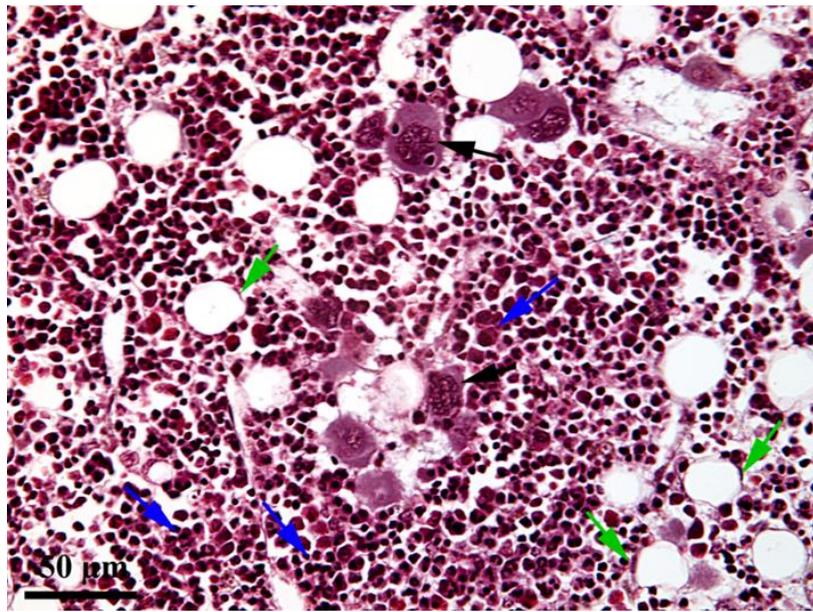


Figure 4. The hematogenous marrow; black arrow – megakaryocyte; blue arrow- progenitors of sanguine figurate elements in different evolution stages, green arrow – adipocyte (Tricrom Goldner) 217

## Discussions

Considering a number of 18 patients, some authors reached the conclusion that the local injection of the autogenous bone marrow is a safe and efficient treatment method for the simple bone cyst, but sometimes repeated injections are necessary [15].

The growth and transplant of undifferentiated bone marrow cells are efficient procedures, but they are also complex and expensive. The bone marrow suction is much facile, fact which lead to its study, both clinically and in the laboratory, for the purposes of filling the bony defects, of stimulating the fracture healing and of pseudarthrosis treatment [16]. In order to reconstruct the bony defects, some authors combined the marrow suction with collagen and tricalcium phosphate fields, and they noticed different degrees of differentiating and maturing of mesenchymal bone marrow stem cells into osteoprogenitor and osteoblast cells osteoblast [17].

The percutaneous injection of the bone marrow suctioned represented the study object on experience animals. Some authors injected the suctioned marrow in the fifth day after osteotomies and induced bony defects, on 41

adult rabbits. The marrow was injected immediately after suction, due to the fact that the number of viable cells decreases as time passes. After 2, respectively 3 weeks, the callus volume was significantly greater on the animals that received suctioned marrow compared to those that have not. After having run the histological and radiologic examination, the conclusion was that the percutaneous inoculation of bone marrow improved the healing process of osteotomies and defects within 4 weeks [18]. Other researchers investigated if the bone marrow administered percutaneous determines the growth of bone production or if it has any effect over the early fracture healing. The tested parameters were represented by the callus transversal sectioned area, the braking resistance, the tension resistance and the callus volume at the fracture place. Two weeks after the administration, the four parameters, especially the callus volume, were significantly bigger ( $0,001 < P < 0,005$ ) in case of marrow injected bones compared to those injected with physiological serum. After four weeks, all four parameters were significantly higher in the bones injected with suctioned marrow compared to those which were not [19].

The bone marrow was used both clinically and experimentally, combined with bone, in order to increase the graft osteogenesis capacity [19]. A big advantage associated with the use of suctioned marrow is the fact that it is available in relatively large quantities. Another advantage is the fact that the administration of the suctioned marrow can be done at a high degree of precision (exactly in the fracture area) based on imagistic information. This fact is of outmost importance especially in certain clinical situations, like infections, for example [19].

The autologous bone marrow concentrate was also tested on human patients with fractured inferior limbs. It is a well-known fact that in the case of inferior limb fractures several risks might arise, such as delays in the bone union or even the non-union of the fractured epiphyses, situation in which the autologous graft is indicated. Some authors claim that the most promising treatment would be the percutaneous injection of a suctioned or even concentrate of autologous bone marrow. They verified this method on 43 cases of open tibia fractures, with initial surgical treatment. In 23 cases (53,5%) when the autologous bone marrow concentrate was used, positive results were obtained [20]. Sugaya and colab. [21] used this concentrate in 17 cases of pseudo-arthritis (ten femoral, five tibial, one humeral and one ulnar) and they obtained a rate of success of 76% %. Other authors reported even higher success rates (88%) for cases of tibial pseudo-arthritis [22], or even higher than 94% [23].

In most cases, the bones that suffer an intervention present bigger or smaller modification, and in these cases, the use of suctioned marrow or some marrow concentrates represents the best reparatory process stimulation method. The modality we presented here offers results that are superior to those obtained when using suctioned marrow or marrow concentrates, but it must be mentioned that it is a bit more specific and can be applied only in some situations. It can be applied only on healthy bones that have cavities with hematogenous marrow, suitable

especially in the cases of dental interventions referring to implant prosthesis.

