Technical note

Use of in-house, full-colour printed three-dimensional model for training in endoscopic periradicular surgery for molar radicular cyst

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Treatment of molar radicular cysts is challenging and many molars may be removed if endodontic treatment is unsuccessful. Conventional periradicular surgery of molars is not always done, because of the technical difficulties and poor visualisation. Endoscopic periradicular surgery (EPS) has been introduced to avoid having to remove molars.\textsuperscript{1–3} If filling of the root canal is insufficient, we use EPS after endodontic treatment. However, it is difficult to train oral surgeons to resect roots and fill the root of the molar precisely in a retrograde manner under endoscopic guidance, and a training system has yet to be established. We have therefore created in-house, full-colour printed three-dimensional model for training in EPS for molar radicular cyst.

To produce the EPS training model, we used ZPrinter 450 (Z Corporation, Burlington, MA, USA), which can print a full-colour, three-dimensional model using a high performance plaster-based composite that is cost-effective with low waste. A full-colour, three-dimensional printer costs 1.9 times the monochrome\textsuperscript{4}, but the running costs are almost the same. The vertical build speed is 23 mm/h and the build size $203 \times 254 \times 203$ mm.

In a patient with a molar radicular cyst, DICOM data were transferred to Mimics 14 software (Materialize, Leuven, Belgium) after computed tomography. The jaw, the molar with the radicular cyst, and the root canal were segmented, and the data were exported as an STL file to ZPrint software (Z Corporation). The crown and roots were coloured, the root canals were produced as cavities, and then the three-dimensional model was printed. We used the model and a $70\degree$ endoscope $2.7$ mm in diameter with a sheath $3.5$ mm in outer diameter (Karl Storz, Tuttingen, Germany) for EPS training for treating molar radicular cysts, and this training was done without irrigation to avoid dissolution of the plaster.

After the buccal bone of the right mandibular second molar has been removed using a round bur, the cystic cavity and yellow roots are exposed (Fig. 1). As the root canal cavities...
are filled with chipped plaster after the root has been resected under endoscopic guidance, we remove the plaster from the root canals, which represented gutta-percha, using a retrograde ultrasonic tip (Fig. 2). Finally, retrograde filling of the root is completed using SuperEBA cement (Fig. 3).

A virtual apicectomy simulator was recently developed as a training tool. Although oral surgeons can repeatedly train with the virtual simulator, training for EPS is not sufficient because of the endoscopic view that it affords. The simulator is also not easily available for use with non-commercial systems. In contrast, a commercial three-dimensional printer can be used with our method at relatively low cost. Although Aleid et al. reported in-house rapid manufacturing of three-dimensional models in maxillofacial surgery, only white models could be produced with a non-colour printer. By using a full-colour three-dimensional printer, the coloured roots in the radicular cyst can be identified and differentiated easily from white bone. Retrograde filling of the root after resection is possible by producing root canals as cavities. For EPS training in preparation for operations on molar radicular cysts, we recommend an in-house, full-colour printed three-dimensional model to simulate EPS preoperatively using a patient-specific model produced at low cost.

References