A Simple Method of Assessing Anteroposterior Skeletal Pattern from a Lateral Cephalogram

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Cephalometric analysis is often used as an adjunct to clinical assessment of the anteroposterior skeletal pattern and maxillomandibular discrepancy.[1] Many such methods, however, are complex and time-consuming.[2,3]

This article describes a simple cephalometric analysis that provides a quick assessment of the AP skeletal pattern: the Mount Vernon Index (MVI), named after the now-closed Mount Vernon Hospital in Middlesex, North London. We conducted a cross-sectional retrospective cephalometric study in which the MVI was compared with three accepted methods of cephalometric analysis to determine the reliability of this new technique.

Materials and Methods

A total of 180 lateral cephalometric radiographs of new patients in the Orthodontic Department at Watford General Hospital, Watford, England, were randomly selected (30 for a pilot study and 150 for the main study). These patients had undergone no prior orthodontic treatment and had no craniofacial disorders. Ethical approval for the study was granted by the Local Research and Ethics Committee, and consent was obtained from all patients whose cephalograms were analyzed.

The radiographs were all taken with the same cephalostat and were of sufficiently high quality that relevant landmarks could be correctly identified. All radiographs were directly digitized and analyzed using a customized computer program (Gela software*). Landmarks were digitized in a predetermined sequence by the same operator, using the method described by Houston.[4]

For each radiograph, the MVI was determined by measuring, to the nearest half-millimeter, the perpendicular distance (d) between B point and a line extending from nasion through A point (Fig. 1). The AP skeletal pattern was also assessed according to the following three accepted cepha-

*Custom software developed by orthodontist Gordon Bennett of Newcastle, UK.

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lometric methods:

1. *Steiner analysis:* Comparison of the relationships of the maxilla and mandible to the anterior cranial base, using ANB. A Class I skeletal pattern was defined as an ANB angle of 2-4°[5] (Fig. 2).

2. *Ricketts analysis:* Measurement of facial convexity, as determined by the distance from A point to the facial plane on the nasion-pogonion line (N-Pog). A Class I skeletal pattern was defined as a facial convexity of 2 ± 2mm[6,7] (Fig. 3).

3. *Wits appraisal:* Assessment of the linear relationship between the perpendicular intersections from points A and B to the functional occlusal plane (FOP). In females with a Class I skeletal pattern, the points would coincide; in males with a Class I pattern, BO would be 1mm anterior to AO[8] (Fig. 4).

A pilot study involving 30 radiographs was conducted to formulate a clinically relevant range of MVI values. For purposes of this study, the AP skeletal pattern was decided by agreement of two out of the three accepted methods listed above. An MVI value was then determined for each radiograph. Measurements were recorded, and cutoff points were assigned to produce a range of values that best corresponded with each of the skeletal classifications (Table 1).

In the main study, another 150 radiographs were digitized to determine reliable and clinically useful ranges of MVI values corresponding to Class I, Class II, and Class III skeletal patterns. As in the pilot study, the AP skeletal pattern for each radiograph was determined by agreement of two out of the three accepted methods of analysis, and a range of MVI values was then determined. Some MVI values were found to be the same for a Class

