TURKISH JOURNAL of ORTHODONTICS

DOI: 10.5152/TurkJOrthod.2020.19033

Original Article

Nahoum Index in Brachyfacial Patients: A Pilot Study

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Cite this article as: Vompi C, Vernucci R, Costantini AM, Mazzoli V, Galluccio G, Silvestri A. Nahoum Index in Brachyfacial Patients: A Pilot Study. Turk J Orthod 2020; 33(2): 98-102.

ABSTRACT

Objective: Our aim is to test the Nahoum Index as a support in the cephalometric study of vertical dimension and therapeutic orientation in adult patients suffering from Class II malocclusion, deep bite, or short face syndrome.

Methods: Twenty-three patients with molar Class II and an overbite >4 mm were stratified into two groups: orthodontic (G2) and surgical orthodontic (G1). The ANB angle and Nahoum Index were calculated for cephalometric tracing pre- and post-treatment. The difference between the ANB and Nahoum Index values were analyzed using the Statistical Package for the Social Sciences software.

Results: In G1, the Nahoum Index decreased from 0.954 to 0.797, and the ANB angle decreased from 5.2° to 3.2°. In G2, the Nahoum Index decreased from 0.825 to 0.817, and the ANB angle decreased from 4.4° to 4°.

Conclusion: In G1, the difference between before and after treatment was significant for the Nahoum Index only. The difference between before and after values was not significant in the G2 group. It is possible to indicate the Nahoum Index of 0.934 as the limit value in case of which a patient may be treated with orthodontics only. This limit is the opposite of the limit proposed by Nahoum for vertical excess cases and respect the same interval. Therefore, we can consider the range 0.81-0.934 to indicate borderline patients, and >0.934 to indicate surgical patients. If the ratio is close to the normal value as 0.81, the treatment will be orthodontic; if it is further increased, the treatment will be surgical.

Keywords: Brachyfacial, cephalometry, deep bite, index, malocclusion, syndrome

INTRODUCTION

The study of the brachyfacial typology, characterized by a defect of the anterior vertical dimension with respect to the transversal dimension, is very interesting and complex. This defect can be due to a dentoalveolar and/or skeletal anomaly, and it often involves all the connected dentofacial structures. The reduction of the vertical dimension can also reach the characteristics of a syndrome, called short face syndrome (SFS) (1-3). Cephalometric analysis is very important in defining this facial typology to decide if the clinical characteristics can be treated with an orthodontic or surgical orthodontic treatment. The Nahoum index is used to determine the amount of facial vertical disorder in the appraisal of the open bite; the Index is indicated to identify which treatment is better: orthodontic or surgical orthodontic (4). Nahoum established the value of 0.81 as the normal ratio, a harmonious relationship between the upper and lower facial portions. When the value is between 0.686 and 0.81, the patient is defined as borderline. If the ratio is <0.686, the case must be treated with maxillofacial surgery. The Nahoum Index is currently used in the pre-surgical Orthodontic Unit of the orthodontics COU in Sapienza University of Rome in the cephalometric analysis (5).

Although the Nahoum Index has been created by the authors as a support to cephalometric diagnosis and therapeutic orientation in open bites, and in any case of vertical excess of the lower third face, it could be also used in the diagnosis of dentofacial disorders when a deficit in the vertical dimension of the lower third is highlighted (6).

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Received: March 28, 2019
Accepted: November 28, 2019
Available Online Date: May 20, 2020

Our aim was to test the Nahoum Index as a tool in the cephalometric study of the vertical dimension and therapeutic orientation in patients suffering from deep bite or SFS at the end of growth. A statistical analysis was performed to explain the clinical value of the Index in these patients and, as a secondary aim was, to suggest the most appropriate therapeutic approach. A retrospective study was designed to compare the values before and after the treatment of ANB angle and of the Nahoum Index in a group of patients affected by Class II malocclusion, who underwent orthodontic-surgical correction of the sagittal and vertical discrepancy; the results were compared with a control group of patients treated with orthodontics only.

METHODS

The study was approved by the Department of Oral and Maxillo-Facial Sciences and by the Ethical Board of the Umberto I General Hospital of the Sapienza University of Rome (protocol number 4663).

