Relation of Pharynx with Orofacial Structures in Jaipur (India) Population Exhibiting Normal Occlusion with Respect to Sex: A Cross-sectional Study

Vijay Agarwal, Giridhar Reddy, Sandhya Jain, Vinod Goyal, Tina Chugh

ABSTRACT

Objective: To investigate the relation of pharynx with orofacial structures in Jaipur (India) population exhibiting normal occlusion with respect to sex.

Materials and Methods: The relation of pharynx with orofacial structures was examined on the lateral cephalometric head films of 180 subjects, 90 males and 90 females. The age groups of the subjects were between 15 to 25 years. The effect of sex on the pharyngeal parameters was analyzed by means of variance analysis (ANOVA).

Results and Conclusion: It was observed that five measurements Ba-PNS, apw2-ppw2, t-ppw, hy-apw2 and Ho perp. to ANS-PNS plane were different for males and females.

Keywords: Pharynx, Orofacial structures, Cephalogram.

INTRODUCTION

The pharynx is a tube-shaped structure formed by muscles and membranes. It is located behind the nasal and oral cavities and the larynx, and extends from the cranial base to the level of the sixth cervical vertebra and the lower border of the cricoid cartilage. Its length is approximately 12 to 14 cm and it is divided into three parts: Nasopharynx, oropharynx and laryngopharynx.

The nasopharynx, forming the upper part of the respiratory system, is situated behind the nasal cavity and above the soft palate. Anteriorly, it is connected with the nasal cavity and posteriorly, it continues downward as the oropharynx. The oropharynx, opening into the oral cavity by an isthmus, extends from the second cervical vertebra to the fourth cervical vertebra. The laryngopharynx joins the oropharynx at the level of pharyngoepiglottic fold and the hyoid, and then it continues to the level of the sixth cervical vertebra.1,2

The nasopharynx and the oropharynx have significant locations and functions because both of them form part of the unit in which respiration and deglutition are carried out. Because of the close relationship between the pharynx and the dentofacial structures, a mutual interaction is expected to occur between the pharyngeal structure and the dentofacial pattern, and therefore justifies orthodontic interest. A significant relationship exists between airway space and facial morphology,3 also, airway space may be affected by conditions such as functional anterior shifting,4 head posture,5 sagittal skeletal relation6 and maxillary protraction.7

Studies involving the pharyngeal space relation are somewhat limited in orthodontic literature, and most of them are related to obstructive sleep apnea. Till date no such cephalometric study has been done in Jaipur population. So, this study was undertaken to establish the norms of different pharyngeal parameters with lateral cephalograms in Jaipur population, and to compare different pharyngeal parameters between male and female.

The aims of the study were as follows:
1. To establish the norms of different pharyngeal parameters in Jaipur (India) population.
2. To evaluate and compare the relation of pharynx with orofacial structures between male and female.

MATERIALS AND METHODS

This study included lateral cephalometric radiographs of 90 male and 90 female subjects. About 1500 subjects from various colleges and schools were screened for the collection of sample and a team of a laymen, an artist, a general dentist and a senior
orthodontist selected 180 subjects. Before participation in the study, written informed consents were given by the parents of subjects or by the subjects themselves. General dentist and layman screened 200 subjects out of 1500 subjects on the basis of well-balanced facial profile. Photographs of these individuals were shown to orthodontist who selected 185 good looking photographs. Finally, artist selected 180 subjects from them.

The selection criteria of the subjects:
1. Jaipur subjects, age ranging from 15 to 25 years.
2. Average built without any physical deformity.
3. Subjects without any facial asymmetry and/or mandibular deviation.
4. Angle Class I molar relation and canine relation.
5. Presence of all permanent teeth from second permanent molar to second permanent molar in both the arches.
6. Overjet and overbite < 3 mm.
7. Absence of crowding, rotation, dental/skeletal protrusions, crossbite, dental asymmetry, ectopic eruptions, supernumerary teeth, retained deciduous teeth and deep curve of Spee.
9. Breathe comfortably through the nose.
10. Absence of any deglutition, visual or hearing disorder.
11. Absence of any wound, burn and scar tissue in the neck region.