TABLE 1
MOUNT VERNON INDEX RANGES DETERMINED FROM PILOT STUDY

	Class III	Class I	Class II
Range 1	<5mm	5-9mm	>9mm
Range 2	<5mm	5-8mm	>8mm

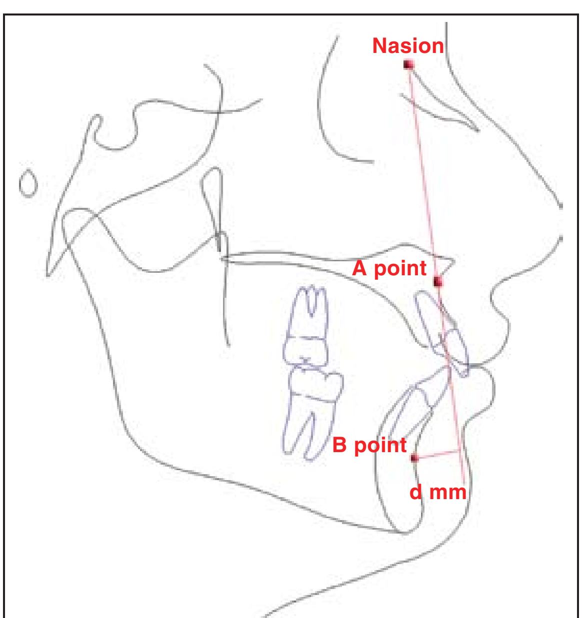

Fig. 1 Mount Vernon Index: perpendicular distance in millimeters (d mm) between B point and line from nasion through A point.

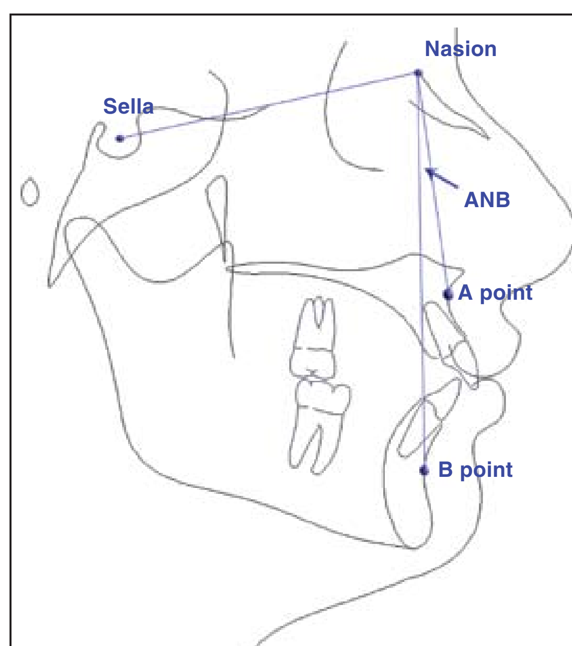

Fig. 2 Steiner analysis used to determine ANB angle.

TABLE 2
MOUNT VERNON INDEX RANGES DETERMINED FROM MAIN STUDY

	Class III	Class I	Class II
Range 1	<3mm	3-7mm	>7mm
Range 2	<4mm	4-6mm	>6mm
Range 3	<3mm	3-6mm	>6mm
Range 4	<5mm	5-9mm	>9mm

I and a Class II or III radiograph, resulting in four distinct ranges of MVI values (Table 2). Statistical analysis was performed using the kappa method[9] to determine which range showed the greatest agreement between the MVI and the other three methods of analysis.

To measure the reliability and reproducibility of the MVI, 29 radiographs from the main study were redigitized following the same protocol as used previously. The error levels of the method and landmark identification were determined using the Bland and Altman method[10] and Lin's concordance correlation coefficient,[11] which indicated satisfactory agreement in all cases.

Results

For all four of the ranges analyzed, the Steiner analysis was found to have the greatest level of agreement with the MVI (Table 3). Overall, the Ricketts analysis showed the second-highest level of agreement, followed by the Wits appraisal. The greatest overall level of agreement between the MVI and the three established methods was found for the 3-7mm range, which was therefore determined as the best indicator of a Class I skeletal pattern. Values of less than 3mm and more than 7mm were defined as indicators of Class III and Class II skeletal patterns, respectively.

Among the three existing methods of analysis, the agreement between the Steiner and Ricketts methods was good (weighted kappa = .658), but the agreement between the Wits appraisal and each of the other two methods was only moderate.