### Conclusions

The insertion of titanium implants in direct contact with the hematogenous marrow was proven as an extremely efficient method of stimulation of the peri-implant reparatory processes, due to the fact that the marrow had a high tolerance towards the material out of which the implant was made. In this context, the reparatory processes fully benefited from rapid, direct and continuous marrow support, as osteoblast and stimulant factor supplier.

**Conflict of interest:** None to declare.

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## STATE OF THE ART



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## Dental photography: Why? What? How?

### Part 1 Why? The role of dental photography in daily practice.

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#### Abstract

Digital Dental Photography (DDP) represents a must-have instrument for all dentists in their daily activities. Nowadays, DDP represents a tool that is no longer reserved for a select small number of dentists but is accessible to every practitioner. Although the number of dentists who use DDP daily is increasing, there is much hesitance, many questions, and resistance regarding the introduction of dental photography in daily practice.

This series of articles aims to demystify all the misconceptions related to the DDP and offer readers a transparent image of how DDP can become the most powerful tool for their offices. All the “mysterious” terms related to the DDP will be explained, and simple protocols that can be easily incorporated in any dental office in daily practice will be presented.

This article is the first in a five-part series dedicated to DDP.

Part 1 defines the role of DDP in daily practice covering the four significant indications: documentation, communication, education, and marketing.

**Keywords:** digital dental photography, initial consultation, intraoral photography, extraoral photography, education, communication.

#### Introduction

The indications of DDP are numerous and they cover all the fields of dentistry. However, DDP can play a significant role in the management and marketing of the dental office. The primary use of DDP in daily practice is linked to documentation, diagnosis, and communication. Three aspects must be covered to transform DDP into a “booster” of any practice: equipment, training, and daily implementation for each patient and treatment [1].

The most frequent reasons evoked by dentists who do not use photo documentation are: documentation is time-consuming, expensive equipment, long learning curve (too complicated), and lack of training [2-5].

Starting with this article, the author proposes to the readers a journey inside the fascinating world of digital dental photography with declared aims:

- To demonstrate the importance and benefits of incorporating the DDP in daily practice for each patient.
- To offer a clear and easy-to-understand vision about the fundamentals of DDP that will allow them to document each clinical case predictably.

- To explain how these photographs can be used during the initial consultation to facilitate communication with the patient regarding his dental status, treatment options, and risk of complications in the absence of the treatment. A successful presentation will increase the acceptance of the proposed plans, and DDP plays a significant role in this success.

There will be five parts in this series.

Part one of this series is dedicated to the question “WHY?”. Why do we need dental photography in our offices? The role and the place of dental photography in our daily practice.

Part two will answer the question “WHAT?”. What equipment do we need, and what settings do we need to know to be able to perform the dental photographic documentation with decent/ good/ excellent results?

Part three will continue with the question “WHAT?” What pictures do we need to take? The author will present an extended series of images organized by ergonomic and medical criteria. Another question that will receive answers in part three of the series: What the

ideal dental photography from technic and medical criteria looks like?

Part four will answer the question “HOW?” How to make these pictures in a standardized manner that will predict the results. A simplified protocol for intraoral and extraoral documentation will be presented, which can be performed with a basic kit in any busy dental office.

Part five will continue with the question “HOW?” How to:

- organize the images in a template (a link for downloading this template will be provided at the end of the fifth article)
- use the template to create a treatment plan
- present with success to the patient.

At the end of this series, the author hopes that all the mysteries and misconceptions regarding digital dental photography will be cleared and demystified. Most readers will understand how to transform dental photography into their most powerful tool during daily activity.

Why? The role of DDP in daily practice

The roles of dental photography are numerous, but they can be organized into four categories: Documentation-Communication-Education- Marketing [6,7].

Of course, we can describe other aspects in which dental photography can be used, but our focus will be on these four principal roles.

**DOCUMENTATION:** this is the primary purpose of DDP

- Initial status of the patient: a good set of pictures with the initial status of the patient is required at the beginning of the collaboration with every new patient. In this stage (initial consultation), DDP becomes a valuable instrument for examination, co-diagnosis, and treatment planning. Without hesitation, we can consider DDP a paraclinical examination with similar value as other investigations and tests. For all complex cases, it is recommended to avoid giving a final diagnosis, a treatment plan, and a financial statement at the end of the first meeting with the patient. The reasons are: many clinical aspects can be overlooked; there are clinical aspects that require an interdisciplinary approach, and we need the opinion of other specialists; there is always more than one option for the treatment plan. A complete set of pictures, together with other investigations (CBCT, 3D models), will allow the dentist to perform a “second examination” in the absence of the patient at a later date. In this way, there will be time to analyze the preoperative dental status, sometimes with colleagues of other specialties, to arrive at a final decision regarding the treatment plan (one or more options) to be presented to the patient (Figure1) [8-12].



Figure 1. Series of “functional images” organized and prepared to analyze the occlusal functional aspects

- The treatment plan evolution stage by stage (restorative, orthodontic). The possibility to analyze different pictures at different moments of the treatment can give precious information to the dentists helping them to adjust the treatment approach according to the goals established at the beginning of the treatment. Also, these pictures can help the

dentist motivate the patient by showing the progress made (for example, long-period orthodontic cases, and complex periodontal treatments) (Figure 2) [9,13,14]. One of the effects of step-by-step photographic documentation of treatment is to create a collection of own images that will be used for educational and marketing purposes.



