

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

MEDLINE 1966 to Feb3, 2019	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]
EMBASE (Excerpta Medica) 1980 to Feb3,2019	using terms as in MEDLINE.
ERIC (Educational Resources Information Center) 1970 to Feb3,2019	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
WEB OF SCIENCE was searched till Feb3,2019	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.¹² 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].

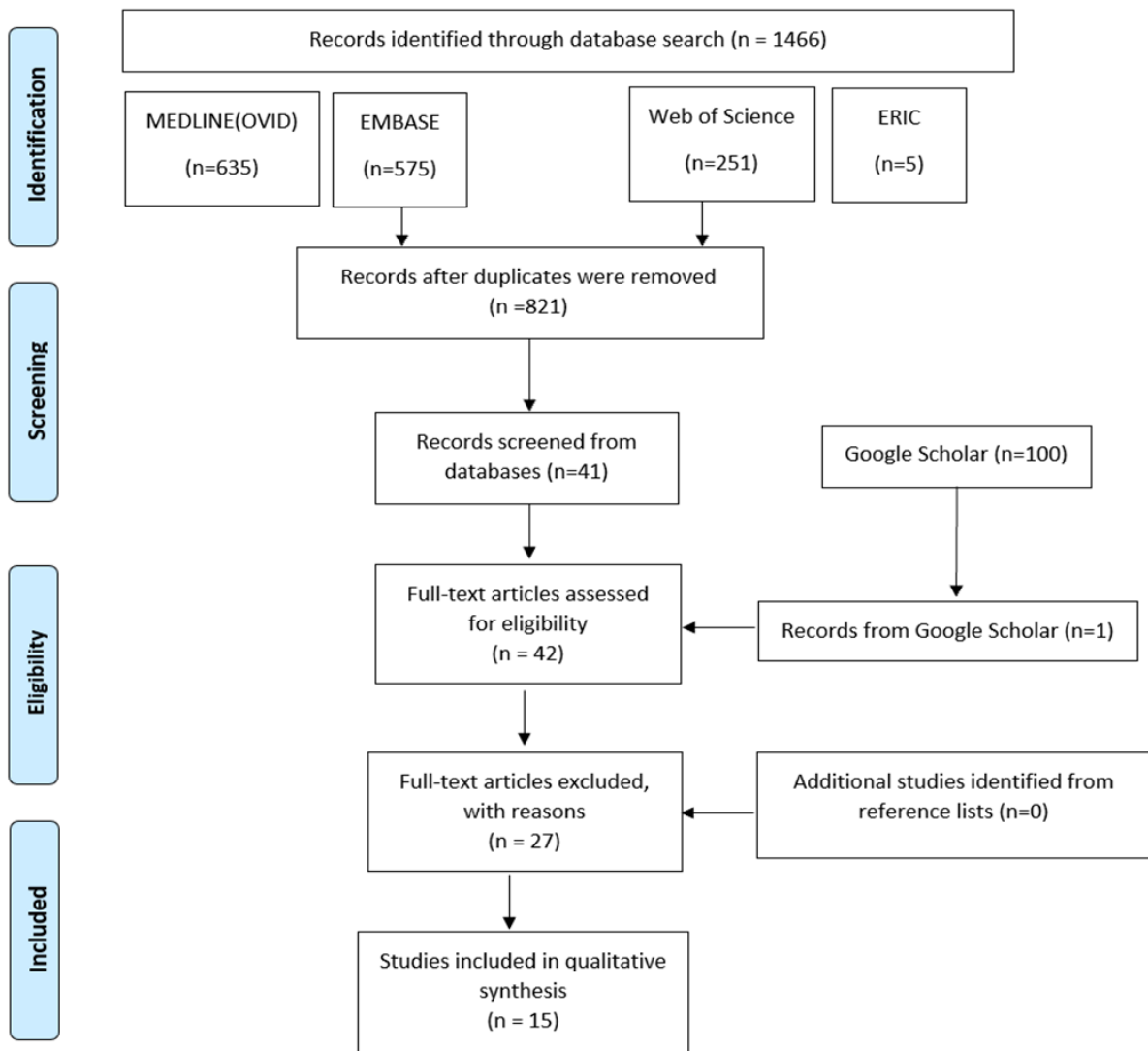


Figure 1: PRISMA 2009 Flow Diagram

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) ²¹	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.

Conflict of interest: None to declare.

