CASE REPORT

# *Facial height index*

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The ratio of posterior facial height to anterior facial height, called the facial height index, is described. The clinical uses of the facial height index are discussed. One of its uses is illustrated in the accompanying case report. (Am J Orthod Dentofac Orthop 1992;102:180-6.)

The objectives given to the orthodontic specialty by Charles H. Tweed emphasize stability, esthetics, health, and function. Tweed's treatment philosophy to reach his objectives consisted of uprighting the lower incisor over basal bone,[1] control of the vertical dimension, and over treatment of the original malocclusion.[2] The desire for facial balance and harmony, stability, and occlusal function become integrated into Dr. Tweed's diagnostic scheme. During the past 20 years, L. Levern Merrifield has updated Tweed's philosophy of treatment with 10-2 sequential system anchorage,[3] total space analysis,[4] dimensions of the denture,[5] sequential banding,[6] and treatment timing.[7]

In 1988 Merrifield and Gebeck[8] presented a study of successfully and unsuccessfully treated Class II cases. They defined posterior facial height (PFH) as the distance in millimeters from the articulare to the mandibular plane along the posterior border of the ascending ramus. Anterior facial height (AFH) was defined as the distance in millimeters from the palatal plane to the menton (Fig. 1). They found that anterior facial height and posterior facial height, and the relative changes of these two values, were closely related to "mandibular response" during the correction of a class II malocclusion. Mandibular response, or the lack of it, seemed to dictate Class II treatment success or failure. Other authors have also studied the dynamic relationship of anterior facial height to posterior facial height. Isaacson[9] and Radziminski[10] found these areas to be highly significant during orthodontic treatment.

If PFH increases more rapidly than AFH during growth and/or orthodontic treatment, the facial pattern of the patient with a Class II malocclusion improves because of the mandibular rotation in an upward and forward direction. Horizontal planes close as the mandibular response increases. Conversely, if AFH increases faster than PFH, the mandible rotates downward and backward. When this unfavorable response occurs, the facial pattern worsens as the horizontal planes open.

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**Table I.** Facial height index—independent samples

| *Variable* | *Mean* | *SD* | *Observation* | *t statistic* | *dF* |
|---|---|---|---|---|---|
| PFH | 41.38 | 5.08 | 165 | −30.03 | 328 |
| AFH | 59.29 | 5.74 | 165 | | |

Significance = $p < 0.000$.
Hypothesis: Ho: $\mu 1 = \mu 2$.
Ha: $\mu 1 = \mu 2$.

**Table II.** Facial height index—distribution of sample

| *Variable* | *Mean* | *SD* | *Observation* | *t statistic* | *dF* |
|---|---|---|---|---|---|
| FH index 1 | 0.7533 | 0.0612 | 67 | 9.0857 | 163 |
| FH index 2 | 0.6571 | 0.0703 | 68 | | |

Significance = $p < 0.000$.
Hypothesis: Ho: $\mu 1 = \mu 2$.
Ha: $\mu 1 = \mu 2$.

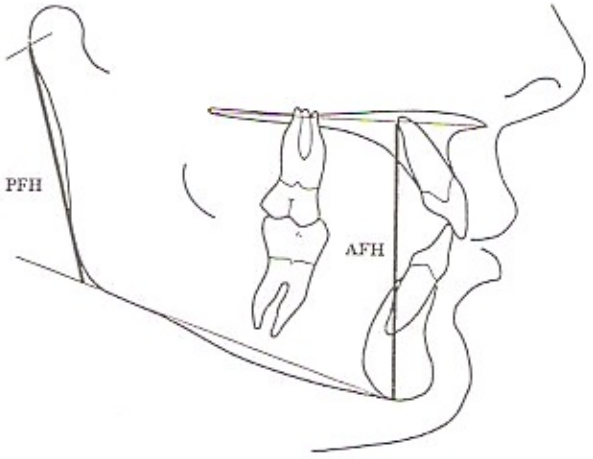


Fig. 1. Anterior facial height (AFH) and posterior facial height (PFH).

There is a decrease in the rate of mandibular response, or in fact, no mandibular response at all. This phenomenon can happen during leveling, anchorage preparation, or any other state of treatment if poor directional forces are used. Anterior facial height can never decrease without surgical intervention. During orthodontic treatment, therefore, the objective should be to maintain the AFH and to improve the PFH.

