Comparison between cavum and lateral cephalometric radiographs for the evaluation of the nasopharynx and adenoids by otorhinolaryngologists

Rhita Cristina Cunha Almeida*, Flavia Artese**, Felipe de Assis Ribeiro Carvalho*, Rachel Dias Cunha***, Marco Antonio de Oliveira Almeida****

Abstract

The lateral cephalometric as well as the cavum radiograph allow the evaluation of the nasopharyngeal airway (NAW). Otorhinolaringologists routinely use the cavum radiograph, even when the patient already has a lateral cephalometric headfilm. The aim of this study was to (a) acknowledge which exams otorhinolaringologists use for the evaluation and measurement of the NAW; (b) evaluate if the otorhinolaryngologists are acquainted to the cephalometric; (c) compare both radiographs to see which one is preferred to visualize the NAW and adenoids and (d) correlate the visual analysis to the measuring method of Schulhof. For this purpose, the cephalometric and the cavum radiographs of 15 mouth-breathing children were taken on the same day. These radiographs were masked leaving only the NAW and the adenoids visible, and were blindly presented to 12 otorhinolaryngologists. They received the radiographs together with a questionnaire asking on their familiarity with the lateral cephalometric, which exams are used for NAW and adenoid evaluation and if they use any method for measuring the NAW obstruction level. They were also asked to visually classify the NAW and the adenoids according to their sizes into small, medium and large. The results demonstrated that all otorhinolaryngologists in the sample use the cavum radiograph. Only one uses the cephalometric radiograph and two are familiar to this technique. The cephalometric was preferred by 49.4% of the otorhinolaryngologists, the cavum by 22.8% and 27.8% did not see any difference between both methods. There was low correlation between the visual method and the Schulhof measuring method.

Keywords: Orthodontics. Otorhinolaryngology. Cavum radiograph. Cephalometric radiograph.
INTRODUCTION

Mouth breathing is a functional problem considered relatively common. 85% of children present some degree of nasal insufficiency, as it has been demonstrated by functional tests, and 20% are total mouth breathers. A child can become a mouth breather because of any obstructive factor or because of wrong habits like thumb sucking, and it can cause changes in the craniofacial normal growth and development.

Among the obstructive factors, the adenoid is the most described in the literature. Because the mouth breather patient has both functional and occlusal changes, its treatment requires a multidisciplinary interaction, involving a speech therapeutic, an otorhinolaryngologist and an orthodontist, so that the primary causes of the malocclusion can be removed avoiding treatment relapses.

The orthodontist uses in daily routine to decide the patient’s treatment plan the lateral cephalometric radiograph described by Broadbent. This radiograph is obtained in a standard way, being always done with the same head position and with the same distance from the radiation cone, allowing the professional to make measurements and compare those measurements in different treatment’s periods. This radiograph is considered by many authors as a simple exam, practical and with good results to diagnose the size of the nasopharyngeal airway. Nevertheless, most of the otorhinolaryngologist uses to evaluate the nasopharyngeal airway the cavum radiograph, which is also a radiograph from the lateral part of the cranium like the lateral cephalometric, but without any stabilized patterns, giving the doctor the image to evaluate the nasopharyngeal airway but inadequate for orthodontic planning.

Because of a poor relation between both specialties and the absence of scientific researches comparing those two techniques, the professionals don’t know which image would provide the best view of the nasopharyngeal airway and which measurement technique would be more precise, leading to the patient having to do both of them.

Gurgel et al described that the mouth breather diagnostic should be done through specialized exams, like the oropharynx clinical exam, anterior rhinoscopy, nasofibroscopy and otoscopy, and by complementary exams, like blood exam, radiographs and patient clinical history. The radiographic exam described by the authors was the cavum radiograph.

Holmberg and Linder-Aronson studied if the lateral and frontal cephalometric radiographs would be useful to evaluate the nasal respiratory function and concluded that the lateral one would give good results about the nasopharyngeal dimensions and the frontal one would give good information about the capacity of the nasal airways.

Major et al concluded in a systematic review about diagnosing hypertrophy of adenoids and nasopharyngeal airway obstruction through the cephalometric radiograph that there is a good correlation in the findings about the size of the adenoid, but the ability to diagnose a small nasopharyngeal airway is not that good. The authors attribute those findings to the adenoid being an anatomic structure simpler than the nasopharynx and loosing less information when transformed in a bidimensional image.

Some papers have being published comparing the cephalometric radiograph with the nasopharyngeal endoscopies. Ianni Filho et al compared both methods and concluded that the radiographic exam is important for the initial diagnostic of the nasopharyngeal obstruction, but it gives very limited information. The endoscope gives more information but would be harder to be obtained. Vilella et al found very similar results regarding the anteroposterior size of the nasopharynx using both methods and suggested that when evaluating the child respi-
ratory pattern it should be done not only a clinical exam, but also cephalometric measurements of the nasopharyngeal space.