The following records were taken for all the subjects:
1. Lateral cephalograms
2. Models—Upper and lower
3. Facial photographs:
   a. Front view
   b. Right-side view
   c. Left-side view
   d. Teeth in occlusion, front view.

**Radiographic Technique**

The lateral cephalograms were taken with the sagittal plane at a right angle to the path of the X-rays; the Frankfort plane was parallel to the horizontal plane, the teeth were in centric occlusion, and the lips were lightly closed. Kodak X-ray films (8” × 10”) were exposed at 70 kVp; 30 mA from a fixed distance of 60 inches for 2 seconds in the Department of Orthodontics and Dentofacial Orthopedics, NIMS Dental College, Jaipur.

The lateral cephalograms obtained were traced on acetate tracing sheets of 0.5 micron thickness with a sharp 4H pencil on a view box, using transilluminated light in a dark room, eliminating stray light. Angular and linear measurements were obtained nearest to 0.5° and 0.5 mm by ruler scale and protractor.

All radiographs were traced manually, and whole angular and linear measurements were recorded by a single author and were reviewed twice by other investigators for accurate landmark identification. To eliminate error, 30 randomly selected cephalograms were traced twice by the same operator to evaluate the reliability and reproducibility of landmarks and measurements. Minimal errors indicated that the measurements were reliable.

**Statistical Analysis**

The different measurements were measured from the tracing of cephalograms of 180 subjects and then tabulated. Arithmetic mean and standard deviation values were calculated for each measurement. Group differences were analyzed with one-way analysis of variance (ANOVA). Twelve linear measurements were used to assess the pharyngeal structures.

**CEPHALOMETRIC LANDMARKS (FIG. 1)**

- **S** (Sella) Midpoint of sella turcica, determined by inspection
- **Ba** (Basion) Lowermost point on anterior margin of foramen magnum
- **Ho** (Hormion) Most inferior point of sphenooccipital synchondrosis
- **ptm** Pterygomaxillary point. Most inferior point on average of right and left outlines of pterygomaxillary fissure
- **ad1** Point of intersection of posterior pharyngeal wall and line ptm to Ba
- **ad2** Point of intersection of posterior pharyngeal wall and line from ptm as normal perpendicular to S-Ba
- **ANS** Tip of anterior nasal spine
- **PNS** Tip of posterior nasal spine of palatine bone in hard palate
- **t** Dorsal tongue surface intersecting occlusal plane
- **ppw** Posterior pharyngeal wall intersecting occlusal plane
- **ppw1** Posterior pharyngeal wall intersecting with ANS-PNS line
- **ppw2** Posterior pharyngeal wall intersecting with cv2ia and hy
- **ppw4** Posterior pharyngeal wall along line intersecting cv4ia and hy
- **apw2** Anterior pharyngeal wall along line intersecting cv2ia and hy
- **apw4** Anterior pharyngeal wall along line intersecting cv4ia and hy
- **cv2ia** Most inferoanterior point on body of second cervical vertebra
- **cv3ia** Most inferoanterior point on body of third cervical vertebra
- **cv4ia** Most inferoanterior point on body of fourth cervical vertebra
- **hy** Most superior and anterior point on body of hyoid bone
**LINEAR MEASUREMENTS (FIG. 2)**