Figure 2. Before and after images during a severe erosion rehabilitation case

- The final result obtained at the end of the treatment. It is essential to have at least 4-6 pairs of pictures before and after, not only for marketing purposes but also for the

morale of the entire team which must learn to celebrate with the patient a successful end of treatment and motivate them for periodic check-ups. Also, these pictures can be used for marketing purposes (Figure 3).



Figure 3. Pictures taken at the end of the treatment

- The initial condition and its progress (evolution or remission). These are very

important, especially for soft tissue lesions [15].

- As a medico-legal document regarding the initial status and the treatment performed. The usefulness of a well-documented medical record in the case of possible disputes is significant. When the patient file is completed with pictures of the initial situation, the different treatment stages, and the final results, it will be much easier to demonstrate the initial oral situation of the patient and the quality of the treatments performed [8,11,16,17]. Ideally, all dental procedures must be documented, but it is also understandable that the standard practitioner, in her/ his practice, does not have time to document all the treatments performed daily. So, what must be documented for a legal purpose? Here are some suggestions:
  - Surgical and esthetic treatments.
  - All the treatment phases were performed on suspicious and reticent patients even if they agreed and signed the treatment plan.
  - The patients with a problematic/ conflictual attitude.
  - Comprehensive dentistry.
  - Minimum two images with the initial situation and ending condition for each treatment we performed.

## COMMUNICATION

- With the patient: The value and communicative power of images have been known since ancient times. Whether or not we are aware of it, we all communicate much better through images. That is also valid in the case of the doctor-patient relationship. The use of DDP will help the patient understand their dental situation faster and better, and all the information regarding the causes and complications we want to explain to them. Using DDP, communication becomes much more effective. Of course, the dentist must improve her/ his verbal skills so that any patient can easily understand the explanations accompanying the presentation of the images. Without the presence of the DDPs, only the verbal explanation of the dental status and treatment proposals may confuse a patient unfamiliar with the medical language. When the dentist uses the patient's clinical images, many confusing terms become more evident, the impact is much more powerful, and confidence increases. Using a series of images presented in a specific order can help the dentist explain the logic behind the proposed treatment plan and the importance of following a specific sequence of treatment sessions (Figure 4) [8,9,18-20].

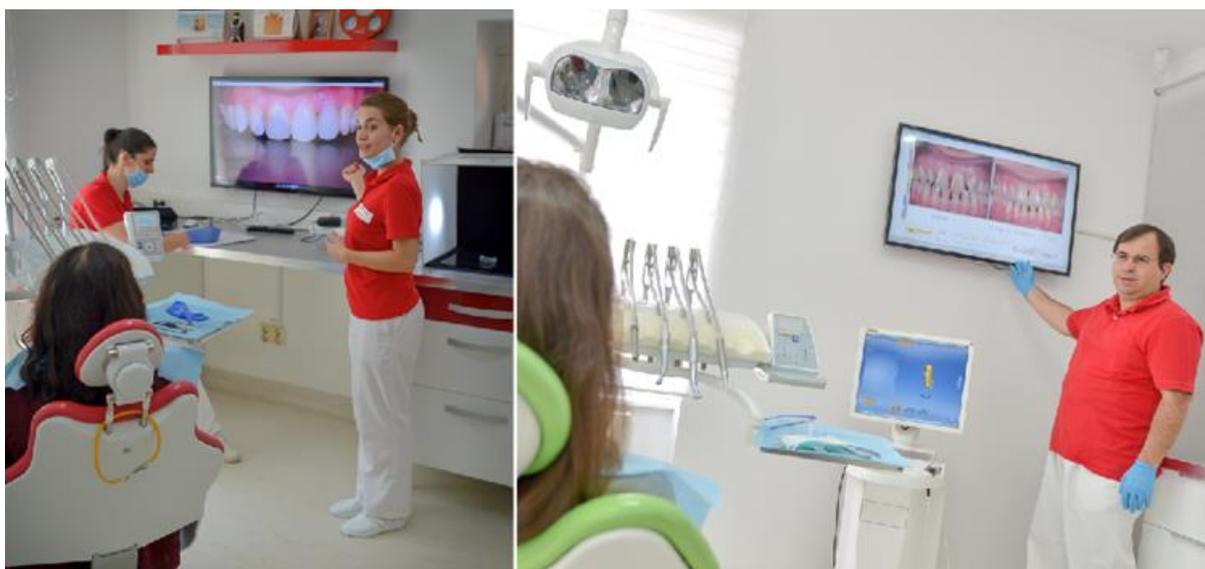


Figure 4. The use of DDP during the initial consultation

- With the members of the dental team: Modern dentistry and complex oral rehabilitation often require a multidisciplinary approach involving more than one dentist. Taking appropriate dental pictures and organizing them according to

an already agreed template will allow team members to collaborate to establish all the diagnoses and implicitly therapeutic solutions and the phasing during dental team meetings online or offline (Figure 5) [16,20-22].