The computerized tomography can also be used in the diagnoses of nasopharyngeal obstruction, being a more precise exam but also more expensive. Montgomery et al described that after evaluating the results obtained by the tomography, it becomes clear how the radiographic exam is poor in information. The authors suggest that the tomography should be used as a gold pattern, but the cephalometric exam should be used as a key to determine if a more detailed exam is needed or not, having in mind that this is a bidimensional exam, and so, very limited.

The radiographic evaluation, besides being the first complementary exam doctors ask for patients with suspect of mouth breathing patterns, stands with the clinical exam as the most used method to evaluate hypertrophy of adenoids and changes in the nasopharyngeal space. The correct radiograph technique should always be followed to minimize possible adversities as bad positioning or moving of patient. The child should always be calm, straight, with mouth shot, inspiring air and with the head oriented in the horizontal plan and lateral to the x-ray.

Araújo Neto et al affirmed that because of the variety and the complexity of the measurement methods for the radiographic diagnoses of adenoids, several radiologists prefer to use the subjective analyses. This way, the visual analyses of the cavum radiograph gives, most of the times, an imprecise diagnosis.

There are several methods described to evaluate nasopharyngeal radiographs and when the adenoids should be considered bigger than normal varies from author to author. The most used methods to measure adenoids in the cavum radiograph are: Johannesson’s method, Fujioka’s, Crepeau’s and Cohen and Konak’s.

As when using the cephalometric radiograph, there are two methods described in the literature, McNamara’s and Schulhof’s.

Since the mouth breathing is a multidisciplinary problem treated by the orthodontist and the otorhinolaryngologist and both uses lateral cranium radiographs, it becomes necessary to compare the lateral cephalometric and the cavum radiograph to try to establish which exam should be asked for, so that the patient has to do only one radiograph instead of two, minimizing expenses and radiation exposure.

This way, this paper aimed to evaluate: (a) Which exams the otorhinolaryngologists are used to ask for to evaluate and measure the nasopharyngeal airway; (b) the percentage of otorhinolaryngologists that are familiar with the lateral cephalometric radiograph; (c) the visualization of the nasopharyngeal airway and adenoids of the mouth breather in the cavum and the lateral cephalometric radiograph by the otorhinolaryngologist; and (d) the correlation between the visual method of analyzing the nasopharyngeal airway and adenoids and the measuring method of Schulhof.

MATERIAL AND METHOD

To collect this sample, 150 children between 6 and 12 years old were evaluated in the city of Recife. The inclusion criteria’s were: not be using orthodontic appliance, not be using any medications, couldn’t have had the adenoids removed, not have any congenital anomalies and had to be a mouth breather.

Only 38 of the 150 could be included in the sample. The parents signed a consent term allowing the children to participate in the study. Two children didn’t have the parents’ approval, resulting in 36 children.

The sample was submitted to clinical exams by the orthodontist and a speech evaluation by the speech therapeutic to certify that all of them were mouth breathers.
The speech evaluation consisted in questions about the masticatory function and the ability to swallow, which kind of food the patient prefers eating during meals, time spent with meal and if there were any stomach aid; besides it was asked about their sleeping time, if the patient had sleeping problems, if he snored, if there was any wrong habits, how was his general health, if there was any respiratory disease, any nasal obstruction, congenital disease, pain in the temporomandibular joint, any history of face trauma and if he had being submitted to any surgery.

It was also done a clinical exam observing lips, tongue, cheeks, and speech test, breathing test, masticatory test and swallowing test.

The patients were submitted to two different radiographic exams in the same day: lateral cephalometric radiograph (Fig 1A) and cavum radiograph (Fig 1B). If any child presented a cold in the day scheduled for the exam, it was postponed to when the child felt better.

The same operator with more than five years experience did the cephalometric radiographs. To evaluate the operator method error it was used a Kappa test that demonstrated an excellent concordance. The radiographs were done as described by Broadbent in 1931.

The same operator did the cavum radiographs. The radiographs were done as described by Bontrager in 2003 with some adaptations for the patient breathing, the area submitted to the radiation and the distance to the radiograph machine.

It was selected 15 patients with ages closer to 10 years old and with different sizes of the nasopharyngeal airway, classified as small, medium and large according to the Schulhof.

FIGURA 1 - Exemplo de radiografia cefalométrica de perfil (A) e de cavum (B) obtidas de um mesmo paciente respirador bucal, no mesmo dia.
analyzes (Fig 2) resulting in a total of 30 radiographs. This selection was done to diminish the time spent by the otorhinolaryngologists that participated in this study.

