upper first and second molars (involving their crowns and roots) [6–10], while another hypothesis suggests that in MPDD cases, the pressure from the erupting maxillary third molar generates a mesial push over the second molar roots with a concurrent simultaneous distal tipping of their crowns [1].

Because of the existing controversy for either one of the described hypothesis, namely mesialization of posterior molars or a distoangulation of the molar crown with a concomitant mesialization of their roots, the purpose of this study was to determine the effect of the MPDD on the sagittal inclination of maxillary molars in open bite individuals with different sagittal malocclusions. If such associations existed, then this information could be useful for clinicians when treatment planning biomechanical approaches to cases with potential MPDD, especially in subject with skeletal open bite.

Methods

This retrospective study was approved by the ethical committee of the School of Dentistry, Universidad Científica del Sur, Lima, Perú.

Sample characteristics

The sample included 90 pre-treatment lateral cephalograms of Latin-American individuals (45 male, 45 female). These cases were part of a previously published [15] sample of cases. All the cephalograms were taken at maximum intercuspidation with the lips at rest in subjects aged 15 to 30 years old (21.50 ± 4.48). Imaging was performed with a digital cephalometric panoramic equipment (ProMax®, Planmeca, Finland) with settings set at 16 mA, 72 kV, and 9.9 s. Cephalometric analyses were performed digitally by two calibrated examiners with MicroDicom viewer software (version 0.8.1; Simeon Antonov Stoykov, Sofia, Bulgaria), without magnification, at a scale of 1:1.

Subjects with previous orthodontic treatment, tumors, infection or prosthetic molar reconstruction in the maxillary molar region and without maxillary third molars (extracted or missing) or any other missing/extracted permanent teeth were not considered.

Although a convenience sample of available records was used, sample size was calculated to demonstrate external validity. The sample size was calculated considering a mean difference of 10° in the maxillary second molar sagittal inclination as a clinically relevant difference between groups with and without MPDD. A standard deviation of 4° was considered (obtained from a preliminary pilot study) with a two-sided significance level of 0.01 and a power of 90 %. Although a minimum of five subjects per group was required, at least eight subjects per group were available. The calculated sample was 30 subjects; however, data from 90 subjects that met the selection criteria in a reference center of imaging were included.

Sample grouping

The study sample included six groups categorized according to their MPDD condition (present or absent) and to their sagittal skeletal facial growth patterns (classes I, II, or III) [16–19] (Table 1).

The definitions of the cephalometric points, distances, and angles [18–22] between them are shown in Table 2.

All subjects had a skeletal open bite (FMP angle greater than 26°, ODI lower than 72°, and lower anterior facial height greater than 67 mm) (Table 3).

Therefore, the groups were set as follows:

- Open bite class I group with maxillary posterior discrepancy OBCIG-PD (n = 18): ANB angle between 0° and 5°, antero posterior dysplasia indicator (APDI) of 81.4° ± 4°, angle class I malocclusion, bilateral class I molar relations, overjet between 1 to 5 mm, negative overbite greater than 0.5 mm, and diagnosed with maxillary posterior discrepancy
- Open bite class I group without maxillary posterior discrepancy (OBCIG-WPD) (n = 10): the same with the OBCIG-PD, but without posterior discrepancy
- Open bite class II group with maxillary posterior discrepancy (OBCIIG-PD) (n = 19): ANB > 5°, APDI < 75°, angle class II-1 malocclusion, bilateral class II molar relations, overjet greater than 5 mm, negative overbite greater than 0.5 mm, and diagnosed with maxillary posterior discrepancy
- Open bite class II group without maxillary posterior discrepancy (OBCIIG-WPD) (n = 22): the same with the OBCIIG-PD, but without posterior discrepancy
- Open bite class III group with maxillary posterior discrepancy (OBCIIIG-PD) (n = 13): ANB < 0°, APDI > 88°, angle class III malocclusion, bilateral class III molar relations, overjet lower than −1 mm, negative overbite greater than 0.5 mm, and diagnosed with maxillary posterior discrepancy

Table 1 Sample distribution by group, sex, and age

Group	Male	Female	Total	Age[a] Mean (SD)
OBCIG-PD	9	9	18	20.40 (4.67)
OBCIG-WPD	4	6	10	20.87 (4.79)
OBCIIG-PD	6	13	19	22.64 (5.39)
OBCIIG-WPD	11	11	22	21.74 (4.46)
OBCIIIG-PD	8	5	13	20.67 (3.83)
OBCIIIG-WPD	7	1	8	22.69 (3.79)
Total	45	45	90	

[a]Not significant based on independent *T* test according to posterior discrepancy by groups

OBCIG open bite class I group, *OBCIIG* open bite class II group, *OBCIIIG* open bite class III group, *PD* posterior discrepancy, *WPD* without posterior discrepancy