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Authors

Hanni, S
Schonenberger, K
Peters, O A
[et al.](#)

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Teaching an engine-driven preparation technique to undergraduates: initial observations

S. Hänni¹, K. Schönenberger¹, O. A. Peters^{1,2} & F. Barbakow¹

¹Division of Endodontics, Department of Preventive Dentistry, Periodontology and Cariology, Zurich University, Switzerland; and

²Endodontic Division, Department of Preventive and Restorative Dental Sciences, University of California, San Francisco, USA

Abstract

Hänni S, Schönenberger K, Peters OA, Barbakow F.

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Aim This paper describes the initial experiences following the introduction of a rotary engine-driven preparation technique into the undergraduate endodontic programme at the Zurich University Dental Centre.

Methods Forty third-year students practised the Pro-File .04 (PF .04) technique between January and July 2001 in a preclinical course. Between November 2001 and February 2002, 20 of these students (Group A) root-treated 51 teeth in their clinical course using either PF .04, the balanced force technique (BFT) or a combination of both. The second group of 20 students (Group B) similarly treated another 36 randomly selected teeth between April and July 2002. Types of teeth treated by the students and the canal preparation

techniques were recorded. The students also completed a short questionnaire, evaluating their opinions of the new course.

Results Of the 87 teeth endodontically treated during the clinical course, 34, 14 and 39 were shaped using PF .04 alone, a combination of PF .04 and BFT and BFT alone, respectively. No rotary instruments were fractured during the 1-year clinical course, although some instruments were fractured during the preclinical laboratory course. Overall, the students rated the rotary technique as positive.

Conclusion A rotary technique was successfully introduced into an undergraduate endodontic programme (this will be continued in the foreseeable future). However, the continuity between the preclinical and the clinical courses was poor as a result of the constraints of the general teaching programme.

Keywords: education, preparation, rotary, undergraduate.

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Introduction

Guidelines for undergraduate curricula in endodontics have stressed the importance of a high standard of education (ESE 2001). Endodontic courses for undergraduates should ideally allow students to attain a minimum level of competence and also encourage continuing their education. This philosophy is important because general practitioners will, for the foreseeable future, perform the

vast majority of root canal treatments in Europe. However, preparation techniques have changed; rotary instruments are gaining in popularity and newly qualified clinicians are confronted with these techniques in their private practices. Consequently, it can be argued that the rotary techniques should be taught in the undergraduate curriculum; to repeat the comment by Hasselgren & Calev (2002) – ‘it’s better that we teach students than having them learn from company representatives’.

The general standard of root canal treatment in Europe is poor as shown in Swiss, Dutch, Scottish, German and Portuguese studies (Imfeld 1991, De Cleen *et al.* 1993, ESE 1994, Saunders *et al.* 1997, Weiger *et al.* 1997, Marques *et al.* 1998). Some national societies have published quality guidelines for dentistry, including

Correspondence: Dr Fred Barbakow, Department of Preventive Dentistry, Periodontology and Cariology, Division of Endodontology, Zurich University, Plattenstrasse 11, CH-8028 Zurich, Switzerland (Tel.: +41 1634 3483; fax: +41 1634 4307; e-mail: barbakow@zsmk.unizh.ch).

endodontics (Self Assessment Manual 1991, Qualitätsrichtlinien in der Zahnmedizin 2000), which may help to improve the standards. Endodontic therapy is required for patients of all ages and for a variety of aetiological reasons. Up to 20% of vital teeth treated with full coverage crowns require endodontic therapy, 5–10 years after placement (Trautmann *et al.* 2000). In addition, increases in the number of treatments are obvious in countries where statistics on endodontics are recorded (Chivian 1984, Hartly 1992). There is no reason to believe that similar increases are not occurring in Switzerland and other countries with ageing populations.

Today's patients are dentally more aware, and increasing numbers of them wish to retain more of their natural dentition than their counterparts did several decades ago. Consequently, such patients now expect clinicians to 'save' their teeth, which could not have been endodontically treated only 20 years ago. Use of nickel–titanium (Ni–Ti) hand instruments may improve the prognosis of more challenging cases, and studies have shown the effects of using them in preclinical (Himel *et al.* 1995) and clinical courses (Pettiette *et al.* 2001). Since the introduction of Ni–Ti instruments, innovative engine-driven preparation techniques have been developed. Amongst others, these include Lightspeed (Lightspeed Technology Inc., San Antonio, USA), ProFile .04 (PF.04) and PF.06 (Dentsply Maillefer, Ballaigues, Switzerland), GT-Files (Tulsa Co., Tulsa OK, USA), Flexmaster (VDW, Munich, Germany) and ProTaper (Dentsply Maillefer). Although some rotary techniques claim to improve the quality of canal preparation, it has been difficult to introduce the rotary techniques at the undergraduate level because the instruments and the required infrastructure are expensive, and time may not be available in the already full teaching schedules.

