EDITORIAL

Does My Tongue Look Fat?

Commentary on Kim et al. Tongue fat and its relationship to obstructive sleep apnea. *SLEEP* 2014;37:1639-1648.

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In today's society that overemphasizes physical beauty and thinness, few have escaped the dreaded experience of a spouse or friend inquiring about their appearance, typically when wearing a new article of clothing. Many have learned the hard way that there are no correct answers in the interrogation that can ensue, and it is usually best to avoid the question at all costs. In contrast, in the current issue of *SLEEP*, Kim and colleagues¹ demonstrate that answering the slightly different question posed in the title may provide valuable information to patients at risk for obstructive sleep apnea (OSA).

Weight gain and obesity are major OSA risk factors and are incorporated widely in screening or prediction tools,^{2,3} but the mechanisms underlying this association are not entirely clear. A study of cadaver tongues was the first to show that increases in body mass index were associated with a greater proportion of fat within the tongue, especially in the tongue base.⁴ This finding offered one explanation for the link between weight gain and obesity and OSA, as fat deposition within a structure adjacent to the upper airway would be expected to produce physical enlargement of that structure and corresponding airway narrowing.

Clinical experience suggests the association between body weight and OSA is more complex than a simple function of body weight. Kim et al. performed a case-control study of overweight and obese individuals with and without OSA, adding a subgroup analysis of pairs matched on the basis of body mass index, age, sex, and race.¹ In both evaluations, the overweight and obese individuals with OSA had greater tongue volumes and a greater volume of tongue fat than those without OSA, adjusted for body mass index, age, sex, and race.¹ For the matched subgroup, the difference in mean total tongue volume and tongue fat volume was over 12 mL and 8 mL, respectively. Similar to the cadaver study,⁴ the difference in the proportion of tongue fat was greatest in the tongue base, although there was substantial variation among individuals within the apneic and control groups. Importantly, there were no such differences seen in the masseter muscles for any of these analyses.

Understanding the pathophysiology of any disorder can serve many purposes, including explaining observed phenomena and offering new directions for treatment. The study of Kim et al.¹ accomplishes both of these purposes. In spite

of rigorous attempts, OSA prediction tools have demonstrated imperfect sensitivity and specificity, and this variation in fat deposition could account for some of their limitations. Treatment outcomes for surgery⁵ and mandibular repositioning appliances⁶ are generally worse among individuals with greater body mass index, although, similar to the risk of OSA, there are many individuals who respond well to these treatments even with marked elevation in body mass index. Variation in tongue size and tongue fat deposition, whether objectively or relative to the space afforded by craniofacial structure, may explain some of this variation and may direct clinicians in their choice among treatment options for individuals who do not tolerate positive airway pressure therapy. It is interesting that a recent multicenter study of tongue base resection for OSA had a mean resection volume of 10.3 mL, with substantial improvement in objective and subjective measures⁷; this volume is consistent with the mean difference in tongue volume between the OSA and control groups in the study of Kim et al.¹ In addition, in a randomized trial of oropharyngeal exercises to treat OSA, reduction in neck circumference was associated with reduction in the apnea-hypopnea index⁸; whether this reduction in neck circumference was caused by loss of fat tissue alone is unclear, but it is consistent with the results of the current study by Kim and colleagues.¹

The current study¹ extends the important research in upper airway imaging that has been performed by this research group over the past 20 years. They have implicated increased upper airway soft-tissue volume (especially of the tongue and lateral pharyngeal walls) as a risk factor for the presence of OSA^{9,10} and demonstrated an inherited basis to the volume of upper airway soft-tissue structures among individuals with OSA and controls.¹¹ It would be interesting to examine whether there is a genetic basis to the degree of fat deposition within the tongue or other upper airway structures. Other work showed a decrease in volume of the lateral pharyngeal wall tissues (but not in tongue volume) in 12 women without OSA who experienced substantial (mean 17.1 kg) weight loss¹²; in light of the current study's findings,¹ it is unclear whether there would have been a change in tongue volume for weight loss among individuals with OSA (presumably with more tongue fat to lose) or in a larger sample.

In addition, there are more potential areas for further investigation. Repeating many of these same studies on tongue volume with a specific focus on tongue fat would more fully characterize changes. Including individuals with normal or low body mass index individuals would evaluate the relationships between tongue volume, tongue fat, and body mass index over a broader range and determine whether total tongue volume is associated with body mass index (it was not in the reported sample¹). Evaluation of fat deposition within soft-tissue

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structures other than the tongue would be extremely interesting; Kim et al.¹ indicated that identification of other structures with Dixon imaging is challenging, but alternative methods of quantifying soft tissue fat content exist, including magnetic resonance imaging with the IDEAL technique.¹³ The authors suggest that fat deposition could contribute to muscle dysfunction, providing another means of contributing to OSA.¹ Although individuals with OSA have demonstrated an increase in genioglossus muscle strength compared to controls, they have shown an increase in fatigability¹⁴; additional research could evaluate a possible association between the degree of fat deposition and measures of muscle function.

Fat deposition within the tongue—and potentially other structures surrounding the upper airway—may transform our understanding of the link between weight gain and OSA, with wide-ranging implications for diagnosis and treatment. Who knows whether we might someday want to ask the question of whether a tongue looks fat?

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DISCLOSURE STATEMENT

Dr. Kezirian has consulted for Apnex Medical, Inspire Medical Systems, Split Rock Scientific, Berendo Scientific, and Nyxoah. He has copyrighted interests with Magnap and Berendo Scientific.

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