Original Article

Diagnosis of Nasopharyngeal Obstruction by Lateral Cephalometric Radiography

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Abstract:

Statement of Problem: Nasopharyngeal obstruction by adenoid enlargement is one of the main causes of mouth breathing. Diagnostic indices of nasopharyngeal obstruction by lateral cephalometric radiography are controversial.

Purpose: The purpose of this study was to diagnose the nasopharyngeal obstruction by means of lateral cephalometric radiography.

Materials and Methods: In this research two groups, (study and control), of 6 to15 years old were studied. In the study group, 46 mouth breathers were clinically examined by an orthodontist and an Otolaryngologist to confirm the nasopharyngeal obstruction. Control group was also comprised of 46 nasal breathers within the same age groups. A lateral cephalogram in centric occlusion was obtained for each patient. After tracing, following 7 nasopharyngeal variables were measured: 1- pp (palatopharyngeal depth). 2- Ad.Pmp (nasopharyngeal airway depth). 3- Air area (nasopharyngeal airway area). 4- NP area (bony area of nasopharynx). 5- Ba.Pmp (bony depth of nasopharynx). 6- d (bony depth of nasopharynx). 7- h (bony height of nasopharynx).

Statistical t-test was conducted following calculating the mean, standard deviation and p-value of parameters. Discriminant function analysis was employed subsequent to the *t*-test for the significant variables, in order to find a method by which the values for several variables could be used simultaneously to determine whether obstruction exists. Qualitative variables of sex and age groups (6-10, 11-12, and 13-15 years old) were also used in discriminant analysis.

Results: In the study group, mean value of pp, Ad.pmp, air area, Np area and Ba.pmp were significantly decreased, whereas mean of d and h variables were not considerably lessened. After performing analysis stage, the following discriminant function equation with critical point of 3.88 and correct classification of 94.57% was determined:

D=0.345 (pp) +0.064 (Ad.pmp)-0.001(NP area) + 0.03(Air area) +0.505(Age1).

If a person's age is between 6 and 10 years old, we use one instead of Age 1 and if the age is between 11 and 15 years old, we consider zero in place of Age 1.

Conclusion: If discriminant score is less than 3.88, the patient has nasopharyngeal obstruction with 94.57% probability.

Key words: Adenoid; Mouth breathing; Nasopharyngeal; Airway Obstruction

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INTRODUCTION

The Nasopharynx is an almost conical space that extends from hormione to hard palate and foramen magnum and increases in size by 80% through growth and development [1]. The relationship between adenoid and neighboring

structures can be well evaluated by a lateral cephalogram. Adenoid tissue connection extends in various degrees from the roof and the posterior wall of nasopharynx to the posterior choana or pharyngeal surface of the palate.

Unbalanced growth of adenoid and naso-pharyngeal bony space (when nasopharyngeal bony space grows less than the adenoid tissue) will result in the obstruction of nasopharyngeal space and consequently mouth breathing begins [2]. Depth of nasopharynx when measured as the distance of PNS to basion will increase by 9% during the growth period and an antero-posterior stability is produced during the first or second year of life [1,3]. The major part of nasopharyngeal growths occurs in a vertical direction, particularly caused by the downward growth of the palate and the growth effects of spheno-occipital synchondrosis which is also in a vertical direction. According to Bergland, naso-pharyngeal height will increase from the age of 6, until puberty approximately by 38%. This increase in height plays a major role in increasing the bony space in this region during growth, and will continue until puberty (up to 18 in boys and 13 in girls) [1,4].

Hendelman and Linder- Aronson evaluated adenoid growth quantitatively in lateral cephalograms. They reported an increase in adenoid mass, at least in two dimensions, during preschool and beginning of school years, also its degeneration at the prepubertal and pubertal period [5,6].

