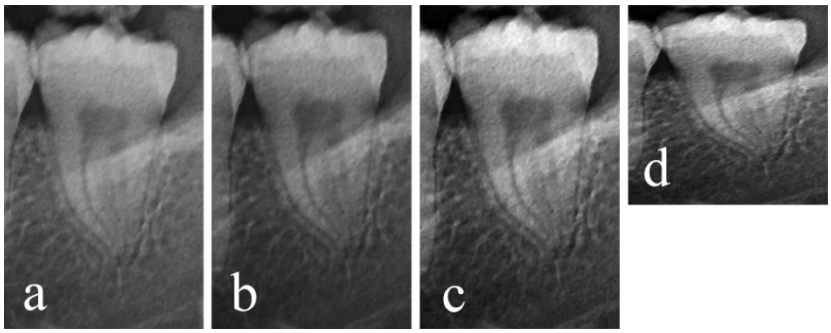
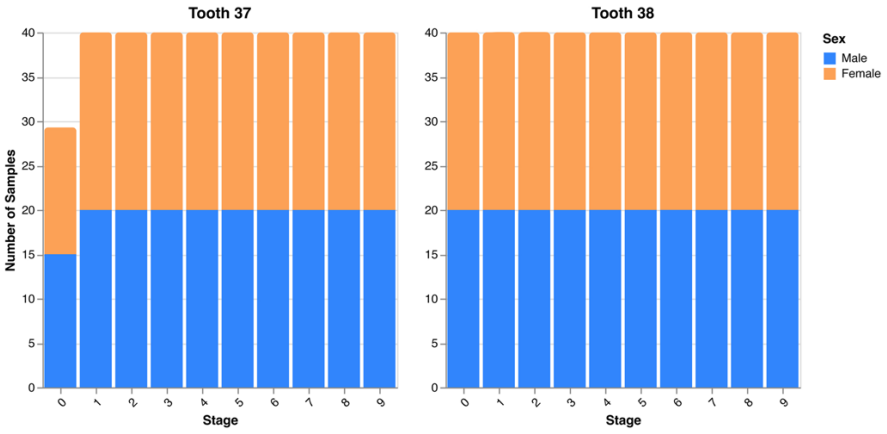
Supplementary Visualizations

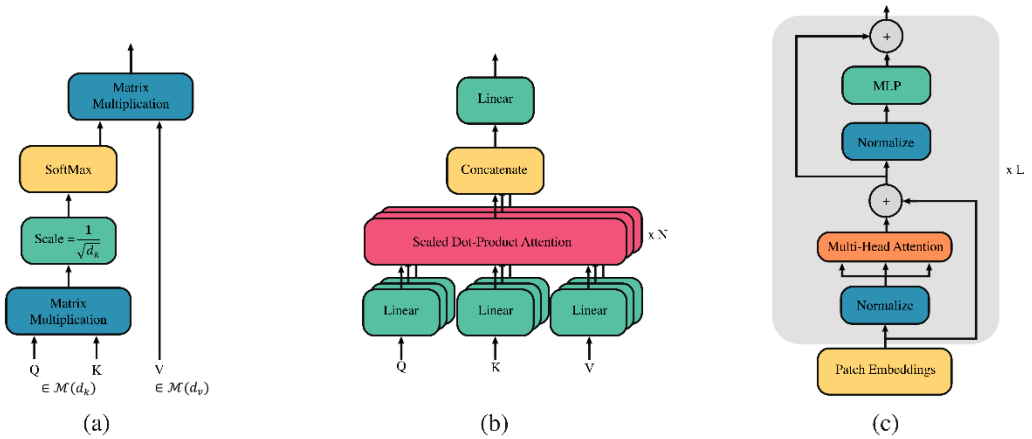
We provide additional visualizations in this section that may benefit the reader's understanding of our work. See figure captions for explanations on individual figures.