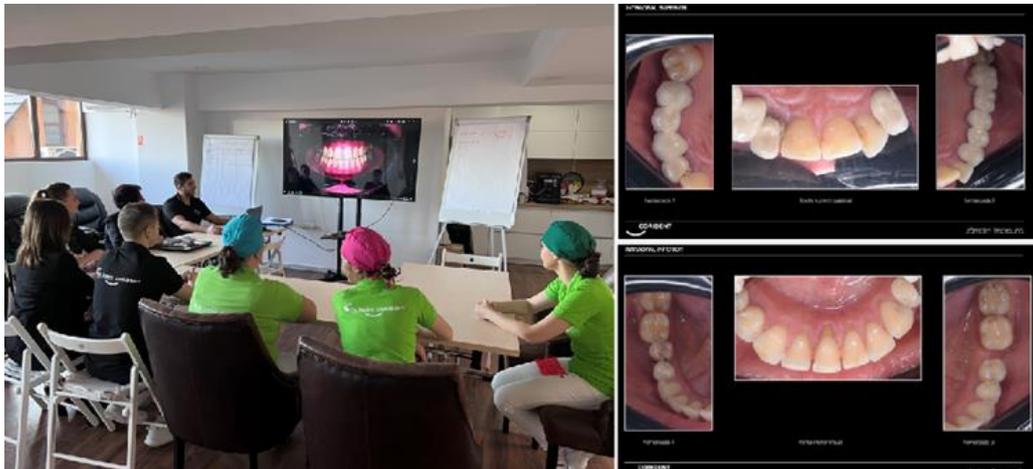


Figure 5. The use of DDP during the interdisciplinary meeting

- With the dental laboratory: Digital or analog, dental technicians work on a model without a face, lips, or soft tissue and depend totally on the information that the dentist provides to them. The photos taken by the doctor will provide the dental technician with important information related to the color, shape, texture, and size of teeth that will allow the technician to create restorations as appropriately as possible from a functional and esthetic point of view. A minimal set of pictures for

a dental technician must include: a portrait, semi-profile, and profile, each one in maximal intercuspation (MI), relaxed lips, smile, large smile; frontal teeth on black background, frontal teeth with polarised light, a picture with the shade guide in normal light and polarized light. This basic photographic information must be accompanied by a list of patient expectations and wishes. Also, the dentist must provide the dental technician with pictures of all try-in stages (Figures 6,7) [8,23-31].



Figure 6. Minimal photo portfolio for the communication with the dental laboratory



Figure 7. Images with prosthodontic restorations during try-in phases and the end of treatment

- With the referral colleagues: If we want to refer our patient to a specialist (for a second opinion or a specific treatment), attaching a picture of the lesion or preoperative status is extremely helpful. The specialist will have more information to better understand the case and schedule the appointment accordingly. That goes both ways and is valid when other colleagues refer patients to us (Figure 8).

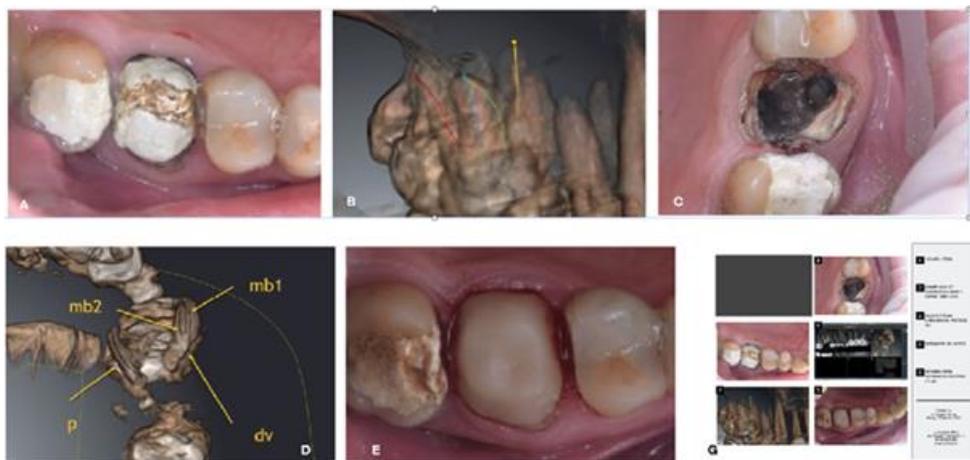


Figure 8. Example of photo portfolio used to create a medical report for the referral dentist. A: initial situation, B: 3D Xray showing an upper first molar with four canals, C: situation after removing the metallic post, D: 3D Xray control validating the quality of root canals obturation, E: clinical image with new ceramic post core, G: example of report created with the images

- Academic, publishing, and education: DDP is the mandatory way to document a clinical case that will be presented to the scientific community, colleagues, and students [8,10,18,32-37]. These are a few recommendations regarding the use of DDP in this field:
- use DDP to document “step by step” any procedures intended to be presented in the academic environment making possible the illustration of a protocol from beginning to end.
- each periodic control must be well-documented (including DDP) to record the changes during the treatment and for long-term survey results.
- organize the pictures on the computer in a way that makes them easy to find according to the topic that must be illustrated.

- respect all the quality criteria for a DDP according to the academic recommendations.

## EDUCATION

- For the patient: by creating a practice portfolio with own solved clinical cases that can be used to:
  - show similar cases and how they are solved,
  - similar cases without treatment and how they evolved into complications.

We must be aware of our educational role as dentists in patient relationships. Patients come from different social backgrounds, they have different educational and even intellectual levels, and most of them do not benefit from any education in the field of dental health. We cannot expect to talk and obtain a real understanding of the clinical situation and treatment plan from the patient. When the patient can see their images or images with similar situations and these images are accompanied by verbal or written explanations, the level of understanding rises, and the decision regarding the chosen treatment is much easier and faster [12,14,38-40].

