

EUROPEAN SOCIETY OF ENDODONTOLOGY

Undergraduate Curriculum Guidelines for Endodontology

R. De Moor, M. Hülsmann, L.-L. Kirkevang, J. Tanalp & J. Whitworth (Chair)

Preamble

Earlier editions of the ESE undergraduate curriculum guidelines for Endodontology were published in 1992 and 2001 (*International Endodontic Journal* **25**, 169–72; **34**, 574–80) and formed a benchmarking reference for dental schools and regulatory bodies. Despite much technological advance and the publication of quality guidelines for endodontic treatment (European Society of Endodontology 2006), studies published during the last decade have continued to show disappointing technical standards of root canal treatment in European populations (Eriksen *et al.* 2002, Segura-Egea *et al.* 2004, Tavares *et al.* 2009, Gencoglu *et al.* 2010, Peters *et al.* 2011). Longitudinal observational studies have also reinforced the relationship between treatment quality and persistent disease (Eckerbom *et al.* 2007, Kirkevang *et al.* 2007). Although a limited number of European countries have recognized endodontics as a speciality, there is no doubt that the vast proportion of endodontic procedures will continue to be undertaken by general dental practitioners. Evidence suggests that many general practitioners lack sufficient knowledge of the factors important in determining the outcome of root canal treatment (Bjørndal *et al.* 2007) and that basic principles are often disregarded (Peciuliene *et al.* 2009). Some of this may reflect the acquisition of foundational knowledge and skills during undergraduate training, where standards remain highly variable (Eleftheriadis & Lambrianidis 2005, Er *et al.* 2006, Sonntag *et al.* 2008, Burke *et al.* 2009, Kelbauskas *et al.* 2009, Khabbaz *et al.* 2010). It is therefore important to ensure that undergraduate training is

undertaken to a level that encourages deep understanding of the factors important in determining clinical outcome.

It is beyond the scope of this pre-amble to provide a detailed critique of all aspects of endodontic practice, but the example of root canal treatment serves to illustrate the motivation of the European Society of Endodontology in promoting standards of scientific education and clinical training across a broad undergraduate curriculum in Endodontology. This includes but is not limited to diagnostic and treatment procedures for the prevention and management of pulpal and periradicular disease, and for the preservation, restoration and monitoring of pulpally compromised teeth that would otherwise be lost. It is implicit that the procedures defined should be exercised within a model of holistic, evidence-based patient care and should be undertaken to support the oral and general health of patients.

This document represents a guideline for an undergraduate curriculum and cannot be exhaustive. The underlying principle must be that a minimum level of competence is reached prior to graduation and that an ethos of continuing professional development is instilled in the graduate.

Curriculum

The curriculum is presented as a list of competencies that the graduating student will be expected to have achieved. These provide a minimum level of competence and are defined by a baseline consensus of the committee. Whilst the time and resource given to endodontic education will vary from school to school, the committee has sought to develop a curriculum that can be delivered by most of the dental schools in Europe. The curriculum includes relevant scientific and interdisciplinary topics to emphasize the scientific foundations of Endodontology and its critical relationships

Correspondence: Professor Paul MH Dummer, School of Dentistry, College of Biomedical and Life Sciences, Cardiff University, Heath Park, Cardiff CF14 4XY, UK (Tel/fax: +44 (0)2920742479; e-mail: dummer@cardiff.ac.uk).

with other clinical disciplines. A competency-based curriculum can be interpreted as being outcome-based, and levels of competency are defined to assist student assessment and the process of course review.

Terms incorporated within these guidelines follow a pattern adopted by the Association for Dental Education in Europe (ADEE) in their Profile and Competencies of the Graduating European Dentist (Cowpe *et al.* 2010).

Be competent at

A dentist should on graduation demonstrate a sound theoretical knowledge and understanding of the subject together with an adequate clinical experience to be able to resolve clinical problems encountered independently or without assistance.

Have knowledge of

A dentist should on graduation demonstrate a sound theoretical knowledge and understanding of the subject, but need/have only a limited clinical/practical experience.

Be familiar with

A dentist should on graduation demonstrate a basic understanding of the subject but need not have clinical experience or be expected to carry out procedures independently.