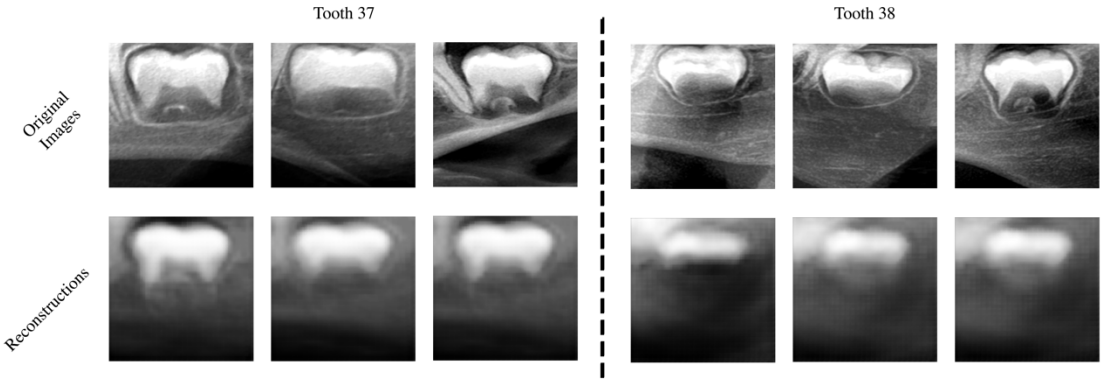
Supplementary Figure 1. The significance of intensity normalization is demonstrated using this example of tooth 38. The image in (a), with increased brightness and reduced contrast, led the human observer to assign stage 9. In contrast, image (b) was interpreted as stage 8. Image (c) shows the result after intensity normalization, while (d) displays the resized square version, used as input for the model.



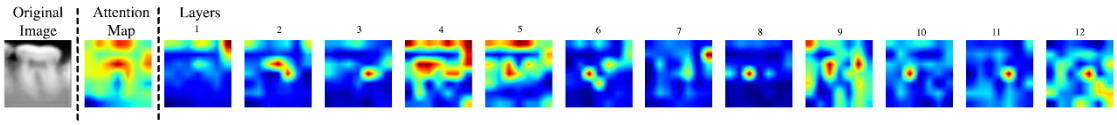
Supplementary Figure 2. Distributions of samples in the datasets of teeth 37 and 38. The datasets are balanced in terms of sex and age, with the exception of stage 0 for tooth 37. This facilitates a more straightforward approach in deep model training, eliminating the need for balancing steps.



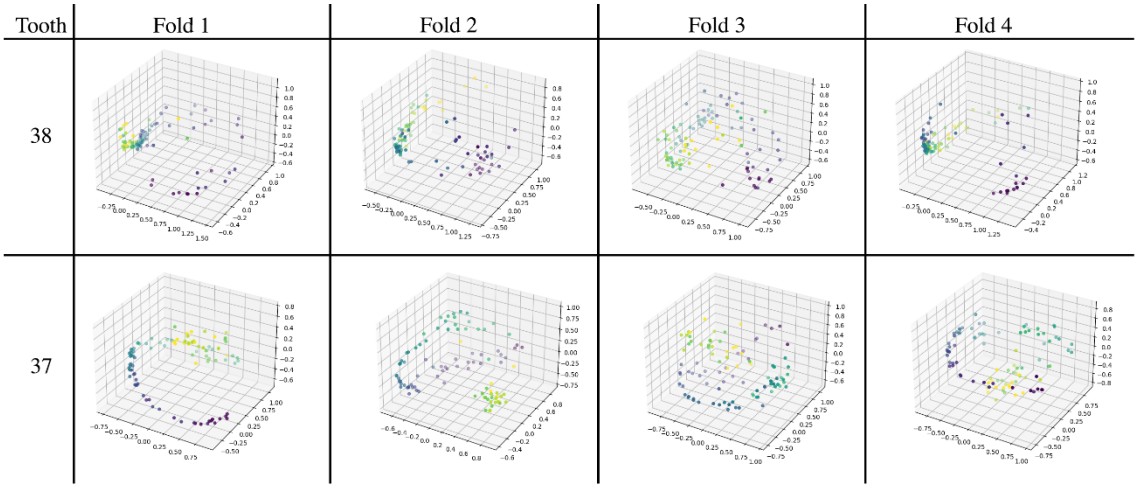
Supplementary Figure 3. A depiction of (a) scaled dot-product attention, (b) multi-headed attention and (c) the ViT encoder structure.



