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Implantology curriculum in India and worldwide at different levels of education

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ABSTRACT

Aim Even though it has remarkable importance in practice, implantology is not given a crucial teaching in the dental curriculum. Therefore the aim of the present systematic review is to perform a content analysis and explore the status of implantology curriculum in India and globally at different levels of education.

Methods The major electronic databases were screened. All types of study including descriptive studies, surveys, reviews, commentaries, editorials were included. The risk of bias assessment in the present study was conducted by using the recommended approach. The two-part tool was used to address the six specific domains.

Result The present systematic review yielded 2000 articles on initial search; first, 976 duplicate publications were removed. After screening additional 968 articles were excluded, leaving 56 publications; 19 studies concentrating upon the current status of prosthodontic implantology curriculum at undergraduate, postgraduate and predoctoral level were included in this systematic review. Various forms of teaching were indicated in the included studies such as didactic form of training, preclinical or laboratory experiences in simulated forms using phantom heads or by performing necessary laboratory work related to implantology. Most of the undergraduate curriculum included didactic forms of teaching.

Conclusion Prosthetic implantology curriculum varies worldwide, but a large percentage of institutes agrees on certain topics. Almost 80% institutes across the world seem to have some form of implantology training as part of the curriculum. Various barriers were identified to implantology education by the experts and included difficulty of integration of additional program into already overcrowded curriculum, introduction of relevant content in suitable time frame, funding, adequate infrastructure and utilization of specialized faculty.

INTRODUCTION

Implantology is a dynamic science which has been under a constant process of innovation. Improvements are at every stage, right from the diagnosis and imaging modalities, where vast strides are made in CT CBCT and MRI imaging (1). Treatment planning has evolved markedly due to softwares that increase the predictability of implant treatment. Guided surgery has improved implant placement, and newer grafting techniques and materials have been adopted (1). Concepts in implantology such as All-on-X have evolved now offering a wide range of components, in particular distinct lengths and zygomatic or pterygoid implants, which are finding greater importance (1). Constant modifications are done in implant designing at micro and macro level with surface modifications and designing technologies. Digitization has served as a boon to implantology with the advent of Computer aided designing and computer aided manufacturing (CAD/CAM) technology, direct metal laser sintering (DMLS) etc. Hundreds of advances are taking place in implantology by the minute (2). Therefore the growing world need to establish and enhance standardized instruction and curricula in prosthodontic implantology (Dental Implant Prosthetics) (3,4). Targeting the curriculums at base level to all the way up to higher education is essential (4). There is increasing recognition to imparting education and preparing students to make independent clinical decisions and steps are taken towards uniform curriculum at various levels in implantology education (4). Dental implants have become an upcoming trend nowadays (5). As more students are trained in implant placement, more patients may receive implants (4). As the global population ages, there is an increased

demand for Prosthodontic rehabilitations (6). The use of Implant dentistry to restore partially and completely edentulous jaw has become highly predictable and is being used more commonly due to its improved esthetics, improved functional phonetics and longevity of the prosthesis (4,5).

Prosthetically determined implantology initially performed within specialty has gained relevance in other specialty and clinical practices (4). Implants are placed with surgical guides and stents provided by prosthetic residents and prosthodontics programs are also providing training of implant prosthodontics (4).

In the Indian scenario, universities and educational institutes work towards the implementation of curriculum for its regulation. The academicians provide advice and guidance towards the fulfillment of proposed curriculum (7). With unprecedented changes undergoing in education today it requires immediate and reasoned response with new and innovative strategies (8). The 'Board of Studies' under the purview of Maharashtra University of Health Sciences (MUHS) and other such state universities has the power and duty for curriculum development, to suggest organization of orientation and refresher courses in the subject, to recommend reference books and advise the faculties concerned regarding improvements in the course of study and provide regulation consequent to curriculum development by the teachers of the university for its introduction in the syllabi of the courses of study under the purview of the Board in accordance with the Regulations made by the Academic Council (9).

Studies evidences that, intense exposure to implant dentistry during training resulted in a significantly greater participation in implant prosthodontics (4). Comparison of Dental implant Education pertaining to diagnosis and treatment planning was done in USA and stated that curriculum was varied and there was scope for improvement in teaching the diagnosis and treatment (10, 11). Assessment of curriculum in Europe also revealed that coverage of curriculum is limited and when compared with 10 years ago, even stagnating (6,12). Surveys conducted in attempt to identify the future direction in education, stated that to optimize education, learning guidelines should be developed, based on the expected competencies for practicing dentists. Undergraduate education may start the process that must continue through all levels of education, including postgraduate level.

Evaluation of workshops and models such as i-lect, ADEA implant workshops *et cetera* were done and proposed that the programs at Academic Centre for Dentistry Amsterdam (ACTA) could be used as a template for other universities (13). The results indicated that, the structured i-lect undergraduate curriculum enhanced knowledge in the specific field of implantology. This program could have pilot character for use in other universities (13). There has not been a recent survey assessing the trends in prosthodontic implantology, that included all the competencies and assessed education at various levels (4). Unlike the previous reports which focuses mainly on data from convenience samples from selected countries supplemented by the literature review in a single database, the present report differs, being a systematic review which includes a more recent and wider literature searched specifically on prosthodontics implantology curriculum in various parts of the world (2).