Structure of training

Endodontic procedures should be practised with the required level of skill and on the basis of sound scientific knowledge. A holistic endodontic curriculum therefore requires knowledge-based input, in the form of lectures, seminars, reading and Web-based learning resources; the acquisition of basic skills in a suitably equipped pre-clinical environment, and the integration of knowledge and skills through clinical observation and supported clinical practice. It is acknowledged that the time and resource devoted by schools to endodontic education varies widely, and it has not been possible to define a minimum level of knowledge or skills-based input. Nor is it possible or desirable to provide definitive directions to schools on the manner in which they plan and deliver their courses (Sonntag *et al.* 2008). Innovation and the implementation of contemporary learning resources are encouraged, and

the sharing of good practice with the ESE Education and Scholarship Committee is welcomed.

Clinical experience

Endodontic procedures should be undertaken within the context of comprehensive patient care. Whilst it was agreed that undergraduate students may benefit from teaching and clinical supervision by specialists, it is acknowledged that this is unrealistic in many schools. The breadth of endodontic procedures is reflected by their integration with aspects of cariology, conservative dentistry, restorative dentistry, surgical dentistry, paediatric dentistry, traumatology and periodontology. Whilst some schools may have dedicated endodontic clinics, it is recognized that many do not, and that the conduct of endodontic procedures in mixed clinics may in fact encourage holistic care. It was, however, agreed that teaching staff should ideally have a special interest in Endodontology, and be able to integrate knowledge and skills in the clinical setting. Recommendations are not made on the appropriate number of procedures such as pulp caps, pulpotomies and root canal treatments required for a student to reach a threshold of competence. Indeed, a competency-based approach to training implies that the quality and consistency of student performance are more important than simply the quantity of clinical exposure, but levels of expertise are intimated by the descriptors (*Be competent at, Have knowledge of, Be familiar with*) assigned to each competency. For root canal treatment, students should be competent to undertake the treatment of uncomplicated molar teeth, and it was the view of the committee that all students should gain adequate experience in the treatment of anterior, premolar and molar teeth in both the pre-clinical and clinical environment. It is essential within an endodontic curriculum that students should gain the assigned level of competence not just in root canal treatment but in vital pulp therapies, the management of endodontic emergencies, the management of dental trauma and in surgical procedures. It is recognized that much of this may occur in clinics other than dedicated endodontic or conservation clinics.

Clinical decision-making

It is important that students are not simply trained as technicians or 'root canal therapists'. Students should be encouraged to consider all options for the

management of compromised teeth and justify the case for tooth preservation by vital pulp therapy, root canal treatment or nonsurgical/surgical retreatment, followed by adequate coronal restoration, and balance this against tooth loss and prosthetic/implant-supported replacement. The foundational nature of endodontic procedures, the importance of assessing the restorability of teeth preoperatively and of planning the restorative strategy before embarking on treatment should be emphasized. Against this background, students should gain the assigned level of competence in assessing endodontic treatment complexity. They should be aware of the factors associated with treatment success and tooth survival, and implement these within their decision-making. They should equally be encouraged to reflect on their own skills and knowledge in case assessment and recognize when referral would be in the best interests of their patients.

Assessment

Assessment ensures that the knowledge and skills learned are reinforced and a standard of competence is achieved by the end of training. The demonstration of competence should involve both formative and summative assessment.

Formative assessment

Assessment manuals can be developed, corresponding to the competencies included in this guideline document. Direct observation has been shown to be a good method of assessing clinical skills. This method can be difficult to standardize, but precise criteria (checklists) can improve consistency and reliability. Formative assessment can only work if there is effective and structured feedback. Quality feedback on performance has been shown to have a positive influence on feelings of competence. Feedback should encourage self-assessment or reflection and is relevant when set against specified criteria. It has been shown (Dunnington *et al.* 1994) that when clinical skills are practised without feedback or evaluation, errors are reinforced rather than corrected. Constructive feedback should wherever possible be provided immediately.

Suitable methods for formative assessment of clinical skills include the objective structured clinical examination (OSCE), structured clinical operative test (SCOT) and procedural observation tests such as direct observation of procedure skill (DOPS) and mini-clinical

evaluation exercise (mini-CEX) tests (Fromme *et al.* 2009, Kogan *et al.* 2009). These can involve the assessment of complete clinical procedures or for lengthy procedures such as root canal treatment can be separated into smaller, defined elements. Students can be encouraged to undertake these when they wish to present themselves as competent. Typically, students are observed during the procedure and also assess themselves using the same criteria as the supervising clinician. When the procedure is completed, the patient is dismissed and the student and staff member meet to discuss the exercise, provide feedback and agree on grading. It is acknowledged that such methods of assessment and feedback are resource intensive and may be aspirational.