The intent of this paper is to propose the use of the ratio of PFH to AFH, to be called the facial height index (FHI), during orthodontic treatment. This index is particularly useful during the treatment of the high Frankfort mandibular plane angle (FMA) Class II case. The use of this ratio enables the clinician to carefully monitor the denture management and the corresponding mandibular response during treatment. The index, PFH/AFH, is as significant as the measurements themselves. It is an indication of mandibular rotation during treatment, and if monitored throughout treatment, it offers a more dynamic picture of what actually happens during treatment.

## SAMPLE SELECTION

One hundred sixty-five cases with an average age of 11 years were selected for this study. The average posterior facial height (PFH) for the populations studied was 41 mm (range was 30 to 60 mm). The average anterior facial height (AFH) for the sample was 60 mm (range 39 to 80 mm) (Table I). Of the 165 patients studied, the average pretreatment FHI was 0.70 (range 0.40 to 0.90). The frequency distribution was not uniform. There seemed to be two subpopulations. The first population had an average of 0.65 and the second an average of 0.75 (Table II).

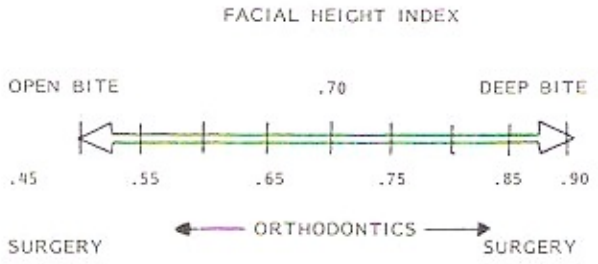


Fig. 2. Facial height index, range.

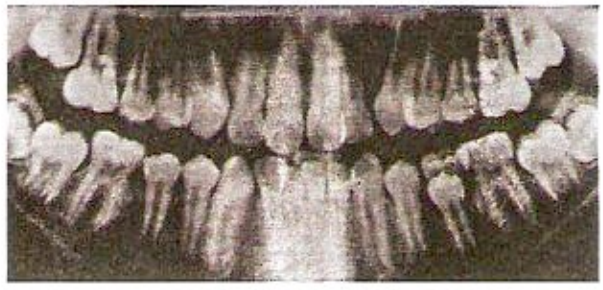

Fig. 3. Pretreatment panoramic x-ray film.

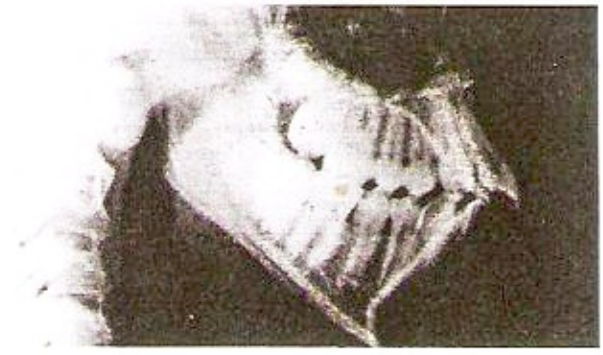

Fig. 4. Pretreatment cephalometric x-ray film.

## CLINICAL APPLICATION

The FHI value can help the clinician make pretreatment decisions to evaluate the mandibular growth rotation. On serial cephalograms taken before treatment, the FHI can give an indication of the tendency of mandibular growth rotation, upward and forward if the FHI increases, downward and backward if the FHI decreases. These variations are often more indicative than the FMA. This index may help the clinician in treatment planning for orthodontic cases (range 0.55 to 0.85) and for surgery in cases outside these ranges (Fig. 2). As an example, because serial extractions lead to a contraction of dentoalveolar space thus a closing of the horizontal planes, a patient with a high FHI might be more amenable to serial extraction procedures than a

