GROWTH-RELATED CHANGE IN THE MANDIBULAR PLANE ANGLE WITH CLINICAL IMPLICATIONS

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INTRODUCTION

Mandibular plane angle (MPA) is used clinically to diagnose malocclusion and dysmorphology and assess treatment. Numerous cephalometric systems use MPA to categorize individuals into facial types. Accurate models of ontogenetic change in MPA will maximize the efficacy of orthodontic treatment by elucidating normal variation in MPA at different time points. Change in MPA captures several aspects of mandibular and craniofacial development, including mandibular growth rotation and changing anterior and posterior facial heights, resulting in considerable variation between individuals in the rate and magnitude of growth-related change in the MPA. Previous studies demonstrate a tendency for MPA to decrease during childhood and adolescence (1–3), although the timing and rate of these changes vary by study. To evaluate patterns of growth-related change, we examine MPA using cephalometric data compiled from six longitudinal studies of human growth and development.

RESEARCH QUESTION

How does MPA change over the course of juvenile and adolescent development in individuals with different adult facial types?

METHODS

Study Sample: 7,026 lateral cephalographs from 728 individuals (366 males, 362 females)

- ❑ Exclusion criteria: Low quality cephalographs with unobservable sella
- ❑ Inclusion criteria: One cephalograph between ages 6 and 9 and one cephalograph between ages 15 and 21 per individual
- ❑ Eight cephalographs per individual for growth modeling

Assessment : MPA is the angle between the sella-nasion plane and the gonion-menton plane

- ❑ Adult facial type determined by MPA from cephalograph closest to 18 years of age
- ❑ Hyperdivergent: MPA > 38°
- ❑ Normodivergent: 38° ≥ MPA ≥ 29°
- ❑ Hypodivergent: MPA < 29°

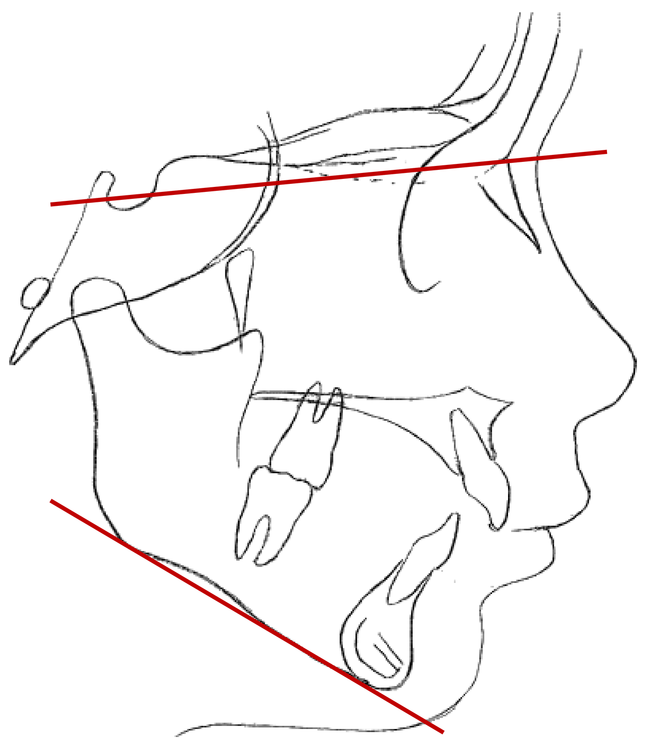

Figure 1. Mandibular plane angle defined by the sella-nasion plane and the gonion-menton plane marked in red.

Statistical Analyses: RStudio Version 1.1.453

- ❑ Does MPA at age 6 differ by adult facial type?
  - ❑ ANOVA with post-hoc pairwise t-tests
- ❑ Does annual change in MPA differ by adult facial type?
  - ❑ ANOVA with post-hoc pairwise t-test
- ❑ Does the pattern of longitudinal change in MPA differ by adult facial type?
  - ❑ Natural cubic splines fitting MPA to age in years with knots at quartiles.

RESULTS

Mean MPA at age 6 and annual change in MPA differ significantly by adult facial type.