According to Pruzansky [7], adenoid tissue is detectable in lateral cephalograms at the second half of first year of life. It occupies half of the nasopharyngeal space when the child is 2 or 3 years old, and continues to grow to reach its maximum size. Using serial radiographs, the maximum size for adenoid will be at 9-10 years of age but may sometimes be delayed until 14-15. Later, it will decrease in size as the nasopharyngeal airway grows. McNamara [8] measured the shortest distance between posterior pharyngeal wall and a point located at the upper surface of soft palate (in its anterior half) to evaluate superior part of pharynx in lateral cephalogram and concluded that nasopharyngeal air way obstruction can be found when the distance is 5mm or less and is usually coincident with an increase in mandibular plan angle. Vig and Spalding [9] evaluated two nasopharyngeal cephalometric indices of McNamara's linear measurement and Schulhof's index for percentage of airway in two matched mouth breather groups and a control one and found that these indices lack the adequate accuracy to determine nasopharyngeal obstruction. Al Kindy et al showed in a study that lateral radiography of nasopharynx is of limited value in determining adenoid hypertrophy [10]. According to Weider et al adenoid enlargement and consequent mouth breathing will affect occlusion in growing children, therefore adenectomy plays a considerable role in the management [11]. Valera et al in a study on children with large adenoids, concluded that compared to a control group, these children exhibit downwardly positioned mandibles, decreased posterior facial heights and dolichofacial growth patterns [12].The main goal of this study was to find a method by which lateral cephalograms can be used more accurately for determining nasopharyngeal space obstructions in order to refer them for adenoidectomy.

MATERIALS AND METHODS

In this descriptive study 46 patients (32girls and 14 boys) with impaired nasal breathing and the mean age of 11.26 years were selected. After a complete clinical examination by an orthodontist they were referred to an Otolaryngologist for a special examination to evaluate and confirm the presence of large adenoids and the resulting obstruction. The control group was comprised of 46 nasal

breathers (35 girls, 11 boys) with mean age of 11.33 years old. None of the patients had history of orthodontic treatment and the presence of any related diseases and/or syndromes were ruled out. Taking lateral cephalograms in centric occlusion were ordered for both groups. Landmarks and lines were traced and seven nasopharyngeal parameters were measured (Fig. 1) as follows:

1- Ad. pmp: Linear distance between Ad and pmp. Measured in mm, represents the depth of airway in nasopharynx.

2- Ba. pmp: Linear distance between Ba and pmp measured in mm, corresponds to the bony depth of nasopharynx.

3- PP (Palato- Pharyngeal depth): The shortest distance between the soft tissue of the posterior wall of nasopharynx and antero-superior part of the soft palate measured in mm, represents the palato- pharyngeal depth of nasopharyngeal airway.

4- d (depth): The distance between pmp and the intersection point of PL and AAl lines (f) measured in mm, signifies the anterior-posterior depth of nasopharynx.

5- h (height): The distance between pmp and the intersection point of PML and SPL lines (c) measured in mm, represents the anterior height of the nasopharyngeal bony space.

6- NP area (nasopharyngeal area): Corresponds to the nasopharyngeal bony area in vertical and antero posterior dimensions. (c.e.f. pmp Square), measured in $mm^{2.}$ The following formula was used:

$$\text{NP area} = d\left(h - \frac{d.tg\theta}{2}\right)$$

7- Air area: Represents the percentage of nasopharyngeal bony area occupied by airway and calculated by the following formula:

$$\text{Air area (\%)} = \frac{Air\ area\ (mm^2)}{NP\ area\ (mm^2)} \times 100$$

In order to analyze the data, statistical tests of *t*-test and discriminant analysis were employed. After measuring the variables and calculating mean and standard deviation, t- test was carried out and the level of significance was determined. In the second stage, variables that showed significant difference between study and control group were considered for the discriminant analysis to find out the nasopharyngeal obstruction in addition to quantitative variables. Qualitative variables considered in this study were sex and 3 age groups (6-10, 11-12, 13-15) which had almost equal distribution in both groups and the discriminant function equation for the nasopharyngeal obstruction was calculated.