Although rotary techniques do not constitute the basic procedure taught at the undergraduate level, both general dentists and specialist endodontists use such instruments. Consequently, it seems logical for dental schools to teach at least one rotary technique at the undergraduate level (Spangberg 2001). Teaching a rotary technique should, like any other dental procedure, include adequate preclinical and clinical courses.

Aim

The aim of this paper is to detail the initial observations by the faculty of the Zurich Dental Centre, following the introduction of the ProFile .04 (PF.04) rotary preparation technique to undergraduates.

Preclinical laboratory course

Forty third-year dental students (Freshmen) began their first preclinical rotary course in November 2000. The students had 8 and 12 two-hour sessions, respectively, during the winter and summer semesters, to learn canal preparation, calcium hydroxide placement and canal obturation. These sessions were held once each week until the beginning of February 2001, and again from April until July 2001. The procedures were taught using plastic blocks with simulated curved canals (Dentsply Maillefer, A0177) and then using extracted human teeth.

Initially, the balanced force technique (BFT) was taught until December 2000, using stainless steel and Ni–Ti hand instruments followed by the PF.04 rotary technique from January 2001 onwards. Quality of work was graded as acceptable or not at different stages, using evaluation forms. The PF.04 technique taught was described by Schrader *et al.* (1999), but did not correspond exactly to that advocated by the manufacturer. Dental units used to drive the hand-pieces had no torque control, but were set to maintain a constant 250 rpm ($\pm 10\%$). After preparing suitable access cavities, decreasing sizes of Gates–Glidden burs (Dentsply Maillefer) were 'stepped-down', extending 3–4 mm from the canal entrances. Decreasing sizes of the PF.04 instruments, starting with size 60, were used in a crown-down manner, covering 1/2–2/3 of the estimated canal length. At this point, the working length for each canal was determined, and the crown-down progressed till the required length was attained. Apical stops were then prepared to sizes 35 or 40, and the preparation was completed by a short step-back followed by a recapitulation with the Master Apical Rotary (MAR).

The following stages were sequentially evaluated during the preparation, medication and obturation whilst treating the root of the extracted teeth, which had been fixed into phantom heads using wax:

- 1 Preparation: diagnostic radiograph, access cavity, step-down, crown-down, working-length determination on radiograph, correcting working length if necessary, Initial Apical Rotary (IAR), MAR, Final Rotary (FR) and recapitulation.
- 2 Medication: calcium hydroxide insertion and checked with radiograph, removal of calcium hydroxide.
- 3 Obturation: cone-fit radiograph, final fill radiograph, removal of excess gutta percha and the provisional restoration. Two digital X-ray machines (Digora, Soredex, Helsinki, Finland) were available to expedite the radiographic requirements as the students frequently took radiographs from the bucco-lingual and the

mesio-distal perspectives. The sensors used with the radiographic technique were particularly sensitive, rather expensive, and became badly scratched under the conditions prevailing in the preclinical lab course.

At the end of the preclinical course in July 2001, all the students had prepared and obturated two plastic blocks, and most had prepared two anterior teeth, two premolars and two molars each, using PF.04 and lateral condensation.

Clinical course

Seventeen weeks after completion of the lab course, 20 fourth-year students of the original 40 students (Group A) began their first clinical endodontic course in November 2001. This 10-week course, held once weekly for 3 h, was supervised by the endodontic staff, and was terminated in the first week of February 2002. During this time, patients diagnosed as having either irreversible pulpitis or necrotic pulps with or without apical periodontitis, were randomly allocated to these students for root canal treatment. In this way, the 20 students (Group A) treated a total of 51 teeth. Most patients had been previously recruited from the Hospital's emergency services, whilst retreatment cases were excluded from the programme. The students and their supervisors discussed whether each canal was more ideally prepared using PF.04 alone, BFT alone or by using a combination of both the techniques.