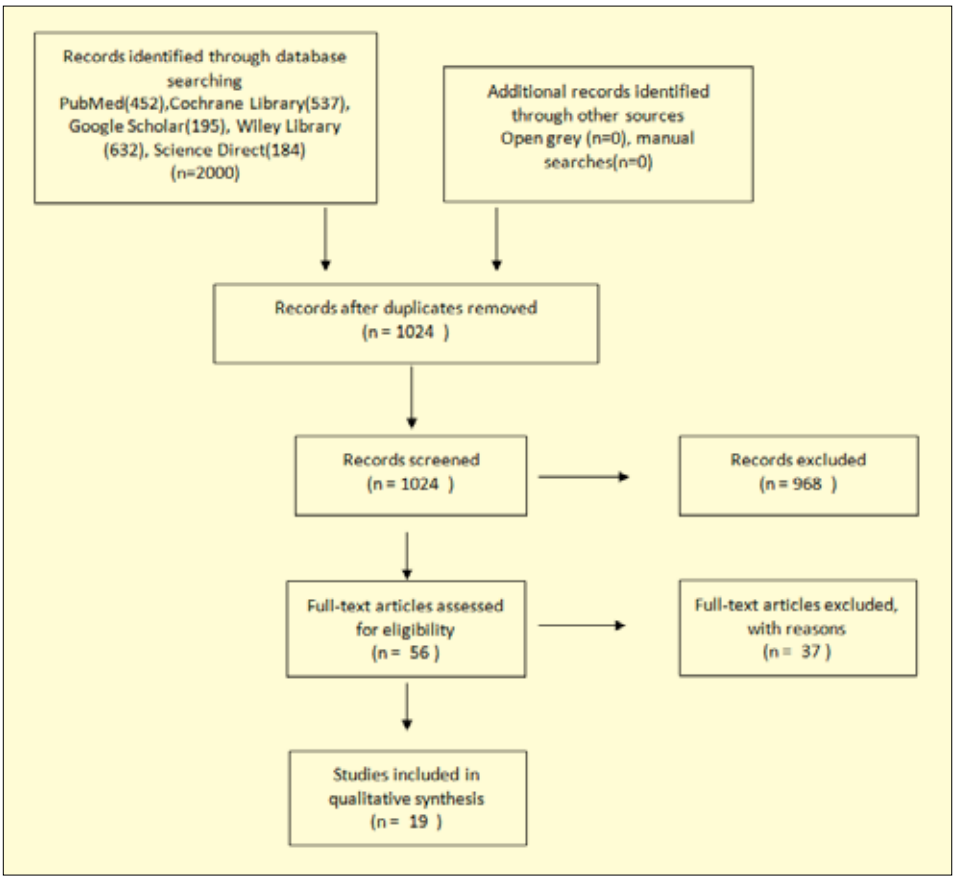
Therefore the aim of the present systematic review is to perform content analysis and explore thoroughly the recent status of implantology curriculum in India and Globally at different levels of education. The method employed to impart the training, to know if the training is theoretical or includes preclinical or clinical training. The educational outcome competencies, barriers and reflection about the integration of implants in the curriculum.

METHODS

The major electronic databases were screened i.e. MEDLINE (via Pub Med), The Cochrane library of the Cochrane Collaboration (CENTRAL), Google Scholar, Wiley online Library and Science Direct. In addition, electronic screening for grey literature was performed at the system for Information on Grey Literature in Europe- Opengrey (http://www.opengrey.eu/) as recommended by AMSTAR (Quality assessment of systematic Review guideline)s. The electronic search was supplemented by hand searches of the bibliographies of the retrieved full-text articles and a hand search of the relevant dental journals. The search strategy included a combination of the controlled terms (MeSH) and keywords were used whenever possible in an attempt to obtain the best search results. In addition, other terms not indexed were used. The keywords used included implant, curriculum, and education, undergraduate, postgraduate and predoctoral. As a complement, a manual search of main primary source related topic was performed and the reference lists of definitely included articles were consulted to find possible eligible studies. The focus question was established to address precisely the purpose of this systematic review.

All types of study including descriptive studies, surveys, reviews, commentaries, editorials were included due to the nature of the review. Only dental undergraduate, postgraduate and predoctoral curriculum and implant curriculum taught only by prosthodontics department was considered. Hygienists or Technicians courses, Studies involving Periodontology or oral surgery department were excluded. Studies conducted during the year 2000 to January 2020 and published in

FIG. 1 Used search strategy



English language only were included in the review. The screening process was carried out in 4 stages keeping in line with the PRISMA flow diagram (Fig. 1). The literature search was performed, all the titles and abstracts of the collected articles were read and judged for the inclusion in the review. All the duplicates were removed. For studies that met the inclusion criteria, full text articles were obtained and further evaluated.

The present systematic review yielded 2000 articles on initial search; first 976 duplicate publications were removed. After screening, further 968 articles were excluded, leaving 56 publications. 19 studies concentrating upon the current status of prosthodontic implantology curriculum at undergraduate, postgraduate and predoctoral level were included in this systematic review. There was a good reliability between the two reviewers with a high kappa coefficient (k> 0.89). Out of the included studies, 14 were descriptive questionnaire surveys while the remaining 3 were program overview, description of program and discussion following implant forum, 9 studies commented on undergraduate curriculum, 4 studies on postgraduate curriculum and 6 studies commented on predoctoral level of education.