It is important that not only theoretical and technical competence is tested, but also the professional attitude of the student. This may form part of a broader assessment of generic skills and professional development, and include compliance with local regulations on matters such as cross-infection control, radiation protection and record keeping, in addition to aspects of patient management and communication skills.

Summative assessment

Summative assessment by formal examination provides another important means of assessing competence. This may take the form of standard-set written, online, practical or oral examinations, or the objective assessment of completed clinical work. Consideration should be given to providing examinations specifically in Endodontology, and students should be given the opportunity to demonstrate their integration of endodontic knowledge and skills within broader summative assessments.

Summary

- It is recommended that the undergraduate curriculum for Endodontology should consist of elements outlined in the following competency document. Elements of didactic teaching, pre-clinical operative techniques classes and clinical treatment of patients will contribute to this curriculum.
- Clinical endodontics should ideally be supervised by specialists or by staff with special knowledge and interest in endodontics.
- Specific assessment procedures should be an integral part of the curriculum in Endodontology, with

both formative and summative assessment protocols.

- The philosophy developed in acquiring the competencies outlined in these guidelines for undergraduate Endodontology should form an integral part of comprehensive patient care.
- A philosophy of lifelong learning should be instilled in all dental undergraduates.

References

- American Association of Endodontists (2010) Case Difficulty Assessment Form and Guidelines [WWW document]. <http://www.aae.org/guidelines/> [Accessed on 5 September 2012].
- Bjørndal L, Laustsen MH, Reit C (2007) Danish practitioners' assessment of factors influencing the outcome of endodontic treatment. *Oral Surgery, Oral Medicine, Oral Pathology, Oral Radiology and Endodontics* **103**, 570–5.
- Burke FM, Lynch CD, Ní Ríordáin R, Hannigan A (2009) Technical quality of root canal fillings performed in a dental school and the associated retention of root-filled teeth: a clinical follow-up study over a 5-year period. *Journal Oral Rehabilitation* **36**, 508–15.
- Cowpe J, Plasschaert A, Harzer W, Vinkka-Puhakka H, Walmsley AD (2010) Profile and competences for the graduating European dentist - update 2009. *European Journal of Dental Education* **14**, 193–202.
- Dunnington GL, Wright K, Hoffman K (1994) A pilot experience with competency-based clinical skills assessment in a surgical clerkship. *American Journal of Surgery* **167**, 604–6; discussion 606–7.
- Eckerbom M, Flygare L, Magnusson T (2007) A 20-year follow-up of endodontic variables and periapical status in a Swedish population. *International Endodontic Journal* **40**, 940–8.
- Eleftheriadis GI, Lambrianidis TP (2005) Technical quality of root canal treatment and detection of iatrogenic errors in an undergraduate dental clinic. *International Endodontic Journal* **38**, 725–34.
- Er O, Sagsen B, Maden M, Cinar S, Kahraman Y (2006) Radiographic technical quality of root fillings performed by dental students in Turkey. *International Endodontic Journal* **39**, 867–72.
- Eriksen HM, Kirkevang LL, Petersen K (2002) Endodontic epidemiology and treatment outcome: general considerations. *Endodontic Topics* **2**, 1–10.
- European Society of Endodontology (2006) Quality guidelines for endodontic treatment: consensus report of the European Society of Endodontology. *International Endodontic Journal* **39**, 921–30.
- Fromme HB, Karani R, Downing SM (2009) Direct observation in medical education: a review of the literature and evidence for validity. *Mount Sinai Journal of Medicine* **76**, 365–71.
- Gencoglu N, Pekiner FN, Gumru B, Helvacioğlu D (2010) Periapical status and quality of root fillings and coronal restorations in an adult Turkish subpopulation. *European Journal of Dental Education* **4**, 17–22.
- Kelbauskas E, Andriukaitiene L, Nedzelskiene I (2009) Quality of root canal filling performed by undergraduate students of odontology at Kaunas University of Medicine in Lithuania. *Stomatologija* **11**, 92–6.
- Khabbaz MG, Protogerou E, Douka E (2010) Radiographic quality of root fillings performed by undergraduate students. *International Endodontic Journal* **43**, 499–508.
- Kirkevang L-L, Væth M, Hörsted-Bindslev P, Bahrami G, Wenzel A (2007) Risk factors for developing apical periodontitis in a general population. *International Endodontic Journal* **40**, 290–9.
- Kogan JR, Holmboe ES, Hauer KE (2009) Tools for direct observation and assessment of clinical skills in medical trainees: a systematic review. *Journal of the American Medical Association* **302**, 1316–26.
- Peciuliene V, Maneliene R, Drukteinis S, Rimkuviene J (2009) Attitudes of general dental practitioners towards endodontic standards and adoption of new technology: literature review. *Stomatologija* **11**, 11–4.
- Peters LB, Lindeboom JA, Elst ME, Wesselink PR (2011) Prevalence of apical periodontitis relative to endodontic treatment in an adult Dutch population: a repeated cross-sectional study. *Oral Surgery, Oral Medicine, Oral Pathology, Oral Radiology and Endodontics* **111**, 523–8.
- Ree M, Timmerman MF, Wesselink PR (2003) An evaluation of the usefulness of two endodontic case assessment forms by general dentists. *International Endodontic Journal* **36**, 545–55.
- Segura-Egea JJ, Jiménez-Pinzón A, Poyato-Ferrera M, Velasco-Ortega E, Ríos-Santos JV (2004) Periapical status and quality of root fillings and coronal restorations in an adult Spanish population. *International Endodontic Journal* **37**, 525–30.
- Sonntag D, Bärwald R, Hülsmann M, Stachniss V (2008) Pre-clinical endodontics: a survey amongst German dental schools. *International Endodontic Journal* **41**, 863–8.
- Tavares PB, Bonte E, Boukpepsi T, Siqueira JF Jr, Lasfargues JJ (2009) Prevalence of apical periodontitis in root canal-treated teeth from an urban French population: influence of the quality of root canal fillings and coronal restorations. *Journal of Endodontics* **35**, 810–3.