<table>
<thead>
<tr>
<th>No.</th>
<th>Measurement Description</th>
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<tbody>
<tr>
<td>1</td>
<td>Distance between the Basion and lower adenoid mass (ad1)</td>
</tr>
<tr>
<td>2</td>
<td>Distance between the Basion and upper adenoid mass (ad2)</td>
</tr>
<tr>
<td>3</td>
<td>Distance between the Basion and PNS (depth of the nasopharynx)</td>
</tr>
<tr>
<td>4</td>
<td>Distance between the pterygomaxillary point and lower adenoid mass (ad1)</td>
</tr>
<tr>
<td>5</td>
<td>Distance between the pterygomaxillary point and upper adenoid mass (ad2)</td>
</tr>
<tr>
<td>6</td>
<td>Distance between the posterior nasal spine and posterior pharyngeal wall (PNS-ppw1)</td>
</tr>
<tr>
<td>7</td>
<td>Distance between the anterior pharyngeal wall 2 and posterior pharyngeal wall (apw2-ppw2)</td>
</tr>
<tr>
<td>8</td>
<td>Distance between the anterior pharyngeal wall 4 and posterior pharyngeal wall (apw4-ppw4)</td>
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<tr>
<td>9</td>
<td>Distance between the hyoid and anterior pharyngeal wall 2 (hy-apw2)</td>
</tr>
<tr>
<td>10</td>
<td>Distance between the hyoid and anterior pharyngeal wall 4 (hy-apw4)</td>
</tr>
<tr>
<td>11</td>
<td>Distance between the tongue to posterior pharyngeal wall (t-ppw)</td>
</tr>
<tr>
<td>12</td>
<td>Distance between the hormion perpendicular and ANS-PNS plane (Ho Perp. to ANS-PNS)</td>
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</table>

**RESULTS**

The present study was conducted on 180 lateral cephalograms of subjects with normal occlusion. Each of 12 parameters was measured in all 180 lateral cephalograms. The observations collected for the parameters were subjected to various statistical analyses. The data thus obtained was used to study any relationship of these parameters between males and females (Table 1).

According to ANOVA results, statistically significant differences were found in Ba-PNS, apw2-ppw2, hy-apw2, t-ppw and Ho perpendicular to ANS-PNS.

**DISCUSSION**

**Pharyngeal Parameters**

Good compatibility for age and sex was observed in the present cross-sectional study. Because only healthy pharyngeal subjects with Class I malocclusion were selected, we estimated that the nasopharyngeal airway space would reflect only natural anatomic conditions without pathology. To eliminate the influences of growth and aging, postpubertal subjects were selected for the current study.

Malkoc et al\(^8\) has stated that cephalometric films are significantly reliable and reproducible in determining airway dimensions. When computed tomography (CT) and cephalometric films were compared in subjects with skeletal malocclusion, Cameron et al\(^9\) found a significant positive
relationship between nasopharyngeal airway size on cephalometric films and its true volumetric size as determined from CBCT scan in adolescents.

Distance between Ba-ad1 and Ba-ad2 was 23.71 and 36.87 mm respectively. Males and females did not show any significant difference in both parameters.

Distance between Ba-PNS (anteroposterior size of the posterior pharyngeal wall) was more in male subjects than female.

Subtelny\textsuperscript{10} found that the nasopharyngeal depth was constant from infancy to maturity in female but increased moderately from 3 years, 9 months to maturity in males.

Distance between ptm-ad1, ptm-ad2 and PNS-ppw1 was not affected by sex. This finding is supported by study of Kerr\textsuperscript{11} who investigated that there was a low correlation between the nasopharyngeal and dentofacial structures when the nasal function was normal.

The study of Ceylan and Oktay\textsuperscript{12} stated that the majority of pharyngeal parameters in different ANB angle cases do not show any difference.

Distance between apw2-ppw2 and apw4-ppw4: Distance between apw2-ppw2 was more in male (16.65 mm) subjects than female subjects (13.14 mm).

Distance between hy-apw2 and hy-apw4: Distance between hy-apw2 and hy-apw4 was 24.99 and 21.61 mm for male subjects which was much higher than female measurements (19.97 mm and 17.56 mm respectively).

The study done by Ceylan and Oktay\textsuperscript{12} on the pharyngeal size in different skeletal pattern also showed that two pharyngeal parameters hy-apw2 and t-ppw showed significant difference between the sexes.