- Self-learning by analyzing the pictures of the procedures performed with good and not-so-good aspects. During the author's lectures or workshops, the participants are encouraged to take pictures of their work and view them on a large screen. The DDP is a merciless teacher who will reveal any mistake, allowing the dentist to correct it. In other cases, the DDP will confirm the success of the treatment, validating a specific protocol, technique, or material used. Taking dental photos step by step during the treatments that are performed will allow the dentist to:
  - self-evaluate her/ his work and discover, possibly, specific errors not noticed during the treatment
  - to assess, afterward, if a particular approach or solution was favorable [41, 42].
  - team training: the pictures with the successful and the failed treatments are the best study materials during the team training. The DDP and other investigations (CBCT and 3D models)

are invaluable tools to validate/improve/ change the protocols.

## MARKETING

DDP plays a significant role in all aspects related to the marketing of the dental office. Whether we speak about internal or external, offline or online marketing, DDP is the element that gives power to the words. We can use DDP:

- Offline – for printed materials for the reception area or to be handed to the patients.
- Online – for the website and social media.

Regarding the use of pictures for the marketing materials (offline or online) it is important to mention that it is recommended to use pictures of practice patients instead of pictures that can be bought from online platforms. The images of a genuinely beautiful smile taken in the dental office, together with pictures of the dental team and real patients smiling, will improve the reputation of the dental office and will create a climate of confidence inside and outside the dental team.

We must obtain written consent from each new patient for taking and using DDP. There are numerous models of standard release forms. The form must contain a clear and explicit statement of the intended use of the pictures and must be signed by the patient before taking any DDP. This form must be kept in the file of the patient. Most of the patients understand and agree to photo documentation as a medical investigation. However, many of them are reluctant if their images are used for marketing purposes, and many patients specify that they do not want to appear in social media posts [43, 44].

## Conclusions

The technological evolution over the last 10-15 years has increased the quality of the images that dentists can obtain for their DDP documentation using digital cameras and specific accessories.

From a financial point of view, a basic kit for DDP is now accessible to any dentist interested in introducing the DDP in his daily practice.

From a learning point of view, nowadays, there are many training solutions (online or offline).

Regarding the use of DDP as a co-diagnostic instrument:

DDP presents some absolutely indisputable advantages when we use it as a co-diagnostic tool, advantages that cannot be overlooked:

- It is non-invasive;
- It is fast and easy for the patient; DDP documentation will not be time-consuming if a protocol is followed and all the team members know it and respect it (Figure 9);

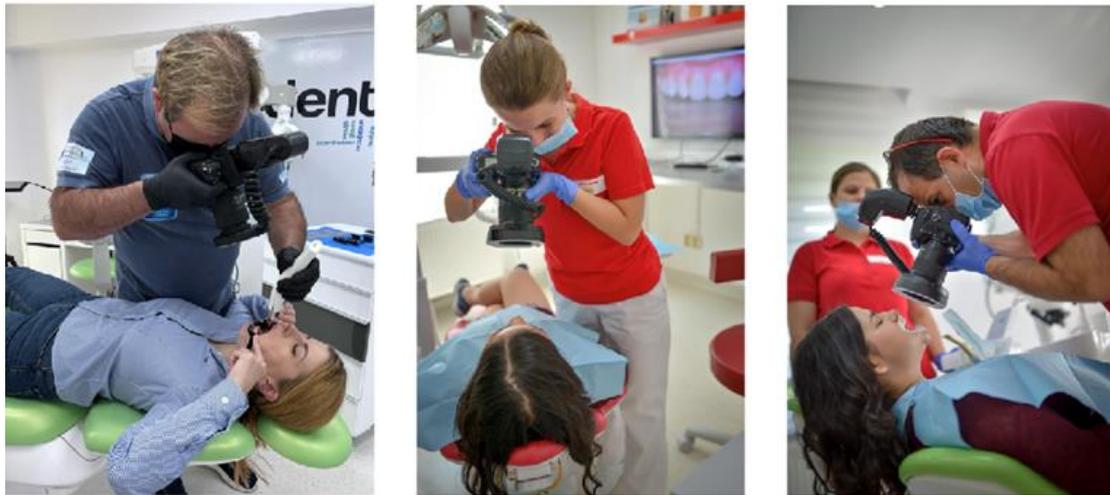


Figure 9. Photo documentation for initial consultation. Fast, easy, painless

- The quality of the information (exposure, composition) can be controlled instantly;
- Provides details and information that can sometimes escape a regular first clinical examination;
- Due to the high resolution, these images allow the observation of the finest details

using the zoom in tool. The quality of the details obtained from an image is equal to or, sometimes, better than the one offered by a microscope (much more expensive and not available on a large scale in each dental office) (Figure 10);



Figure 10. DDP are easy to check for quality criteria

- Allows the examination time to be extended indefinitely. Creating a comprehensive treatment plan, fully responding to the

esthetic and functional needs of the patient, must rely not only on a thorough clinical and para-clinical examination but also on a

stage of reflection upon the collected information in order to provide an accurate diagnosis. DDP, together with the other test and investigations, offers dentists extra time (in the absence of the patient) for this reflection stage. The time we have with the patient on the dental chair is limited, and

often, many aspects can be missed or overlooked. Having a set of original images will allow the dentist to examine them later on the computer and observe details that might have escaped during the clinical examination (Figure 11).



Figure 11. DDP allows a later examination without the need for the patient to be present

Due to its numerous indications, dental photography represents one of the most critical “instruments” we can add to our daily practice.

Dental photography can boost real and long-term professional and financial growth for dentists and their offices through correct and day-to-day use.