Competencies expected of a graduating European dentist in endodontology

The following pages present a list of competencies that the European Society of Endodontology considers essential for a graduating dentist in Europe. Competencies are presented in three domains:

Domain 1: Scientific foundations of endodontic practice.

Domain 2: Nonsurgical endodontic treatment.

Domain 3: Surgical endodontic treatment.

Each domain includes a list of major competencies which is followed by a list of supporting competencies – the elements of the curriculum that will allow students to achieve the desired level of competence.

Domain 1: Scientific foundations of endodontic practice

All undergraduates should be adequately grounded in basic and applied science for the safe practice of clinical dentistry (including endodontics). For the safe practice of clinical endodontics, undergraduates should *have knowledge of*:

- 1 Development, structure, function and ageing of oral and dental tissues.
- 2 Anatomy of the head and neck region.
- 3 Dental anatomy.
- 4 Pathology of oral and dental diseases.
- 5 Microbiology and immunology.
- 6 General medicine and surgery as applied to the management of dental (including endodontic) patients.
- 7 Pharmacology and therapeutics as applied to the management of dental (including endodontic) patients.
- 8 Biomaterials science as applied to endodontics.
- 9 Diagnostic imaging.
- 10 Epidemiology, public health measures and biostatistics.

Supporting competencies

In order to meet these competencies, the dental curriculum should provide didactic teaching, in addition to a range of open and experiential learning opportunities for students to be able to:

- 1 *Have knowledge of the development, structure, function, and ageing of oral and dental tissues:*
 - 1.1 Bony maxilla and mandible.
 - 1.2 Teeth.
 - 1.3 Dental hard tissues, including enamel, dentine and cementum.
 - 1.4 Dental pulp/dentine complex.
 - 1.5 Periodontal tissues, including alveolar bone, periodontal ligament, alveolar mucosa and gingiva.
- Be familiar with:*
 - 1.6 The potential of stem cell therapies for tissue repair and regeneration.

- 2 *Have knowledge of the anatomy of the head and neck region:*

- 2.1 Gross anatomy of the head and neck.
- 2.2 Innervation, vascular supply and lymphatic drainage of the teeth, jaws and adjacent structures.
- 2.3 Communications between the pulp and perodontium.

- 3 *Have knowledge of dental anatomy:*

- 3.1 Crown, root and pulp morphology of primary and permanent teeth.
- 3.2 Morphological changes in response to ageing and disease.

