

Estimating interproximal wear in upper first molars

Jennifer Eyre & Shara Bailey

Department of Anthropology and the Center for the Study of Human Origins, New York University & The New York Consortium in Evolutionary Primatology

1. Research Question

Introduction

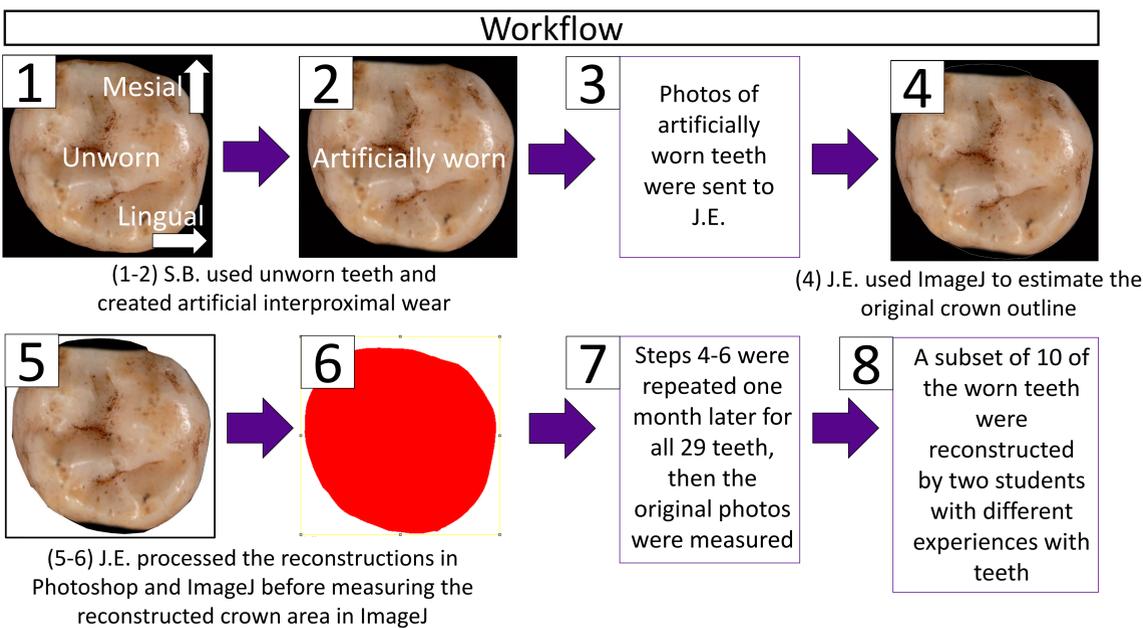
- Fossil hominin dental remains play an important role in determining taxonomic affinity and investigating differences among known species (e.g. Leakey et al., 1964; Villmoare et al., 2015).
- Crown and/or cusp areas are frequently the object of study; however, these measurements are affected by interproximal wear (see Box 1).
- It is not always clear how researchers account for interproximal wear, and how accurate their reconstructions are when they do compensate for it (Wolpoff, 1971).
- One method for estimating crown area relies upon recreating the worn sections of the original crown from occlusal photographs. In this method the original mesial and distal borders are estimated based on the buccolingual extent of the wear facet and preserved tooth shape.

Hypotheses

- We hypothesized that estimated crown areas using this method accurately reflect actual crown areas, but that accuracy may be influenced by an individual's experience/familiarity with tooth morphology.**

2. Materials & Methods

- N=29 upper first molars from geographically varied modern humans



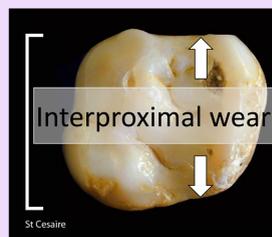
Experience levels of the reconstructors

All reconstructors are PhD students who were enrolled in S.B.'s Dental Anthropology course. J.E. (Rec 1.1 & Rec 1.2) was then a 5th year, and studies postcranial functional morphology; P.C. (Rec 2) was then a 1st year studying dental anthropology; E.K. (Rec 3) was then a 2nd year studying dental anthropology.

Box 1: What is interproximal wear?

Interproximal wear reduces tooth crown area (right) through loss of enamel where there is tooth-to-tooth contact. Interproximal wear is influenced by

- Diet
- Age
- Paramasticatory use (Kaidonis et al., 1992; Kaidonis 2008)



3. Results

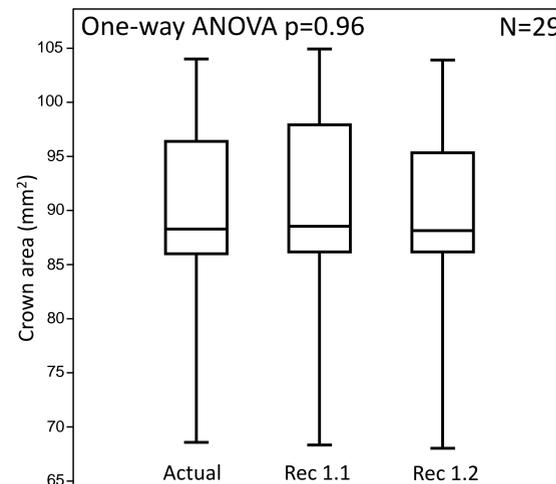


Figure 1: Means and ranges of crown areas for all 29 teeth. Means do not differ significantly.

