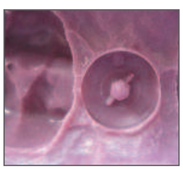
# Increasing implant dentistry in undergraduate education using new technology: A pilot project

Hugo De Bruyn, MDS, MsC, PhD ± & Stefan Vandeweghe, DDS †



Although demographic factors and growing patient awareness of the benefits of dental implants have increased the need for dental schools to educate their students about implant treatment, university curricula have been slow to adjust. This article reports on a program recently implemented at the dental school of Ghent University in Belgium to expand undergraduate instruction in this area. The program utilizes new technology that simplifies implant restorations. A case illustrating the use of this technology is reported.

**Key Words:** implant dentistry, undergraduate dental education, Encode® Impression System, clinical training

## Introduction

In daily dental practice, implants are well established as a means of replacing missing teeth in a large number of indications. Patient demand for implant treatment is also growing. Whereas implant dentistry was once considered a highly specialized treatment, routine implant procedures are increasingly being performed by general dentists who have acquired competence not only in prosthetics but also surgery. Given this paradigm shift, it is essential for newly graduated dentists to understand the possibilities and limitations of implant dentistry. This includes not only patient selection, treatment planning, and practical clinical implementation of the reconstructive therapy but also appropriate responses to technical and/or biological complications.

At both the undergraduate and postgraduate levels, university curricula have been slow to adjust to these developments. A recent review of European universities[1] assessed the status of dental implant education and addressed various aspects related to competence level, practical implementation, and barriers for further development in the field. The survey found that the average time assigned to implant dentistry was 36 hours, with a range of three to 120. Furthermore, the allocated time was dispersed among various courses (periodontics, prosthetics, oral diagnosis, oral imaging, oral and oral-maxillofacial surgery) and consequently rather theoretical in nature. Although 70% of the institutions that participated in the study claimed to offer their students clinical prosthetic training, this merely involved assisting others or receiving hands-on laboratory training. Only one-third of the students today are allowed during their dental training to perform prosthetic implant treatment, and in most cases this is limited to single-tooth restorations and/or overdenture treatment. Implant surgery is predominantly a part of postgraduate curricula and is available at 90% of the institutions. Fifty-three percent of the universities reported that undergraduate students do assist with surgery, but only 5% of the students at those universities actually treat patients.

Barriers for including prosthetics and surgery in dental curricula were primarily logistical such as lack of time (53%), funding (28%), or assisting staff (51%). General comments were that there are too many students for the limited number of patients who are able to comply with and pay for the proposed treatment. Academic institutions commonly struggle to find enough patients with a broad enough variety of treatment needs to allow for adequate student training. Given that implant training has the reputation of being more advanced, it may not be surprising that clinicians don't refer their patients for treatment by students. However, this implies that dental students are insufficiently prepared for the reality of today's dental practice.

### The Rationale for Increasing Implant Dentistry

The rationale for increasing implant dentistry within the dental curriculum is largely based on demographic aspects. Estimates are that each year one million patients in Europe alone become edentulous. Despite advances in dentistry, the number of lost teeth still increases with age, and the need for care in those elderly patients will continue to grow. Additionally, treatment paradigms are changing. Conventional crown-and-bridge work is no longer considered to be the first choice. For single-tooth replacement, implant solutions are not only a more biological approach but also are comparable in cost to a three-unit conventional bridge when all factors are considered. Including this treatment modality in undergraduate curricula also complies with regulations that require patients be offered reasonable options.

Patient-centered thinking also provides an important argument for improving implant dental education. Edentulism is often associated with functional and aesthetic burdens and appears to have a negative impact on quality of life.[2] Tooth loss can also deeply affect patients' psycho-social well-being, even for patients who seem to adjust reasonably well to conventional dentures.[3] Clinical studies indicate that not only technical aspects determine patient satisfaction with given treatments. Patient-related treatment outcomes may also be important determinants for patient satisfaction. These include perception of general comfort, aesthetics, masticatory function, and speech.[4] Dierens et al[5] found that more than 90% of the patients preferred a single-stage surgical approach to the classical two-stage delayed loading protocol.