- 4 *Have knowledge of the pathology of oral and dental diseases of endodontic relevance, including*

- 4.1 Dental caries.
- 4.2 Noncarious tooth surface loss.
- 4.3 Marginal periodontal disease.
- 4.4 Cracked and crazed teeth.
- 4.5 Pulp reactions to caries, trauma, and operative procedures and dental materials.
- 4.6 Mechanisms of dental pain.
- 4.7 Classification of pulp and periapical conditions.
- 4.8 Pulpitis.
- 4.9 Periapical disease of endodontic origin, including localized and spreading infections.
- 4.10 Dental root resorption.
- 4.11 Pulp–periodontal inter-relationships.
- 4.12 Odontogenic and nonodontogenic lesions of the jaws.
- 4.13 Wound healing in dental and oral tissues.

- 5 *Have knowledge of microbiology and immunology:*

- 5.1 Oral colonization and biofilm formation.
- 5.2 Dental caries.
- 5.3 Marginal periodontal disease.
- 5.4 Ecological niches in the oral environment, including the dental root canal.
- 5.5 Pulpitis and periapical disease of endodontic origin.
- 5.6 Cross-infection control, disinfection and sterilization.

Be familiar with:

- 5.7 Microbiological sampling and identification.

- 6 *Have knowledge of general medicine and surgery as applied to the management of dental (including endodontic) patients:*

- 6.1 Medical emergencies.
- 6.2 Oral signs of systemic disease.
- 6.3 Special considerations for young, elderly and medically compromised patients.

- 6.4 Systemic effects of oral and specifically endodontic infections.
- 7 *Have knowledge of pharmacology and therapeutics as applied to the management of dental (including endodontic) patients:*
- 7.1 Oral and systemic effects of drugs.
 - 7.2 Drug interactions.
 - 7.3 Pharmacological pain management.
 - 7.4 Management of microbial infections.
 - 7.5 Mechanisms and significance of antimicrobial resistance.
 - 7.6 Haemostasis.
 - 7.7 Therapeutic agents in the management of pulp and periradicular disease.
- Be familiar with:*
- 7.8 Pharmacological anxiety management.
- 8 *Have knowledge of biomaterials science in relation to endodontics:*
- 8.1 Principles of biocompatibility.
 - 8.2 Materials for use in vital pulp therapies.
 - 8.3 Materials for the production of endodontic instruments.
 - 8.4 Materials for the disinfection and debridement of root canals.
 - 8.5 Materials for root canal filling and repair.
 - 8.6 Materials for the temporization and restoration of root canal-treated teeth.
 - 8.7 Bonding to dental tissues.
 - 8.8 Principles of ultrasound generation and application.
- Be familiar with:*
- 8.9 Materials used for tissue regeneration.
 - 8.10 Principles of fluid mechanics and dynamics.
- 9 *Have knowledge of diagnostic imaging:*
- 9.1 Principles of X-ray generation for conventional and digital systems.
 - 9.2 Principles of 2D and 3D imaging modalities, including cone-beam computerised tomography (CBCT).
 - 9.3 Biological effects of ionizing radiation, principles of radiation hygiene and as low as reasonably achievable (ALARA) guidelines.
 - 9.4 Optimizing image quality, including the use of paralleling devices for intra-oral views.
 - 9.5 Processing and storing diagnostic images.
- 10 *Have knowledge of epidemiology, public health measures and biostatistics:*
- 10.1 Community prevalence of dental caries, noncarious tooth surface loss, dental trauma and periradicular disease of endodontic origin.
 - 10.2 Prevention and management of dental caries, noncarious tooth surface loss and dental trauma.
 - 10.3 Principles of epidemiology and biostatistics in public health.

Domain 2: Nonsurgical endodontic treatment

The undergraduate should *be competent at:*

- 1 Conducting a detailed general and dental history.
- 2 Conducting a comprehensive clinical examination of a patient with an endodontic-related problem.
- 3 Reaching a diagnosis and possible differential diagnosis.
- 4 Establishing a treatment plan and communicating this to the patient.
- 5 Performing procedures to retain all or part of the dental pulp in health.
- 6 Performing good quality root canal treatment.
- 7 Restoring root canal-treated teeth.
- 8 Monitoring and evaluating the outcome of endodontic treatment.
- 9 Communicating verbally and in writing with dental and medical colleagues.

The undergraduate should *have knowledge of:*

- 10 The management of dentoalveolar trauma.

