Abstract

Introduction: This introductory dental anatomy module begins the process of teaching dental students how to analyze the structure and form of human teeth, a skill that is foundational to all subsequent areas of restorative dentistry. This module is an interactive preclinical activity that allows the learner to master the important morphologic and functional features of human maxillary incisors, as well as to become familiar with common clinical anomalies. Methods: As the first in a series of dental morphology lectures, it includes basic skills that are applicable to later modules. The lab waxing activity, which follows the 40-minute lecture, requires two 4-hour sessions. Since this is one of the first hand-eye coordination technique labs in dental school, it is an early opportunity to teach dental laboratory procedures and safety, as well as the level of attention to detail required in dentistry. The goal of the exercise is to create a wax model of tooth #8 on a commercially available simulated preparation. To aid the student, there is a video of the steps of a correct wax-up and a grading rubric with specific expectations. Results: Comparing the 3 years before the introduction of the module improvements with the 3 years after, the average percentage of A grades more than doubled (from 17.1% to 38.5%), while the average percentage of failures also doubled (from 7.0% to 14.5%), identifying the struggling students who needed additional help. The opinion from student tutors, who themselves were graded under the previous grade form, is that the new rubric clarified expectations, thus improving practice and performance. Discussion: While the exercise had been a part of the instructional course for many years, the introduction of the video and, particularly, the rubric has improved the students' understanding of the specific expectations of the task, simplified the grading, reduced the time spent explaining grades, and reduced student concerns that the grades were subjective.

Keywords
Dental Anatomy, Dental Morphology, Dental Occlusion, Incisors, Waxing, Preclinical Lab

Educational Objectives

At the conclusion of this educational activity, the learner will be able to:

1. Explain the major functions, positions in the arch, and universal numbers of human incisors.
2. Describe the form and features of maxillary incisors in detail, using the following terms: height of contour, outline form, cervical outline, imbrication lines, lingual fossa, and cingulum.
3. Describe the difference between the central and lateral incisors in all aspects.
4. List from memory the important developmental dates of both central and lateral incisors.
5. Recognize common maxillary incisor anomalies from clinical photographs or radiographs.
6. Create a tooth #8 in wax on a simulated preparation in a stepwise fashion.
7. Critically self-assess lab work using an illustrated grading rubric.

Introduction

Creating wax models of individual teeth is a time-honored technique for teaching dental anatomy. Shaping a tooth in an inexpensive and malleable material like wax allows the student to explore the intricacies of dental anatomy through mastering each tooth, which no high-tech method to date has improved upon. Using this teaching technique, the relatively simple tooth #8 is used as a starting point in learning tooth anatomy. However, as in any class, students arrive with different backgrounds and skill in hand-eye...
coordination abilities. Many students struggle with their speed and confidence in this demanding technical skill, so this module supplies teaching tools to assist in this task.

The lecture starts by engaging the learners’ attention with the fact that central incisors are the most important teeth in the smile and are essential to facial and dental aesthetics. The lecture then uses this tooth to create the framework that can be used to evaluate any other tooth by:

1. Describing the general function of the tooth.
2. Describing the shape from all views in general, focusing on each view in detail, including the root form.
3. Explaining how the tooth functions in occlusion.
4. Describing how the tooth forms and erupts.
5. Identifying tooth anomalies.

Students often have difficulty with the high level of expectations in skill achievement, and uncertainty only adds to that difficulty. Rubrics have been proposed as an important tool to “establish clear rules for evaluation and define the criteria that differentiate acceptable, outstanding, or other designated levels of performance.” With the development of a careful, precise grading rubric, which is distributed and explained at the beginning of the lab, the learners are clear on the goals they should achieve. By clarifying exact standards, all faculty are teaching to the same goal, which reduces the perception of personal preference in teaching.

Exact areas of error are designated on the rubric, so that during grading, specific areas can be circled or indicated on the diagram, showing the student exactly where his/her errors occurred. The rubric is organized by aspects or views of the tooth to make explanations to the student easier and to facilitate dividing the task of grading among multiple faculty members. The illustrations (taken from photographs of the actual dentaform teeth) include key features such as occlusal contact points and interproximal contacts correctly located and sized. The diagrams are positioned as the student or faculty would hold the dentaform to view that feature.