The risk of bias assessment in the present study was conducted by using the recommended approach for assessing risk of bias in studies included in Cochrane Reviews (Higgins, 2011) using the tool RevMan 5.4.1

The two-part tool was used to address the six specific domains. Each domain included one or more specific entries in a 'Risk of bias' table. Within each entry, the first part of the tool involves describing what was reported to have happened in the study. The second part of the tool involves assigning a judgment relating to the risk of bias for that entry: either low risk, unclear risk or high risk.

The domains of sequence generation, allocation concealment, incomplete outcome data and selective outcome reporting are addressed in the tool by a single entry for each study. When the operator assessed the outcome of the trial, this was noted. The final domain ('other sources of bias') was assessed as a single entry for studies as a whole. After taking into account additional information provided by the authors of the trials, review authors grouped studies into the following categories. There was a good reliability between the two reviewers with a high kappa coefficient (k>0.89), 'Risk of bias' table for each included study was completed and results were presented graphically (Fig. 2, 3).

RESULTS

The studies included reported the presence of

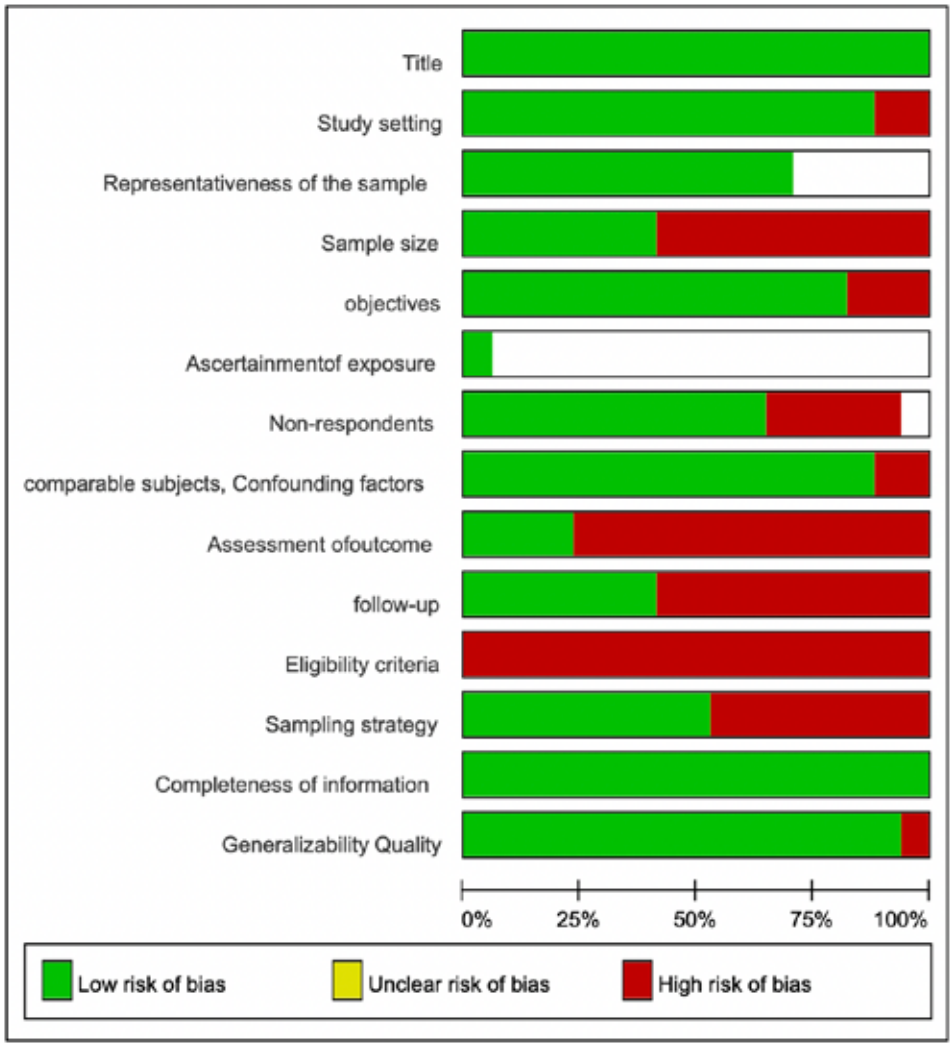


FIG. 2 Risk of bias graph-review authors' judgments about each risk of bias item presented as percentages across all included studies.

implantology as a part of undergraduate curriculum. Four studies summarizing 44 institutes from Europe and south East Asia reported presence of implantology as a part of undergraduate curriculum. Chaudhary et al. reported the status of undergraduate implantology curriculum from one institute in India, where only 26.6% of students reported that they are provided sufficient information about implants. The prosthodontic postgraduate curriculum at 59 institutes in 18 countries of Europe, and 6 institutes in Iran reported presence of implatology as part of the curriculum. Only 40% of institutes included in the study by Sukotjo et al. (2008) in USA and Canada reported implantology as part of curriculum. The predoctoral curriculum at 33 countries in Europe indicated 75% out of 56 countries provide education in implantology. Studies conducted by Lim et al., Petropolous et al., Barwacz et al. and Kihara et al. in USA and Canada indicated 84- 100% presence of implantology amongst the total institutes included in the study.

Various forms of teaching were indicated in the included studies such as didactic form of training, preclinical or laboratory experiences in simulated forms using phantom heads or by performing necessary laboratory work related to implantology, clinical training was provided by either observing or assisting in implant restorative procedures or during the surgical placement of implants, training for the maintenance of implants was also provided.