### A Team Approach

In the last decade, implant therapy has often been performed in conjunction with immediate provisionalization and immediate loading. These protocols require a highly effective collaboration between surgeons and restorative dentists, both pre- and post-surgically. Future dentists will need to know how to act as efficient team members and be able to perform treatment planning and pre-implant therapy. In a growing number of cases, both surgical and prosthetic procedures are being performed by one clinician, because this may simplify treatment planning and treatment. On the other hand, additional competencies may be required depending on the nature and complexity of the case. Dental students must learn their own limitations and understand the need to refer patients to specialists whenever necessary to ensure the best treatment. All these aspects must be included in dental education.

### Educational Guidelines and Future Implementations

At a recently held consensus meeting organized by the Association for Dental Education in Europe (ADEE), there was widespread agreement among the academicians and implant-industry representatives about the urgent need to increase the penetration of implant dentistry within dental curricula.[6] The following guidelines were proposed for implementation within European dental education:

- Future dentists should learn to incorporate oral implants into their overall treatment planning.
- They should understand basic aspects of healing and tissue integration, basic biomechanical and material-science principles, as well as surgical and prosthetic techniques.
- They should be prepared to continuously monitor the peri-implant tissues, render appropriate supportive therapy, and cope with biological and technical complications.
- The surgical technique for placing implants in straightforward cases should be included in the dental curriculum, while additional competence in the surgical phase should be required.
- The academic community should determine the levels and limitations to which the various aspects of implant dentistry and related skills are taught. Ethical and legal aspects of implant dentistry should not be forgotten.

## Implementing Single-Implant Restoration in Undergraduate Education

As part of the implementation of these guidelines, the educational board of the dental school of Ghent University, Belgium, recently expanded the final year of undergraduate clinical education to include the practice of placing implants extraorally in artificial bone, performance of hands-on prosthetic procedures for single and overdenture cases, and flap creation and management using pig jaws. With a commitment from BIOMET ***3i*** to provide surgical and prosthetic kits, dental implants, and abutments, it became possible to further implement these acquired preclinical skills in clinical practice. Because of time constraints, it was essential to choose straightforward cases and provide a prosthetic solution that was valid for all students and all cases. Furthermore, it was the aim of this course to instruct students in implant-restorative treatment for a common clinical situation.

Patients with a single missing maxillary tooth with two intact neighboring teeth were thus recruited via e-mail from university hospital personnel. They were to receive tooth replacement with a NanoTite™ Tapered Implant (BIOMET ***3i***) and an implant-supported restoration created using the Encode® Impression System (BIOMET ***3i***). This practical solution limits the number of visits required for treatment. Students must be able to complete their cases prior to graduation, so a maximum four- to six-month time framework is essential.

Potential patients were clinically and radiographically screened, and a waiting list was created. Prior to final inclusion, patients were also treated for any remaining tooth or soft-tissue problems. At the start of the academic year, every student was assigned a patient and expected to adhere to the following learning steps.

1. At an initial consultation, the student plans the presurgical steps necessary to restore the remaining natural teeth to a periodontally healthy condition. Periapical as well as orthopantomographic radiographs are taken, study casts are obtained, and clinical pictures are taken to document the dental condition and aesthetic appearance. This information is downloaded in the student's portfolio for evaluation by the teaching staff.
2. Periodontal pretreatment (e.g. scaling, root planing, and tooth extraction) is performed, oral hygiene instructions are given, and the patient is re-evaluated prior to surgery.
3. A surgical guide is fabricated.
4. The radiographic analysis is performed, and the implant position, length, and diameter are selected. This presurgical planning is downloaded in the portfolio.
5. On the day of surgery, the student checks the instruments and reviews the case and drilling procedures with his or her professor, prior to administering a local anesthetic.
6. The student creates a full-thickness flap, prepares the implant osteotomy, places the implant and appropriate Encode Healing Abutment, and secures the flap with sutures. The patient is given post-operative instructions and dismissed.
7. After one week, the sutures are removed, oral hygiene instructions are reviewed, and follow-up appointments are scheduled.
8. After four months, the prosthetic procedure is initiated by making an impression of the Encode Healing Abutment. Although the Encode Impression System eliminates the need to make an implant-level impression with an impression coping, the student does so at this point to become familiar with the more traditional implant-restorative procedure. An opposing jaw impression is also made, and an occlusal registration is performed, along with a shade selection. The work order for the dental technician is filled in, and the impression is sent to the BIOMET ***3i*** PSP Department.
9. The casts are scanned, and a definitive Encode Abutment is designed virtually, then milled from a solid blank of titanium. A robot inserts an implant analog into the master cast, and the definitive Encode Abutment is inserted.
10. The dental laboratory receives the Robocast and the definitive Encode Abutment and uses these to fabricate the definitive restoration.
11. One week later, the definitive Encode Abutment is seated and secured with a Gold-Tite® Abutment Screw (BIOMET ***3i*** ) tightened to 20Ncm of torque. The definitive crown is cemented. The patient is released with oral hygiene instructions and appointments for follow-up care.