In addition, the video is a key audiovisual aid in the waxing laboratory exercise. It demonstrates an organized, stepwise approach for creating the anatomy of the tooth that most students are able to duplicate with time and practice.

Methods

Beginning dental students are the target audience for this session. Logistically, this session is held for the entire class in the technique laboratory over two 4-hour sessions. As preparation for this module, students should be given reading assignments from the textbooks to master basic anatomy and functional occlusion concepts prior to class.

The lecture on permanent maxillary incisors with the PowerPoint (Appendix A) includes speaker notes and key teaching point prompts. Have students get out their Boley gauge and their model central and lateral incisors (Kilgore International, Inc.) to use during the lecture to emphasize height of contour concepts so they can follow the features in three dimensions.

The video of a color-coded additive waxing technique (Appendix B) is divided into logical sections. There are several ways to use the video, such as requiring it to be viewed prior to class or showing it at the start of the laboratory while doing a commentary over it. However, we have found the most effective way is to interweave the teaching of the skill by showing a section of the video and then performing the process step by step as a class. This way, questions can be asked and concepts can be clarified for the entire class, while instructors can monitor skill acquisition and errors while making sure no one falls behind.

When all students have completed a step, the class moves on to the next one. This video is also effective if used for the half-tooth preparation and is a very good starting section to interweave as a class.
The grading rubric (Appendix C) should be distributed at the start of the waxing exercise. Students should be encouraged to keep it handy for reference. The teeth are represented from the perspective of the student or faculty who would be evaluating the tooth for easier student understanding and faculty grading. After the waxing exercise is completed, students first self-assess using the rubric, then exchange their teeth with a partner for peer assessment, openly discussing their observations. Only after those assessments are completed will a faculty member review his/her evaluation of the project with the student using the rubric. The rubric diagrams are designed so that notes can be added for student clarification, which is a convenience for student feedback in grading as well.

An alternate technique is to use a sample waxed tooth (perhaps a mediocre one left over from a previous year) and work through the rubric item by item, showing how to evaluate each point, either in small groups or on a projected document camera for the class if available.

After the students have had the opportunity to practice tooth #8 (as well as waxing a tooth #6 and a tooth #26) over the course of eight sessions with formative feedback, they wax a tooth #8 independently in a 4-hour session as the first graded summative assessment.

Any student who does not achieve a grade of 75 or better attends an intensive remediation session. Three of the most experienced faculty members evaluate the learner’s assessment tooth and rubric with him/her for areas that need improvement. The learner then waxes another tooth #8 under observation for technique and conceptual issues, which are corrected through individual demonstrations. The student leaves the session having completed an acceptable tooth #8 wax-up.

Faculty members have found that several unlikely instruments are very helpful in visualizing relationships and contours. A periodontal probe is effective for introducing measurements in a simpler mechanism than the Boley gauge, as well as providing a straightedge to illustrate issues of contour or point out discrepancies in incisal edge alignment. A PK3 burnisher is useful for pointing out discrepancies and comparisons in embrasure dimensions. Because of its triangular shape, it can be used to fill most of the space of the embrasure, showing a student the size of a reference embrasure on the contralateral side. The student can then compare his/her embrasure as being objectively more open or closed.

When using the rubric for grading, note that it is organized by viewpoint so that graders can easily divide the sections without overlap, eliminating the concern of faculty calibration as a single grader evaluates that section for all students. Each item has locations and errors listed so that feedback can be outlined for the learner. The diagrams are shaded so that lines and notes can be added for clarification. This reduces time spent in class explaining or clarifying points taken off in any area. Depending on the number of students, we have used two or three graders.

