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Exploring existing methods for calculating dental arch form and curvature

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The rapid advancement of artificial intelligence technologies has progressively expanded into applications in dental medicine. In clinical dentistry, numerous prosthodontics-related software platforms have already integrated artificial intelligence technologies.[1] Currently, the morphology, arrangement, and occlusal function of dental prostheses are established based on the curvature of the maxillary and mandibular arches. Moreover, from traditional orthodontic treatments to modern digital workflows, the dental arch curve has consistently served as one of the key references in treatment planning. Accordingly, obtaining an accurate dental arch curve remains a critical challenge for the integration of artificial intelligence into clinical dentistry. The present study aimed to examine previously reported methods for calculating dental arch curves, thereby offering algorithmic references to support the future development of artificial intelligence models (Table 1).

In 1975, Pepe proposed the use of polynomial equations to measure dental arch curves.[2] To evaluate the accuracy of polynomial and catenary curve-fitting models, and to assess the validity of the common line of occlusion concept. Researchers calculated coefficients and mean square errors (MSE) for second, fourth, and sixth-degree polynomials, restricting the degree to eight or fewer to avoid oscillations and numerical errors. Results showed that sixth-degree polynomials generally achieved better fitting accuracy than fourth-degree polynomials, with notable reductions in MSE in certain arches. In 1998, Braun et al. studied the correlation between dental arch curve data and the mathematical dental arch curve represented by the β function.[3] For the complete sample of 80 models, the mean correlation coefficient of the curve fitting was 0.98. The authors suggested that a fourth-order polynomial function, derived from a combination of a parabola and an ellipse, was suitable for investigating gender differences in dental arch shape. However, with respect to changes in dental arch perimeter dimensions and the computational models for arch expansion curves, the beta function has been shown to represent the dental arch curve more accurately. Subsequently, in 2015, Lee et al. introduced the Gaussian functional mixture model to calculate the dental arch curve.[4] The dental arches were modeled using a symmetric I-spline function and subsequently clustered with a functional gaussian mixture model. The results demonstrated that this approach achieved greater accuracy and lower variance. It was not until 2023 that Bogdanov et al. introduced second-order curves for modeling dental arch shape.[5] The coordinates of the central incisors, canines, and second molars were marked, followed by mathematical modeling using a second-order curve. The results indicated that the ellipse was the most suitable curve for describing the mandibular and maxillary dental arch shapes in orthodontics.

Based on previous studies, the dental arch curve has been calculated from the lines of occlusion of the teeth using a mathematical formula. However, different types of orthodontic treatment and variations in maxillary–mandibular occlusal relationships require

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Table 1 Overview of methods for calculating dental arch form and curvature. The table lists years, author, formula, type and reference.

Years	Author	Formula	Type	Reference
1975	Pepe	Polynomial equations	Lines of occlusion	2
1998	Braun et al.	Beta function curve	Lines of occlusion	3
2015	Lee et al.	Functional Gaussian mixture model	Lines of occlusion	4
2023	Bogdanov et al.	Second-order curve	Lines of occlusion	5

correspondingly appropriate calculation formulas. In addition, age and gender should also be taken into consideration. Future research should further investigate the suitability of artificial intelligence algorithms for dental arch curve alignment. This will help improve the accuracy and effectiveness of restoration design and orthodontic treatment.

Declaration of competing interest

The authors have no conflicts of interest relevant to this article.

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