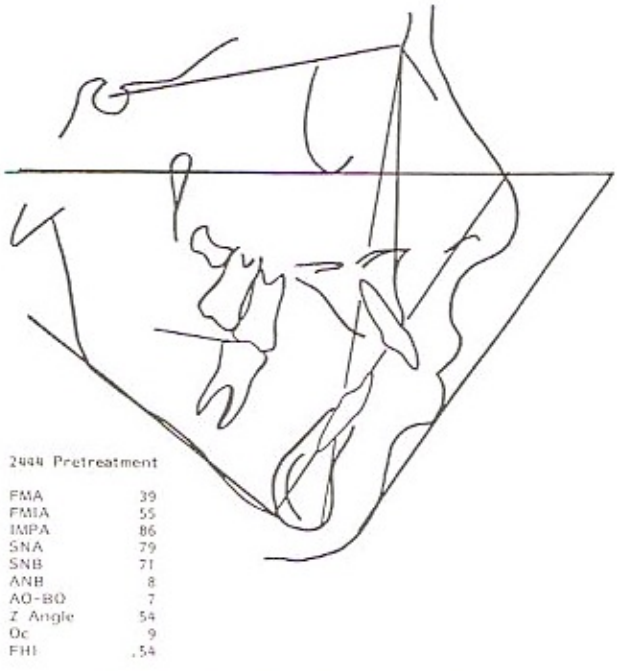


**Fig. 5.** Pretreatment cephalometric tracing.

patient with a low FHI. With the FHI, the clinician will also be permitted to differentiate between cases that have normal mandibular plane angles but react as either low angle cases or as high angle cases. For example, two cases with the same FMA may have very different FHI values. They should therefore be treated with different force systems or different extraction sequences. This index can be systematically compared with the FMA, just as AO-BO is compared to ANB angle.

The FHI should be used during treatment. By carefully monitoring the FHI during the various stages of treatment, the clinician can determine whether the vertical dimension is being controlled. If FHI decreases during leveling (opening in the vertical dimension), the clinician must immediately take steps to control the denture, and therefore the vertical dimension. Class II mechanics without anchorage preparation or the treatment of high angle cases without extractions will also decrease the FHI. In all the cases studied, there was an almost universal decrease in the FHI during active treatment. This finding confirms the *fact that all orthodontic mechanics are extrusive in nature*. This was found to be especially true during the leveling process. A word of caution for the clinician is therefore that the high FMA low FHI cases must be treated with extreme care.

The following case report is shown to illustrate the use of the FHI. Treatment of this case, a difficult high FMA Class II malocclusion, illustrates the use of the

**Fig. 6.** Pretreatment facial profile.

FHI both in confirming the vertical problem and in monitoring vertical control during treatment. The fact the FHI increased during treatment is indicative of a favorable mandibular response as a result of treatment.

## CASE REPORT
### Angle Class II, Division 1 malocclusion

A 7-year-old boy was seen for the first time in 1981. He presented with a mixed dentition that exhibited no pathology (Fig. 3), and an Angle Class II, Division 1 malocclusion complicated by a high Frankfort mandibular plane angle, and a bimaxillary protrusion (Figs. 4 and 5). An FMA of 38°, an FMIA of 50°, and an ANB of 8° confirmed the severity of the problem. There was a marked protrusion of the lips causing a facial disharmony (Fig. 6). The patient was followed on recall until 1986. At that time, he again presented with the Class II malocclusion, a high Frankfort mandibular plane angle of 39°, and a facial height index of 0.54. This 0.54 FHI is probably the limit at which a surgical consideration must be made. With the Merrifield's total dentition space analysis, a total anterior deficit of 14 mm was calculated. The 14 mm consisted of an 8 mm cephalometric discrepancy and 6 mm of anterior crowding. Differentiation should be made between the crowding deficit and the cephalometric discrepancy deficit. In the midarch area, no crowding was exhibited, but 4 mm of space was required to correct the curve of Spee. To correct the Class II molar relationship, 5 mm of space was required on each side of the lower arch. In the posterior denture area, the measurement of the unerupted third molars and a calculation of the available space revealed a deficit of 18 mm.

## DIAGNOSIS

With the Merrifield's total dentition space analysis and differential diagnosis, it was determined that the extraction of four premolars in itself would not yield enough space to