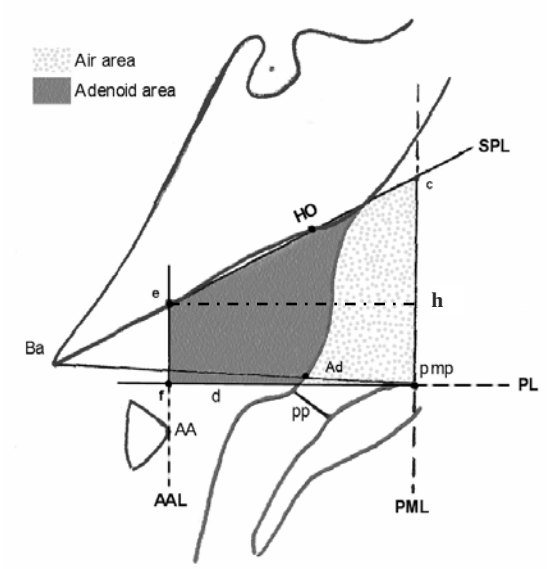

Fig 1: Landmarks, lines and measurements used in cephalometic analysis

RESULTS

The mean values of 5 parameters were significant between the two groups (Table I). Mean values of PP, Ad. pmp, Air area, NP area, Ba. pmp were significantly lower in the mouth breather group. Although the mean of h and d were lower in mouth breathers, the differences were not significant. Five quantitative variables which showed a significant difference between the study and the control group and also qualitative variables including sex and age group (6-10, 11-12, 13-15) were considered in discriminant analysis. Variables, which were entered in different stages of discriminant analysis, were as

Table I: Mean and Standard deviations of variables measured in study and control groups

Variables	Study group n=46		Control group n=46		P-value
	Mean	SD	Mean	SD	
d (mm)	31.81	3.35	32.98	4.48	0.162
H (mm)	28.77	4.31	29.41	3.09	0.146
Ad.Pmp (mm)	11.15	4.02	21.71	4.48	0.001*
Ba.Pmp (mm)	42.29	6.09	44.93	3.41	0.012*
Pp (mm)	3.47	1.28	9.33	2.48	0.001*
NP area (mm2)	588.58	125.18	660.57	108.34	0.004*
Air area (%)	30.74	9.20	52.10	8.68	0.001*

* Indicates significant different (P<0.05).

follows: Ad. pmp- pp- NP area -Air area, and age group 1 (6-10 years old group).

Although each variable had standardized and unstandardized coefficient, the latter was used. Finally, the following discriminate function an equation was defined with critical value of 3.88 and correct classification percentage of 94.57%:

"D= 0.345 (PP) + 0.064 (Ad. pmp)
– 0.001 (NP area) + 0.03 (Air area) +0.505 (Age group)"

If person's age is between 6-10 years old, one will be used instead of "Age group". However, if the patient is in the 11-15 age groups, zero will be used. In this equation if D becomes less than 3.88 indicates that with 94.57% probability, the patient would have mouth breathing problem. However, with the same probability, the function numbers more than 3.88 point out the normal breathers (Table II).

Table II: Classification of the cases based on discriminant formula

Number of cases in study and control groups	Number and percent of cases in study and control groups based on discriminant formula	
	Group 1	Group 2
Group 1 (46)	46 %100	0 %0
Group 2(46)	5 %10.9	41 %89.1

Group 1= mouth breathing group
Group 2= nasal breathing group

DISCUSSION

The measured parameters in this study could be divided into two separate groups: 1- the bony parameters related to nasopharyngeal space (h, d, Np area, Ba. pmp) and 2- the parameters of nasopharyngeal airway (PP, Ad pmp, Air area). Ba- pmp and d show the anteroposterior depth of the bony space of nasopharynx and "h" parameter represents the anterior height of the bony space of nasopharynx and NP area is the bony area of this space. The mean findings of NP area and Ba.pmp were significantly lower which can be explained by reduced amount of air passage through the nasopharyngeal space and is in agreement with "Functional Matrix" theory. Other studies also found this reduction in nasopharyngeal bony space [6,13].

Significant reduction of all measured parameters of air way in study group showed a reduced nasopharyngeal airway caused by large adenoids and reduced nasopharyngeal body space. PP and Ad.pmp represent the depth of nasopharyngeal airway in two different levels. As adenoidal maximal prominence in nasopharyngeal space in vertical dimension is variable from person to person, and will appear in varying locations, the airway depth was measured in two different levels.

As was discussed in discriminant analysis, after using quantitative variables which were significant and qualititative variables of sex and age group in this analysis, discriminant function equation was presented. Four out of five variables were entered in the equation and only Ba. Pmp, the fifth variable with lowest level of significance, was omitted in the process of this analysis. Among quantitative variables of sex and age group the first age group (6-10yrs) was considered in discriminant function equation which raised the discriminant function score 0.505 and put patients further in the normal group.

To explain this point, one must consider that

adenoids usually reach their maximum size at 9-10 yrs and will atrophy afterwards [13]. Hence among a population the 6-10 years age group, usually have larger adenoids, as compared with older age groups.

