

# Can Increased Head and Neck Blood Flow from Mastication be Quantitatively Evaluated with Infrared Thermography ?

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## (Problem)

Various beneficial effects of chewing have been confirmed, from the prevention of oral and lifestyle-related diseases. Most of the methods that exist to evaluate masticatory function directly measure the effects of occlusion. Assuming the intention is to prevent oral frailty, evaluation that includes the status of the surrounding muscle that indirectly supports occlusal function would seem to be necessary. We could find no reports that have examined the increased blood flow in tissues that support occlusion, which function in the head and neck region around the oral cavity as a result of mastication. In this study, with the aim of obtaining basic data for the development of such an evaluation method, infrared thermography was used to assess the magnitude of the increase in head and neck blood flow that occurs with the simple chewing of food. The function of tissue around the oral cavity such as muscle and salivary glands that support masticatory function is thought to be strongly affected by the hemodynamics in the head and neck. We hypothesized that the development of a method to evaluate that hemodynamics would contribute to the prevention of oral frailty.

## (Methods)

The subjects in this study were 14 males and females aged from the teens to 30s (mean age 21.4years) who had no tooth loss or malocclusion. The study was explained to the participants, and their informed consent was obtained. They were given the instructions, "Please eat as you normally would, without rushing. Do not drink until the measurements are over," and then asked to freely consume commercial crackers (3.15 g each; Photo 1) for 4 minutes. Using infrared thermography (Photo 2), thermal images (Photo 3) were taken starting immediately before chewing commenced. After the start of chewing, they were taken at 30-second intervals. We also investigated metrics that can be used in oral training to prevent the need for nursing care.



Photo 1. Crackers consumed



Photo 2. Infrared thermography

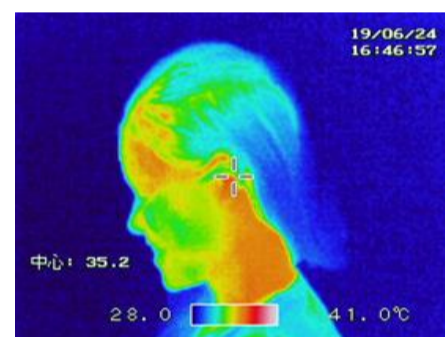


Photo 3. Thermal image before chewing

## (Results)

An example of the time course of measured thermal images (taken at 30-sec intervals) is shown in Photo 4.

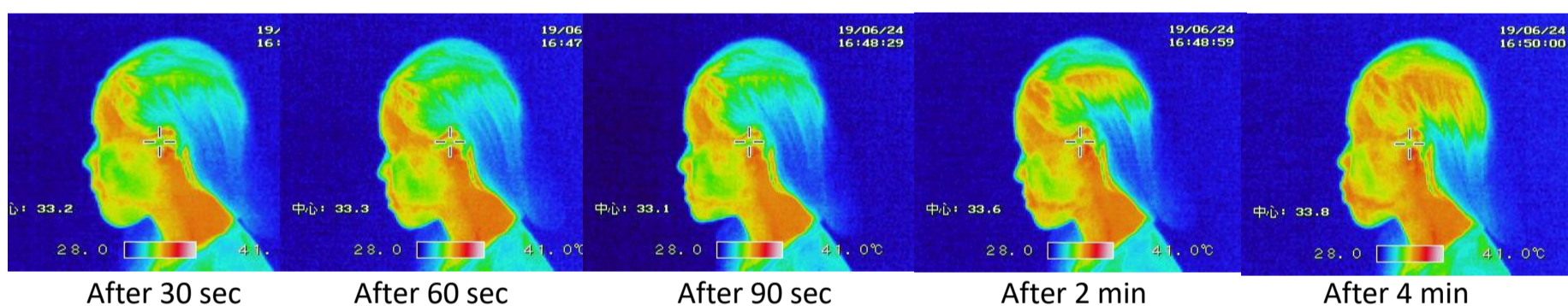


Photo 4. Thermal image measurements of temperature elevation in the head and neck region accompanying mastication (taken at 30-sec intervals)

The temperature rose first in the neck and then in the forehead, after which there was little change in those areas. In contrast, a trend was seen in all subjects in which the area with temperature  $\geq 34^{\circ}\text{C}$  expanded continuously in the temperature changes in the buccal region.

Next, the pixel number distribution in units of  $0.1^{\circ}\text{C}$  in the rectangular range below the Frankfort plane corresponding to the masseter muscles of the buccal region was compared in each stage. Comparisons of the pixel number distribution are shown in Figs. 1 and 2.

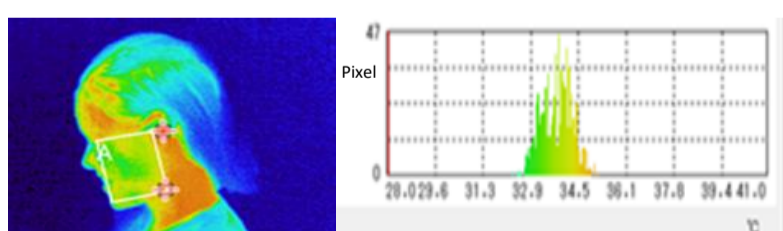


Fig. 1. Pixel distribution before the start of mastication

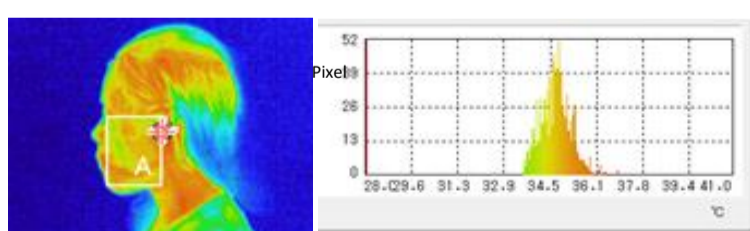


Fig. 2. Pixel distribution 4 min after the start of mastication

In this example, the highest point in the measurement grid before the start of mastication was  $34.45^{\circ}\text{C}$ , the lowest point was  $28.82^{\circ}\text{C}$ , and the mean temperature was  $33.24^{\circ}\text{C}$ . In the final measurement at 4 minutes after the start of mastication, the highest point was  $35.20^{\circ}\text{C}$ , the lowest point was  $32.08^{\circ}\text{C}$ , and the mean temperature was  $34.90^{\circ}\text{C}$ . A rise of  $1.66^{\circ}\text{C}$  was confirmed. The mean rise in temperature for all 14 people measured was  $1.26^{\circ}\text{C} \pm 0.75$ . Based on these results, the pixel percentage at the end of measurements above the mean value before the start of measurements was calculated as an index for understanding temperature change. The mean value was  $72.4\% \pm 18.8$ , suggesting the possibility that it can be used as an index.

## (Conclusion)

We practice effective utilization of this index, the effects of functional training, and other practices can be evaluated using a simple technique. Changes in thermal images are also easy for elderly people to understand, suggesting the possibility that this index can be used in the care prevention setting.

※ Ethics statement : The protocol was approved by the research ethics committee.

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