Clinical Communications

Determination of the preferred tongue position for optimal inhaler use

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Clinical Implications

- An incorrect technique during inhaled corticosteroid use can affect drug deposition and compromise primary treatment, leading to poor asthma control. Endoscopic imaging during inhaled corticosteroid use revealed a significant effect of the tongue position on drug deposition in the trachea and beyond.

TO THE EDITOR:

Asthma causes chronic airway inflammation, for which inhalation therapy is essential. In Japan, the basis of the treatment of symptomatic bronchial asthma is the administration of inhaled corticosteroids, as described in the Global Initiative for Asthma guidelines.[1] Unlike oral medicines, unless they are correctly self-administered, inhaled corticosteroids do not reach the trachea and beyond, and may thereby exert insufficient effects. Incorrect inhalation of corticosteroids can lead to unnecessary treatment escalation.[2] Accurate delivery of each dose to the trachea and beyond is crucial for maximizing the efficacy of inhaled glucocorticoids. Therefore, it is important to examine both observable inhaler techniques and conditions in the oral cavity that are not externally visible, such as tongue position. In this study, we endoscopically evaluated intraoral conditions while placebo inhalers were being used. We then analyzed the endoscopic images to determine the preferred tongue position during inhaler use.

Six healthy nonasthmatic volunteers (3 men and 3 women; aged 28-41 years) used 2 types of placebo inhalers: the Relvar training inhaler as a representative dry powder inhaler (DPI) and the Flutiform training inhaler as a representative pressurized metered dose inhaler (pMDI). None of the subjects used a holding chamber when using the pMDI. Each volunteer used the inhalers first without lowering the tongue, that is, the volunteers placed the mouthpiece in the mouth without paying attention to the tongue. The volunteers then used the inhalers while lowering the tongue and tongue base as much as possible and expanding the back of the throat. Images were taken using an endoscope (BF-260, diameter: 4.9 mm; Olympus, Tokyo, Japan) to record the delivery of the placebo drug into the trachea. The endoscope was inserted immediately in front of the pharynx before taking images (see Figure E1 in this article's Online Repository at www.jaci-inpractice.org). Endoscope insertion was performed along the right side of the inhaler. It was not attached to the inhaler. The endoscope tip was positioned at 45 and 55 mm from the first incisor for women and men, respectively, to ensure that the endoscope tip was in the same location in the oral cavity when the images were taken. Static images showing peak delivery of the placebo drug into the pharynx were extracted from the recorded video. Because DPI (powder) and pMDI (aerosol) differ in terms of how they deliver the drug, their drug delivery cannot be

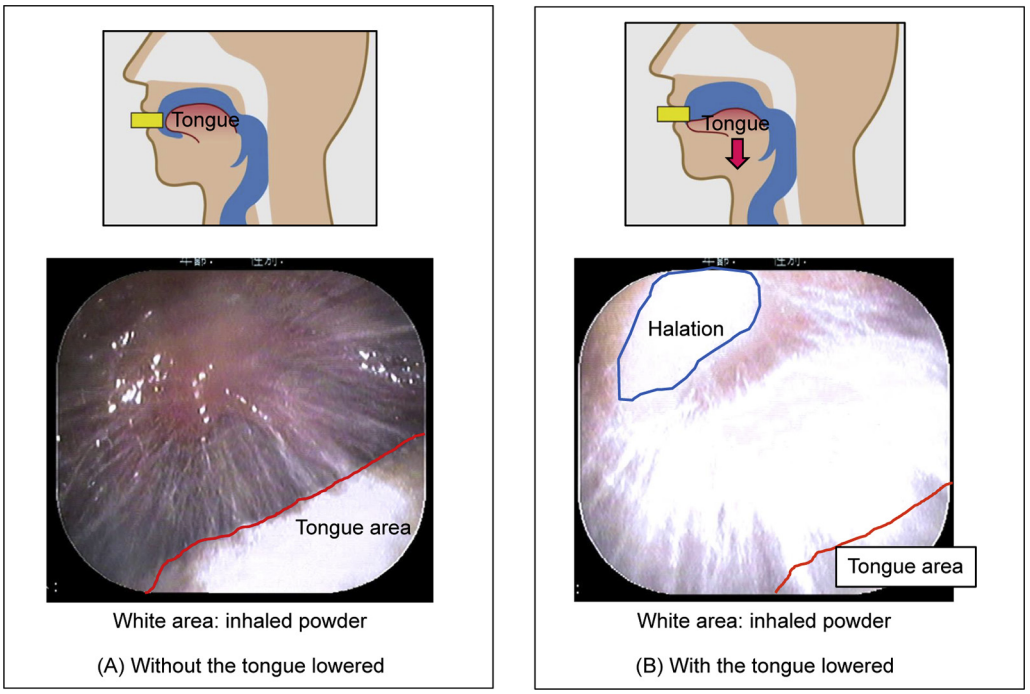

FIGURE 1. Effect of lowering the tongue on tracheal drug deposition using a DPI. With the tongue lowered (upper-right panel), a larger proportion of the powder was carried toward the trachea and beyond (lower-right panel). *DPI*, Dry powder inhaler.