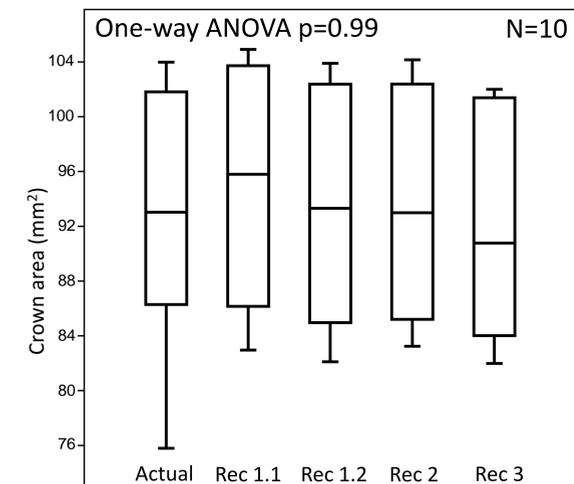


Figure 2: Means and ranges for subset of 10 teeth. Means do not differ significantly.

- The areas of the reconstructed crowns in Rec 1.1 and Rec 1.2 (N=29) each did not differ significantly from the areas of the unworn crowns when compared using Student's t-test ($p=0.69$ & $p=0.91$, respectively).
- The means of Rec 1.1 and Rec 1.2 (N=29) did not differ significantly from one another and the mean of the actual areas in a one-way ANOVA ($p=0.96$) (see Fig. 1).
- The means for Rec 1.1 and Rec 1.2 were both slightly higher (0.93mm^2 & 0.25mm^2 , respectively) than the actual mean

Table 1: p values from Tukey's pairwise comparison of the subset of 10 teeth reconstructed by all researchers.

| N=10 | Actual area | Rec 1.1 (J.E.) | Rec 1.2 (J.E.) | Rec 2 (P.C.) | Rec 3 (E.K.) |
|----------------|-------------|----------------|----------------|--------------|--------------|
| Actual area | | | | | |
| Rec 1.1 (J.E.) | 0.61 | | | | |
| Rec 1.2 (J.E.) | 0.25 | 0.36 | | | |
| Rec 2 (P.C.) | 0.30 | 0.36 | 0.048 | | |
| Rec 3 (E.K.) | 0.30 | 0.91 | 0.55 | 0.60 | |

- None of the reconstructions of the subset of 10 teeth differed significantly from the actual areas of the unworn crowns or from each other in Tukey's pairwise comparisons, with the exception of Rec. 1.2. Rec 1.2 differed significantly from Rec 2 ($p=0.048$) (see Table 1). In a one-way ANOVA, the means did not differ significantly ($p=0.93$) (see Fig. 2).
- The means of the reconstructions differed from each other by a maximum of 2.6mm^2 (between Rec 1.1 and Rec 3) and a minimum of 0.14mm^2 (between Rec 1.2 and Rec 2). Rec 1.1 differed the most from the actual areas (1.7mm^2). The means of Rec 1.1, 1.2 and 2 were larger than the actual mean, while Rec 3's mean was smaller (see Fig. 2).
- If the crown morphology was unusual (see Box 2) or the reconstructor was inexperienced (e.g. Rec 1.1 by J.E.), the reconstructions were significantly less accurate

Box 2: PB9, the problem tooth



The reconstructions of PB9 were the most inaccurate across reconstructions due to barely noticeable differences between the unworn tooth and the artificially worn version (left). All reconstructors significantly overestimated the worn area.

4. Conclusions

- This method of reconstructing crown areas from worn UM1s is a justifiable way of accounting for interproximal wear when the investigator is experienced, but caution should be used in interpretations that rely upon reconstructed crowns.

Acknowledgements & Citations

Emma Kozitzky, Paola Cerrito. Bailey, S. E. (2004). A morphometric analysis of maxillary molar crowns of Middle-Late Pleistocene hominins. *Journal of Human Evolution*, 47(3), 183-198. Kaidonis, J. A., Townsend, G. C., & Richards, L. C. (1992). Interproximal tooth wear: a new observation. *American Journal of Physical Anthropology*, 88(1), 105-107. Kaidonis, J. A. (2008). Tooth wear: the view of the anthropologist. *Clinical oral investigations*, 12(1), 21-26. Leakey, L. S., Tobias, P. V., & Napier, J. R. (1964). A new species of the genus *Homo* from Olduvai Gorge. *Nature*, 202, 7-9. Villmoare, B., Kimbel, W. H., Seyoum, C., Campisano, C. J., DiMaggio, E. N., Rowan, J., ... & Reed, K. E. (2015). Early *Homo* at 2.8 Ma from Ledi-Geraru, Afar, Ethiopia. *Science*, 347(6228), 1352-1355. Wolpoff, M. H. (1971). Interstitial wear. *American Journal of Physical Anthropology*, 34(2), 205-227. Wood, B. A., & Abbott, S. A. (1983). Analysis of the dental morphology of Plio-pleistocene hominids. I. Mandibular molars: crown area measurements and morphological traits. *Journal of Anatomy*, 136(Pt 1), 197.