Criteria influencing which preparation technique to use included complexity of the canal geometry, particularly in the apical-third, the student's self-confidence with the rotary technique, the tooth's location and inclination in the dental arch, mouth opening and the patient's perceived ease of management. BFT or PF.04 were used alone in canals considered appropriate for that procedure. However, a combination of BFT and PF

.04 was used in canals where (i) larger apical stops were required than that permitted by the PF.04 system or (ii) when the canal's curvature was too marked to safely accommodate an adequately sized PF.04 instrument. In such cases, the BFT was used after initially completing the crown-down phase using PF.04.

During the clinical course, the students used motors (TCM-Endo, Novag, Goldach, Switzerland) kindly donated by the manufacturers. These motors ensured that the instruments constantly rotated at 250 rpm, whilst the integrated torque control was engaged when a certain torque value was reached. Lubricants and disinfecting irrigants included RC-Prep (Premier Co., King of Prussia, PA, USA) and 1% NaOCl.

The second group of 20 fourth-year students (Group B) began their clinical course in April 2002, roughly 37 weeks after completing their lab course. This 13-week course, also held once weekly for 3 h, was similarly supervised, but the time available was used to teach both endodontics and periodontics. Consequently, the Group B students treated only 31 teeth in contrast to the 51 teeth treated by the Group A students. Finally, all the fourth-year students anonymously completed a six-question endodontic course evaluation.

Results

Preclinical course

The preparation and obturation of the second extracted molar served as a practical end-of-term test, which also included a 10-min oral examination. A series of radiographs of an extracted maxillary (Fig. 1A–D) and a mandibular molar (Fig. 2A–D) indicate the general standard achieved in the preclinical endodontic course. Figure 3(A–D) shows a root-treated extracted mandibular molar with the disto-buccal canal straightened



Figure 1 Radiographs taken at various stages during root canal treatment of an extracted maxillary left molar prepared by ProFile .04 (PF.04) rotary instruments and laterally condensed by a third-year student showing: (A) preoperative diagnostic radiograph; (B) optimal working lengths indicated by size 15 K- and Hedström files in the palatal, mesio-buccal and disto-buccal canals; (C) position of the three master gutta percha points; and (D) final fill prior to removing excess gutta percha from the pulpal cavity.

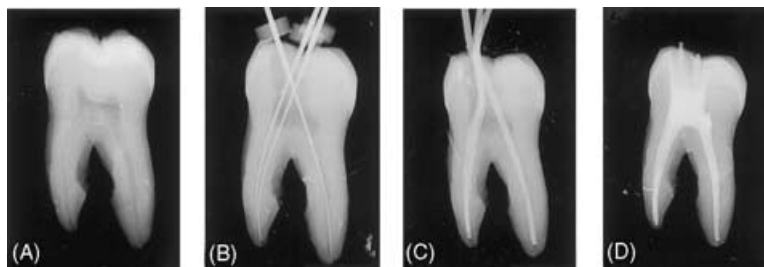


Figure 2 Radiographs taken at various stages during root canal treatment of an extracted mandibular left molar prepared by ProFile .04 (PF.04) rotary instruments and laterally condensed by a third-year student showing: (A) preoperative diagnostic radiograph; (B) optimal working lengths indicated by size 15 K- and Hedström files in the distal and two mesial canals; (C) position of the three master gutta percha points; and (D) final fill prior to removing excess gutta percha from the pulpal cavity.

and the fractured tip of a size 35 PF.04 instrument in the disto-lingual canal. Eleven PF.04 instruments fractured during the preclinical course and seven of these occurred whilst shaping the canals in the plastic blocks. The students were advised to discard the PF.04 instruments after using them in 10 canals or if they noted changes in the flute geometry. However, this proved difficult to control.

Clinical course

Tables 1 and 2 list the types of teeth treated and the preparation techniques employed during the clinical course by Groups A and B. Of the 51 teeth root-treated by the students in Group A, 19, 9 and 23 were prepared using PF .04 alone, a combination of PF .04 and BFT and BFT alone, respectively (Table 1). Of the 36 teeth root-treated by students in Group B, 15, 5 and 16 were prepared using PF.04 alone, a combination of PF.04 and BFT and BFT alone, respectively (Table 1). Figure 4(A,B) shows the first root canal treatment carried out by a fourth-year student using PF.04 alone.

Of the 15 anterior teeth treated by students in Groups A and B, 7, 4 and 4 were treated by PF.04 alone, a combination of PF.04 and BFT and BFT alone, respectively (Table 2). Of the 34 premolars treated during the clinical course, 17, 4 and 13 were treated by PF.04 alone, a combination of PF.04 and BFT and BFT alone, respectively. Finally, of the 38 molars treated by students in Groups A and B, 10, 6 and 22 were treated by PF.04 alone, a combination of PF.04 and BFT and BFT alone, respectively.

