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Nasal Cavity Length or Analyzed Nasal Segment of Acoustic Rhinometry in Thai Adults

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Abstract

Background: Nasal cavity length (NCL) is important for determining analyzed nasal segment (ANS) of acoustic rhinometry (AR). AR is a technique for nasal airway assessment which nasal cross-sectional areas and nasal volume (NV) are obtained. NCL or ANS is the important parameter to determine NV measured by AR. The ANS used to calculate NV in previous literatures vary from 4 to 8 cm. However, there has not been any study regarding NCL of Asians which is probably different from that of Western countries.

Objectives: To measure NCL in Thai adults using nasal telescope and compared NCL between left and right sides as well as male and female as well as among age groups.

Design: Prospective study

Methods: This study was performed on patients, aged 18–95 years, who underwent nasal telescopy under local anesthesia at the Department of Otorhinolaryngology, Siriraj Hospital. Baseline characteristics (sex and age) of patients were collected. NCL (from anterior nasal spine to posterior edge of nasal septum) of both nasal cavities was measured using rigid nasal telescope of 0 degree. Mean NCL length of both nasal cavities was calculated.

Results: There were 1277 patients, with 498 (39%) male and 779 (61%) female. The mean ± standard deviation (SD) of NCL of male was 6 ± 0.6 cm whereas that of female was 5.7 ± 0.5 cm. There were no significant differences in NCL between left and right sides as well as among age groups in each gender ($p > 0.05$ all). However, male had significantly longer NCL compared with that of female ($p < 0.001$). The mean ± SD of NCL of total population was 5.9 ± 0.6 cm.

Conclusion: The NCL of Thais was approximately 6 cm. These data are useful to determine ANS used to calculate NV when AR is performed.

Plain Language Summaries

- The length of nasal cavity (LNC) is important variable for acoustic rhinometry (AR) which is the instrument to measure nasal volume (NV). We use AR in clinical researches to diagnose and monitor the results of treatment of nose and sinus diseases
- The LNC used to calculate NV in previous studies vary from 4 to 8 cm. However, there has not been any study of LNC of Asians which is probably different from that of Western countries
- We measured LNC in 1277 Thai adults, aged 18–95 years, with 498 (39%) male and 779 (61%) female using nasal rigid endoscope and compared LNC between male and female.
- The average of LNC was 5.9 cm. Male had longer LNC compared with that female. The LNC of Thais was approximately 6 cm. These data are useful for AR to calculate NV.

Keywords: nasal cavity length, analyzed nasal segment, nasal telescopy, acoustic rhinometry

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Introduction

Nasal cavity serves as the first part of upper respiratory tract which plays important roles in respiration. Nasal obstruction is caused by many etiologies such as chronic rhinitis, deviated nasal septum, rhinosinusitis, sinonasal polyp or tumor, etc. Acoustic rhinometry (AR) is an objective assessment of nasal airway by using acoustic signal reflection[1] and firstly developed by Hilberg and colleagues.[2] AR is helpful for diagnosis, treatment planning, and follow-up of nasal diseases. Nasal cross-sectional areas and nasal volume are obtained from AR. Nasal cavity length (NCL) or analyzed nasal segment (ANS) is an important parameter to determine nasal volume. The ANS used to calculate nasal volume in previous literatures vary from 4 to 8 cm.[3–9] According to Consensus report on AR and rhinomanometry in 2005, the recommended ANS is 5 cm.[10] However, there has not been any study that really measures the exact NCL, especially those of Asians which is probably different from those of Western countries, resulting in those variations of NCL or ANS used.

Real-time polymerase chain reaction (RT-PCR) detection of severe acute respiratory syndrome coronavirus-2 (SARS-CoV-2) mRNA on nasopharyngeal swab is the standard for diagnosing Covid-19 disease. Inappropriate nasopharyngeal sampling is a relevant cause of false negative findings.[11] When nasopharyngeal swab is performed, the depth of insertion of the swab along the nostril should be more than NCL which brings it in contact with the mucosa of the posterior nasopharyngeal wall (Figure 1A). Thus, if NCL (c distance in Figure 1) is known, we can mark nasopharyngeal swab stick at the point (d point in Figure 1) where the distance from the tip of swab to that point is equal to NCL. When swab is inserted into nasal cavity, mark on the stick (d point in Figure 1) needs to be in the nasal cavity (Figure 1A), leading to more accurate results.

