Dental Arch Shape and Dimensions Influence Maxillary and Mandibular Third Molar Impaction

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Introduction

Third molar impaction is a common pathology worldwide, with prevalence estimated at 24.4%.[1] Third molar extraction is therefore among the most common oral-maxillofacial surgeries performed, and there is ongoing debate over the risks and benefits of prophylactic third molar extraction.[2-4] The frequency of third molar impaction has been hypothesized to result from evolutionary reduction of the human face that has occurred in tandem with expansion of the neurocranium and reduction of the masticatory apparatus.[5] To test our hypothesis that certain dental arch dimensions could contribute to obstruction of an erupting third molar on both the human mandible and maxilla, we collected landmark coordinates from 3D scans of dental arch casts collected from 61 individuals living in India in the 1980s.

Research Questions:

•Which dental arch dimensions differ in those with and without third molar impaction?

•Are there differences in the relationships between dental arch dimensions and third molar impaction between sexes and caste populations?

Caste	Males	Females
Madia (tribe)	Impacted = 4 Non-impacted = 13	Impacted = 2 Non-impacted = 3
Mahar (caste)	Impacted = 10 Non-impacted = 8	Impacted = 1 Non-impacted = 1
Maratha (caste)	Impacted = 5 Non-impacted = 14	Impacted = 0 Non-impacted = 0
Total	Impacted = 19 Non-impacted = 35	Impacted = 3 Non-impacted = 4

Table 1. Sample sizes by sex, caste, and impaction used in these analyses.

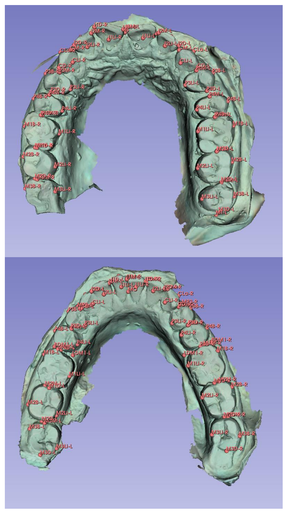

Figure 1. Occlusal views of maxillary (left) and mandibular (center) landmarks, and an oblique view of a cast with impacted right mandibular third molar (right).

Materials and Methods

- Dental casts were made in India in 1983-1984 under the direction of Dr. John Lukacs with support from the Smithsonian Institution in collaboration with the Government Dental Hospital and Clinic (Ahmedabad), Deccan College, Post-Grad Research Institute (Pune), and Sri Venkateswara University, Department of Anthropology (Tirupati)
- Each dental cast has associated records including date of birth, birthplace, age, sex, and anthropometric measurements including stature and weight
- All three populations inhabit Maharashtra: the Madia are a Gond tribe and among the most socio-economically disadvantaged groups in India, the Mahar are of low-to-intermediate status, and the Maratha of high socio-economic status[6]
- Dental casts from 61 individuals between 18-30 years of age (the time frame for third molar eruption[7-8]) were scanned using the Trios3 intraoral scanner[9-10]
- Third molar impactions were determined visually following published visual standards[11]
- LA collected landmarks from the maxillary and mandibular dentition and bone of all individuals
- General Procrustes Alignment and principal component analysis were performed on each digitized sample, and linear models and ANOVA were used to identify individual and population-level differences

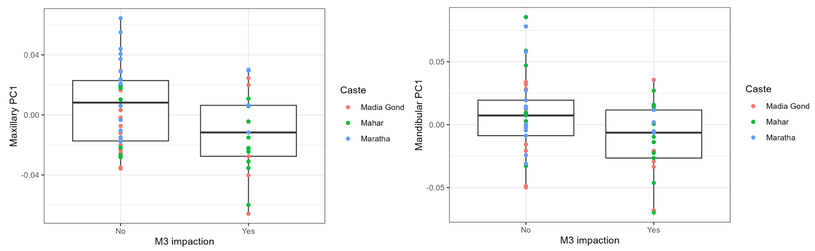

Figure 2. ANOVA tests demonstrate significant differences in maxillary arch shape (left, p = 0.02) and mandibular arch shape (right, p = 0.03) between impacted and non-impacted groups.