Most of the undergraduate curricula included didactic forms of teaching. The studies across Europe indicated presence of various forms of preclinical and clinical training. The study conducted by Lang et al. across 7 south Asian countries involving 10 institutes mentioned that none of the institutes provide preclinical training and only 1 institute provided clinical experience in implantology. The postgraduate curriculum of prosthodontics as assessed in Europe, USA, Canada and Iran reported presence of didactic form of teaching. Other forms included preclinical training via plastic jaws, human cadaver or Simlab, the clinical training for prosthetic postgraduate involved restorative components but also 66% schools in US and Canada required to observe implant surgery. The predoctoral curriculum worldwide also included

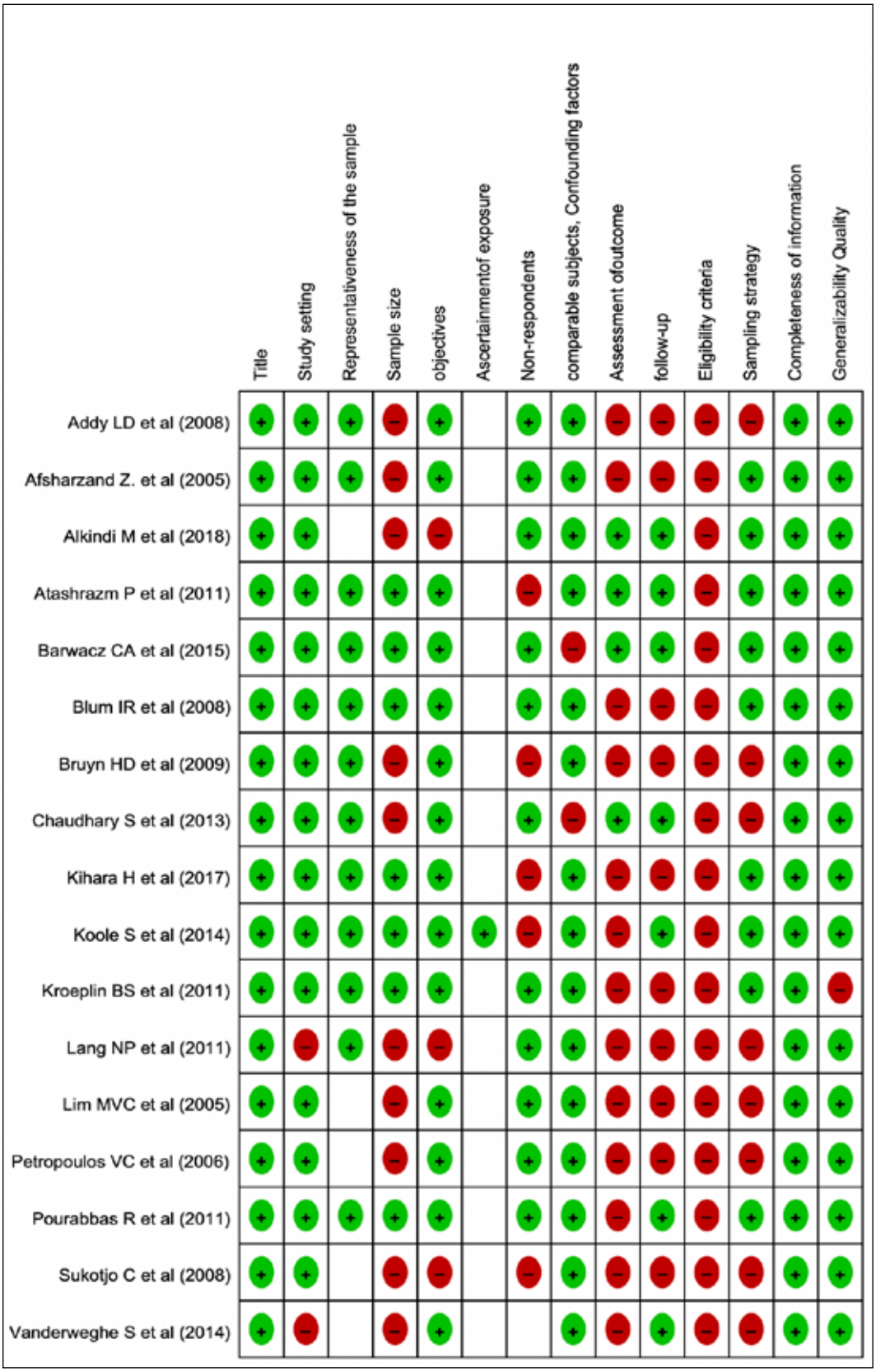


FIG. 3 Risk of bias summary-review authors' judgments about each risk of bias item for each included study. The data extracted from included study were gathered and arranged into tables to evaluate the outcome and characteristics of included studies.

didactic form of training as the leading method of teaching while laboratory and clinical training in certain percentage were included in institutes as summarized in Table 1.

