Artificial Versus Natural Teeth for Preclinical Endodontic Training: A Randomized Controlled Trial

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Abstract

Introduction: The aim of this study was to compare preclinical endodontic training solely on artificial teeth (AT) versus training on natural teeth (NT) with regard to students' performance on NT in an objective structured practical examination (OSPE) in a randomized trial. **Methods:** Forty-three students were randomly allocated to training on AT (test, n = 20) or NT (control, n = 23). Practical training included intraoral root canal treatment of all tooth types on mannequin heads. Students' performance was assessed via an OSPE first on AT (TrueTooth Mandibular Molar; DELendo, Santa Barbara, CA) and then on a lower mandibular NT. Assessment was performed during the OSPE (13 items) and afterward on teeth and radiographs (22 items). The Mann-Whitney U and Wilcoxon tests compared performance between or within groups. Regression analysis and Bland-Altman plots were used to assess agreement between AT and NT performance. **Results:** The performance between training groups did not significantly differ on NT (P = .761/Mann-Whitney) or AT (P = .278). The performance on NT was significantly lower than that on AT in the test group (P < .05, Wilcoxon) but not the control group (P > .05). Performance on AT did not significantly predict performance in NT, with relative and proportional bias being present. **Conclusions:** Within the limitations of this study, training on AT seems suitable to prepare students for endodontic treatment on NT. Because performance on AT does not predict performance on NT, assessment using AT should be regarded with caution, and control of training success using NT might be more reliable. *(J Endod 2016;42:1212–1217)*

Key Words

Artificial teeth, assessment, dental education, preclinical endodontic training

Significance

Preclinical endodontic training using artificial teeth was found not to yield significantly different performances compared with natural teeth. However, because students' performance on artificial teeth did not predict performance on natural teeth, control of training success using artificial teeth should be regarded with caution.

Manual endodontic competencies expected of a graduating dentist include (among other things) accessing the pulp chamber and identifying canal orifices, shaping root canals without procedural error, and filling them in uncomplicated anterior and posterior teeth (1). Undergraduate training should allow students to acquire these skills, starting in a suitably equipped preclinical environment on the basis of sound scientific knowledge in endodontics (1). For such preclinical training, natural human teeth have been regularly used in the past. Although working on natural teeth (NT) allows students to experience the anatomy of the root canal system as well the natural hardness of dentin, their use in education needs to follow infection control guidelines in order to avoid cross infections (2). Moreover, natural human teeth (collected under informed consent) are increasingly difficult to obtain. Lastly, the anatomic variability of NT complicates both standardized training and valid assessment of root canal treatments (3), and identification of suitable teeth is time-consuming and requires a large tooth biobank.

Therefore, alternatives to NT have been developed. For example, simulated root canals in clear resin blocks allow a standardization of length, diameter, and degree of curvature and are valuable for visualizing endodontic treatment steps (4). However, treatment of these blocks is usually performed extraorally, not within mannequin heads. Accessing the pulp chamber is not at all practiced, and the internal root canal anatomy, dentin hardness, and radiopacity are often not accurately reproduced in these blocks (5).

To overcome these disadvantages, artificial teeth (AT) have been developed, aiming to reproduce anatomic and physical characteristics of NT. This should allow standardized training and evaluation. The suitability of these teeth for teaching undergraduate preclinical endodontic manual skills has been described in recent studies, with ambiguous results (3, 5–7). Although 1 study showed that the use of AT instead of NT in preclinical education did not detrimentally affect the technical quality of root canal fillings subsequently provided in a clinical setting (3), another study found AT to not accurately reproduce NT, limiting their suitability for preclinical training because students are not confronted with the true anatomic complexity and variations of teeth (5). As a result, it remains unclear if AT can replace NT in preclinical endodontic training.

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A number of questions need to be answered before deciding to not at all, partially, or fully train students on AT. Does the endodontic performance on NT (as required clinically) differ between students trained solely on AT versus those trained on NT? Does a student's endodontic performance on AT predict the performance on NT?

The aim of the present study was to answer these questions by performing a randomized controlled trial comparing preclinical endodontic training solely on AT with that on NT. Our primary outcome was students' performance on NT assessed via an objectively structured practical examination (OSPE). Our null hypothesis was that students' performance on NT would not significantly differ between training groups. Using a sequential examination, with both groups treating AT and NT within the OSPE, we also aimed to assess the predictive value of a student's performance on AT for the performance on NT. In addition, a subjective evaluation of AT by students and endodontic specialists was performed.

Materials and Methods

The study was approved by the Ethics Commission of the Charité-Universitätsmedizin Berlin, Berlin, Germany (no. EA1/129/15). All students voluntarily participated in this trial and signed an informed consent form before commencement. The study flow is summarized in Figure 1.