Probably the essential use of photography is that of a co-diagnostic and communication tool during the first consultation. However, this is a vast subject so we will dedicate it to part five of this article series.

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## STATEMENT OF ETHICS

All research studies involving human subjects must have received approval of the appropriate institutional ethics committee and informed consent must be obtained from all the patients participating in the studies, prior to manuscript submission.

In cases where the institutional ethics review committee ruled that approval from them was not required or that the need for informed consent was unnecessary, a statement from the committee to this end should be forwarded to the Editor with the manuscript.

Human and animal rights

Studies involving experimental research on animals or humans must conform to the guiding principles of the Declaration of Helsinki. In order to respect a patient's right to privacy, identifying information such as patients' names, images, initials of hospital numbers should not be included in any published material (tables, figures, text), unless the information is essential for scientific content. In these cases written permission must be obtained from the patient, and should be submitted to the editorial office at the time of manuscript submission. In the case of animal experiments, both national and the institutional guidelines pertaining to the experimental use of laboratory animals should be rigidly followed.

Conflict of interest (Declaration of Interests)

The manuscript should contain a statement fully disclosing any conflict of interest related to the manuscript. If there are no conflicts of interest, this should be stated as "none declared". Material and financial support should also be acknowledged.

Scientific misconduct

Scientific misconduct includes data fabrication, falsification, plagiarism, redundant publication, ghost authorship or other fraudulent research practices. In order to prevent plagiarism issues, all manuscripts sent to the journal will be screened using anti-plagiarism soft-ware. Where there is a suspicion of scientific misconduct, the Editor will act in conformity with the principles stated in the COPE guidelines and if the fraudulent practice is confirmed the manuscript will be rejected outright and without the Editor entering into any further correspondence.

Clinical trials

In case of manuscripts presenting clinical trials, the clinical trial should be registered in a public trials registry at or before the time of first patient enrollment, as a condition for consideration for publication. Trials should be preferably registered in ClinicalTrials.gov, but any registry that is a primary register of the WHO International Clinical Trials Registry Platform (ICTRP) is acceptable, in accordance with the guidelines of the International Committee of Medical Journal Editors.

## INSTRUCTIONS FOR AUTHORS

Acta Stomatologica Marisiensis Journal is an international journal dedicated to publishing high quality peer-reviewed articles pertaining to dental medicine. The themes covered by the journal include all the fields of dentistry, within a broad spectrum of disciplines and therapeutic areas, including, but not restricted to oral health, prosthetic dentistry, endodontics, paedodontics, orthodontics, oro-maxillo-facial surgery, implantology, dental materials, digital dentistry, nanotechnology and materials or medical engineering.

The journal does not have article processing charges, neither article submission charges.

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All manuscripts submitted to Acta Stomatologica Marisiensis must be original, high quality and

conform to the "Uniform Requirements for Manuscript Submitted to Biomedical Journals" published in *Annals of Internal Medicine* (1997;126:36-47).

Authors should not submit the same manuscript simultaneously to more than one journal, in the same or different language.

Authorship

All individuals listed as authors should qualify for authorship and should have participated sufficiently in the work to take public responsibility for appropriate portions of the content.

Authors included in the manuscript should meet all of the following conditions as stated in the ICMJE (International Committee of Medical Journals Editors) guidelines:

- Substantial contributions to the conception and design of the work, acquisition, analysis or interpretation of data;
- Drafting the article or revising it critically, for important intellectual content;
- Final approval of the version to be published.

- Agreement to be accountable for all aspects of the work in ensuring that questions related to the accuracy or integrity of any part of the work are appropriately investigated and resolved.

Any other contributors, who do not qualify for authorship, should be acknowledged in an acknowledgment section. For further information about authorship, please refer to the ICMJE guidelines.

Studies involving experimental research on animals or humans must conform to the guiding principles of the Declaration of Helsinki. In case of research involving human subjects, the manuscript must contain a statement within the "Material and Methods" section indicating that the study protocol has been approved by the author(s) institutional ethical committee and that all study participants have given informed consent to the participate, or that the ethical committee has waived the need for informed consent. In order to respect patient confidentiality and the right to privacy, identifying information such as patient's names, images, hospital or hospital record details, should not be included in any published material unless the information is essential for the scientific content. If so, written permission must be obtained from the patient, and this permission should be submitted to the editorial office prior to publication.

In case of manuscripts reporting clinical trials, these should be registered in a public trials registry at or before the time of first patient enrolment, as a condition for consideration for publication. Trials should preferably be registered in ClinicalTrials.gov, but in accordance with the guidelines of the International Committee of Medical Journal Editors any primary register of the WHO International Clinical Trials Registry Platform (ICTRP) is acceptable.

The journal does not have article processing charges nor article submission charges.

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The submission should include the following attachments:

1. Cover letter
2. License to publish
3. Manuscript
4. Figures
5. Tables
6. Appendices

#### 1. Cover letter

All manuscripts should be submitted together with a cover letter attached as a separate file, stating that:

- the manuscript is original
- no portion of the manuscript is under consideration for publication in any other journal

or has been previously published, except as an abstract of fewer than 400 words.

- all authors have read and approved the manuscript and accept responsibility for the full content.
- Authors must state all possible conflicts of interest relating to the manuscript or, if there are none, this should be stated as "none declared".

The cover letter should be signed by all authors. The corresponding author submits the manuscript and annexes on their behalf.