Out of the included studies only four studies mentioned the course content. The topics included in the lecture series included historical overview, concepts of osseointegration, classification and types of dental

Publication	Main Outcome					
	Presence of implantology in curriculum	Method of teaching	Contents of curriculum	Procedures performed	Teaching hours	Barriers to implantology to become a part of curriculum
UNDERGRADUATE CURRICULUM						
Blum et al	100% schools provided didactic teaching	9 schools provided opportunity for implant placement. 2 schools provided laboratory based hands on experience 4 schools provided clinical hands on with restorative and maintenance stage of implant 7 schools provided opportunity to observe the restorative treatments stage			11 schools provided less than 10 lecture hours and 2 schools reported 11-20 lecture hours.	
Addy et al	87% schools provided training in implant	Eight schools utilized phantom head for training 7 schools provided clinical experience by observing restoration, in 5 schools students observed live implant surgery			47% schools- 4-6 teaching sessions 20% schools- 1-3 sessions 20% schools- >6 sessions	-funding -lack of available time -Insufficient trained staff
Bruyn et al	100% reported that implant dentistry is a part of undergraduate curriculum	100% institutes provide theoretical instructions 65% provide preclinical instructions 51% are allowed to assist and 28% provide clinical experience 70% receive clinical experience in prosthetic restoration			Amount of time assigned is avg 36 hrs ranging from 3 to 120 hours.	
Kroeplin et al	Present	28 lecture hour Hands on courses with phantom heads Clinical experience also provided				
Lang	Presence of implant curriculum in all the 10 universities	No institute provides practical stimulation while 1 out of 10 institute provides clinical experience			with3-40 hrs dedicated to implantology	

Publication	Main Outcome					
	Presence of implantology in curriculum	Method of teaching	Contents of curriculum	Procedures performed	Teaching hours	Barriers to implantology to become a part of curriculum
Chaudhary et al	Present	Only 26.6% reported that they are provided sufficient information about implant				
Vandeweghe et al	Present	Preclinical training before actual placement of implant			10.5 lecture hours on basics of implantology	
Koole et al	98% indicated presence of implantology as a part of curriculum	75% reported that ugs are allowed clinical experience in prosthetic restoration 64% respondents reported clinical experience in surgical placements at their institute			Average of 72 hrs spent on the curriculum with the range of 4 to 288 hrs.	
Alkindi et al	All schools provide implant dentistry education	Only 3 out of 5 schools exposed the students to laboratory or clinical training			22-30 hours dedicated to implantology curriculum.	
POSTGRADUATE CURRICULUM						
Sukotjo et aL	40% reported having a specific implant curriculum	20% schools require residents to place implants 23% have option to place implants 12% are prohibited implant placement 44% allow residents to participate in all phases 51% use plastic jaw for lab training 3% use human cadaver 7% use simlab 44% took the same surgical course 66% schools reported that prosthodontic residents are required to observe implant surgery				

Publication	Main Outcome					
	Presence of implantology in curriculum	Method of teaching	Contents of curriculum	Procedures performed	Teaching hours	Barriers to implantology to become a part of curriculum
POSTGRADUATE CURRICULUM						
Bruyn HD et al	Included in pg prostho of all the institutes.					
Pourabbas R et al	Implant was a part of curriculum at all the six facilities					
Koole s et al	Present					
PREDOCTORAL CURRICULUM						
Afsharzand et al	75% schools reported to have implant dentistry course	37% schools have laboratory course in adjunction while 65% did not. 37% schools reported that predoctoral students restore implant cases	18% reported that they include all 26 of the BIOLOGICAL AND CLINICAL TOPIC. OTHER SCHOOLS TEACH DIFFERENT COMBINATION OF TOPICS		30% schools reported 11-20 lecture hours 23% reported 21-30 hours 30% reported less than 10 hrs and 10% reported 31-40 hrs Mean no. of lecture hour was 20.3	Lack of curriculum time,should not be in predoctoral curriculum, lectures are incorporated in restorative/ prosthetic course, lack of financial resource.
Lim et al	84% schools reported implant dentistry course as a part of curriculum	78% schools have a laboratory course in adjunction to course 88% schools report that students perform implant restorations	25% schools cover all the topic listed while 13% schools included all the topics except cranio-facial application of implants		57% schools reported 11-20 lecture hrs, 22% reported 21-30 hrs 9% reported less than 10 hrs and 6% reported 31-40 hrs. mean being 20.4 hrs	
Petropoulos et al	Present	97% schools reported that students receive didactic instruction in implants. 86% received clinical experience		Single tooth molar 90% Sngle tooth bicuspid 87% Implant overdenture with two implants and ball or stud attachment 83% 2-3-4 unit FPD 33% Implant overdenture with two implant an a bar attachment 175 No limits 3% 74% schools received surgical experience Restoration thaught by prosthodontics faculty in 94% of the schools Prostho faculty teaches implant surgery at 20% of the schools		

Publication	Main Outcome					
	Presence of implantology in curriculum	Method of teaching	Contents of curriculum	Procedures performed	Teaching hours	Barriers to implantology to become a part of curriculum
PREDOCTORAL CURRICULUM						
Atashrazm et al	86% of responding schools indicated the presence of implant curriculum (44% from north America and Europe and 56% from asia, Africa and south america)	49% dental schools reported that they involve predoctoral student in surgical and prosthodontic clinical procedures as observers, 14% schools allowed surgical placement and 33% allowed implant restoration 40% schools offered laboratory course in conjunction.			39% schools reported <10 lecture hours, 29% reporte 11-20 lecture hours, 15% reported 21-30 lecture hours and 6% reported 31-40 lecture hours	
Barwacz C et al	Some implant education is a part of curriculum			96.2% posterior single crown 88.5% mandibular overdenture 61.5% anterior crown 32.7% 3 unit fpd 59.6% anterior 3 unit fpd 7.7% cantilevered		
Kihara H et al	100% schools provided implant into core curriculum	98% reported didactic implant curriculum 17 hours on avg in didactic 87% reported laboratory component 29 schools provided clinical experience 89% reported participation in implant surgery 68% reported participation in implant restoration			14.4 hours were dedicated to lab component	