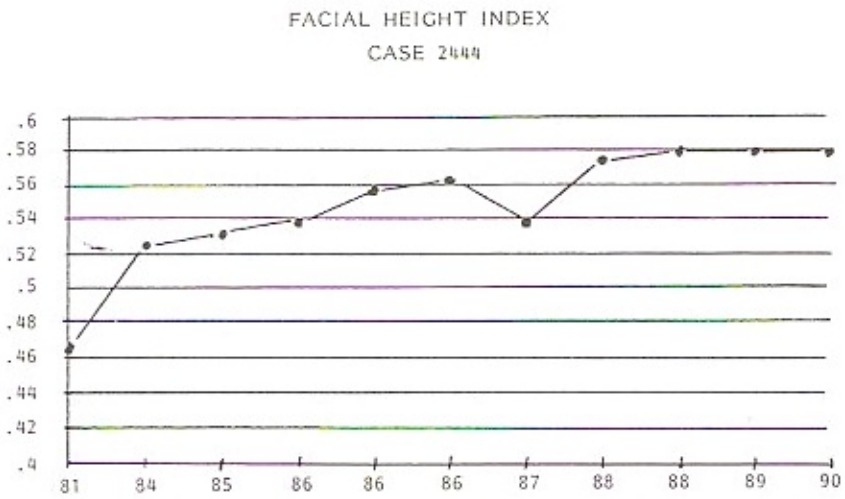


Fig. 7. Facial height index, Case 2444.

Fig. 8. Posttreatment facial profile.

Fig. 9. Posttreatment cephalometric x-ray film.

correct the protrusion, the crowding, and the Class II molar relationship. Because the use of Class II elastics on a case of this severity would tend to open the bite (decrease FHI), and therefore impede the improvement of the facial profile, the maxillary first molars were extracted in June 1986. This was done after a careful diagnosis of the space requirements in an attempt to secure a Class I molar relationship. In October 1986, the mandibular first premolars were extracted. The case was banded in June 1987, immediately after the maxillary first premolar extractions. It was treated with an 0.022 standard edgewise appliance and the Tweed-Merrifield 10-2 directional forces system. Total active treatment time was only 18 months. The mandibular third molars were removed immediately after the patient was debanded in June 1988. The FHI was carefully monitored during the treatment of this case. Note the extrusive tendencies that presented even though the force systems were monitored carefully. The use of the index at intervals during treatment enhanced an awareness of the sequelae of each force system used (Fig. 7).

## TREATMENT RESULTS

There was a marked improvement in the soft tissue profile. Facial balance and harmony were enhanced (Fig. 8). The FMA was decreased from 39° to 35°, and pogonion moved downward and forward (Figs. 9 and 10). Dental radiographs reveal the continued absence of pathology and the unimpeded eruption of the maxillary third molars (Fig. 11). The mandibular second molars exhibited some distal tipping and a small amount of elevation because of anchorage preparation. The FHI increased from 0.54 to 0.57. This control of the horizontal planes permitted the forward movement of the total chin. This type of mandibular response should be the objective