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A license to publish statement should be signed by be signed by all authors. The standard format of this document is available at [www.asmj.ro](http://www.asmj.ro)

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The manuscripts, including all tables and references, must be prepared in Word format. The text should be typed double-spaced with no indent, using "Times New Roman" font size 12.

Please arrange the contents of your manuscript in the following order:

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- Author names and affiliations. Where the family name may be ambiguous (e.g., a double name), please indicate this clearly. Present the authors' affiliation addresses (where the actual work was done) below the names. Indicate all affiliations with a lower-case superscript number immediately after the author's name and in front of the appropriate address. Provide the full postal address of each affiliation, including the country name and, if available, the e-mail address of each author.
- Corresponding author. Clearly indicate who will handle correspondence at all stages of refereeing and publication, also post-publication. Ensure that phone numbers (with country and area code) are provided in addition to the e-mail address and the complete postal address. Contact details must be kept up to date by the corresponding author.

II. Abstract – an abstract of no more than 300 words should accompany manuscripts relating to original research, case presentations and review articles. This should be structured using the following headings: Introduction, Aim of the study, Material and Methods, Results, Conclusions. Detailed instructions on abstract preparation according to each manuscript type are given below.

III. Key words – up to 10 keywords should be supplied by the author(s).

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IV. Full text – should be formatted in Microsoft Word, double-spaced, single columned. Use headings and subheadings in all the sections. Original research articles should not exceed 5.000 words including references, tables, table legends and figure legends, and should be divided into the following sections:

a. Introduction

This must be presented in a structured format, covering the following subjects, although actual subheadings should not be included:

- succinct statements of the issue in question;
- the essence of existing knowledge and understanding pertinent to the issue (reference);
- the aims and objectives of the research being reported relating the research to dentistry, where not obvious.

b. Materials and methods

- describe the procedures and analytical techniques.
- only cite references to published methods.
- include at least general composition details and batch numbers for all materials.
- identify names and sources of all commercial products e.g. Voltarol® Emulgel® Gel (Company, Town, Country).
- specify statistical significance test methods.

c. Results

- refer to appropriate tables and figures.
- refrain from subjective comments.
- make no reference to previous literature.
- report statistical findings.

d. Discussion

- explain and interpret data.
- state implications of the results, relate to composition.
- indicate limitations of findings.
- relate to other relevant research that should be cited and listed in the references section.

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- must NOT repeat Results or Discussion
- must concisely state inference, significance, or consequences

When preparing your manuscript, consider the following rules:

- Define abbreviations that are not standard the first time they appear in the text, followed by the abbreviation in brackets.. Such abbreviations that are unavoidable in the Abstract must be defined at their first mention there. Ensure consistency of abbreviations throughout the article
- All references, tables and figures should be cited in numerical order.
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preparing the manuscript. Poorly written manuscript will be returned for improvement before commencing the editorial process.

V. Acknowledgments – collate acknowledgements in a separate section at the end of the article before the references and do not, therefore, include them on the title page, as a footnote to the title or otherwise. List here those individuals who provided help during the research (e.g., providing language help, writing assistance or proof reading the article, etc.).

Please indicate any source of funding including grants, contracts or any other form of financial support relating to the study.

VI. References – Number the references in the order in which they are first cited in the text. References should be indicated as full-size Arabic numerals in square brackets placed before punctuation marks.

VII. Reference style – List all authors if six or less; otherwise list first three and add “et al”. Please abbreviate titles of periodicals according to Index Medicus, or spelled out in full if not listed in Index Medicus. Use the following formats, paying close attention to the use of punctuation i.e.colon (:), semi-colon (;), coma (,) and full-stops (.)

For journal articles: Kim J, Fitzgerald JG, Sanders AK, Hofman HG. Long term survival following implantation of drug eluting stents. *J Am Coll Cardiol.* 2002;42:652-8.

For articles-in-press: Hendricks-Ferguson VL, Sawin KJ, et al. Novice Nurses’ Experiences with Palliative and End-of-Life Communication. *J Pediatr Oncol Nurs.* 2015. doi: 1043454214555196. [Epub ahead of print]

For a chapter in a book: La Rovere MT, Schwartz PJ: Baroreflex sensitivity. In Opie, L: *Drugs for the Heart*, Sixth Edition. Philadelphia: WB Saunders. 2006, pp.67-93.

For a Book: Eisen HN. *Immunology: an introduction to molecular and cellular principles of the immune response.* 5th ed. New York: Harper&Row; 1974. P.406.

VIII. Units – follow internationally accepted rules and conventions: use the international system of units (SI). If other units are mentioned, please give their equivalent in SI.

4. Figures

Figures should be prepared separately and sent as additional files, in TIF or JPG format, or compressed into one ZIP file. The figures should be prepared at the standard resolution of 300 dpi. All abbreviations used in a figure should be explained in the figure legend. Figure legends should be concise but explicit, enabling a clear understanding of the illustration. Figures and figure legends should be numbered in Arabic numerals in the order of appearance in the text and should not be imbedded within the text. Colour figures are preferred. Where a figure(s) is reproduced

or adapted from another source, the author must first seek permission from both the author and publisher of the original material. Written evidence of permission for reproduction in both print and electronic formats for worldwide distribution must be forwarded with the manuscript and state "Reproduced with permission from..." or "Adapted with permission from..."

