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Visualization/scoring-based evaluation of tooth preparation for skill assessment by axial wall taper analyses

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Introduction

Objective assessment methods for technical skills in the preparation of teeth for crowns are still not well established in dental education. We have developed an AI image recognition system to assess tooth preparation skills. An algorithm that automatically extracts the characteristics of abutment teeth is required to establish the system.

Objective

The purpose of this study was to determine the algorithms to extract characteristics of abutment teeth by numerical analysis.

Materials and Methods

First, the algorithm for extracting the minimum practical convergence angle (taper) between axial walls was verified.

A non-prepared standard artificial tooth and 41 artificial teeth prepared by 4th grade undergraduate students were scanned on a positioning jig to standardize the three-dimensional (3D) position. On an occlusal surface in a 3D image of a non-prepared artificial tooth, buccolingual and mesiodistal baselines for sagittal and coronal cross-sections parallel to the tooth axis were set by connecting between the buccal and lingual cusps and between pits, respectively (**Fig. 1**).

Outlines of each prepared tooth on the sagittal and coronal cross-sections in baselines were obtained. To derive an algorithm for automatically extracting the taper, buccolingual and mesiodistal tapers of each prepared tooth were quantified by geometric analysis.

Results

The algorithm derived from the directional derivative calculation of the outlines of the 41 abutment teeth recognized tapers accurately in 160 out of 164 abutment tooth surfaces (97.6% accuracy). It tended to be less accurate in improperly prepared teeth (**Fig. 2**).

Conclusion and Future Perspectives

The proposed algorithm could extract the characteristics of abutment teeth with high accuracy. This algorithm would promote the application of machine learning to the development of an AI image recognition system to assess tooth preparation skills and advance the field of dental education.

Acknowledgement

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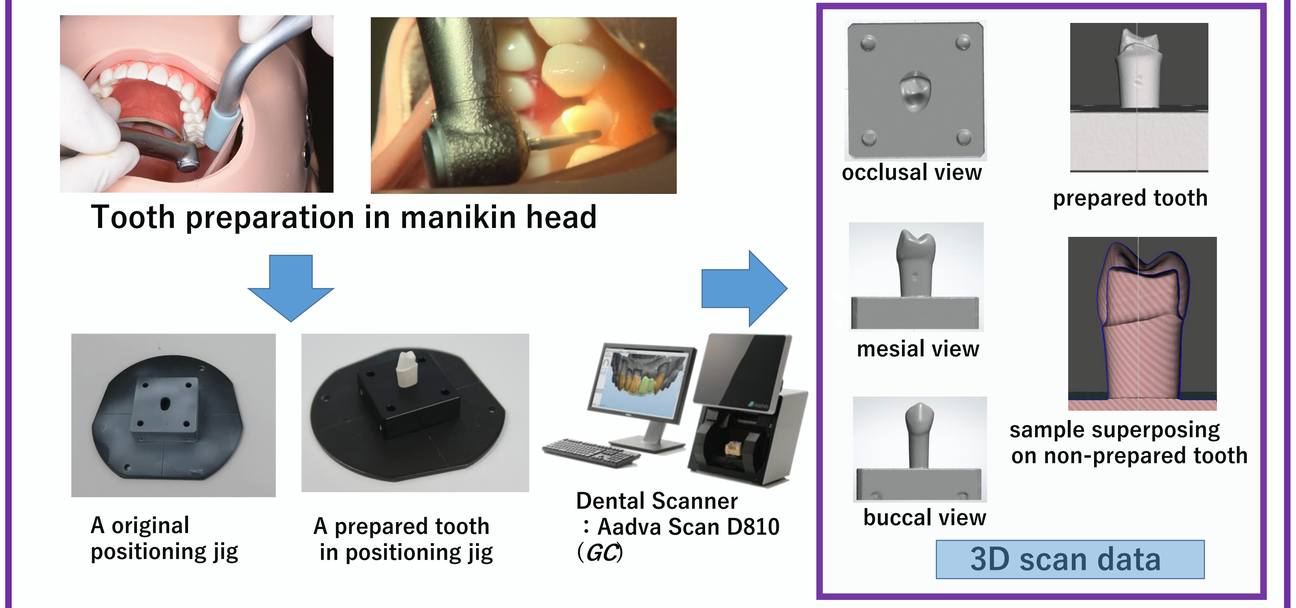

Process of prepared tooth to 3D data

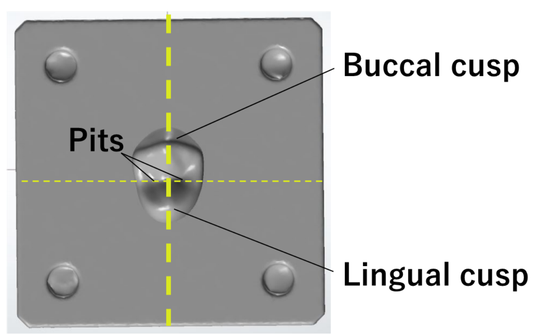

Fig.1 Buccolingual (dashed) and mesiodistal (dotted) baselines on occlusal surface in 3D data of a reference tooth.