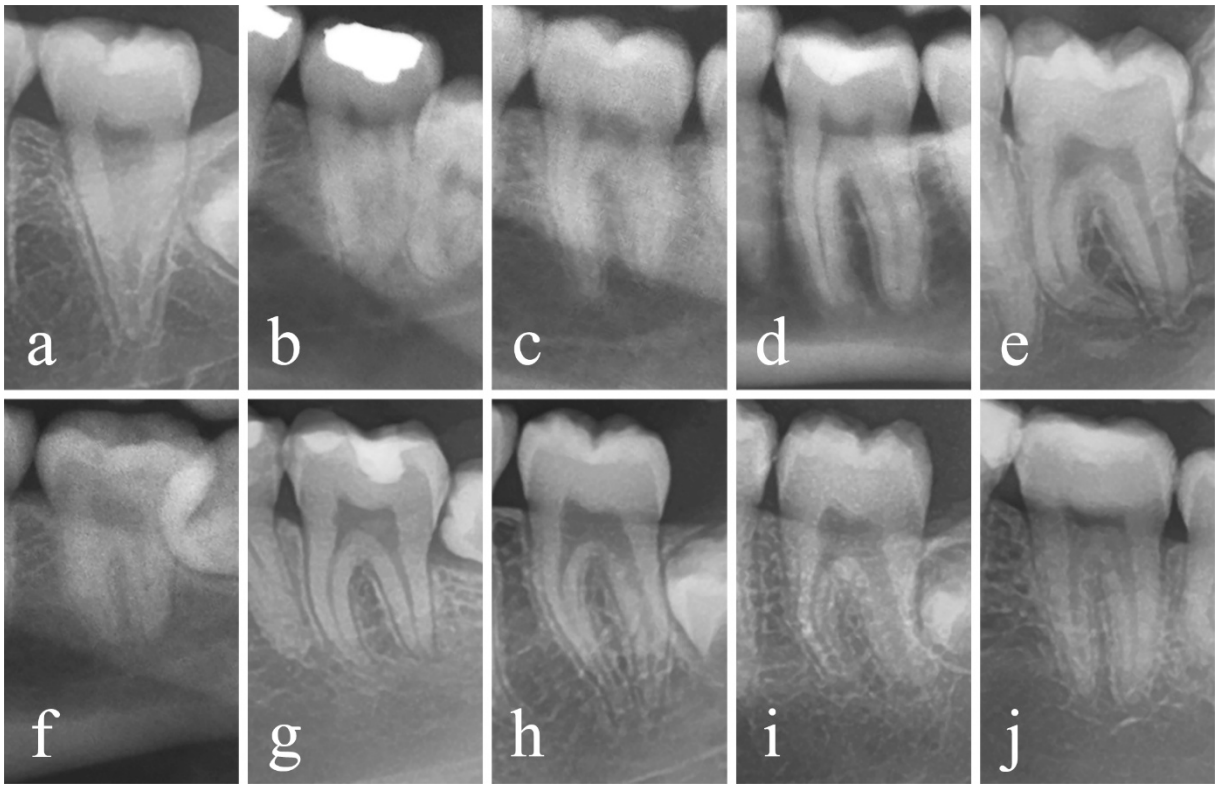
Supplementary Figure 4. Samples of several stage 5 images and their reconstructions, illustrating the prototyping effect of the autoencoder. We can see the images are reconstructed to contain the characteristics of their stage, while also incorporating their stochastic differences. This is more prominently seen in tooth 37. For tooth 38, the reconstructions are less distinct and less similar to one another. This is an indication of the samples of the same class showing morphologies too different from each other to converge into similar prototypes, containing more stochastic features and lacking in semantic representations, which further points to the high intra-class variability for tooth 38.