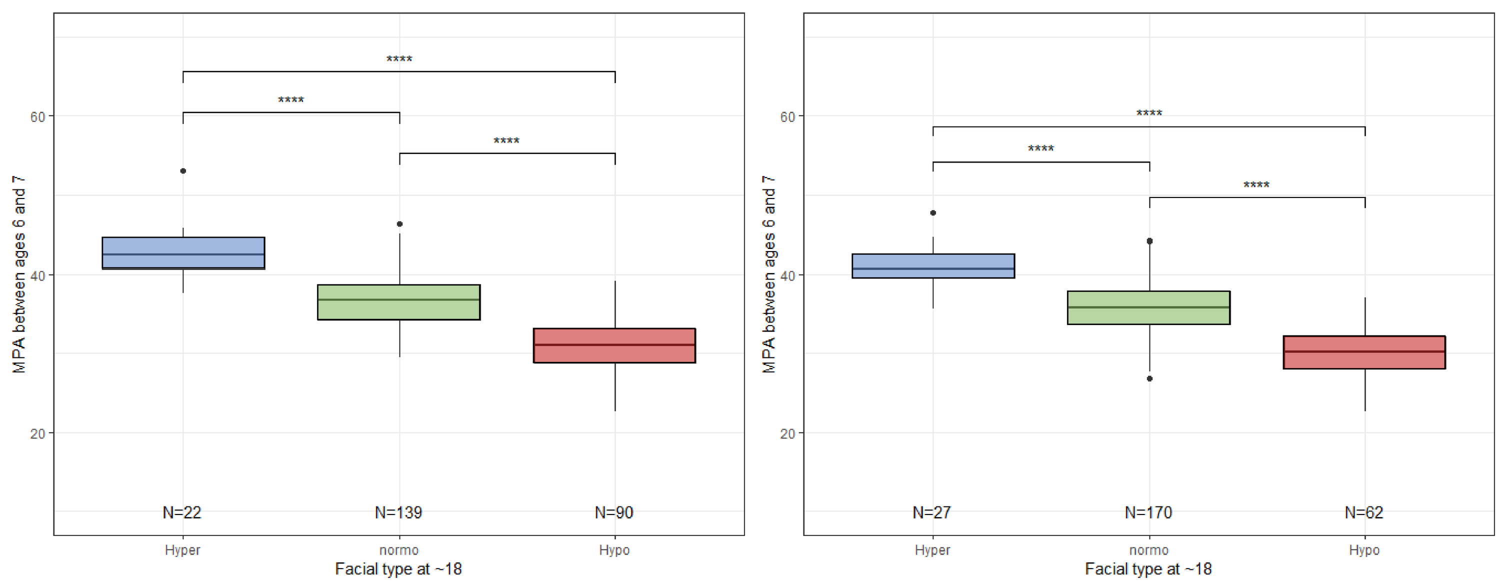

Figure 2. *MPA at age 6 by adult facial type in males (left) and females (right). ****p<0.0001.*