The objective of this study was to measure NCL in Thai adults using nasal telescope and compared NCL between male and female as well as among age groups and find out if Asians have different NCL from that of the western people, which could affect the interpretation of nasal cavity volume gained with AR. Derived NCL will be the standard ANS used to calculate nasal volume in the future and minimize the use of varied aforementioned ANS. In addition, known NCL could improve yield of nasopharyngeal swab sampling.

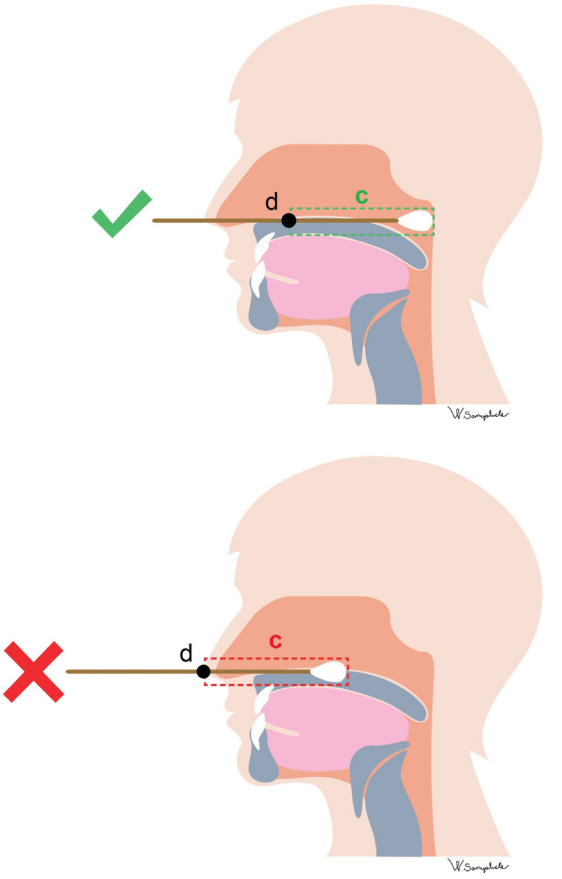

Figure 1. (A) Correct technique of performing nasopharyngeal swab in case with suspected influenza virus or severe acute respiratory syndrome coronavirus-2 (SARS-CoV-2) infection. c = nasal cavity length (NCL). d = mark on nasopharyngeal swab stick where the distance from the tip of swab to d is equal to NCL. Mark "d" needs to be in the nasal cavity when inserting swab. (B) Incorrect technique of performing nasopharyngeal swab. Mark "d" is still out of the nasal cavity when inserting swab, resulting in inaccurate results.

Materials and Methods

Subjects

This prospective study was performed on patients, aged 18–95 years, who underwent nasal telescopy under local anesthesia at the Department of Otorhinolaryngology, Faculty of Medicine Siriraj Hospital from October 2016 to October 2017. The sample size calculation was conducted prior to collecting data to ensure sufficient population in this study. We preliminarily measured NCL of 30 patients to obtain mean and standard deviation (SD). The sample size of 384 patients was then calculated. Baseline characteristics (sex and age) of patients were collected. Indications of nasal telescopy included epistaxis, chronic sinonasal symptoms, biopsy sinonasal lesions, nasal toilet after sinonasal surgery. The exclusion criteria included craniofacial abnormality, previous history of facial trauma, unable to perform nasal endoscopy due to abnormal anatomy of nasal cavity. The study was approved by Siriraj Institutional Review Board (Si 677/2016) and written informed consent was obtained from each subject before entry into the study.