Distance t-ppw for males and females differed significantly. Mean value of distance t-ppw for male was 20.70 mm and in female it was 19.73 mm. Ho perp. to ANS-PNS plane for male (21.422 mm) was greater than female (19.388 mm).

Studies involving the pharyngeal space relation are somewhat limited in orthodontic literature, and most of them are related to obstructive sleep apnea. As we know that different growth patterns have different facial types [Schudy,\textsuperscript{13} Popovich and Thompson,\textsuperscript{14} Siriwat and Jarabak,\textsuperscript{15} Bishara and Jacobson\textsuperscript{16}] so there is a possibility that pharynx which has a close proximity to dentofacial structure could also affect them. There might be a mutual interaction between them. Joseph et al\textsuperscript{17} reported that the nasopharyngeal airway in hyperdivergent individuals was significantly narrower than that in normodivergent individuals. However, they suggested that this difference occurred because of the relative bimaxillary retrusion exhibited by the hyperdivergent group. Significant differences in craniofacial morphology and orofacial airway dimensions of Class I subjects with different growth patterns were identified by Faruk Izzet Ucar and Tancan Uysal.\textsuperscript{18}

\section*{CONCLUSION}

Statistically significant differences were identified in following craniofacial measurements among Class I subjects with different sex: Ba-PNS, apw2-ppw2, t-ppw, hy-apw2 and Ho perp. to ANS-PNS.

\section*{REFERENCES}


\begin{table}[h]
\centering
\caption{Showing mean, standard deviation of pharyngeal parameters of male and female healthy subjects of Jaipur}
\begin{tabular}{|l|c|c|c|c|c|}
\hline
S. no. & Parameters & \multicolumn{2}{c|}{Male} & \multicolumn{2}{c|}{Female} \\
& & \textbf{N} & \textbf{Mean} & \textbf{SD} & \textbf{N} & \textbf{Mean} & \textbf{SD} \\
\hline
1. & Distance between the Ba and ad1 (Ba-ad1) mm & 90 & 24.35 & 3.723 & 90 & 23.32 & 3.714 \\
2. & Distance between the Ba and ad2 (Ba-ad2) mm & 90 & 37.34 & 3.992 & 90 & 36.40 & 3.725 \\
3. & Distance between the Ba and PNS (Ba-PNS) mm & 90 & 52.03 & 3.647 & 90 & 47.62 & 3.393 \\
4. & Distance between the pterygomaxillary point and ad1 (ptm-ad1) mm & 90 & 21.04 & 3.827 & 90 & 20.83 & 3.795 \\
5. & Distance between the pterygomaxillary point and ad2 (ptm-ad2) mm & 90 & 13.95 & 3.642 & 90 & 13.85 & 3.458 \\
6. & Distance between the posterior nasal spine and ppw1 (PNS-ppw1) mm & 90 & 27.23 & 4.022 & 90 & 26.13 & 4.168 \\
7. & Distance between the apw2 and ppw2 (apw2-ppw2) mm & 90 & 15.65 & 3.714 & 90 & 13.14 & 3.245 \\
8. & Distance between the apw4 and ppw4 (apw4-ppw4) mm & 90 & 16.00 & 3.873 & 90 & 15.58 & 2.854 \\
9. & Distance between the hy and apw2 (hy-apw2) mm & 90 & 24.99 & 5.182 & 90 & 19.97 & 3.974 \\
10. & Distance between the hy and apw4 (hy-apw4) mm & 90 & 21.61 & 3.223 & 90 & 17.56 & 2.059 \\
11. & Distance between the t and ppw (t-ppw) mm & 90 & 20.70 & 2.015 & 90 & 18.77 & 2.242 \\
12. & Distance between the ho perpendicular and ANS-PNS plane (Ho Perp. to ANS-PNS) mm & 90 & 21.42 & 2.098 & 90 & 19.38 & 2.381 \\
\hline
\end{tabular}
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