Table 2 Definitions of cephalometric points and angles used in this study

Angular measurements	Definition
SNA	The angle between points sella (S), nasion (N), and subnasal (A) in degrees [16]
SNB	The angle between points sella (S), nasion (N), and supra mental (B) in degrees [16]
ANB	The angle to assess the skeletal relationship between points A and B in degrees [16]
APDI	The anterior-posterior dysplasia indicator to assess the skeletal relationship and is obtained from the algebraic sum of the angles N-Pg-FH (facial plane) plus/minus the angle AB-facial lane (is positive when the point B is ahead of point A and is negative when the point A is ahead of point B) and plus/minus the angle FH-PP (palatal plane) (is negative when PP is tilted upward and positive when tilted down) [17]
FMP	The angle between the porion-orbital line and mandibular line in degrees
ODI	The overbite depth indicator to assess the tendency toward open bite is obtained from the algebraic sum of the angles AB-MP plus/minus the angle FH-PP (palatal plane) and is negative when PP is tilted upward and positive when tilted down [18]
Maxillary first molar angulation	The angle formed by the maxillary first molar axis (intercuspid groove-bifurcation) and the palatal plane (ANS-PNS), represented by a horizontal line
Maxillary second molar angulation	The angle formed by the maxillary second molar axis (intercuspid groove-bifurcation) and the palatal plane (ANS-PNS), represented by a horizontal line
Linear measurements	**Definition**
A'P'	The distance between the perpendicular extensions of points A and P on the palatal plane (A'P') in millimeters: point A' is the perpendicular projection of point A to the palatal plane and point P' is the perpendicular projection of the posterior—most point of the maxillary tuberosity to the palatal plane [6, 9, 19]
A'6'	The distance between A' and 6' in millimeters, the anterior maxillary base length is defined by the measurement between A' and 6'. Point 6' is the perpendicular projection of the anterior-most point on the proximal surface of the maxillary first molar to the palatal plane [6, 9, 19]
Ratio (A'6'/A'P')	The ratio of the anterior maxillary base length A'6' to the maxillary base length A'P' (A'6'/A'P') [6, 9, 19]
Overbite	The overbite in millimeters is the distance between incisal edge of maxillary and mandibular central incisor, perpendicular to occlusal plane [20]
Lower anterior facial height (LAFH)	The length in millimeters of a line between points anterior nasal spine (ANS) and mental (Me) [21]
Ratio facial height (S-Go/N-Me × 100)	The ratio of posterior facial height and anterior facial height [22]

- o Open bite class III group without maxillary posterior discrepancy (OBCIIIG-WPD) ($n = 8$): the same with the OBCIIIG-PD, but without posterior discrepancy

When both cephalometric methods (ANB and APDI) to diagnose sagittal skeletal facial growth pattern did not agree an additional evaluation that included the analysis of skeletal facial profile (sagittal relationship of the points N, A, and Pg), overjet, anteroposterior malocclusion, and soft profile convexity was considered before making a decision to which sagittal malocclusion group to assign any included case. All cephalometric radiographs were evaluated randomly.

Maxillary posterior dentoalveolar discrepancy (MPDD)

The dichotomous primary diagnosis of maxillary posterior discrepancy was made through radiographic evaluation by two calibrated examiners (LEAG, AADC). When the eruption of the maxillary third molar was apparently blocked by the presence of the erupted second, a maxillary posterior discrepancy was deemed present (Figs. 1 and 2).

In addition, for statistical analysis purposes, the ratio of the anterior maxillary base length A′6′ to the maxillary base length A′P′ (A′6/ A′P′) was also calculated as a continuous variable that reflects maxillary posterior discrepancy (Fig. 3, Table 2). If the radio of the anterior maxillary base length A′6′ to the maxillary base length A′P′ (A′6/ A′P′) was greater than 0.46, then a maxillary posterior discrepancy was suggested [6, 9, 19]

Maxillary molar sagittal angulation

The sagittal angulations of maxillary first and second molars were measured by the angle formed by the molar axis (intercuspid groove—root bifurcation) and the palatal plane (Fig. 4).

Statistical analysis

All statistical analyses were performed using SPSS Ver.22 for Windows (IBM SPSS, Chicago, IL, USA). Data distribution normality was according to Shapiro-