#### 5. Tables

These must be self-explanatory and should not duplicate the text. Tables should be numbered in Arabic numerals in the order of mention in the text and should not be imbedded within the text. Instead, each table should be typed on a separate page at the end of the manuscript. All the abbreviations used in the table should be typed as footnotes immediately below the table. Tables should be created with Word's Insert Table function in order to be editable. Do not submit tables as image files.

#### 6. Appendices

If there is more than one appendix, they should be identified as A, B, etc. Formulae and equations in appendices should be given separate numbering: Eq. (A.1), Eq. (A.2), etc.; in a subsequent appendix, Eq. (B.1) and so on. Similarly for tables and figures: Table A.1; Fig. A.1, etc.

Acta Stomatologica Marisiensis Journal also publishes the following types of papers:

##### Reviews

The journal publishes comprehensive review papers on actual topics of interest related to dental medicine. Review articles should include a brief non-structured abstract of no more than 300 words and the text should be limited to 5.000 words including tables and figures, excluding references. In extraordinary situations or relevant and extensive topics, the Editor-in-Chief may decide to accept papers with a higher number of words, a maximum of 400 words for the abstract and 6.500 for the text, including tables and figures, excluding the references. Review articles can be submitted by invitation or unsolicited. In both cases, full consideration will be given to articles providing a substantial contribution to a better understanding of a pathophysiological or clinical aspect in a field related to dental medicine.

##### Case reports and case series

Case reports should be limited to presentation of a single particular and uncommon case, or uncommon presentation of a disease. Case series include description of a series of a maximum of 10 cases with common particularities. The abstract should be limited to 300 words, being divided into introduction, case presentation / presentation of case series and conclusions. The full manuscript should not exceed 3.000 words including references, figures and tables,

being divided into sections headed Introduction, Case presentation / presentation of case series, Discussions, Conclusions. In manuscripts pertaining to case presentation or case series, the number of authors should be limited to four, the number of references to thirty and the number of figures to 8.

##### Original papers

Definitive reports on a full study, describing original preclinical or clinical study (which is not a case presentation or a case series report) represent research of high scientific level and timeliness. A concise abstract of no more than 300 words is required. The abstract should briefly state the purpose of the research, the main results and major conclusions. An abstract is often presented separate from the article, so it must be able to stand alone. The manuscript should be written clearly and concisely. The authors are responsible for providing the correct nomenclature, which must be consistent and unambiguous. The text should be arranged in the following order: Introduction, Materials and Methods, Results, Discussion and Conclusions.

The length of the manuscript should be limited to 5000 words (including references, tables and figures).

##### Brief reports

Brief reports refer to articles presenting a short communication related to an original preclinical or clinical study which is not a case presentation or a case series report. While the structure of the abstract and of the full text should be detailed similar to that for full original articles, the length of the manuscript should be shorter, the abstract limited to 200 words and the full text (including references, tables and figures) to 2.000 words.

##### Letter to editor

A letter to the editor may refer to an article recently published by the journal, commenting on the article in a constructive professional manner the content of which, in the opinion of the author(s) would add the current status of knowledge in the field. If accepted, the letter will be sent to the authors of the original article who will have the opportunity to respond and to have their response published in the same journal issue as the letter to the editor. The letters should be limited to 500 words, 5 references and 3 authors. No abstract is required.

##### Editorial

Editorials should be limited to 3000 words (including references) and should be related to an article published in the current number or to a specific topic that is current and of high interest to the readers.

##### State-of-the-art papers

The journal publishes state-of-the-art articles that aim to provide an update on the current status of areas of high interest to dental medical specialists. The main aim of such articles is to offer the specialist and other practitioners a source of continuous

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education and forum for discussion. A state-of-the-art article should have a full text limited to 5.000 words, in addition to a 300 word unstructured abstract. Sections of the article should be divided using headings relevant to each particular case.

#### Peer review process

Submitted manuscripts are first checked to ensure that they comply with instructions to authors and are in accordance with the "Uniform Requirements for Manuscripts Submitted to Biomedical Journals", *Annals of Internal Medicine*, 1997,126, 36-47, and that all references, figures and tables meet the journal's requirements.

All manuscripts sent to the journal are routinely screened using specialized anti-plagiarism soft-wares. In all cases where any possible irregularity exists, the editorial office will follow the principles stated in COPE (Committee on publication ethics) guidelines.

Only manuscripts complying with the above requirements and free of possible irregularities, will be entered into the review process. The author(s) will be informed that the manuscript has been accepted for review.

Authors may suggest the names of potential reviewers and the Editor may choose, without obligation or explanation, to use one or more of these. Authors may also specify the names of a person(s) which they do not wish to review their manuscript, in which case a brief explanation should be given.

All articles will be reviewed by at least two peers with expertise in the manuscript's subject matter. The identities of the reviewers, chosen by the editor, will not be disclosed to the authors.

The average time from submission to a decision following the first review is approximately 4-6 weeks. Based on the reviewers' opinion, the Editor will choose one of the following alternatives:

- Accepted;
- Minor revisions required;
- Major revisions required;

In cases where revision is required, the author(s) will be invited to amend their manuscript, which should be resubmitted as soon as possible, but not later than 6 weeks. The revised manuscript will be reappraised by the initial reviewers and notification of a final decision will be sent to the author in approximately three weeks.

After acceptance and prior to publication, authors will receive a pdf file with the edited version of their manuscript for final proofreading and will be asked to carefully check the completeness and accuracy of the text, tables and figures.

#### Complaints

In cases where the authors wish to file a complaint, please contact the editorial office:

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