In the diagnosis of nasopharyngeal space obstruction, the discriminant formula will be useful because of considering the constant amount of 0.505 in the above group, and they can be compared with the older groups with large adenoids, as a result of which, the diagnosis of nasopharyngeal obstruction can be confirmed.

CONCLUSION

After taking lateral cephalograms in mouth breathers, using discriminant formula, the nasopharyngeal obstruction can be diagnosed with 94.57% of probability and patients can be referred for adenoidectomy with more confidence.

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تشخیص انسداد فضای بینی– حلقی (نازوفارنژیال) با استفاده از رادیوگرافی لترال سفالومتری

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چکیده

بیان مسأله: انسداد نازوفارنکس در اثر بزرگ شدن لوزه‌ها (آدنوئیدها) یکی از دلایل عمده تنفس دهانی است. معیارهای تشخیص انسداد فضای نازوفارنکس بر مبنای رادیوگرافی نیم‌رخ جمجمه (لترال سفالوگرم) مورد اختلاف نظر است.

هدف: مطالعه حاضر با هدف تشخیص انسداد فضای نازوفارنژیال با استفاده از رادیوگرافی نیم‌رخ جمجمه (لترال سفالوگرم) انجام شد.

روش تحقیق: در این مطالعه دو گروه (مورد و شاهد) ۶ تا ۱۵ ساله مورد بررسی قرار گرفتند. در گروه اول (مورد) ۴۶ کودک با تنفس دهانی جهت تعیین انسداد یا عدم انسداد فضای نازوفارنژیال توسط یک نفرمتخصص ارتودنسی و یک نفر متخصص گوش و حلق و بینی مورد بررسی قرار گرفتند. در گروه دوم (شاهد) ۴۶ نفر که از راه بینی تنفس می‌کردند، انتخاب شدند. رادیوگرافی نیم‌رخ جمجمه (لترال سفالوگرم) از هر بیمار در حالت رابطه مرکزی (سنتریک اکلوژن) تهیه شد و پس از تریسینگ، ۷ متغیر در ناحیه نازوفارنژیال مورد بررسی قرار گرفتند: ۱- PP یا عمق کام حلقی ۲- Ad. Pmp یا عمق راه هوایی در ناحیه نازوفارنژیال ۳- Air area مساحت مسیر نازوفارنژیال ۴- NP Area مساحت ناحیه استخوانی نازوفارنژیال ۵- Ba Pmp عمق استخوان در ناحیه نازوفارنژیال ۶- d: عمق استخوانی نازوفارنکس ۷- h ارتفاع استخوان نازوفارنکس. پس از تعیین میانگین و انحراف معیار هر کدام از شاخصها، از آزمون t برای نمونه‌های مستقل استفاده شد و متعاقب آن جهت به کارگیری روشی که با آن بتوان از مقادیر چند متغیر به طور همزمان جهت مشخص کردن وجود انسداد استفاده نمود، آنالیز Discriminante Function به کار گرفته شد. متغیرهای کیفی مثل گروههای سنی (۶-۱۰، ۱۱-۱۲ و ۱۳-۱۵ساله‌ها) و جنس نیز در آنالیز فوق بررسی شدند.

یافته‌ها: میانگین شاخصهای PP، Ad. Pmp، air area، NP area و Ba Pmp به طور معنی‌داری در گروه مورد، کمتر از گروه شاهد بود؛ در حالی که در مورد متغیرهای h و d اختلاف معنی‌دار آماری وجود نداشت. پس از آنالیز، معادله Discriminant Function به شرح زیر با عدد بحرانی برابر ۳/۸۸ و صحت گروه‌بندی برابر ۹۴/۵۷٪ به دست آمد:

D=۰/۳۴۵×(pp)+۰/۰۶۴ (Ad. Pmp)-۰/۰۰۱ (NP area)+۰/۰۳ (Air area)+۰/۵۰۵ (Age 1)

اگر فردی در سن ۶-۱۰ سالگی بود، به جای Age 1 عدد یک و اگر ۱۱- ۱۵ ساله بود، عدد صفر قرار می‌گرفت.

نتیجه‌گیری: در مواردی که عدد حاصل از فرمول discriminant کمتر از ۳/۸۸ باشد، بیمار به احتمال ۹۴/۵۷٪ مبتلا به انسداد فضای نازوفارنژیال است.

واژه‌های کلیدی: آدنوئید؛ تنفس دهانی؛ حلق- بینی؛ انسداد راه هوایی

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