TABLE 1 Main outcomes.

implants, implants biomechanics, implant biomaterials, implant surface treatment, anatomy and histology of hard and soft tissue/implant interface, implant patient education, dental and medical presurgical assessment, radiographic evaluation, treatment planning for implant supported fixed partial denture, implant retained overdenture, partially edentulous cases, fully edentulous cases, single tooth restoration, screw and cement retained restorations, occlusion on implant restoration, craniofacial applications of implant, implant site selection, stage 1 and 2 surgical procedure, postsurgical care, adjunct surgical techniques, surgical complications and management, failing implants, implant prosthetic complications and management and current research and development in implantology.

Teaching hours dedicated to implantology in undergraduate curriculum were presented in the included study. Of all the studies included the average ranges from as low as 10.5 hours, as mentioned by Vandeweghe et al. in Belgium, to an average of 72 hours dedicated to implantology, as reported in the study by Koole et al. in Europe. Teaching hours dedicated to implantology in predoctoral curriculum ranged from 10 to 40 hrs across the studies.

Four studies included in the present systematic review also commented on the barriers to implantology as part of the curriculum. The major barriers mentioned in the studies included insufficient funding, lack of available course time within existing teaching curriculum, and insufficient number of trained faculty in prosthodontics. Other barriers mentioned were lack of patients, government or insurance regulations and emphasis on basic prosthodontic curriculum rather than advanced procedures.

DISCUSSION

Prosthetic implantology or dental implant prosthetics is an upcoming and evolving field (3). The prevalence of implants for prosthetic rehabilitation of partially dentate and edentulous patients is increasing (6). Implants provide success and predictability in prosthetic treatment which has led to an increasing number of patients seeking treatment (6). Implantology is a multidisciplinary entity and professionals work in collaboration in providing the treatment (14). Prosthodontic Implantology is a highly specialized form of treatment and currently there is a shift towards the practice of prosthetic driven implantology (14). As the interest in implant treatment has increased, the demand for a provider who is well trained in delivering total implant treatment has also increased tremendously (4).

There has been a steady increase in inclusion of implantology in the prosthodontic curriculum (14, 15). The trend to incorporate implant placement into the postgraduate curriculum was already evident prior to 2004 (4). Didactic material and hands on workshops concerning implant placement and the option of placing implants were present in some programs (4). Interdisciplinary seminars where residents from different specialty interacted were also common (4).

A study also showed that recent graduates were more inclined to offer and perform implant prosthodontics in their practices when their dental school curriculum included implant courses (16). A brief review of the literature has shown that most developed countries have developed implant programs at the undergraduate level within the last ten to fifteen years (17); much of the progress has been made over the last five years, particularly with regards to an increased range of student learning experiences such as pre-clinical laboratory and simulation exercises, clinical attendance and hands on experience in the placement and restoration of implants (17).

All the studies in the review indicate the presence of implantology in some form as a part of undergraduate curriculum. Although theoretical training triumphs in undergraduate level, a small percentage of responding institutes shows the presence of laboratory and clinical training as well. On the other hand, predoctoral implant dentistry educational programs vary amongst institutes. Yet, almost all institutes agree on certain topics including the importance of including implant education in predoctoral dental programs (18). Thus, In this time for dental education reform, it is timely to examine how innovations to dental practice are introduced into already overloaded undergraduate, postgraduate and predoctoral degree curricula (19).

India is a remarkable country with the population of 1.2 billion, the second largest in the world and constitutes around 17.5% of the world population (20). With its large population the dentist:patient ratio is estimated to be 1:9000 in urban areas and 1:200,000 in rural areas with roughly 35,000 specialists practicing in the country (18). The prevalence of edentulism in India varies from 60% to 69% of 25 years and above age group (21), a consensus also states that 40% of Indian population will be of adult age group by 2030. Thus there will be an increase in demand for dental care. The increase in life expectancy with the huge population and continued economic growth, the country is experiencin, will result in a tremendous demand for better health care, consequently the scope for dental care and dental market is increasing exponentially (20).

All around the world, more than 80% institutes teach prosthetic implantology in some form (20). There has been a gradual increase in the numbers over the last 20 years (20). Most of the institutes are from the USA and Europe. The rest of the Asian and African countries are following closely behind in the development and

implementation of the curriculum. The difference can be attributed to the socioeconomic status of the developing countries and the lack in general dental care delivery systems (20).

A survey was conducted by the Association of Dental Education in Europe (ADEE) to organize a first workshop on implant dentistry university education in 2009. The survey was aimed to access the status of education in Europe and to develop competencies to overcome the deficits. The survey reported that implant dentistry is a part of the undergradauate curriculum, albeit with a disparity of time. The coverage of curriculum was found to be limited. In the workshop the academic leaders from Europe agreed on the recommendation that implant dentistry should be taught in undergraduate education. The workshop also laid out postgraduate competencies in four domains: clinical, management and leadership, communication and professionalism and ethics at different levels of clinical practice (20). After 5 years another survey was conducted for a second consensus workshop to monitor the progress since the first one (22). Comparison of the results from the two surveys revealed that all the institutes had theoretical teaching of implantology. There was a marked increase in preclinical training in prosthetic and surgical procedures and clinical training, and this demonstrates that implant dentistry is becoming more integrated in curriculum (12, 22).