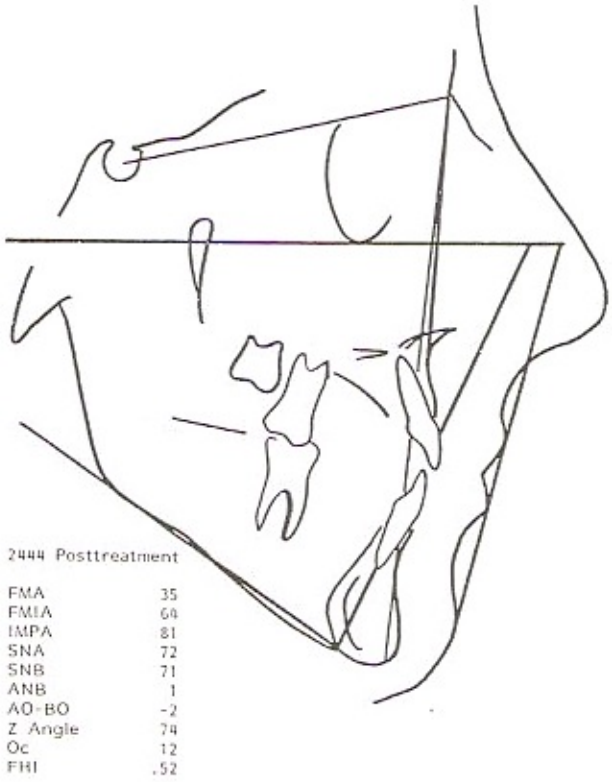


**Fig. 10.** Posttreatment cephalometric tracing.

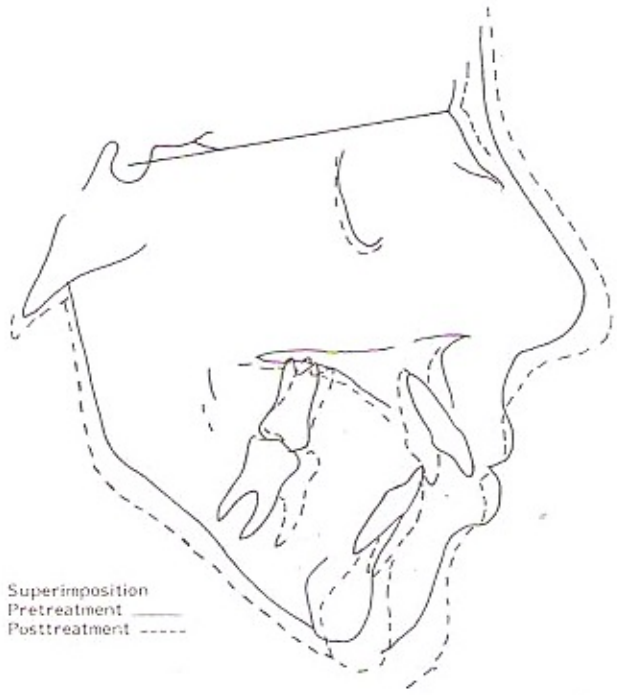


**Fig. 12.** Superimposition of pretreatment and posttreatment tracings.

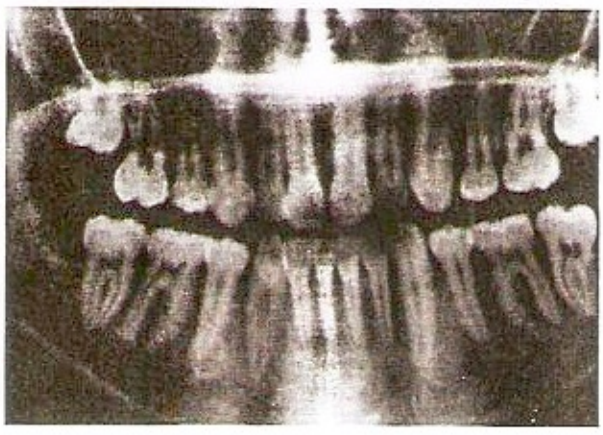

**Fig. 11.** Posttreatment panoramic x-ray film.

**Fig. 13.** Recovery facial profile.

during the treatment of these types of difficult high angle Class II cases. The ANB was reduced from 8° to 1° as the AO-BO decreased from +7 mm to −2 mm. Superimposition of the pretreatment and posttreatment tracings (Fig. 12) confirms the fact that vertical control, along with good mandibular response, and thus an increase in FHI, was accomplished.

Recovery facial profile photographs (Fig. 13), the recovery cephalometric tracing (Fig. 14), and pretreatment to recovery cephalometric tracing superimpositions (Fig. 15) exhibit the continued improvement of facial balance and harmony. Composite photographs of the pretreatment, posttreatment, and recovery casts confirm the severity of the original malocclusion and its subsequent correction and recovery (Fig. 16). Note that the mandibular second molars have recovered to a good functional occlusion.