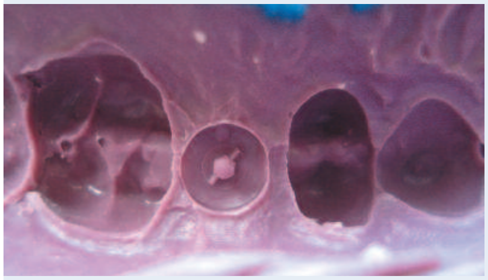


Fig. 1
Intaglio surface of the definitive impression that accurately reproduced the codes on the occlusal surface of the EHA.

Fig. 2
Occlusal surface of the EHA, duplicated in dental stone, in the master cast.

Fig. 3
Lateral image of the articulated casts in the articulator. The mounted casts, not the articulator, were sent to the BIOMET ***3i*** PSP Department.

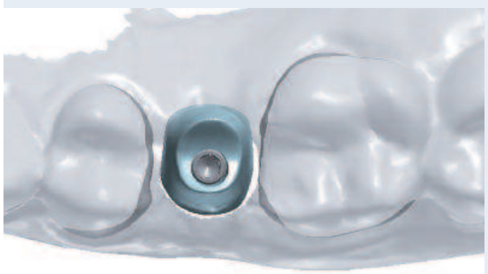


Fig. 7
Digital image of the occlusal aspect of the specific Encode® Abutment in the virtual maxillary cast.

Fig. 8
Laboratory image of the CNC machine milling the definitive Encode Abutment.

Fig. 9
Laboratory image of the definitive Encode Abutment just prior to removal from the milling unit.

### Clinical Case Presentation

The following case illustrates the use of the Encode Impression System to achieve optimal aesthetics for a single-implant crown.

The patient was a 38-year-old female who presented with a 4mm diameter Certain® Implant (BIOMET ***3i***) placed into the No. 4 [15] tooth position six months previously. The implant had been placed in a single-stage approach; an Encode Healing Abutment (EHA) was placed at the time of implant placement.

The implant was determined to be stable, immobile, and surrounded by healthy peri-implant soft tissues. The codes on the EHA were noted to be supragingival circumferentially. A polyether impression was made of the EHA (Fig. 1). The clinician verified that the codes on the occlusal surface of the EHA were recorded in the impression. These codes contain vital information regarding the implant/abutment connection, implant restorative platform, emergence profile of the EHA, and the three-dimensional position of the implant, including the hex orientation.

The impression was sent to the dental laboratory, where it was poured using a Type IV dental stone, and a master cast was fabricated (Fig. 2). The casts were mounted on an articulator with Adesso Mounting Plates (Fig. 3). The mounted casts were sent to the BIOMET ***3i*** PSP Department in Valencia, Spain.

A PSP technician placed the casts into a 3Shape Laser Optical Scanner (Fig. 4). Using specialized computer software, the definitive Encode Abutment was designed in accordance with the clinician's directions (Figs. 5-7).


Fig. 4
3Shape Laser Optical Scanner.

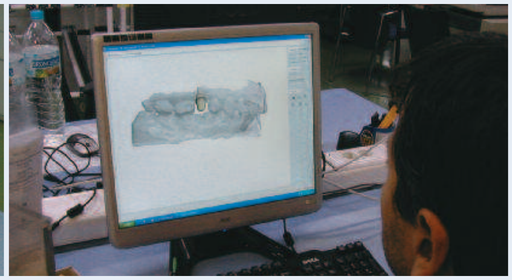


Fig. 5
Image of one step in the process of the computer-aided design of the definitive Encode® Abutment.