Supporting competencies

In order to meet these competencies, the curriculum should provide didactic teaching and clinical experience for students to be able to:

- 1 *Conduct a detailed general and dental history:*
 - 1.1 *Be competent at* deriving a clear, concise medical and dental history.
 - 1.2 *Be competent at* clarifying points of uncertainty without prejudicing the response.
 - 1.3 *Be competent at* keeping legible, accurate and concise clinical notes.
- 2 *Conduct a comprehensive clinical examination of a patient with an endodontic-related problem:*
 - 2.1 *Be competent at* conducting a detailed examination of extra-oral and intra-oral tissues and structures.
 - 2.2 *Be competent at* prescribing and conducting a range of diagnostic tests of endodontic relevance, including periodontal probing; assessment of tooth mobility; soft-tissue palpation for tenderness and fluctuance; tenderness to tooth percussion; investigation for cracks by differential cusp wedging, transillumination and staining; occlusal examination; pulp

- sensibility testing; sinus tract exploration; selective anaesthesia; intra-oral radiography, including the use of paralleling devices and extra-oral radiography.
- 2.3 *Be competent at identifying endodontic treatment complexity.* Case assessment guidelines such as the Dutch Endodontic Treatment Index (Ree *et al.* 2003) and the American Association of Endodontists Endodontic Case Difficulty Assessment Form and Guidelines (2010) may provide a helpful framework for structured patient evaluation, and the identification of clinical challenges.
- 2.4 *Have knowledge of orofacial pain conditions.*
- 3 *Reach a diagnosis and possible differential diagnosis:*
- 3.1 *Be competent at interpreting the outcomes of clinical examination and diagnostic tests.*
- 3.2 *Be competent at recognizing the symptoms and signs of common pulpal and periradicular conditions.*
- 3.3 *Have knowledge of conditions that may mimic pulp and periradicular disease of endodontic origin.*
- 4 *Establish a treatment plan and communicate this to the patient:*
- 4.1 *Be competent at prioritizing endodontic interventions.*
- 4.2 *Be competent at communicating the principles and practice of preventing pulpal and periradicular disease.*
- 4.3 *Be competent at communicating with patients to describe management options, and their potential benefits, risks and likely outcomes.*
- 4.4 *Be competent at securing informed consent for treatment.*
- 4.5 *Be competent at identifying personal limitations of experience and expertise in the management of endodontic care.*
- 4.6 *Have knowledge of conditions and complexities that may warrant referral to a medical or dental specialist.*
- 5 *Perform procedures to retain all or part of the dental pulp in health:*
- 5.1 *Be competent at performing topical, local infiltration and regional dental local anaesthesia.*
- 5.2 *Be competent at tooth isolation, including the use of rubber dam.*
- 5.3 *Be competent at managing dental caries for disease control and pulp survival.*
- 5.4 *Be competent at preserving vital pulp functions by the implementation of vital pulp therapies including indirect and direct pulp capping.*
- 5.5 *Have knowledge of the principles and practices of managing pulp and periradicular disease in primary and immature permanent teeth, including pulp capping, pulpotomy, continued root development (apexogenesis), root-end closure (apexification) and pulp revascularization/regenerative procedures.*
- 6 *Perform good quality root canal treatment:*
- 6.1 *Be competent at managing the clinical environment for infection control, including the disinfection of cabinetry and equipment surfaces, the sterilization of instruments, zoning and the use of appropriate barrier techniques.*
- 6.2 *Be competent at performing topical, local infiltration and regional local anaesthesia for the management of pulp and periradicular pain.*
- 6.3 *Be competent at performing rubber dam isolation for endodontic purposes.*
- 6.4 *Be competent at accessing the pulp chamber and identifying canal orifices in uncomplicated anterior and posterior teeth.*
- 6.5 *Be competent at securing undistorted intra-oral radiographs during root canal treatment.*
- 6.6 *Be competent at negotiating uncomplicated root canals and securing a working length by radiographic and electronic means.*
- 6.7 *Be competent at shaping root canals without procedural error in uncomplicated anterior and posterior teeth.*
- 6.8 *Be competent at irrigating root canals for the elimination of microorganisms, organic and inorganic materials.*
- 6.9 *Be competent at medicating root canals for the control of microbial infection.*
- 6.10 *Be competent at filling the root canals of uncomplicated anterior and posterior teeth, densely and with length control.*
- 6.11 *Be competent at securely temporizing teeth during and after root canal treatment.*
- 6.12 *Be competent at providing appropriate post-operative instructions on mouth care and the management of postoperative pain and swelling.*
- 6.13 *Have knowledge of the benefits and use of magnification and enhanced illumination in endodontic practice.*