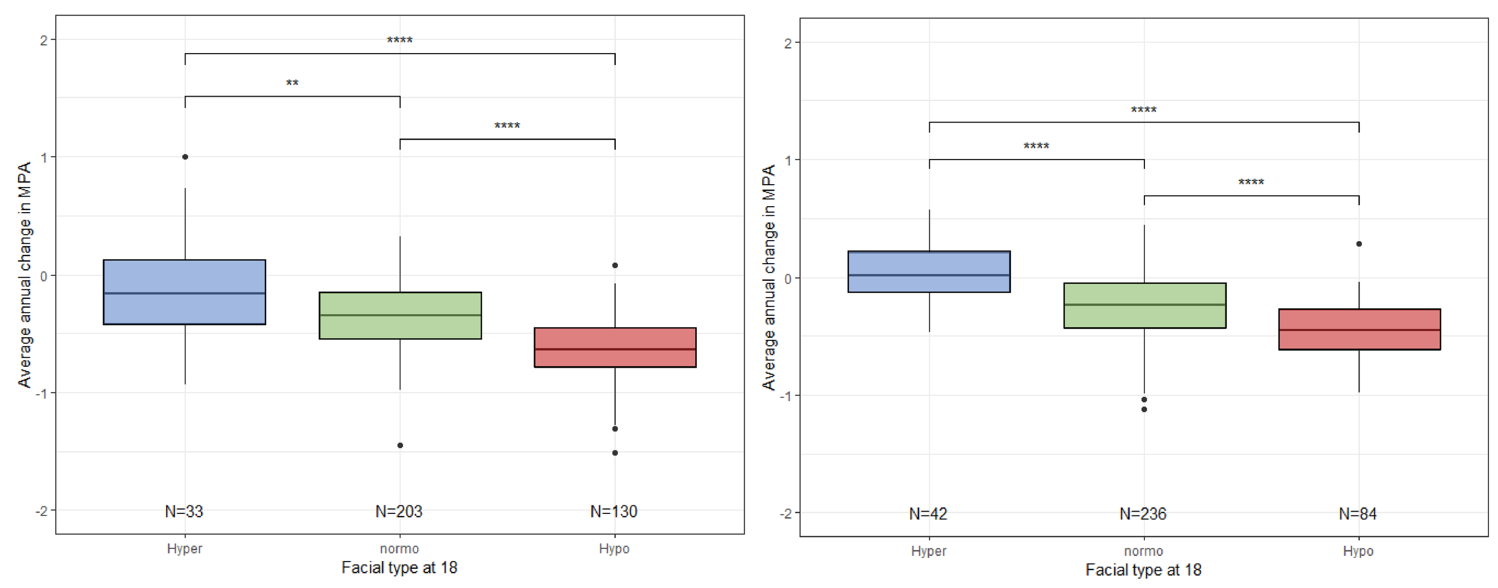

Figure 3. Annual change in MPA by adult facial type in males (left) and females (right). **p<0.01; ****p<0.0001.

The pattern of MPA growth-related change varies by adult facial type.