This radiographs were put in envelopes done with black thick paper and the area covering the nasopharyngeal space and the adenoids was removed so that this was the only area that could be seen in the radiograph. This was done so that the examiners couldn’t know which radiograph they were evaluating, avoiding any tendency of picking the image they were more used to. The radiographs were denominated radiograph A (cavum) and radiograph B (cephalometric). It was asked for 12 otorhinolaryngologists of the city of Rio de Janeiro with at least two years of clinical experience to compare both radiographs and to answer the questionnaires.

The examiner received the radiographs with a presentation letter of the project, one general questionnaire and one to evaluate each pair of radiographs. In the general questionnaire there was questions about the familiarity of the doctor with the cephalometric radiograph, about which exams the doctor used to ask for to visualize nasopharyngeal airways and adenoids, and if he used any type of measurement of the airways. This questionnaire intended to evaluate the study sample. In the questionnaire to evaluate the radiographs there was questions about which one had the best quality in visualizing the adenoids and nasopharyngeal airways and it was asked for them to classify the size of the adenoids and nasopharyngeal airways as small, medium or large, through the visual method.

For the statistical treatment it was used a binomial distribution to see which radiograph was preferred by the otorhinolaryngologists to visualize adenoids and nasopharyngeal airways with absolutes and relatives frequencies of preferences. To evaluate the correlation between the results of the visual method and the Schulhof measuring method it was calculated the values of percent agreement and kappa.

**RESULTS**

The first part of the questionnaire had the aim to present which exams the otorhinolaryngologists of this sample are used to ask for to visualize nasopharyngeal airways and adenoids, if they use or not any measuring method and if they are familiar with the cephalometric radiograph.

This questionnaire showed that the cavum radiograph is the most asked for (100%), followed by endoscope (83%) and the cephalometric was only used by one of the doctors in this sample. Only one of them used any type of measurement to evaluate the degree of ob-
struction of the nasopharyngeal airway, while only two of them were familiar with the cephalometric technique as a method of diagnosing obstruction.

The sample preference in visualizing adenoids and nasopharyngeal airway are described in tables 2 and 3. They show the absolute and relative frequencies of the preferences related to the cavum and cephalometric. Table 1 shows the preference in visualizing the adenoids, where 49.4% preferred technique B (cephalometric), 22.8% preferred A (cavum) and 27.8% didn’t observe any difference in both. As for the nasopharyngeal airway, 48.9% preferred technique B (cephalometric), 23.9% preferred A (cavum) and 27.2% didn’t observe any difference between both of them (Table 2).

Table 3 shows concordance values between the visual analyses done by the otorhinolaryngologists when analyzing the radiographs and the values found using the measuring method of Schulhof. It was found a low correlation between both methods.

DISCUSSION

Considering the controversies in accepting only the clinical signs to confirm the diagnosis of mouth breather, the professionals of medical and dental areas uses complementary exams to help in this diagnosis.

Despite the limitations, the radiographic exams are the most used and the first to be asked for when trying to make a diagnosis. After analyzing a radiograph the doctor will decide if any other exams are necessary.

The use of a radiographic technique to evaluate nasopharyngeal airway has been questioned because of its bidimensional visualization and static view to evaluate a tridimensional and dynamic structure. Several papers have demonstrated a significant correlation between the results obtained in the radiographic evaluation and the clinical evaluation, in the direct observation during the surgical procedure, in the posterior rinoscopy and in the nasal endoscopy. Holberg and Linder-Aronson concluded that the lateral cephalometric radiograph would

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TABLE 1 - Absolutes and relatives frequencies of the preference of the otorhinolaryngologists (n=12) to visualize adenoids in mouth breathing children (n=15) in the cavum radiograph (technique A) and the lateral cephalometric (technique B).

TABLE 2 - Absolutes and relatives frequencies of the preference of the otorhinolaryngologists (n=12) to visualize nasopharyngeal airways in mouth breathing children (n=15) in the cavum radiograph (technique A) and the lateral cephalometric (technique B).

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<td>37.78%</td>
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<td>-0.13</td>
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TABLE 3 - Percent agreement values and Kappa between the visual method and the Schulhof measuring method to evaluate the size of adenoids and nasopharyngeal airways (NAW) of mouth breathing children (n=15).
give satisfactory results about the dimensions of the nasopharynx, although Vig\textsuperscript{28} sent a letter to the author questioning this result and saying that the cephalometric radiograph was not adequate to evaluate nasopharyngeal airways. But the research of those authors had a sample of 162 children, which is considered a relatively large sample and they found values for the size of adenoids very close to the clinical findings done after a posterior rinoscopy, which is a very interesting result.