Measurement of Nasal Cavity Length

Before performing nasal telescopy, two puffs of the mixture of 4% lidocaine and 3% ephedrine were sprayed into each nostril. After a 5-min wait, NCL (from anterior nasal spine to posterior edge of nasal septum) (Figure 2) of both nasal cavities was measured using rigid nasal telescope of 0 degree, 2.7 or 4 millimeters in diameters. Endoscope was inserted along the nasal floor until the tip of endoscope reached the most posterior part of nasal septum. The proximal end of the endoscope was then marked at anterior nasal spine position. Endoscope was removed and the length from tip of endoscope to that mark or NCL was measured in centimeters (cm) and recorded. Then, the mark was deleted and the same procedure was repeated on the other side of nasal cavity. Mean NCL length of both nasal cavities was calculated.

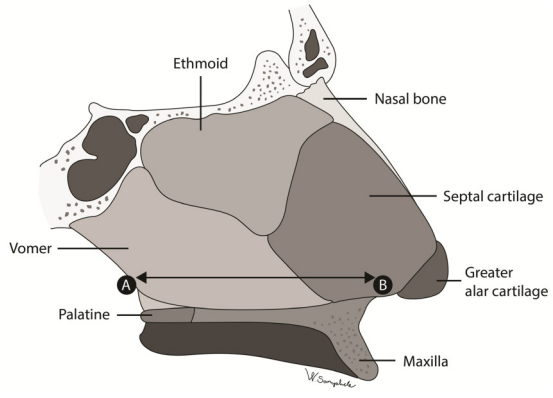

Figure 2. Measurement of nasal cavity length (from posterior edge of nasal septum (A) to anterior nasal spine (B)).

Statistical Analysis

Statistical analysis was performed with SPSS version 22.0 (SPSS Inc., Chicago, Illinois). Data are reported as frequency and percentage for categorical data or mean ± SD for continuous data. Normality of data was evaluated by One-Sample Kolmogorov–Smirnov test. Since the data were normally distributed, NCL in all age groups and of each gender were demonstrated by mean ± SD. Paired t-test test was used to compare NCL between left and right sides whereas comparison of NCL between genders was performed by unpaired t-test. Analysis of variance (ANOVA) was applied to compare NCL among age groups. A p-value less than 0.05 was considered statistically significant for all tests.

Results

A total of 1277 patients were recruited in this study with 498 (39%) male and 779 (61%) female. The mean age ± SD of total population was 46.9 ± 15.4 year with the age range of 18–95 years. The gender, number, mean NCL ± SD, and mean difference of NCL between gender including 95% confidence interval of subjects of 5 patient groups were shown in Table 1. The result demonstrated that male had significantly longer NCL than female in all age ranges. The mean ± SD of NCL of total population was 5.9 ± 0.6 cm with the range of 4–7.8 cm. There were no significant differences in NCL between left and right sides as well as among age groups in each gender ($p > 0.05$ all). Age did not differ significantly between male [mean age ± SD = 47.6 ± 16.3 year, age range 18–90 year] and female [mean age ± SD = 46.5 ± 14.8 year, age range 18–95 year] ($p = 0.21$).

Discussion

Nasal cavities are the first airway passages in upper airway systems. AR is a rapid, objective, painless and non-invasive assessment of nasal geometry

Table 1. The gender, number, nasal cavity length (NCL), and mean difference of NCL between gender including 95% confidence interval (CI) of subjects in each age group. P value < 0.05 indicates significant differences of NCL between gender in each age group.

Age group	Gender	Number	NCL (cm) Mean ± standard deviation	Mean difference of NCL (95% CI)	*p-value*
18–25 yr	Male	44	6.1. ± 0.6	−0.48	<0.0001
	Female	71	5.8 ± 0.5	(−0.68, −0.27)	
26–35 yr	Male	108	6.1 ± 0.6	−0.36	<0.0001
	Female	145	5.8 ± 0.6	(−0.51, −0.22)	
36–45 yr	Male	74	6 ± 0.6	−0.30	<0.0001
	Female	158	5.7 ± 0.5	(−0.45, −0.15)	
46–55 yr	Male	96	6.0 ± 0.5	−0.30	<0.0001
	Female	168	5.7.± 0.5	(−0.44, −0.17)	
≥56 yr	Male	176	5.9 ± 0.5	−0.19	<0.0001
	Female	237	5.7 ± 0.5	(−0.29, −0.09)	
Total	Male	498	6.0 ± 0.6	−0.29	<0.0001
	Female	779	5.7 ± 0.5	(−0.35, −0.23)	