If students are not yet comfortable with the tooth numbers and terms like mesial and distal, we do an exercise that has been very effective at internalizing basic dental terminology. It takes place during a break after an introductory lecture on basic dental terminology and numbering and also serves as a good icebreaker for a new first-year class. Depending on the size of the class, arrange the students in groups of 32 and 20 in double lines facing each other to simulate dental arches. For our class of 86, for example, this allowed two adult dentitions with one primary dentition and still permitted several supernumerary teeth to be inserted in the most likely spots later in the exercise. Asking the students to pretend that the classroom is a giant head, we explore concepts such as whether right and left refer to the operator or the patient. We then have the students count off, marking the third molars as the corners and the cutoff between 8-9 and 24-25 as the midline break. After they have identified the midline, we have them point to their mesial surface, put their distal arm in, flap their proximal hands, and identify the anterior teeth as those that have incisal surfaces instead of occlusal surfaces. Finally, we have the primary teeth count off with letters and discuss which permanent teeth are succedaneous. This kinesthetic reinforcement of abstract concepts has virtually reduced to zero the number of students who are not able to use those terms in discussion and feedback over the first few weeks.
Results

While some combination of lecture with lab has been used for over 30 years at our institution, in 2013 the video and rubric were added. The overall response has been very positive, especially regarding the rubric, with many students asking in their written course feedback for the video and rubric to be added to all of their lab courses. Comparing the 3 years before the introduction of the module improvements with the 3 years after, the average percentage of A grades more than doubled (from 17.1% to 38.5%), while the average percentage of failures also doubled (from 7.0% to 14.5%), identifying the struggling students who needed additional help. The opinion from student tutors, who themselves were graded under the previous grade form, is that the new rubric clarified expectations, thus improving practice and performance.

There are practical benefits to using this resource as well. The number of faculty needed to grade each practical exam has been reduced by 50%, from four graders to two graders. In the past, all four faculty graders spent 2 hours per practical exam explaining and answering questions in the lab; this has been reduced to two graders answering questions for less than an hour as students have almost no questions. For those students doing poorly, it has clarified and defined the shortcomings in the work, decreasing their concerns that the grading is subjective. The overall tone of grading discussions has become more professional and objective, changing from “I felt that this embrasure was too open” to “I see how yours is different from the image here.”

Discussion

Nearly all dental schools employ waxing as part of initial dental anatomy and occlusion training. While there are often calls to remove this method from the curriculum, pointing to the fact that dentists rarely do their own wax-ups for diagnosis or fabrication of indirect restorations, it is widely applicable to many other follow-on skills. Those skills include placement and sculpting of composite resin and, critically, lab communication. One key skill involved is visualizing and verbalizing discrepancies in one’s own and one’s peers’ projects by using the rubric. This skill will be directly applicable to analyzing and discussing cases in clinic and in communication with the dental laboratory.

Many students become discouraged by the demands of this skill and question their ability to succeed in their chosen path. Honest, objective feedback is central to student mastery of these skills, but care must be taken in how feedback is phrased. While the feedback sandwich of praise-criticism-praise is widely used, it is problematic in that it may be misinterpreted, be perceived as insincere, or simply be ineffective. Instead, insisting on the student’s self-assessment allows the expert to validate, or work together with the student to correct, a missed perception on the student’s part.7 The rubric is a useful, time-saving tool for this process.

Brief group discussions are often helpful in this module. By bringing groups of eight to 10 students together and asking what difficulties they are encountering, the teacher can address common problems with a single answer or demonstration. This technique gives students the feeling they are not the only ones struggling with new concepts and skills acquisition.

Faculty members new to the course should be afforded the opportunity to practice this skill with the guidance of an experienced teacher. Articulating discrepancies at the level of detail demanded in the grading rubric is not usual in clinical dentistry. If all faculty are not calibrated precisely, students can feel that grading is subjective or based on personal preference.

The remediation has proved highly effective for nearly all learners. Many are able to achieve high grades in follow-on practical examinations and to be successful in the course. Remediation sessions are held after the first two practical exams, and any repeat learners are offered personal student tutors for additional support.

One limitation of this module is its specificity for tooth #8. It is the first in a series, and many more are needed to develop the full necessary skills.
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References

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