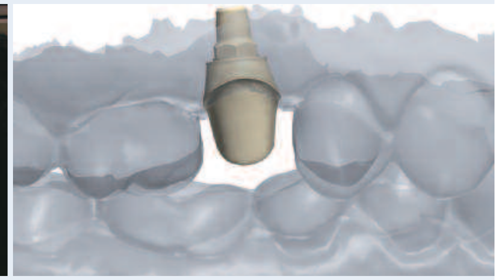


Fig. 6
Digital image of the buccal aspect of this specific Encode Abutment within the virtual articulation of the mounted casts.

Fig. 10
Laboratory image of the maxillary cast after the stone was removed by the robot.

Fig. 11
Occlusal laboratory image of the implant lab analog correctly positioned within the Robocast.

Fig. 12
The definitive abutment was placed onto the Robocast and evaluated for fit, axial wall taper, marginal design, and overall finish.

The data were sent to a computer numerically controlled (CNC) milling machine; the definitive abutment was milled from a blank of titanium alloy (Figs. 8 & 9). In a separate process, but using the same digitized data from the laser optical scan, a robot removed stone from the maxillary master cast in the area of the EHA stone replica (Fig. 10). A technician placed the corresponding implant analog into the robotic arm, and the robot placed the implant lab analog into the precise position as dictated by the optical scan (Fig. 11). The analog was luted in place with light-cured cyanoacrylate cement.

The definitive Encode Abutment was placed onto the Robocast and evaluated (Fig. 12). It was found to be satisfactory relative to the inter-occlusal clearance, axial wall taper, and marginal design (chamfer). The casts and definitive abutment were packaged and returned to the commercial laboratory for fabrication of the definitive all-ceramic crown.

The patient returned to the clinic and the Encode Healing Abutment was removed from the implant. The implant was stable, and the peri-implant soft tissues were free of inflammation. The definitive Encode Abutment was placed with a try-in screw (Fig. 13), and a radiograph was taken. The restoration was tried in (Fig. 14), interproximal contacts were adjusted as needed, and another radiograph was taken to verify that the crown was completely seated onto the abutment (Fig. 15). The occlusion was adjusted for centric contacts. The crown and abutment were removed, and the crown was polished. The retaining screw securing the definitive Encode Abutment was tightened to 20Ncm of torque. The crown was cemented with temporary cement, and a final radiograph was verified to confirm complete removal of the excess cement. The patient was given oral hygiene instructions and released.

Fig. 13
Definitive Encode® Abutment in place intraorally.

Fig. 14
Clinical image of the crown in place on the definitive Encode Abutment.

Fig. 15
Radiograph demonstrating that the definitive crown was correctly seated onto the abutment.

## Clinical Relevance

In implant dentistry, proper abutment selection is crucial for aesthetic and functional success. An ideal abutment supports the peri-implant soft tissues, and the margins follow the gingival contours. This allows clinicians to easily and predictably remove excess cement. Placement of a definitive Encode Abutment, as illustrated in this clinical case presentation, meets these requirements and reduces soft-tissue concerns associated with conventional impression procedures.

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### Hugo De Bruyn, MDS, MsC, PhD ±

*Prof. De Bruyn is Professor and Chairman of the Department of Periodontology and Implantology at the University of Ghent, Belgium. He is responsible for undergraduate education and is also the director of the accredited specialist program in periodontology and the postgraduate implant program. He is also a visiting professor at the Department of Prosthetic Dentistry at the University of Malmo, Sweden. Prof. De Bruyn also holds memberships in the Academy of Osseointegration and American Academy of Periodontology.*

### Stefan Vandeweghe, DDS †

*Dr. Vandeweghe graduated as a dentist in 2006 from the University of Ghent, Belgium. Today he is working in a private practice and at the University of Ghent, with a focus on implant surgery and prosthetics. He is involved in education and research at the department of periodontology and oral implantology and is currently working on his PhD thesis.*