Results of the questionnaire indicated that the endodontic courses were graded good or excellent, adequate and inadequate by 87, 1 and 12% of the students, respectively. On the other hand, 86% of the students could readily assess whether BFT or PF.04 was indicated to shape the canals in a given tooth. Although most of the students preferred the rotary technique in the preclinical course, they treated more teeth clinically using BFT than PF.04 (61% vs. 39%). The students considered PF.04 to be quicker and more user-friendly than BFT, but regarded the possibility of instrument fracture with PF.04 as a negative point. In contrast, the students consid-

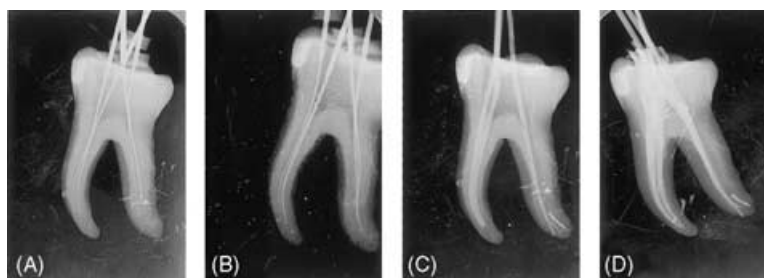


Figure 3 Radiographs taken at various stages during root canal treatment of an extracted mandibular left molar prepared by ProFile .04 (PF.04) rotary instruments and laterally condensed by a third-year student showing: (A) radiograph with four size 15 K- and Hedström files significantly short of optimal working lengths; (B) corrected and optimized working lengths; (C) position of the three master gutta percha points in the patent canals and the fractured tip of a size 35 PF.04 instrument in the disto-lingual canal; and (D) final fill prior to removing excess gutta percha from the pulpal cavity.

Table 1 Number of teeth treated by the students in Groups A ($n = 20$) and B ($n = 20$) using ProFile .04 (PF.04) alone, a combination of PF.04 and balanced force technique (BFT) or using BFT alone

Technique	Group A		Group B		Total	
	No. of teeth	%	No. of teeth	%	No. of teeth	%
ProFile .04 alone	19	37	15	42	34	39
ProFile .04 and balanced force technique	09	18	05	14	14	16
Balanced force technique alone	23	45	16	44	39	45
Total	51	100	36	100	87	100

Table 2 Breakdown of tooth types treated by the students in Groups A ($n = 20$) and B ($n = 20$) using ProFile .04 (PF.04) alone, a combination of PF.04 and balanced force technique (BFT) or using BFT alone

Tooth type	ProFile .04 alone		ProFile .04 and balanced force technique		Balanced force technique alone		A
	A	B	A	B	B	Total ($n = 15$)	
Anteriors	03	04	04	00	03	01	15
Premolars	13	04	04	00	07	06	34
Molars	03	07	01	05	13	09	38
Total	34		14		39		87

ered BFT to be a safer preparation technique than PF.04. Students who graded the endodontic courses as inadequate complained that the curriculum co-ordination was poor, too much clinical time was spent waiting for wet-developed radiographs compared to digital types available in the preclinical course and that too little time was devoted to clinical endodontic courses generally.

Discussion

Teaching a rotary technique to the undergraduates at the University of Zurich can be regarded as successful 1 year after its introduction. This step was contemplated for many years, but could not be undertaken until January 2001, when belt-driven dental units were replaced by modern units. It was quite a paradigm shift to add a

rotary technique to the established BFT. The latter had been introduced in 1997, and, at that time, replaced the standard 'push-pull' and 'step-back' techniques. Budgetary restrictions excluded purchasing suitable motors, with reverse control, for the clinical endodontic course. Fortunately, 24 such motors were donated by Novag AG (Goldach, Switzerland) to be used exclusively by the fourth-year undergraduates for root canal preparation. Students began their clinical endodontic courses either 17 or 37 weeks after completing their preclinical courses. Although such long delays were counterproductive, the curriculum could not be changed. Such time gaps diluted the knowledge and expertise gained earlier in the preclinical courses, particularly for Group B students, even though revision lectures were held before patients were treated.