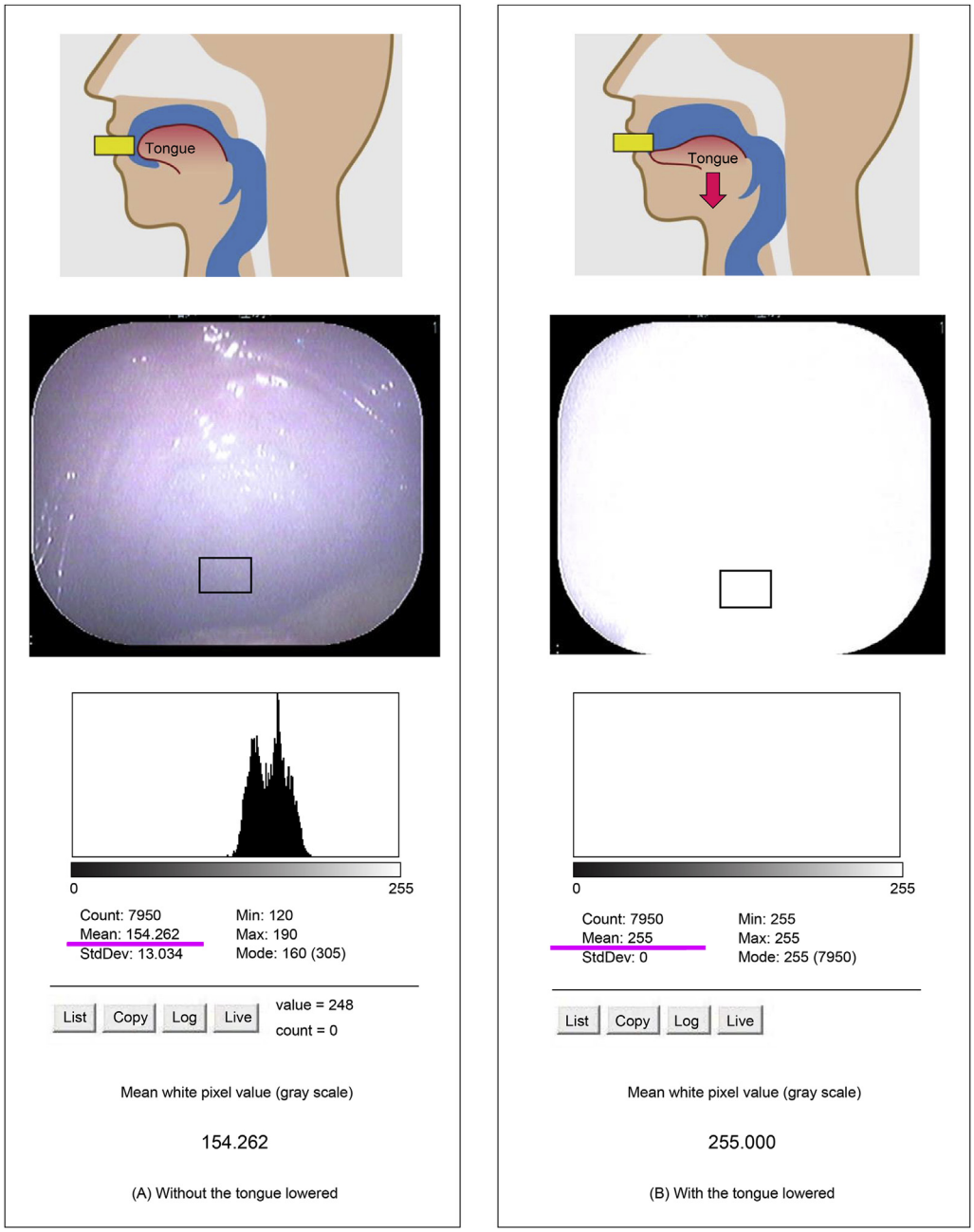

FIGURE 2. Quantitative analysis of drug deposition in the pharyngeal region when the tongue is lowered during pMDI use. Areas proximal to the larynx with a homogeneous background were selected (closed boxes). After grayscale conversion, the mean pixel intensity was analyzed using Image J. The selected region appeared significantly whiter when the tongue was lowered, indicating increased aerosol deposition. *pMDI*, Pressurized metered dose inhaler.

measured and compared using the same method. Therefore, for comparison, DPI drug delivery was measured as the quantity of powder that had entered the throat, whereas pMDI drug delivery was quantified in terms of concentration.

Colored images obtained during inhaler use were converted into grayscale images using Photoshop CC. For DPI images, the proportion of the areas covered with the powder, which appeared white on the grayscale, was compared between the 2 inhalation groups. For pMDI images, areas of a certain size with homogeneous backgrounds were converted into 256-level grayscale and compared between the 2 inhalation groups using Image J software (National Institutes of Health, Bethesda, Md). All data are expressed as the mean ± standard deviation. Statistical analysis was performed using paired *t*-tests, with significance set at $P < .05$.

Figure 1 shows representative images of peak powder appearance (indicating maximum delivery of the powdered placebo drug) from a volunteer when using the DPI training inhaler. These images demonstrate that a larger amount of powder was carried toward the trachea when the tongue was lowered. The halation area in Figure 1 appears white because the