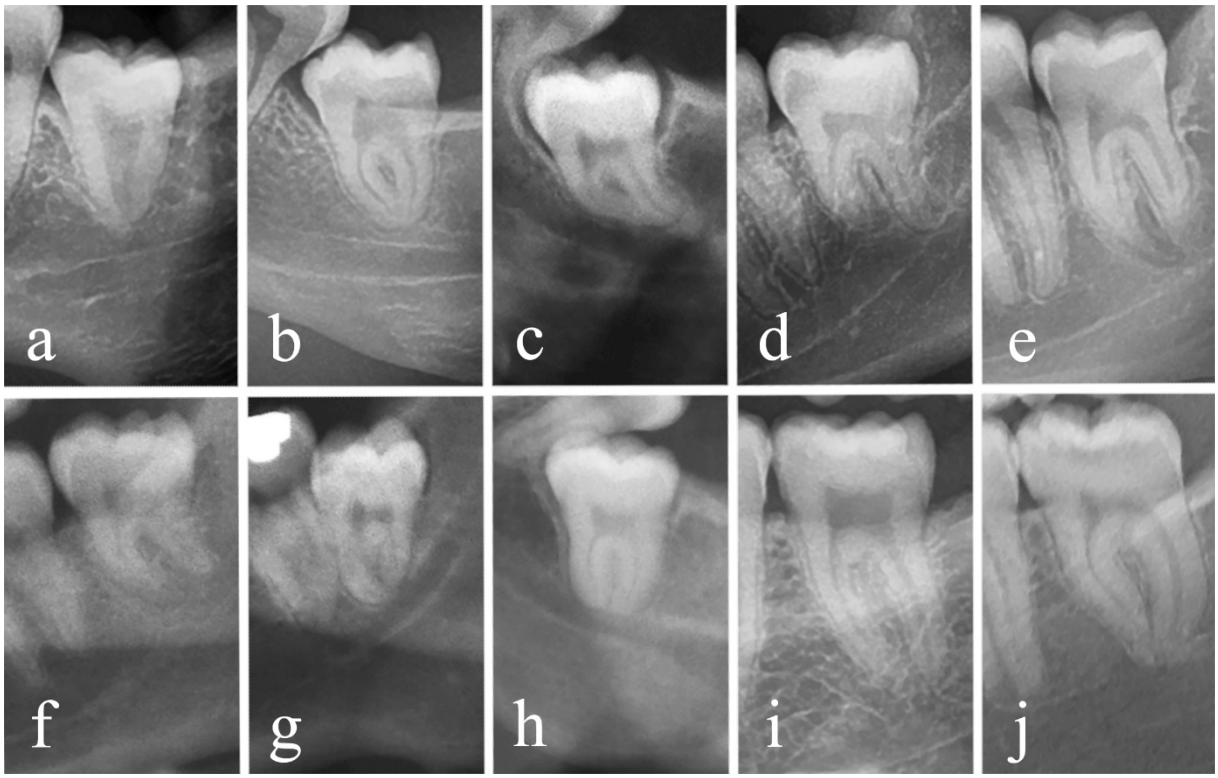
Supplementary Figure 5. An example on how the ViT self-attention matrices evolve throughout encoder layers, best viewed zoomed in. The layers 1 through 3 learned highly localized attention patterns, while layers 4 and 5 show a spread attention. This evolution is key to the attention of the ViT, where each layer extracts different information from the image, and all these different attentions culminate in the total attention map via the rollout method.



Supplementary Figure 6. The embeddings from each fold in the cross-validation process, shown in a similar fashion to Fig. 6 in the main text. It can be seen that the embeddings of tooth 37 consistently depict the ordinality enforced by the triplet loss across folds, while those of tooth 38 are much less structured.



Supplementary Figure 7. Illustrations of morphological variation of tooth 37.
(a) Single root with a large pulp.
(b) Fused roots and occlusal filling.
(c) A long thin mesial root versus a shorter wider distal root.
(d) The mesial root splits into a buccal and a lingual root apex.
(e) Dilaceration of the mesial root.
(f) Relatively short roots.
(g) Relatively short roots and occlusal fillings.
(h) Long thin roots.
(i) The pattern of trabecular bone hinders interpretation of root anatomy.
(j) A thin mesial root versus a wider distal root.
Note that despite illustrating considerable variation, these images still reveal a remarkable uniformity in the appearance of tooth 37, especially when contrasted with those shown in Supplementary Figure 8.



Supplementary Figure 8. Illustrations of morphological variation of tooth 38.

(a) Single root with a large pulp.
(b) Fused roots, at a slight distance of the mandibular canal. Mesial impaction.
(c) Strongly curved roots, with superposition of both roots. Mesial impaction.
(d) Short mesial root and superposition of the distal root with the mandibular canal. Distal impaction.
(e) Aberrant appearance of root apices. No impaction.
(f) Relatively short roots, with apices in contact with the mandibular canal. No impaction.
(g) Fused roots in contact with the mandibular canal. Superposition of teeth 37 and 38, both at the level of the crowns and the roots. Distal impaction.
(h) Superposition of tooth 38's crown with tooth 37's root. Mesial impaction.
(i) The pattern of trabecular bone hinders interpretation of apical root anatomy. No impaction.
(j) Large crown and wide roots. No impaction.

Note that these images reveal a large variability in the appearance of tooth 38, especially when contrasted with those shown in Supplementary Figure 7.