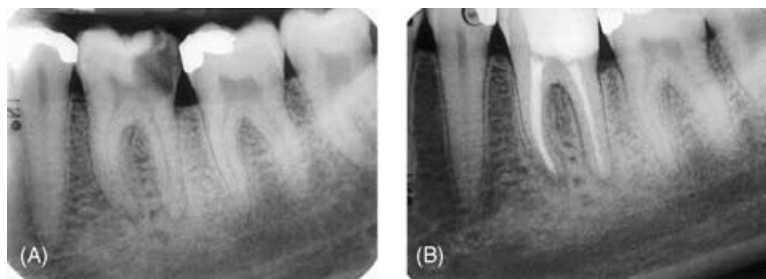


Figure 4 Radiographs taken at various stages during root canal treatment of a mandibular left first molar prepared by ProFile .04 (PF.04) rotary instruments and laterally condensed by a fourth-year student showing: (A) preoperative diagnostic radiograph with caries distally and two periapical areas on the mesial and distal roots; and (B) final fill of both mesial and one distal canal with the canal entrances sealed using a dentine bonding agent and then adequately temporized.

Preclinical laboratory course

The time allocated to teach BFT was reduced to ensure adequate training of PF .04 during the preclinical programme, as no additional time was allocated to endodontics. Despite this, the students achieved an acceptable level of competence. However, 11 and 17 PF .04 instruments were fractured during this course in Groups A and B, respectively. At least half of these fractured whilst shaping canals in plastic blocks, indicating that the blocks may not be ideal or that the students' dexterity was not yet sufficiently developed. The remaining instruments fractured whilst shaping canals in extracted human teeth. Students were encouraged to fracture instruments during their preclinical course, thereby becoming familiar with the limitations of the system. Although impossible to prove, experience gained from numerous continuing education courses indicates that it may be easier to teach novice students the 'delicate' touch necessary for the rotary techniques compared to their clinically more experienced counterparts. On the other hand, the clinicians understand the consequences of instrument fracture far better than the students who have not yet treated any patient.

Clinical course

This course began for students in Group A 17 weeks after completing their preclinical course. Clinically, similar evaluation protocols were used as in the laboratory courses, but additional information on main complaint, history, clinical and radiographic findings and diagnosis were also recorded. Students suggested which preparation technique their case required, but where appropriate, they were encouraged to use PF .04. However, no student was obliged to use the rotary technique if he/she felt uncomfortable with the system on a particular case. In contrast, the 20 students in Group B began their clinical course 37 weeks after completing their preclinical programme. A significant dilution of knowledge was expected, and most of the students in Group B were hesitant to use the rotary instruments compared to their counterparts in Group A. Although instrument fracture was a major concern, no rotary or hand instruments were fractured during the first clinical course. This may indicate improved manual dexterity, but clinically, the unpleasant experience of instrument fracture will certainly occur in time. All students completed one or more cases using PF .04 alone or in combination with BFT. Criteria used to choose one of the three possible techniques enabled the students to learn and under-

stand 'case selection', which is not possible when only one preparation technique is taught.

Most (45%) of the teeth were prepared using BFT alone (Table 1). Of these cases, the majority were molars (22 of 39), but 13 and 4 were premolars and anteriors, respectively. Students were encouraged to begin using the rotary techniques clinically on cases, which appeared simpler to treat, such as premolars and anteriors. This instruction was followed as 22 and 10 molars were shaped by BFT and PF .04, respectively. In multi-rooted teeth, PF .04 or BFT could be used solely in certain canals or in combination with others. This depended on the required sizes of the apical stops and the associated canal curvatures. Quality was not assessed at this point as the number of cases in each group was rather small.

Although the authors have not evaluated all European Dental Schools, some do already teach a rotary preparation technique at the undergraduate level. These include dental schools affiliated to the Universities of Geneva, Cologne and Hanover (Prof. M. Baumann, personal communication). The positive outcome of introducing a rotary technique to the undergraduates in Zurich could help motivate more dental schools to consider such a change.

Key learning points and conclusions

- 1 Incorporating a rotary technique at the undergraduate level is easy to accomplish, which was initially envisaged. Students appreciated having a choice of preparation canals instead of assuming that only one manual technique will suffice for all clinical situations.
- 2 It is imperative to discuss which preparation technique is most appropriate in a specific situation, and this helps students to evaluate endodontic cases better.
- 3 If appropriate infrastructure is not available, introducing a rotary technique may be hampered by financial restraints.
- 4 Although PF .04 was selected by the Zurich Dental School, any other accepted Ni-Ti rotary technique can probably be equally well introduced.
- 5 To ensure ongoing education for the undergraduates, other clinical departments within a school that also treat patients endodontically, should ideally use the same rotary technique. This ensures continuity of education.

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