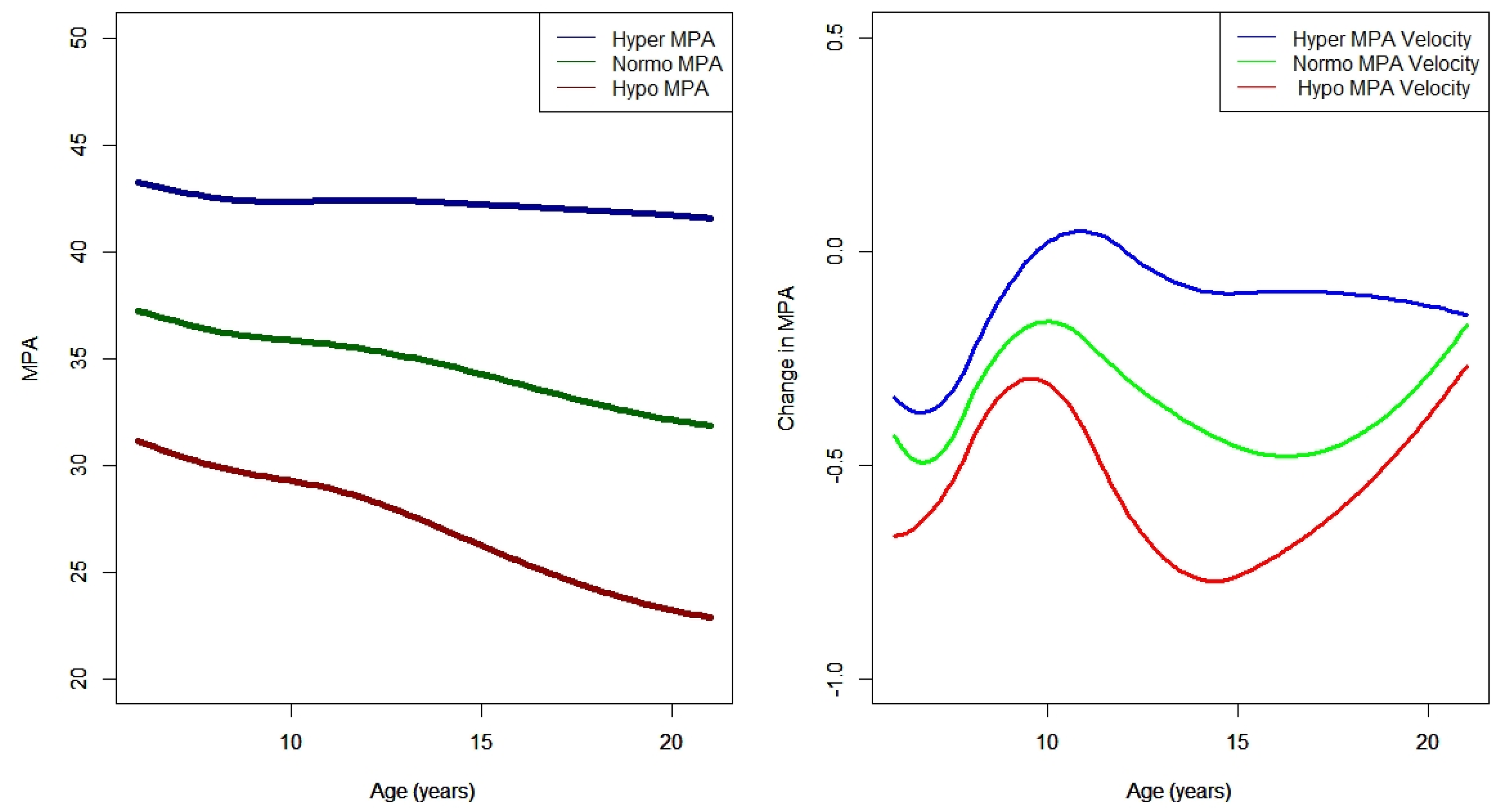

Figure 4. *Natural cubic spline model of growth-related change in MPA from ages 6 to 21 in hyper-, normo-, and hypo-divergent males (left), and the first derivative of the growth model for hyper-, normo-, and hypo-divergent males (right).*

Table 1. *Summary of mean MPA at age 6, mean average annual change in MPA, and mean MPA at age 18 ± 3 years in different adult facial types*

	Males			Females		
Adult facial type	Hyper	Normo	Hypo	Hyper	Normo	Hypo
Sample size	33	203	130	42	236	84
Mean MPA at age 6	42.8°	36.7°	31.0°	40.9°	35.8°	30.1°
Mean annual change in MPA	-0.14°	-0.35°	-0.64°	0.04°	-0.25°	-0.46°
Mean MPA at age 18	41.7°	33.1°	24.3°	41.9°	33.4°	25.3°

SUMMARY OF RESULTS

- ❑ Does MPA at age 6 differ by adult facial type?
  - ❑ Significant differences in MPA at age 6 from all pairwise t-tests
- ❑ Does annual change in MPA differ by adult facial type?
  - ❑ Significant differences in average annual change in MPA from all pairwise t-tests
- ❑ Does the pattern of longitudinal change in MPA differ by adult facial type?
  - ❑ Models of longitudinal change in MPA in males differ by adult facial type in the timing of growth milestones

DISCUSSION

- ❑ MPA tends to reduce over the course of juvenile and adolescent growth
- ❑ MPA can increase overall during growth
- ❑ Individuals with large MPA in adulthood (>38°) tend to have large MPA early in childhood and minimal reduction in MPA
- ❑ Individuals with small MPA in adulthood (<29°) tend to have small MPA early in childhood and reduction in MPA
- ❑ Longitudinal models demonstrate differences among adult facial types in the timing of growth milestones
- ❑ Individuals with large MPA at age 6 can reach normal MPA in adulthood
- ❑ Greater proportion of females than males are hyperdivergent
- ❑ Females have larger average MPA than males in all adult facial types

CLINICAL IMPLICATIONS

- ❑ Variation in MPA at age 6 is greater than has been previously shown (4)
- ❑ Orthodontic treatment of the hyperdivergent phenotype occurs between ages 7 and 13 (5-6), yet individuals with large MPA at age 6 can 'self-correct' at age 15
- ❑ Sex differences in morphology may require different definitions of hypo- and hyper-divergent facial types

CONCLUSIONS

- ❑ Multiple patterns of craniofacial growth can produce a hyper-, normo-, or hypo-divergent adult facial type
- ❑ Differences in MPA early in development, overall change in MPA during growth, and the timing and rate of change in MPA all differ by adult facial type
- ❑ MPA early in development is not necessarily consistent with adult facial type
- ❑ Individuals with large MPA in childhood and adolescence may not require early orthodontic or surgical intervention to reach a normo-divergent adult phenotype
- ❑ Large and diverse longitudinal samples such as the MU Craniofacial Growth Study are needed in the construction of craniofacial growth standards

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