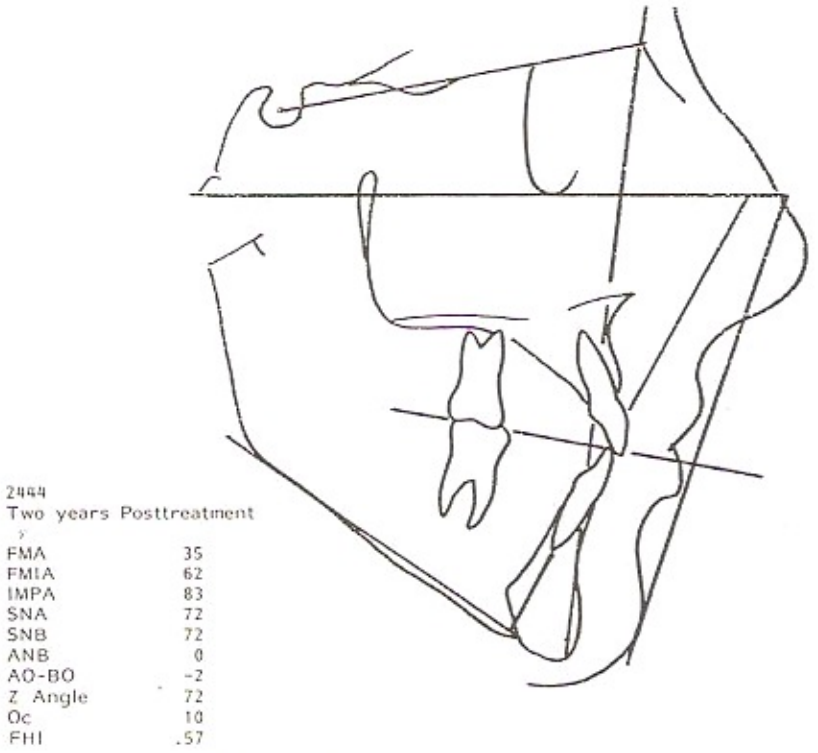


**Fig. 14.** Recovery cephalometric tracing.


**Fig. 15.** Pretreatment-recovery tracing superimposition.

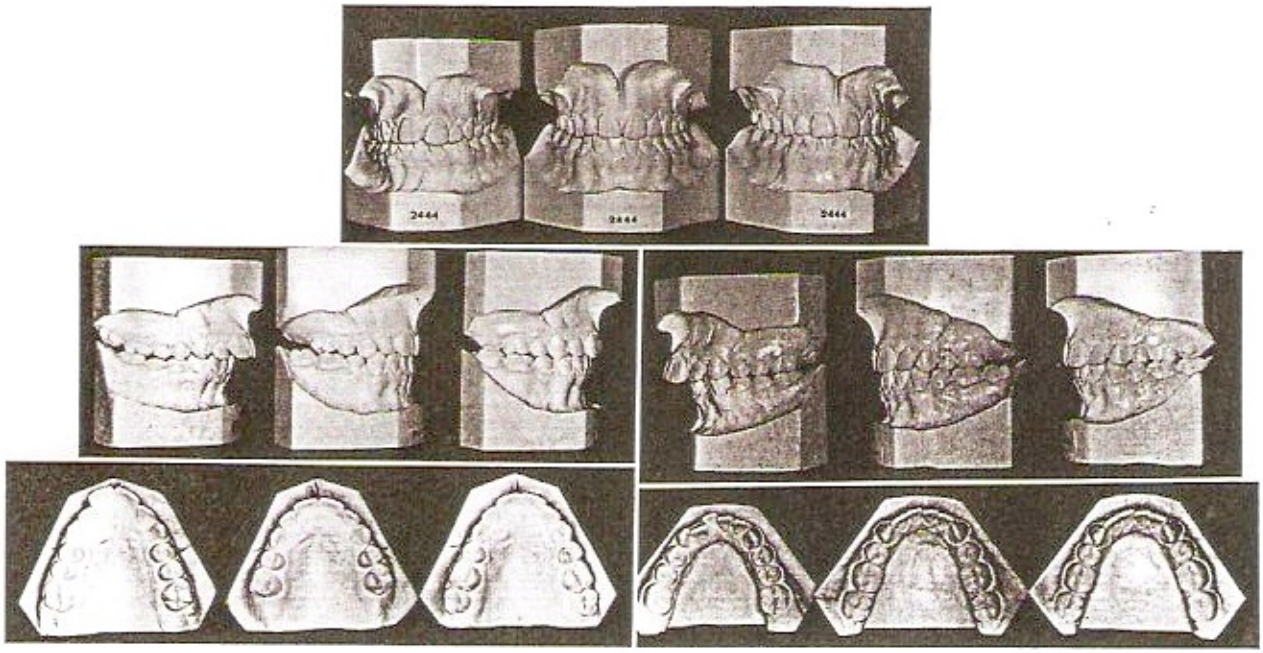

**Fig. 16.** Photographs of pretreatment, posttreatment, and recovery casts.

## SUMMARY

The use of this ratio has been illustrated in this case report. The ratio is a complement to diagnosis, a tool to be used to help make diagnostic decisions. It is also an "alarm signal" that can be used in the diagnosis of cases with either an excess or a deficit in the vertical dimension. One of its primary uses, however, should be as a barometer during the course of treatment. Its use in this manner allows the clinician to carefully monitor the relationship of posterior facial height to anterior facial height and adjust treatment mechanics to compensate for any unfavorable tendencies that might surface. The use of the FHI in this manner is quite probably one of the principle interests that it should have for the clinical orthodontist.

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