Other surveys from Europe also reported that implantology was included as a part of undergraduate curriculum, however there were marked variations in the content and delivery of the teaching (6, 23, 24). Other surveys assessed the success of implants placed by undergraduate and it was found to be comparable to implants placed by experienced dentists. Clinical outcomes were acceptable, patient satisfaction and positive student perceptions were also achieved (25,26).

USA and Canada have seen a steady increase in implantology as a part of curriculum since 1974 (15). Most of the responding institutes had an established implant course in 2002 (15). Another study revealed that almost all the institutes provide implant education by the year 2006 (27).

In 2013, the Commission on Dental Accreditation added competence in providing dental implant prosthetic therapies to the accreditation standards for dental education programs (27). Studies reveal that all institutes had prosthetic implantology as a part of curriculum in 2017 (28,29). In spite of good statistical numbers the survey also reported the need for improvement in clinical experiences and need to develop ways to facilitate collaboration between advanced programs. Studies also revealed that although institutes share program directors or curricular similarities, clinical practices and modalities vary significantly by region (29).

A survey was conducted amongst the deans after ADEA implant workshop conference, and it was found that most schools have advanced dental education programs. Single-tooth implant restorations and Implant-retained overdenture prostheses are performed at the predoctoral level in most schools. Prosthodontic specialty faculty and periodontics and oral and maxillofacial faculty are often responsible for teaching implant prosthodontics and implant surgery respectively at the predoctoral level. There is a lack of adequately trained faculty in implant dentistry, which is a significant challenge in providing predoctoral students with clinical experience with dental implants (27).

The American College of Prosthodontics also conducted a survey to address the demand for implant treatment in patient care and enhance surgical implant knowledge and in 2005 they added placement of implants to its accreditation standards for advanced specialty education programs in prosthdodontics (4).

A worldwide survey of predoctoral curriculum was done including 62 countries from USA, Europe, Asia and Africa and revealed that a large percentage of responding schools included implant education in the predoctoral dental curriculum, in the onset year of course, topics included in lecture series, lecture hours faculty to student ratio and practical courses vary amongst schools (30).

A first Asia-Pacific Forum on Implant Dentistry was held in 2010 including institutes from 7 Asian countries with an aim to establish realistic goals in university education in implant dentistry for curriculum leaders and developers (19). Each participating institute shared an overview of their undergraduate curriculum and the status of the introduction of implant therapy in curriculum (19). It indicated that there is great variation across region with regard to curriculum structure but all facilities reported that they had introduced a knowledge component related to implant dentistry, either in the form of didactic lectures, problem based learning or case based learning (19).

A survey in Saudi Arabia also found that implant dentistry was taught to the undergraduate students not as a dedicated course but as sessions by multiple departments (31). The didactic lectures were provided in all the institutes but only half of them offered the students laboratory or clinical training, this indicates that in Saudi Arabia implantology curriculum has a long road ahead (31). Another survey from Iran on postgraduate curriculum indicates that all the institutes require the prosthetic residents to complete training in implantology, the details of the same vary across the institutes but content of program was homogenous (32).

Majority of the countries in Europe and USA have some form of implantology education integrated into the curriculum as opposed to countries in Asia

and Africa. This could be attributed to the fact that countries are developed with good socioeconomic status. The countries already have a well-rounded education system and integration of implantology to the same was done. The developed countries also have more aware population and demands are as such, thus the increased need also paves the way for faster development of healthcare and dental curriculum. Still there is a lack of uniformity as the development has occurred in bits and not at a single time thus standardization is essential.

To overcome the challenge of incorporating prosthodontictic implantology into the already overloaded dental curriculum various programs and models were proposed from time to time to effectively deliver the necessary competencies. One such program was developed and pilot tested at Ghent university (25). The program stretched out from second to fifth year of undergraduate training including lectures, hand on and clinical training: 10.5 hours were dedicated to theoretical teaching of basic implantology including the restorative as well as the surgical aspects (40). Knowledge regarding prosthetic components and procedures, sutures and drilling and placement was imparted with hands on training (25). The clinical training included diagnosis, case planning, risk assessment and maintenance therapy (25). The assessment of the program revealed that clinical outcomes were acceptable, the patient perception showed overall satisfaction and students perspective towards the program was also favorable, as they thought it to be a valuable addition to curriculum in line with the theoretical courses previously provided (25).

In 2008, a consensus meeting of the association for dental education in Europe was held and in 2009 Friedrich-Alexander university, Nuremberg (Germany) implemented a voluntary structured educational program for pre-graduate dental students, called *i-lect* (13). This program provides 200 hrs of training in 3 years spread over 6 semester and included basic theoretical training, hands-on and clinical exposure (13). The result evaluation revealed that the program was very effective and popular. Student course evaluation showed that theoretical and practical requirements were adequately met and knowledge was enhanced concerning dental implants. Additionally the tutorial had no negative effect on the successful completion of other subjects (13).

Such programs provide practical and tested methods of employing implantology into the curriculum. The models need to be integrated and modified according to individual institute requirements.