Besides the radiographic evaluation being the diagnostic exam most used in the medical literature to evaluate hypertrophy of adenoids, it is also the most used method in planning orthodontic treatment. But the doctors usually ask for a cavum radiograph and the orthodontists ask for lateral cephalometric. Both of them are radiographs of the lateral cranium, but the cephalometric has a standard method to be obtained using the cephalostat to hold the patient’s head in position. In the cavum radiograph the patient is able to move his head, and that required from the radiologist technician to be even more alert. According to Oliveira, Anselmo-Lima and Souza\textsuperscript{25} a small change in the head position in the moment the exam is obtained can give important changes in the structures involved in the analyzes of the degree of obstruction of the nasopharyngeal airways. Being so, this lack of standard makes it impossible for the orthodontist to use the cavum radiograph, because the measurement analyses wouldn’t be precise.

But the results of the present study shows that the otorhinolaryngologist are not familiar with the cephalometric technique, since only two of the 12 involved knew this radiographic method. It’s important to notice that when both radiographs were compared, most of them picked as the best view of the nasopharyngeal airways and adenoids the cephalometric radiograph (49.4% and 48.9%) and approximately one forth didn’t see any difference in both of them (27.8% and 27.2%). This shows that the otorhinolaryngologists could use the same radiograph as the orthodontists, and the patient wouldn’t need to be submitted to two radiographs, since the major part of treatments involving mouth breathers are multidisciplinary.

Araújo Neto et al\textsuperscript{1} affirmed that because of the variety and complexity of he measurement methods preconized for the radiographic diagnoses of adenoids, many radiologists prefer to use the subjective analyzes. But the present study showed that the subjective analyzes has low correlation with the measurement analyzes done, which shows that the subjective analyzes is not precise. It was found a lot of divergence between the doctors when classifying the size of the nasopharyngeal airways and adenoids by the visual method. This suggests that the same radiograph could have different diagnoses depending on who is analyzing it. The diagnoses would be more precise if the professionals got used to using any measuring method in their routine.

In this study, the nasopharyngeal analyzes was based in the work of Schulhof,\textsuperscript{26} because this method combines four different measurements of different researchers. It was used the computerized result of the analyses of the nasopharyngeal airway since this doesn’t exclude the basic knowledge of anatomic structures, besides diminishing the probabilities of errors as it was observed by David and Castilho.\textsuperscript{7} To evaluate the method error it was used Kappa indices, which demonstrated excellent correlation. This result was already expected because the professional was specialist in radiology with more than 5 years of clinical experience.

Regarding the results about the nasopharyngeal airway, the findings were inside the patterns of mouth breathers according to Handelman and Osborn\textsuperscript{12}, Linder-Aronson\textsuperscript{18} and Schulhof.\textsuperscript{26} But the main objective of this study was not to verify the presence or not of hypertrophy of adenoids, those measurements were only done so
they could be compared with the visual method used by the doctors.

There are several other methods of measurements described in the literature that the professional may use, according to which one he finds easier to learn or has the best quality. Wormand and Prescott\textsuperscript{30} compared the most used methods when using the cavum radiograph which are the Johanneson, Fujioka, Crepeau and Cohen and Konak and they found that the method of Cohen and Konak had the best results and the best efficiency, although the lack of patterns of the cavum radiograph may compromise the measurements.

If the cephalometric radiograph is used, there is the McNamara’s\textsuperscript{22} and the Schulhof’s\textsuperscript{26} technique. Papers evaluating those methods are ambiguous. Kluemper, Vig and Vig\textsuperscript{17} concluded that both analyses are wick indicators of nasal obstruction when compared to clinical results, but they didn’t compare those methods with computerized tomography, which would be the ideal golden pattern.

It would be interesting that the otorhinolaryngologists started using the measurement methods that already exists and from there started to develop other methods better elaborated, more precise and easy to use that could turn the diagnoses of nasopharyngeal airways and adenoids more precise.

Having in mind that the otorhinolaryngologists picked the cephalometric radiograph over the cavum, they should consider starting using this technique so they could ask for the same exam as the orthodontists. This would facilitate the dialog between both of them and diminish the cost and radiation for the patient.

**CONCLUSION**

The present study concluded that according to the sample used, the otorhinolaryngologists are not familiar with the cephalometric radiograph and have the habit of using the cavum radiograph with no measurement technique.

When both techniques were evaluated in a blind way, most doctors chose the lateral cephalometric as the best one.

When compared the visual and the Schulhof measurement method it could be seen that there was low correlation between them.
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