Participants

Forty-three students, enrolled in the 2015 preclinical course of operative dentistry and endodontics, participated in the present study (30 women and 13 men). Note that no sample size calculation was performed in the absence of valid estimates on the expected difference of OSPE performance between groups. The participants were number coded by 1 independent researcher (F.S.) and, using a random number generator (random.org), randomly and blindly assigned to 2 groups, with 20 participants in the test group (training solely on AT) and 23 in the control group (training on NT).

Training Interventions

All participants were required to attend 7.5 hours of basic lectures on endodontics including the following topics: tooth morphology, access cavity preparation, endodontic instruments, root canal cleaning and shaping, and obturation. The lectures were accompanied by practical demonstrations given by a trained endodontic specialist (O.W.). After the lectures and demonstrations, both groups attended 11.5 hours of practical training. During these practical exercises, students were trained using the criteria that were used for evaluation in the planned OSPE.

The training schedule was as follows: students were first familiarized with the handling of endodontic instruments and so on during an extraoral training exercise involving root canal preparation and filling on an acrylic block (VDW, Munich, Germany). The process of access cavity preparation was initially demonstrated and practiced intraorally in mannequin heads (Kavo, Biberach, Germany) on an artificial lower molar (TrueTooth Replica 19-002; DELendo, Santa Barbara, CA) being fixed within individualized plaster models. Full root canal treatments (including access cavity, root canal preparation, and obturation) were then demonstrated and practiced intraorally on a lower artificial molar (TrueTooth Replica 19-002), which was fixed in a mannequin head model (Castillo, VDW) using boxing wax (Kerr Corporation, Orange, CA).

After these initial demonstrations and procedural practices, intraoral training was performed, with students being separated to train either solely on AT (test group) or NT (control group). For the AT group, TrueTooth AT were provided to students (Table 1). NT had been obtained under an ethics-approved protocol (EA4/102/14) and had been cleaned with curettes, sterilized (121°C, 2.4 bar), and stored in 1% sodium hypochlorite for a maximum of 6 weeks.

Access cavities had to be prepared on 2 incisors, 2 premolars, and 2 molars. (See Table 1 for details on the AT used.) Then, root canal instrumentation and obturation needed to be performed on at least 1 of the incisors, 1 of the premolars, and both molars.

Access cavities were prepared using diamond burs and safety tip tapered diamond burs. Enlargement of the coronal third of the canal orifice was achieved using sequential Gates-Glidden burs 1 through 3 (Komet, Lemgo, Germany). The method of choice for manual canal instrumentation was the "crown-down pressureless" technique followed by apical step-back. Manual instrumentation is still the standard in Germany for primary instrumentation education followed by rotary root canal instrumentation. For this, Flexicut files ISO 15-35 (VDW) were used. If a smaller file size was required, C-Pilot (ISO 10) files (VDW) were provided. The master apical file was required to be a minimum of ISO 35 and to be at least 3 sizes wider than the initial apical file. Root canals were obturated using lateral condensation with ISO standardized gutta-percha points according to the master apical file and AH Plus sealer (Dentsply Maillefer, Ballaigues, Switzerland). All intraoral treatments were performed using a rubber dam. Pre-, intra-, and postoperative radiographs were taken (D 3334; Sirona, Bensheim, Germany) using standardized holders, allowing repositioning of the tooth

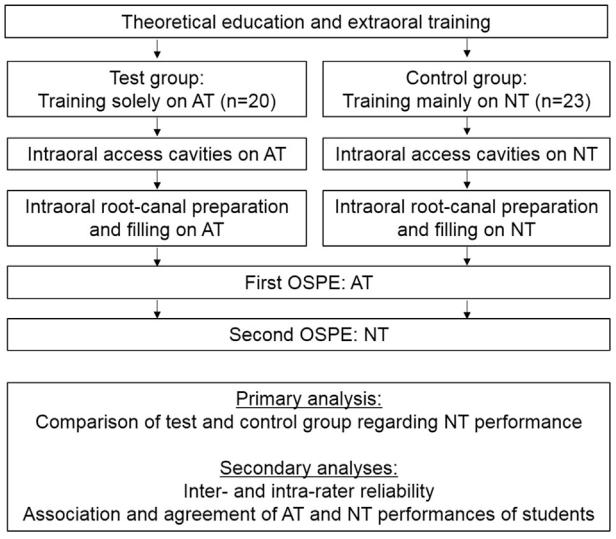

Figure 1. Study flow.

TABLE 1. Artificial Teeth Used in This Study

Artificial tooth	Manufacturer	Model no.
Opaque maxillary central incisor		TT8-001OPAQUE
Opaque mandibular incisor		TT24-001OPAQUE
Opaque maxillary premolar		TT5-001OPAQUE
Opaque mandibular premolar		TT29-003OPAQUE
Opaque maxillary molar		TT3-001OPAQUE
Opaque mandibular molar		TT19-002OPAQUE