The delivery of prosthodontic implantology constitutes didactic, preclinical and clinical form of training. The theoretical training is the most important part of implantology, as it is necessary for cognitive development and forms the background of other forms of training. Preclinical training are essential for the development of soft skills. Preclinical education provides students with a controlled environment in which to learn implant related skills and to become familiar with implant procedures, materials and instruments. Surveys reveal that preclinical exercises have lesser frequency as compared to theoretical ones, the reason could be the infrastructural and monetary limitations at some facilities. Beside phantom heads, Haptics based simulation as well as VR simulators with Realtimetics Tactile feedback, and newer methods are being developed and implemented (7).

Clinical training is the most important method of delivering implant training and is essential for psychomotor development. Surveys revealed that students clinically trained during the course of education were more likely to practice implantology in their practice. The early clinical training constitutes proper diagnosis, formulating a treatment plan and maintenance of implants (8). At an advanced level students assist the implant surgery before they can place implants and perform complex restorative procedures. Close supervision of students by trained faculty is an important aspect of clinical training. The patient factor sometimes serves as a limitation to clinical training in implantology (33).

Despite the acknowledged significance of prosthodontic implantology curriculum, it is evident that at present universities are experiencing challenges to fully integrate implant dentistry within their educational programs (33). Multiple barriers have been identified throughout the literature. Difficulty in integration of implantology into an already overcrowded curriculum is often attributed as the prime reason for absence of focus on implantology (12,23,30,34,35), while some may consider implantology as an advanced topic that should be taught only in postgraduate curriculum (26,30); some authors are even of the view that implantology is not a priority in curriculum (33).

The undergraduate curriculum in dentistry is already overcrowded and integration of a vast specialized curriculum presents a special challenge (18,23,36). The laboratory and clinical training is an essential part of implantology training but requires specialized labs, equipments and components which may not be available at every institute. Implantology, even though gratifying, in the long term is an expensive treatment and institutes require vast financial resources for implementation and conduction of implant training amongst other monetary obligations this serves as an additional factor to the present challenges (18,23,34). Implantology is also a multidisciplinary entity, with professionals specialty trained in either surgical or restorative aspect if implantology, so to provide a staff adequately trained in all the aspects of implantology that can impart sufficient overall knowledge to the

students is again a hurdle (25).
In spite of so many challenges, implantology is on a steady stride towards development and major work is being done on overcoming the barriers and developing an effective training method and integrating prosthetic implantology into mainstream curriculum.
The clinical use of evidence-informed practice in education has been regarded as one of the most significant advancements of the last century. Navigating through the vast database of literature pertaining to dental implants and their related research need to be evaluated *in vivo* for their long-term efficacy before they are clinically acceptable. In order to help clinician(s) make patient oriented decisions, evidence-based techniques are becoming increasingly popular. This can be a very useful tool in translating research findings into clinical practice, thus narrowing the gap between research and clinical dentistry (37). Research fund are to be established by government and various regulatory bodies to promote the evidence informed education.
In the wake of COVID-19 pandemic the education system underwent a turmoil but digitization has played a major role in keeping the education steady. The preparedness for such circumstances also is a major achievement and should be recognized.

CONCLUSION

With the increase in population requiring prosthetic treatment the use of implants has increased exponentially. To remain relevant and to keep pace with the booming prosthodontic implantology, education has to permanently monitor clinical practice and to integrate all the new developments in the domain of prosthodontics. There is increasing recognition to imparting education and preparing students to make independent clinical decisions and steps are taken towards uniform curricula at various levels in prosthodontic implantology education.
The primary form of teaching mainly includes didactic method wherein number of lectures, time dedicated, list of basic topics recommended and reference books were of relevance. Development of a good laboratory or preclinical training is done on mannequin heads, live demonstrations and implant related laboratory work. Integration of clinical skill development by assisting and performing implant placement is carried out.
India has a well-established prosthodontic implantology curriculum at undergraduate and postgraduate level as proposed by DCI. Various Regulatory bodies involved in the process of curriculum development and implementation include the Ministry of health and welfare of government of India, Indian Prosthodontic Society (IPS), various state universities such as MUHS through their 'Board of studies', various universities, academicians etc. India also has a 'Indian society of Oral Implantologists' (ISOI) created with the aim of the advancement of the science and art of Oral Implantology. It focuses on research and education by promoting current and innovative procedures. Various research funds, awards and grants are also provided by the Ministry of Health and welfare (MoHF), Indian council for Medical research (ICMR), Council of scientific and industrial research (CSIR) and Indian Prosthodontic Society (IPS), various state universities such as Mahrashtra University of Health Sciences (MUHS) in India to promote the evidence informed education. Although such vast developments in prosthodontics implantology curriculum are occurring in the country, challenges still remain to implement existing competencies and to evolve with the innovations.
Prosthetic implantology curriculum varies worldwide but large percentage of institutes agree on certain topics. Almost 80% of institutes across the world seems to have some form of implantology training as a part of curriculum. It is well established in developed countries, whereas some developing counties might lack the definitive guidelines for implementation of implantology curriculum.
Various barriers were identified to implantology education by the experts and included difficulty of integration of additional program into already overcrowded curriculum, introduction of relevant content in suitable time frame, funding, adequate infrastructure and utilization of specialized faculty.
Major strides are being made towards digitization and development of a uniform curriculum worldwide so as to produce skilled clinicians devoted to development of prosthodontic implantology and for the benefit of the society at large. The undergraduate education may lay down the foundation for all the upper levels of education. Thus this systematic review explores educational programs, researches, barriers and reflections regarding the prosthodontic implantology curriculum worldwide and a good follow up to the report will further assess the evolving trends and developments.

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