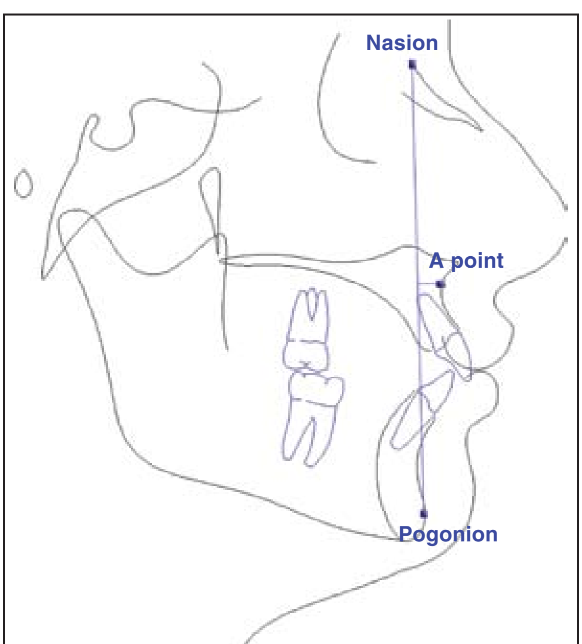

Fig. 3 Ricketts analysis used to determine facial convexity.

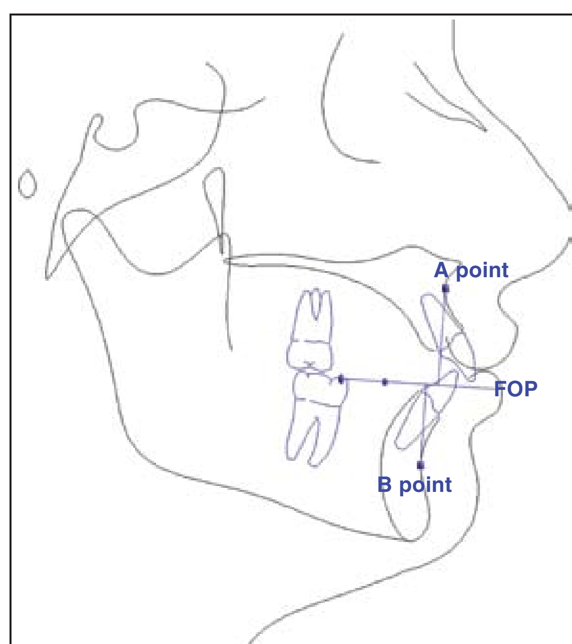

Fig. 4 Wits appraisal used to determine relationship with functional occlusal plane (FOP).

TABLE 3
AGREEMENT BETWEEN MOUNT VERNON INDEX RANGES (FROM MAIN STUDY) AND EACH CEPHALOMETRIC ANALYSIS

		Confidence Interval (95%)	Weighted Kappa	Standard
Range 1				
	Steiner	0.778-0.930	0.887	Very good
	Ricketts	0.452-0.681	0.640	Good
	Wits	0.330-0.574	0.640	Good
Range 2				
	Steiner	0.691-0.874	0.837	Very good
	Ricketts	0.386-0.624	0.599	Good
	Wits	0.396-0.620	0.630	Good
Range 3				
	Steiner	0.701-0.882	0.841	Very good
	Ricketts	0.414-0.650	0.616	Good
	Wits	0.286-0.537	0.537	Moderate
Range 4				
	Steiner	0.417-0.643	0.632	Good
	Ricketts	0.367-0.600	0.616	Moderate
	Wits	0.298-0.533	0.517	Moderate

Discussion

All methods of determining AP skeletal patterns from lateral cephalometric radiographs have inherent limitations. Perhaps the most common cephalometric measurement used to assess horizontal disharmony of the lower part of the face is the ANB angle, which is based on a cranial reference plane. Variations in the position of nasion and the rotational effect of the jaws make this approach problematic, however, and the MVI method shares that basic weakness. It might be argued that the use of an extracranial perpendicular reference plane, as in some methods of analysis, would result in a better assessment of the AP relationship. On the other hand, the severity of a skeletal discrepancy depends on the relationship of the jaws to each other, rather than on their relationships to cranial or extracranial landmarks. Therefore, at least two methods of analysis may be needed to support the orthodontist's clinical findings.

Our statistical analysis demonstrates that the MVI is a quick and reliable method of confirming the clinical and radiographic evaluation of a patient's AP skeletal pattern. Its relatively small degree of error is comparable to that of other analyses. Although the MVI will not replace more complex evaluation systems, it can be a useful clinical diagnostic tool.

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