- 6.14 *Have knowledge of* the removal of restorations such as crowns and posts for endodontic access.
- 6.15 *Have knowledge of* techniques to manage natural impediments to access, such as secondary and tertiary dentine, and pulp stones.
- 6.15 *Have knowledge of* different techniques for shaping root canals.
- 6.17 *Have knowledge of* common procedural errors during the instrumentation of root canals, including ledges, fractured instruments and root perforations; their prevention and management.
- 6.18 *Have knowledge of* different techniques for filling root canals.
- 6.19 *Have knowledge of* the management of endodontic emergencies, including reversible pulpitis, symptomatic irreversible pulpitis, symptomatic apical periodontitis, acute apical abscess (including mid-treatment 'flare-ups'), hypochlorite accidents and cracked/fractured teeth.
- 6.20 *Have knowledge of* materials and methods for the removal of root canal filling materials.
- 6.21 *Be familiar with* supplementary agents and methods for the management of intra-operative pulpal and periradicular pain, including intraligamentary, intra-osseous and intrapulpal routes of delivery and computer-controlled systems for local anaesthetic delivery.
- 6.22 *Be familiar with* methods of enhancing irrigant action, including the use of ultrasound.
- 6.23 *Be familiar with* techniques for the removal of foreign bodies such as fractured instruments and posts from root canals.
- 7 *Restore root canal-treated teeth:*
- 7.1 *Be competent at* restoring root canal-treated teeth to function and aesthetics using intracoronary and extracoronary restorations, including provisional restorations, post-placement, permanent plastic restorations, core build-ups and extracoronary restorations (onlays, crowns).
- 7.2 *Have knowledge of* bleaching procedures to restore the aesthetics of discoloured root canal-treated teeth.
- 7.3 *Have knowledge of* adjunctive treatments for the restoration of root canal-treated teeth, including surgical crown lengthening and orthodontic forced eruption.
- 8 *Monitor and evaluate the outcome of endodontic treatment:*
- 8.1 *Be competent at* prescribing monitoring plans for endodontic patients.
- 8.2 *Be competent at* identifying patient-reported symptoms that may indicate the presence of post-treatment endodontic disease.
- 8.3 *Be competent at* conducting a dental history to elucidate symptoms and clinical signs of post-treatment endodontic disease.
- 8.4 *Be competent at* prescribing, conducting and interpreting the results of investigations for post-treatment disease, including responses to pulp sensibility testing, tenderness to percussion or palpation, presence of a soft-tissue swelling, presence of a sinus tract or locally deep periodontal probing defect, increased tooth mobility, radiographic signs of static or expanding periapical lesions, radiographic signs of root fracture or resorption.
- 8.5 *Have knowledge of* management options when post-treatment disease is identified, including continued monitoring, nonsurgical re-treatment, surgical treatment and extraction with or without prosthetic (including implant-supported) replacement.
- 9 *Communicate verbally and in writing with dental and medical colleagues:*
- 9.1 *Be competent at* keeping clear, concise and contemporaneous clinical records.
- 9.2 *Be competent at* presenting the details of a previously examined patient to a colleague for case discussion.
- 9.3 *Have knowledge of* dental and medical specialists who may be able to provide advice during the assessment and treatment of endodontic patients.
- 9.4 *Have knowledge of* the content and structure of a formal referral letter to a medical or dental colleague.
- 10 *Describe the management of dentoalveolar trauma:*
- 10.1 *Have knowledge of* the prevention of dental trauma, especially during sporting pursuits.
- 10.2 *Have knowledge of* the principles and practice of managing dentoalveolar trauma, including crown fractures, crown-root fractures, root fractures, luxation injuries, avulsions.

- 10.3 *Be familiar with the principles of emergency trauma management, splinting protocols and recommended follow-up regimes.*

Domain 3: Surgical endodontic treatment

The undergraduate should *be competent at*:

- 1 Conducting a detailed general and dental history for a patient with post-treatment endodontic disease.
- 2 Conducting a comprehensive clinical examination of a patient with post-treatment endodontic disease.
- 3 Reaching a diagnosis and possible differential diagnosis, and presenting treatment options for the management of post-treatment endodontic disease.