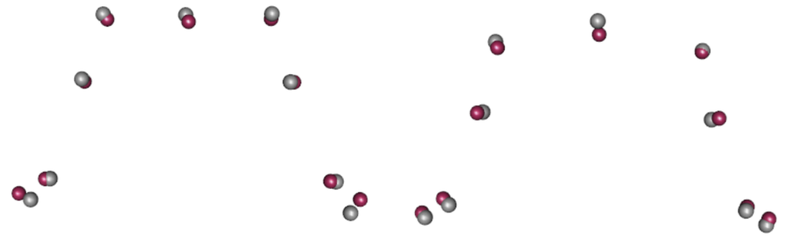

Figure 3. On the left, the average impacted maxillary arch (in gray) tends to be longer and narrower that the average non-impacted maxillary arch (in maroon). On the right, the average impacted mandibular arch (in gray) tends to have narrower and more medially positioned M2s and more anteriorly positioned canines than the average non-impacted mandibular arch (in maroon).

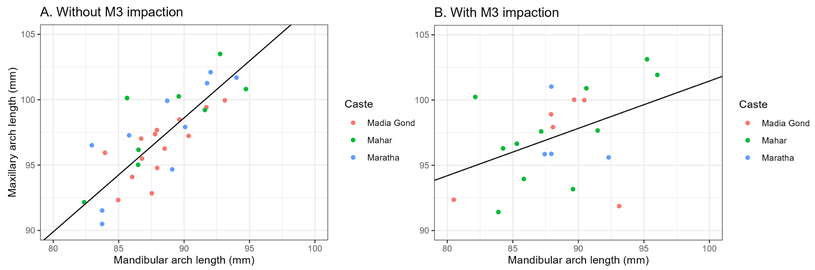

Figure 4. A linear model testing for differences in the relationship between maxillary and mandibular arch length between those with and without M3 impaction identified a significant positive relationship (slope = 0.866) between the arches in those without M3 impaction. M3 impaction significantly reduces this positive relationship (slope = 0.363).

Acknowledgements

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Results

- Maxillary, but not mandibular, PC1 scores differ significantly by caste
- Maxillary and mandibular PC1 scores do not differ significantly by sex
- Maxillary and mandibular arch lengths do not differ significantly by caste or sex
- Maxillary and mandibular PC1 scores differ significantly with M3 impaction (Figure 2)
- There is a stronger positive relationship between maxillary and mandibular arch length in the sample without M3 impaction (Figure 4)

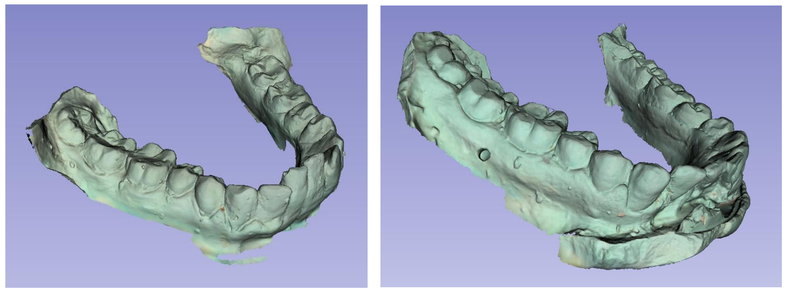

Figure 5. Mandibular casts with (left) and without (right) impaction of the right M3.

Discussion

These data suggest dental arch shape may influence third molar impaction, both maxillary and mandibular, or vice versa. The difference between maxillary and mandibular relationships between those with and without impaction also suggest a lack of developmental integration between the maxilla and mandible in those with M3 impaction. Though whether this is due to some innate biological difference or an environmental interruption of growth is unclear. Additionally, the significant difference in maxillary PC1 scores between castes suggests population-level environmental or genetic differences that will require further study. Further research will also be needed to evaluate the application of these statistical findings to other human populations.

Predicting third molar impaction in patients could guide treatments and improve patient outcomes globally. Proper prediction algorithms based on 3D landmarks within patients' jaws would allow for earlier detection and intervention before a patient's health is negatively impacted. Combining these methods used here with more invasive imaging modalities, such as CBCT, would improve evaluation of third molar impaction and generate useful shape data.

The prevalence of third molar impaction is much greater in modern humans than in other primates and has been linked to changes in human craniofacial morphology and reduced masticatory stress during development.[12] Understanding patterns of integration, or dis-integration, between the maxilla and mandible and between the jaws and teeth can therefore improve not only treatment of impaction but also our understanding of the evolutionary etiology of third molar impaction in modern humans.

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