Among all the patients who were referred to our clinic, we selected a sample of adult patients consecutively treated and who completed the therapy, according to the inclusion and exclusion criteria. The inclusion criteria involved patients with the CS6 stage of cervical maturation, who had suffered from Class II malocclusion and were clinically classified on the basis of the occlusal molar relationship, and also had SFS face and/or deep bite (7). All the patients selected also had to have complete documentation, including clinical examination, photographic and, radiographic records, and cast models, at pre and post treatment. The exclusion criteria involved patients affected by cranio facial deformities or syndromes, patients atment with incomplete documentation, and patients who did not complete the therapy. For the inclusion in the study, we selected patients having Class II molar relationship and with an overbite more than 4 mm. The selected group of 23 subjects consisted of 9 men and 14 women, aged between 20-37 years. The patients were stratified into two groups according to the therapy performed. The first group consisted of patients who underwent orthodontic-surgical treatment (G1, 10 subjects); the second group consisted of patients treated only with orthodontics, and it was used as the control group (G2, 13 subjects) (Table 1. a, b). Among the patients in orthodontic-surgical group, 2 BSSO, 3 BSSO and genioplasty, 3 Le Fort I osteotomy and BSSO, and 2 Le Fort I, BSSO and genioplasty procedures were performed.

Table 1a. Patients treated with surgical orthodontic treatment involved in the study (G1), stratified by age and sex

Patient	Sex	Age
1	m	22
2	f	34
3	f	24
4	m	36
5	m	29
6	m	31
7	f	37
8	f	20
9	f	21
10	m	24

Table 1b. Patients treated with orthodontics involved in the study (G2), stratified by age and sex

Patient	Sex	Age
1	f	24
2	f	29
3	f	35
4	f	32
5	f	21
6	m	34
7	m	26
8	f	39
9	m	28
10	f	35
11	m	31
12	f	26
13	f	23

A retrospective analysis was then performed to measure the latero-lateral cephalometric tracing of each patient in both groups, at the beginning and at the end of therapy, and to identify the pattern of ANB angle, and the Nahoum Index. The Nahoum Index is the ratio between the upper anterior facial height (N-ANS, expressed in mm) and the lower anterior facial height (ANS–Me, expressed in mm). To test the data reliability, another Investigator repeated the measurements again in random order after 1 month, and the method error was calculated using Dahlberg's test.

Statistical Analysis

For each group, we performed descriptive statistical analysis with calculation of the mean and standard deviation (SD). To highlight the characteristics of the two groups, the pre- and post-treatment values between the groups were evaluated with a *t*-test for independent samples. The null hypothesis to test if there was any significant difference between the groups, before the therapy, and that the Nahoum Index is useful to suggest the most appropriate therapeutic approach.

The differences between the values before and after treatment within both groups were tested using the analysis of variance, the F test, and the *t*-test for paired data. The significance level was set at 0.05.

The purpose of the statistical analysis was to verify possible differences between the two groups before the treatment, compare the before and after treatment results, and compare the two groups after treatment to obtain the clinical significance of the Nahoum Index in brachyfacial patients. The parameters were analyzed using the Statistical Package for Social Sciences version 21.0 software (IBM Corp.; Armonk, NY, USA).

RESULTS

The results of the Dahlberg test were 0.4° for the measure of ANB and 0.08 for the Nahoum Index, indicating a good inter-examiner reliability for both measures. Especially for the Nahoum Index, these results are important because the Index is a pure number without units of measurements, and it depends on the measure of two linear distances.

Table 2. Parameters of the orthodontic-surgical group (G1)

	Nahoum Index		ANB Angle	
Patient	Pre-treatment	Post-treatment	Pre-treatment	Post-treatment
1	0.97	0.69	6	7
2	1.02	0.81	4	4
3	0.96	0.8	8	3
4	1.01	0.88	1	1
5	0.95	0.8	6	1
6	0.94	0.7	3	1
7	0.98	0.93	2	1
8	0.93	0.84	7	5
9	0.89	0.78	7	5
10	0.89	0.74	8	4
Mean (SD)	0.954 (0.044)	0.797 (0.075)	5.2 (2.53)	3.2 (2.15)

Table 3. Parameters of the orthodontic group (G2)

	Nahoum Index		ANB Angle	
Patient	Pre-treatment	Post-treatment	Pre-treatment	Post-treatment
1	0.7	0.73	6	6
2	0.79	0.78	2	2
3	0.94	0.9	3	4
4	0.82	0.81	2	2
5	0.71	0.73	1	1
6	0.82	0.81	5	3
7	0.91	0.88	2	2
8	0.84	0.81	5	6
9	0.8	0.78	3	0
10	0.74	0.75	9	8
11	0.99	0.98	5	5
12	0.84	0.86	6	6
13	0.83	0.8	8	7
Mean (SD)	0.825 (0.085)	0.817 (0.072)	4.38 (2.46)	4 (2.51)

