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Commentary

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A Complementary Mechanism Explaining Dry Eye Disease during the COVID-19 Pandemic

Reza Rastmanesh*

Abstract

Prolonged wearing of face masks might reduce movement of the jaw muscle, thereby reducing salivary gland secretion, and indirectly lacrimal gland secretion. Also, less frequent yawning and face-to-face verbal communication during the pandemic may have also reduced mandibular motion, thus contributing to altered patterns of blood flow to the eyes and regional cerebral blood flow. This may serve as an additional mechanism that might help to explain pandemic-related dry eye disease and facilitate the discovery of better preventive measures and therapeutic agents for the management of dry eye symptoms.

Keywords:

Dry eye; Face mask; Mandibular movement; Regional blood flow; Facial nerve

Introduction

Face mask wearing has been associated with an increase in dry eye symptoms among some people during the COVID-19 pandemic, negatively impacting visual quality [1]. Some mechanisms have been proposed to explain this, including:

- A mechanical explanation involving poor fit of the mask or looseness of mask apposition against the face and nose. This allows exhaled breath to be directed toward the ocular surface [2].
- Ocular microbiota alteration, involving changes in ocular microbial species, which can sometimes be associated with the dry eye syndrome. This may be less a cause, than a corollary to ocular surface disorders [3].
- Possible direct damage to the lacrimal glands by the COVID-19 virus [4,5].

Dry eye disease may have multiple contributing factors. It is important to consider all possible mechanisms in order to determine the best strategy for prevention and alleviation of dry eye symptoms. Combining some previously recognized physiologic factors [6-10] with results of a recent human experiment [11], I believe that an altered pattern of mandible movement, resulting from the wearing of a face mask [12,13], may serve as an additional mechanism that might help to explain pandemic-related dry eye disease. Furthermore, normal yawning which is a physiological behaviour could be deregulated due to the restriction of mandibular jaw movement by face mask wearing [12].

It worth to remind that tears can be described as of two types: reflex tears, which are induced by a range of stimuli (for instance, yawning, as a major stimulus), and basal tears, which are the non-stimulated lacrimation of the tear glands [14]. Yawning is contagious and can be both conscious and unconscious. Face masks inhibit contagious yawning in many settings [13,15]. Even self-induced yawning can stimulate aqueous tear [16], and saliva production [17]. It is also intriguing to know that during yawning, facial muscle sympathetic nerve activity is highly suppressed [18]. Furthermore, a substantial increase of cerebral blood flow [19], and a drastic increase in blood flow through the ophthalmic veins occurs [20], all of which substantially contribute to functional tear production.

Evidence exists showing a direct association between the salivary flow rate and jaw muscle activity during mastication [21]. This suggests that the greater the chewing rate or speaking/talking duration, the higher the saliva secretion. There is also evidence suggesting a direct physiologic association between salivary glands and lacrimal glands, and that treatment of salivary gland hypofunction, improves dry eye symptoms [22]. As for direct association between impaired jaw movement and dry eye, current evidence comes mainly from case series reports of patients with impaired jaw movement [23-25], which all share in the facial nerve impairment and hypofunction of lacrimal component of the nerves intermedius function [26].

It is not surprising that agents that stimulate salivary gland secretion, such as pilocarpine and cevimeline, may also stimulate lacrimal gland and/or Meibomian gland secretion, thus alleviating dry eye symptoms [27]. However, it was surprising to find that simply chewing gum or candy also alleviated dry eye symptoms, without involvement of receptors, antagonist(s) or agonists(s). Higher salivary secretion brought about by chewing gum or candy led to significantly lower dry eye scores [11], with no drug-receptor interactions involved.

Asakawa [11] recently evaluated eye dryness in healthy subjects experiencing eyestrain. Participants were instructed to keep their eyes open for 10 seconds. Severity of eye dryness was then evaluated by measuring ring break-up time (RBUT). The RBUT was measured by analysing break-up of the tear layer within a 6-mm radius of the center of the cornea and its deformation over time, and measuring the number of seconds required to reach the cut-off value of –0.5 D. Each 10-year age group cohort included 12 subjects, with the exception of the 30s group, which included 10 subjects. Participants performed a visual task, reading material displayed on a computer screen at a fixed distance for 60 minutes. Then, they were asked to chew gum or candy (two pieces for two 15-minute periods) starting 15 and 45 minutes after starting to read. Subjects chewed gum on Day1 and candy on Day2, and vice versa. With regard to the visual analogue scale, there was no significant difference between scores of subjective eye fatigue between chewing gum and chewing candy ($P = 0.397 - P = 0.909$). The scores of eye heaviness and eye tiredness were significantly longer in duration before and after the visual task after chewing candy ($P = 0.013$ and $P = 0.025$, respectively), but not after chewing gum. The changes of subjective accommodation were significantly lower after the visual task, after chewing candy or chewing gum ($P = 0.043$).

***Corresponding author:** Reza Rastmanesh, Department of Ophthalmology, The Nutrition Society, London, UK, E-mail: r.rastmanesh@gmail.com

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Most importantly, in terms of eye dryness there was no significant difference between chewing candy and chewing gum (P = 0.680). However, before and after the visual task, the RBUT values were 10.0 sec and 9.6 sec, respectively, with chewing gum (P = 0.053) and 9.9 sec and 9.6 sec, respectively, with chewing candy (P = 0.132) [11].

This study provides the first experimental evidence supporting our novel hypothesis that increased salivary secretion can (either directly or indirectly) enhance lacrimal secretion, possibly via a mechanism involving mandibular jaw movement. A full description of the mechanism justifying this hypothesis is beyond the scope of a short editorial, due to the space limits, but can be made available by the author on request.

Chewing-mastication and other actions involving mandible motion, such as speaking-talking, increase cerebral blood flow (rCBF) [28]. Chewing gum increases blood flow to the eyes and to the parasympathetic nerves, which act to contract the iris sphincter muscle [11]. At the same time, alteration of cerebral blood flow homeostasis results in dysfunction of aquaporins (AQPs) both in the brain and secretory glands, including the lacrimal and Meibomian glands, which are rich in AQPs [10].

Pandemic-related social distress and the limitation of physical activity brought about by the COVID-19 pandemic may also play a role in exacerbating dry eye disease. Social distress negatively impacts verbal communications, resulting in a further decrease in mandibular jaw movement. Decreased salivary flow rate, in part related to insufficient lower jaw movement resulting from face mask wear, may represent an additional mechanism by which dry eye disease is exacerbated in face mask wearers.

I hypothesize that prolonged wearing of face masks might reduce movement of the lower jaw, thus reducing salivary gland secretion, and indirectly lacrimal gland secretion. Less frequent face-to-face verbal communication during the pandemic, due in part to social distress, physical confinement and social distancing may have also reduced mandibular motion, thus contributing to altered patterns of blood flow to the eyes and rCBF. If my hypothesis proves to be true, then adopting mask designs that permit freer and transparent mandibular movement and reduced air leakage may be helpful in reducing pandemic-related dry eye disease.

Disclosure statement

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Author Affiliation

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Department of Ophthalmology, The Nutrition Society, London, UK