The undergraduate should *have knowledge of*:

- 4 Recognizing conditions that may best be managed by surgical endodontic treatment.
- 5 Assessing the benefits, risks and likely outcome of endodontic surgery.
- 6 Postoperative monitoring of surgical endodontic patients.

Supporting competencies

In order to meet these competencies, the curriculum should provide didactic teaching and clinical experience for students to be able to:

- 1 *Conduct a detailed general and dental history for a patient with post-treatment endodontic disease:*
 - 1.1 *Be competent at deriving a clear, concise medical and dental history.*
 - 1.2 *Be competent at clarifying points of uncertainty without prejudicing the response.*
 - 1.3 *Be competent at keeping legible, accurate and concise clinical notes.*
- 2 *Conduct a comprehensive clinical examination of a patient with post-treatment endodontic disease:*
 - 2.1 *Be competent at conducting a detailed examination of extra-oral and intra-oral tissues and structures.*
 - 2.2 *Be competent at prescribing and conducting a range of diagnostic tests of relevance to the diagnosis of post-treatment endodontic disease, including pulp sensibility testing; periodontal probing; assessment of tooth mobility; soft-tissue palpation for tenderness and fluctuance; tenderness to tooth percussion; investigation for cracks by differential cusp wedging, transillumination and staining; occlusal examination; sinus tract exploration;*

selective anaesthesia; intra-oral radiography, including the use of paralleling devices and extra-oral radiography.

- 2.3 *Be competent at identifying signs of post-treatment endodontic disease.*
- 2.4 *Have knowledge of orofacial pain conditions.*
- 3 *Reach a diagnosis and possible differential diagnosis, and present treatment options for the management of post-treatment endodontic disease:*
 - 3.1 *Be competent at interpreting the outcomes of clinical examination and diagnostic tests in the diagnosis of post-treatment endodontic disease.*
 - 3.2 *Be competent at presenting treatment options to patients.*
 - 3.3 *Have knowledge of conditions that may mimic pulp and periradicular disease of endodontic origin and the principles of their management.*
 - 3.4 *Have knowledge of management options for patients with post-treatment endodontic disease, including continued monitoring, non-surgical retreatment, surgical endodontic treatment and extraction with or without prosthetic (including implant-supported) restoration.*
 - 3.5 *Be familiar with implant surgical procedures.*
 - 3.6 *Be familiar with outcome data for a range of conditions including nonsurgical endodontic retreatment, apicectomy and root canal filling, conventional and resin-bonded bridgework, implant-supported prostheses.*
- 4 *Recognize conditions that may best be managed by surgical endodontic treatment:*
 - 4.1 *Have knowledge of the indications for surgical endodontic procedures.*
 - 4.2 *Have knowledge of the principles of microsurgical endodontics, including perisurgical care, infection control, magnification and illumination, pain and anxiety control, flap design and elevation, osteotomy, periradicular curettage, haemostasis, root-end resection (apicectomy), minimally invasive root-end preparation and filling, the properties of alternative root-end filling and perforation repair materials, suturing, postoperative wound care.*
 - 4.3 *Have knowledge of the general care of surgical patients.*
 - 4.4 *Have knowledge of systemic conditions that may complicate oral surgical procedures.*

- 4.5 *Be familiar with* a range of surgical endodontic procedures, ideally by observation or direct assistance, including incision and drainage, exploratory endodontic surgery (e.g. for the diagnosis of root fractures or perforations), planned extraction and reimplantation, hemisection, root amputation, surgical perforation repair, apicectomy and root-end filling.
- 4.6 *Be familiar with* adjunctive surgical procedures, including guided bone regeneration.
- 5 *Assess the benefits, risks and likely outcome of endodontic surgery:*
 - 5.1 *Have knowledge of* common risks associated with surgical (including endodontic surgical) procedures and how they are managed.
 - 5.2 *Be familiar with* outcome data for surgical endodontic procedures.
- 6 *Postoperative monitoring of surgical endodontic patients:*
 - 6.1 *Have knowledge of* the postoperative care and monitoring of surgical (including endodontic surgical) patients.
 - 6.2 *Have knowledge of* the management of post-surgical complications including pain, swelling, haemorrhage and infection.
 - 6.3 *Have knowledge of* when referral to a specialist may be indicated.