Table 4. Results of T-test for the comparison of values before and after treatment

	G1	G2
Nahoum Index	p<0.001	0.786
ANB	0.0728	0.6975

Table 5. T-test for comparison of values between groups before and after treatment

	Before	After
Nahoum	p<0.001	0.5256
ANB	0.4457	0.4305

For both groups, Table 2 and 3 report the results of the parameters studied. In the surgical orthodontic group, the Nahoum Index before treatment was higher than the normal value (0.81), with a mean of 0.954 (SD, 0.045); after the surgical orthodontic treatment, with the recovery of a physiological vertical dimension, the mean value was 0.797 (SD, 0.075). The mean value of the ANB angle was found 5.2°(SD, 2.53) before treatment, and 3.2° (SD,2.15) at the end of treatment.

In the orthodontic group (G2), the mean Nahoum Index before treatment was 0.825 (SD, 0.084). At the end of the treatment, the mean value was 0.817 (SD, 0.072). The average value of the ANB angle before the treatment was 4.4° (SD, 2.47), and at the end, it was 4° (SD, 2.52). In the G1 group, the difference between before and after treatment was significant for the Nahoum Index only. The differences between the before and after values were not significant in the G2 group (Table 4, 5).

To compare the two groups, a *t*-test for independent data was performed to compare the intragroup values before as well as after treatment. Before treatment, the mean Nahoum Index was statistically different between groups. After the treatment, the two groups did not have significant differences regarding the two parameters analyzed (Table 4, 5).

DISCUSSION

The typical brachyfacial patient may not only be affected by a dentoalveolar disease, but all the structures of the stomatognathic system were involved, defining what is more properly called short face syndrome (8, 9). These patients are usually characterized by a skeletal decrease of the lower third of the face with the mandible having a closed gonial angle and anticlockwise rotation of the mandibular plane, which tends to be parallel to the Frankfort horizontal plane (10, 11). The maxilla may appear normal or hypoplastic, with a reduced dentoalveolar height, or even with vertical overdevelopment of the incisal portion and inversion of the upper occlusal compensation curve, and the palatal plane is rotated clockwise. Patients with SFS usually suffer from inadequate sagittal mandibular development, thus resulting in a skeletal Class II malocclusion. Some patients show palatal inclination of the upper incisors (Class II Division 2), giving a typical trapezoidal shape of the upper arch and linguo-version of lower incisors, other patients show over-inclination of the upper incisors (Class II Division 1). Both types of malocclusion can lead to an occlusal contact between lower incisors and palatal mucosa. These structural abnormalities affect the adaptation of the soft tissues to the skeleton, leading to: the rolling up of the lower lip with a deepening of the lip-dental groove, which gives the patient the typical "sullen" look; a prominent chin; Furthermore, the labial tension may determine an increase in overbite, with severe crowding of lower incisors and serious deepening of the curve of Spee. TMJ disorders may be present for the reduction of the physiological spaces of the temporomandibular joint and for the anterior disc displacement (12, 13).

Orthodontic treatment of a Class II malocclusion with deep bite is based on the opening of the bite and the flattening of the curve of Spee, which normally occurs with an extrusion of the posterior sectors to determine a clockwise rotation of the mandible (1). As a result, the posterior facial height increases, but the existing Class II relationship worsens. Moreover, the masticatory muscles, well developed in this type of patients, tend to counteract the extrusion obtained orthodontically. In cases where a short face skeletal dysgnathia is present, in addition to dental malocclusion, an increase of the height of the lower facial third is one of the most important purposes: the conventional orthodontic treatment corrects the malocclusion but is usually ineffective in changing facial proportions in patients with SFS; therefore, adult patients with SFS need a combined surgical orthodontic treatment for the complete resolution of the disease as described by Turley (14).

In surgical orthodontic cases, the opening of the bite is the first orthodontic purpose, which allows to obtain the correct axial positioning of the incisors in relation to their skeletal bases, to properly assess the real crowding of the arches, to reveal the real extent of the skeletal discrepancy, usually masked by the retroclination of upper and lower incisors and to coordinate the transversal diameters (1, 15, 16). After the intrusion of the incisors, leveling is completed with the correction of the curve of Spee. Once the leveling of the arches was achieved, it is possible to assess the need for extractions and finally the pre-surgical coordination of the arches.