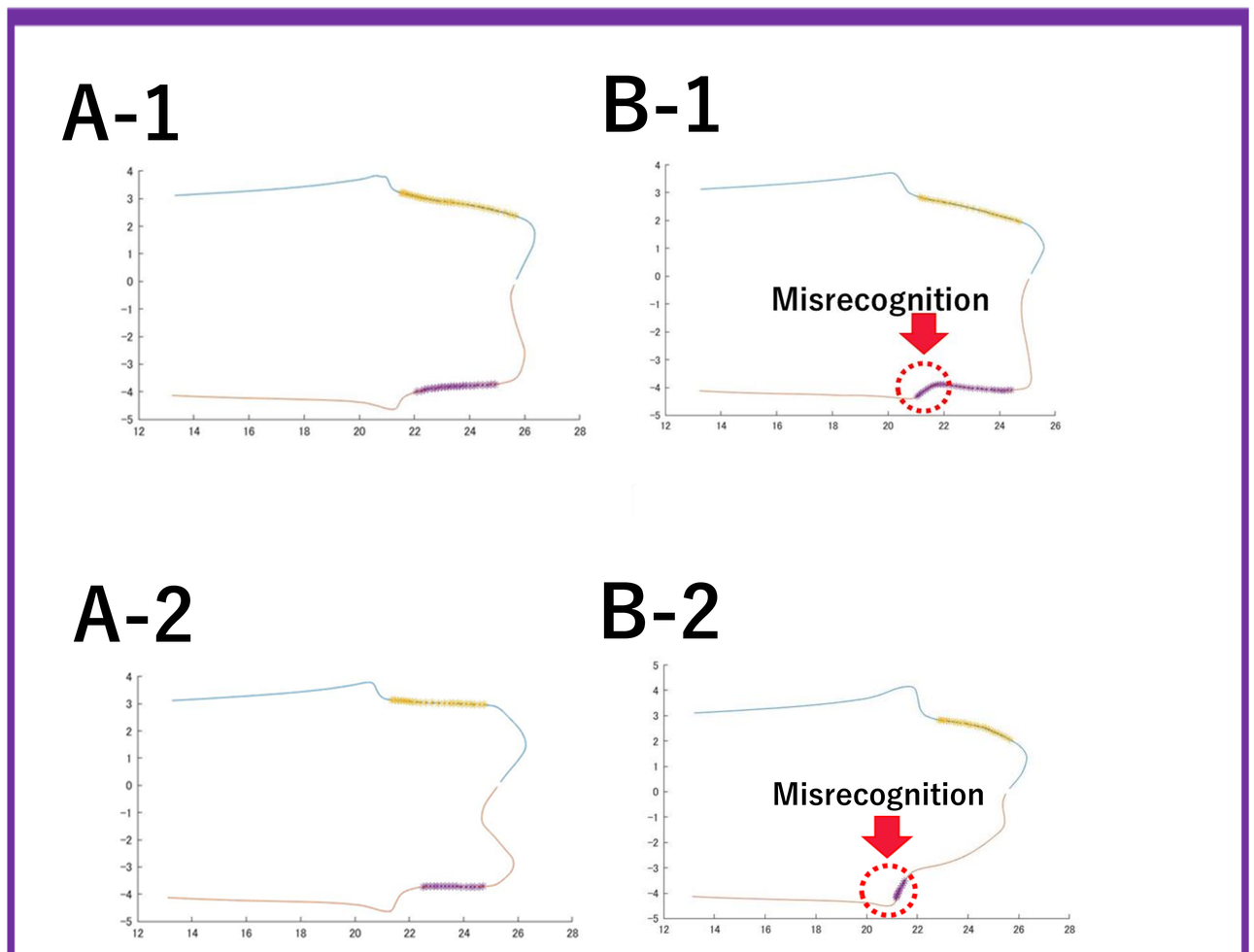

Fig. 2 Representative images for buccolingual cross-sectional outline with recognitions (yellow and purple regions) for tapers by the algorithm in prepared teeth. Note the presence of misrecognition on the inadequately prepared teeth (B-1, 2) in contrast with the adequate ones (A-1, 2).