Acknowledgments: None declared

References

1. Chaudhary S, Gowda TM, Kumar TAB, Mehta DS. Knowledge, Attitude and Practice of undergraduate dental students towards dental implants-An All-India Survey. *Implant Dent* 2015; 24:160-5.
2. Guo Q, Lalji R, Le AV. Survival rates and complication types for single implants provided at the Melbourne Dental School. *Australian Dental Journal* 2015; 60:353-61.
3. Maalhagh-Fard A, Nimmo A. Eleven-year report on a predoctoral implant dentistry program. *J Prosthodont* 2008; 17:64-8.
4. Kohavi D, Azran G, Shapira L, Casap N. Retrospective clinical review of dental implants placed in a university training program. *J Oral Implantol* 2004; 30:23-9.
5. Lee DJ, Harlow RE, Yuan JC, Sukotjo C, Knoernschild KL, Campbell SD. Three-year clinical outcomes of implant treatments provided at a predoctoral implant program. *Int J Prosthodont*. 2011 Jan-Feb;24(1):71-6.
6. Prasad S, Bansal N. Predoctoral Dental Students' Perceptions of Dental Implant Training: Effect of Preclinical Simulation and Clinical Experience. *J Dent Educ* 2017;81: 395-403.
7. Daneshvar SS, Matthews DC, Michuad PL, Ghiabi E. Success and Survival Rates of Dental Implants Restored at an Undergraduate Dental Clinic: A 13-Year Retrospective Study with a Mean Follow-up of 5.8 Years. *Int J Oral Maxillofac Implants* 2016; 31:870-5.
8. Al-Sabbagh M, Jenkins DW, de Leeuw R, et al. Programmatic assessment of a university-based implant training program using patient-reported outcomes. *J Dent Educ* 2014; 78:1534-1.
9. Moher D, Liberati A, Tetzlaff J, Altman DG. PRISMA group. preferred reporting items for systematic reviews and meta-analyses: The PRISMA statement. *Open Med* 2009; 3:123-30.
10. Joanna Briggs Institute. Checklist for cross sectional studies. [Internet]. Australia: University of Adelaide; 2014. At: <https://wiki.joannabriggs.org/display/MANUAL/Appendix+7.5+Critical+appraisal+checklist+for+analytical+cross-sectional+studies>. Accessed: June 27, 2019
11. Joanna Briggs Institute. Checklist for case series studies. [Internet] . Australia: University of Adelaide; 2014. Available from <https://wiki.joannabriggs.org/display/MANUAL/Appendix+7.3+Critical+appraisal+checklists+for+case+series>
12. Bonde MJ, Stokholm R, Schou S, Isidor F. Patient satisfaction and aesthetic outcome of implant-supported single-tooth replacements performed by dental students: a retrospective evaluation 8 to 12 years after treatment. *Eur J Oral Implantol*. 2013; 6:387-95.
13. P. Atashrazm, N. Vallaie, R. Rahnema et al. Worldwide Predoctoral Dental Implant Curriculum Survey. *Journal of Dentistry* 2011; 8:12-18.
14. Temmerman A, Meeus M, Dhondt R, et al. Oral implant placement and restoration by undergraduate students: clinical outcomes and

- student perceptions. *Eur J Dent Educ* 2016; 20:73-83.
15. Harrison P, Polyzois I, Houston F, Claffey N. Patient satisfaction relating to implant treatment by undergraduate and postgraduate dental students - a pilot study. *Eur J Dent Educ* 2009; 13:184-8.
 16. Prasad S, Hambrook C, Reigle E, Sherman K, Bansal N, Hefti A. Implant Treatment in the Predoctoral Clinic: A Retrospective Database Study of 1091 Patients. *J Prosthodont* 2017; 26:559-67.
 17. Hickin MP, Shariff JA, Jennette PJ, Finkelstein J, Papananou PN. Incidence and Determinants of Dental Implant Failure: A Review of Electronic Health Records in a U.S. Dental School. *J Dent Educ* 2017; 81:1233-42.
 18. Vandeweghe S, Koole S, Younes F, De Coster P, De Bruyn H. Dental implants placed by undergraduate students: clinical outcomes and patients'/students' perceptions. *Eur J Dent Educ* 2014; 18:60-9.
 19. Lee DJ, Yuan JC, Hedger PJ, et al. Patient Perception and Satisfaction with Implant Therapy in a Predoctoral Implant Education Program: A Preliminary Study. *J Prosthodont* 2015; 24:525-31.
 20. Dias R, Moghadam M, Kuyinu E, Jahangiri L. Patient satisfaction survey of mandibular two-implant-retained overdentures in a predoctoral program. *J Prosthet Dent* 2013; 110:76-81.
 21. Moghadam M, Dias R, Kuyinu E, Ferguson MB, Mucciolo T et al. Predoctoral fixed implant patient satisfaction outcome and challenges of a clinical implant competency. *J Dent Educ* 2012;76:437-42.
 22. Kronstrom M, McGrath L, Chaytor D. Implant Dentistry in the Undergraduate Dental Education Program at Dalhousie University. Part 1: Clinical outcomes. *Int J Prosthodont* 2008; 21:124-8.
 23. McAndrew R1, Ellis J, Lynch CD, Thomason M. Embedding implants in undergraduate dental education. *Br Dent J* 2010; 208:9-10.
 24. Koole S, De Bruyn H. Contemporary undergraduate implant dentistry education: a systematic review. *Eur J Dent Educ* 2014; 18:11-23.
 25. Koole S, Vandeweghe S, Mattheos N, De Bruyn H. Implant dentistry education in Europe: 5 years after the Association for Dental Education in Europe consensus report. *Eur J Dent Educ* 2014; 18:43-51.
 26. Seitz SD, Zimmermann RL, Hendricson WD. Expansion of a Predoctoral Surgical Implant Selective for Dental Students. *J Dent Educ* 2016; 80:328-33.
 27. Kroeplin BS, Strub JR. Implant Dentistry Curriculum in Undergraduate Education: Part 2- Program at the Albert-Ludwigs University, Freiburg, Germany. *Int J Prosthodont* 2011; 24:544-56.
 28. Cummings J, Arbree NS. Prosthodontic treatment of patients receiving implants by predoctoral students: five-year follow-up with the IMZ system. *J Prosthet Dent* 1995; 74:56-9.

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