which provides cross-sectional area and volume of the nasal cavity based on reflected sound waves. When nasal volume is required, ANS or NCL is needed to be entered into the AR software. Nasal volume is then calculated based on ANS provided. Different nasal volume is then obtained if varied ANS or NCL is used. Nasal volume values measured by AR in normal subjects have been reported by various authors using different ANS such as 4 cm,[3,4] 5 cm,[5] 6 cm,[6] 7 cm,[7,8] and 8 cm.[9] Because of different sizes and shapes of the noses in different races (e.g., between oriental and western nose),[6,12,13] the aim of our study was to measure NCL in male and female Thais in different age groups and used it as the reference ANS for nasal volume measurement by AR.

We found that NCL did not differ significantly among age groups and male NCL was significantly longer than that of female. The comparison of AR parameters [minimal cross-sectional area (MCA), nasal volume and the distance from the nostril to the point of MCA (D)] between male and female subjects was performed in 135 healthy Thai adults.[4] After decongestion, the mean MCA, D, and nasal volume were significantly higher in male subjects than in female subjects ($p < 0.05$ all), in agreement with our finding. In addition, the mean ± SD of NCL of total population (n = 1277) was 5.9 ± 0.6 cm. Our study showed that normal NCL or ANS value of Thai subjects (approximately 6 cm.) was different from that of the European study which was 5 cm.[10] Each ethnic group has different ANS values. We suggest using 6 cm as the reference ANS value for nasal volume measurement by AR in Thai and Oriental subjects. As far as we know, our study is the first one to really measure NCL. Hopefully, NCL or ANS derived from our study will be standard ANS used to calculate nasal volume from AR in the future.

Since December 2019, the coronavirus disease 2019 (COVID-19) pandemic has spread to many countries. One of the every country strategic objectives is to control clusters and prevent community transmission by rapidly identifying the infected cases. The identification of cases is typically performed using material collected from a nasopharyngeal swab, which is tested for SARS-CoV-2 using RT-PCR. Although RT-PCR tests are highly specific and the

probability of false positives is low, but false negatives are possible depending on swab technique and time since symptom onset. One possible cause of false negative RT-PCR is incorrect sampling of nasopharyngeal swab.[11] For example, the tip of swab does not contact with mucosa of the posterior nasopharyngeal wall (Figure 1B). With known NCL, marking nasopharyngeal swab stick at the point (d point in Figure 1) where the distance from the tip of swab to that point (d) is equal to NCL will eliminate false-negative results in testing for SARS-CoV-2 and other respiratory viruses.

There are few limitations of our study. Firstly, the majority of study population is adult female. Secondly, in patients with septal deviation or septal spur, NCL on those sides were probably longer than actual length because of the measurement techniques. Thirdly, NCL measured by this technique might not be the exact one because of the distortion of image obtained from endoscope.

Conclusion

Normal NCL or ANS value of Thai subjects was different from that of the European study. We suggest using 6 cm as the reference ANS value for nasal volume measurement by AR in Thai and Oriental subjects. Additionally, known NCL is able to diminish false-negative results in testing for SARS-CoV-2 and other respiratory viruses by nasopharyngeal swab.

Declarations

Ethics Approval and Consent to Participate

Siriraj Institutional Review Board (Si 677/2016) approved this study and written informed consent was obtained from each subject before entry into the study.

Author Contribution(s)

Paraya Assanasen: Conceptualization; Data curation; Methodology; Writing – original draft.

Triphoom Suwanwech: Conceptualization; Data curation; Writing – review & editing.

Bannapuch Pinkaew: Formal analysis; Writing – review & editing.

Anupa Khongsri: Data curation; Writing – review & editing.

Phawin Keskool: Conceptualization; Supervision; Writing – review & editing.

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Competing interests

The authors declared no potential conflicts of interest with respect to the research, authorship, and/or publication of this article.

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