From the above, it is clear the importance of assessing if a "short" vertical discrepancy is suitable to be corrected with orthodontics or orthognathic surgery: Nahoum, with its Index, set the parameters with respect to open bites; in this study an evaluation of this Index is tested for the application in patients with deep bite.

In this retrospective study, the average value of the Nahoum Index at pretreatment inthe group G2 appeared to be very close to normal value, indicating a proper vertical relationship. These patients from a cephalometric point of view did not show a vertical skeletal disorder and were properly treated with orthodontics. At the end of treatment, the normal value of the Index did not change because the orthodontic treatment was limited to the correction of the dentoalveolar alteration.

In this group, the average ANB angle (4.4°) confirmed the clinical diagnosis of skeletal Class II; after the treatment, the average value slightly decreased (equal to 4°), and this decrease was not statistically significant.

In Group G1, the average Nahoum Index before therapy had values far from the normal value, due to the vertical deficiency of the lower facial third. In these patients, ANB was increased, being equal to 5.2°; these patients also had a greater sagittal involvement than the other group, as well as a vertical skeletal disorder, so the complexity of the malocclusion required a combined surgical orthodontic intervention.

The average value obtained at the end of the orthognathic treatment showed how the recovery of a correct three-dimensional skeletal situation may also restore the vertical dimension, giving a ratio between the medium and lower facial third very close to the normal value proposed by Nahoum; this ratio indeed was slightly lower, probably because of a surgical vertical overcorrection, which is desirable in this kind of patients. The mean ANB angle after surgical correction (ANB, 3.2°) returned within normal ranges.

In disorders with deficiency of the lower facial third, we expect that the Nahoum Index will always be increased due to the decrease of the ANS–Me distance. If we see the differences between groups, the only parameter statistically different before therapy is the Nahoum Index. After therapy, there were no differences between the groups regarding both parameters.

Although this Index alone cannot provide precise indications of the best therapeutic approach in patients with deficit of lower facial third, it is possible to indicate the value of 0.934 as the limit value within which a patient may be treated with orthodontics only. This limit is the opposite of the limit proposed by Nahoum (<0.686) for cases with vertical excess, and it respects the same interval.

Therefore, we can consider the values between 0.934 and 0.81 as borderline cases and values >0.934 indicate surgical correction of the vertical defect. Our sample of surgical patients in fact exceeded this limit, having as the mean Index 0.954. Instead, the mean value of the patients treated with orthodontics is 0.825, very close to the normal value of 0.81.

It is obvious that the choice of the best treatment cannot be established only on the basis of vertical cephalometric parameters, but it must always be related to the sagittal and transversal characteristics of the patient. The choice of therapy, orthodontic or surgical orthodontic, will depend on how the vertical changes are related to concurrent sagittal and transversal disorders that affect the complexity of malocclusion. Further investigations conducted on a larger number of patients could improve the statistical significance of the study.

CONCLUSION

The features of the brachyfacial morphotype affect the therapeutic choice, and the results could be obtained with the therapy. A cephalometric instrument that discriminates the dentoalveolar vertical discrepancy from the skeletal one could be useful.

The Nahoum Index can be, even in brachyfacial subjects, of great help in determining the most suitable treatment. If this ratio is close to the normal values, the treatment will be orthodontic; if the ratio is further increased, the approach will be surgical.

Ethics Committee Approval: Ethics committee approval was received for this study from the Department of Oral and Maxillo-Facial Sciences and by the Ethical Board of the Umberto I General Hospital of the "Sapienza" University of Rome (protocol number 4663).

Informed Consent: Informed consent wasn't necessary for to the retrospective nature of this cohort study.

Peer-review: Externally peer-reviewed.

Author Contributions: Supervision - A.S., G.G.; Design - C.V. A.M.C, R.A.V.; Resources - C.V., V.M., A.M.C.; Materials - R.A.V.; Data Collection and/or Processing - R.A.V, V.M., A.M.C.; Analysis and/or Interpretation - C.V., R.A.V.,G.G.; Literature Search - A.M.C., V.M., C.V.; Writing Manuscript - C.V, R.A.V.

Conflict of Interest: The authors have no conflict of interest to declare.

Financial Disclosure: The authors declared that this study has received no financial support.

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