Evaluation of the Masticatory Muscles Temperature by Thermal Imaging During Mastication

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1. INTRODUCTION

The mastication is the first step in the digestion process and has as an objective prepare the food for the swallowing process and procession by the digestive system. (1-3) The masticatory sequence begins with the introduction of the food in the oral cavity, and ends with the swallowing of the bolus (2, 4, 5). Each masticatory sequence is a set of masticatory cycles, each cycle is composed by a opening, closing, and side movements (2, 4). The rhythm is the main characteristic of the mastication process (4). The masticatory rhythm is generated by the Central Pattern Generator, that active a motor program, and coordinate the mandibular, tongue and facial muscles movements. (1, 4).

There are a lot of methods that can be used for the study and analysis of the mastication function, one of those methods is the surface electromyography, that records the bioelectrical potentials of the masticatory muscles, trough electrodes placed in the skin surface(4-6). These bioelectrical potentials are related with the strength developed by the muscle during the mastication. So surface electromyography is a widely used method in studies that relate the muscle activity in the masticatory process (4-6).

Infrared termography has been used in medical applications to evaluate cutaneous blood flow adaptation during a specific function like in swimming were it was possible to observe significant variations in the cutaneous temperature according to swimming styles (7).

This work had as main goal, to study the application of infrared termography in the mastication process and to see a possible correlation beetween the values obtained with the electromigraphy.

2. MATERIALS AND METHODS

This study has involved 7 young individuals, with an average age of 22.4 years old (SP +/- 1.173) the maximum age was 25 years old, and the minimum 22 years age. As exclusion criteria: 3th molars mallpositioned, orthodontic treatment, orofacial lesions, malocclusion Class III, sintomatology and/or symptoms of temporomandibular disorders. To aid screening the presence of temporomandibular disorders, was used the Research Diagnostic Criteria for Temporomandibular Disorders (RDC), translated into Portuguese.

The selection of ten individuals started with a sample of 25, among which the differences were calculated from records of the masseter electromyography during chewing of a slice of carrot. Five subjects were chosen with differences of potential bioeléctricos less than 10 micro-volts between the right and left masseter. And two who had differences of more than 25 micro-volts between the muscle of the right and left side.

The bioelectrical potentials were recorded bilaterally in the anterior temporal and masseter muscles. The electromyographic equipment used was the BioEMG II of BioResearch® with BioPak software for Windows. The surface electrodes used were the BioFlex® from BioResearch (Ref : 800-251-2315). To place the electrodes the skin was cleaned with alcohol, and then the position for placement of the electrodes was determined by muscular palpation and the electrodes were arranged parallel to the longitudinal direction of the muscle fibers, with firm pressure (Fig 1). The ground wire was placed in the lateral-cervical triangle of the neck. For the EMG records, it was analysed the first four seconds of EMG for each food in each head position. The software used, allowed to calculate the average in micro-volts of those first four seconds for each muscle and this was the value used for the results.

Thermal images were performed using the thermographic camera Flir® A325, were further interpretation of the thermographic patterns were realized with a software analysis system – ThermaCAM Researcher Professional.

Fig. 1 - Surface electromyography of jaw muscles with eletroelectromyographic equipment BioEMG II of BioResearch ®.

To obtain the images of thermography, subjects were seated in a chair, placing the camera sideways to each participant. A thermal image was obtained at rest position in lateral, right and left view of the participants (Fig. 2). The subjects were instructed to chew three slices of carrot without having the indication of chewing to a specific side. After completing this task, another thermal image was obtained of lateral, right and left view of the participants (Fig 3).
Thermal images were performed using the thermographic camera Flir® A325, were further interpretation of the thermographic patterns were realized with a software analysis system – ThermaCAM Researcher Professional.

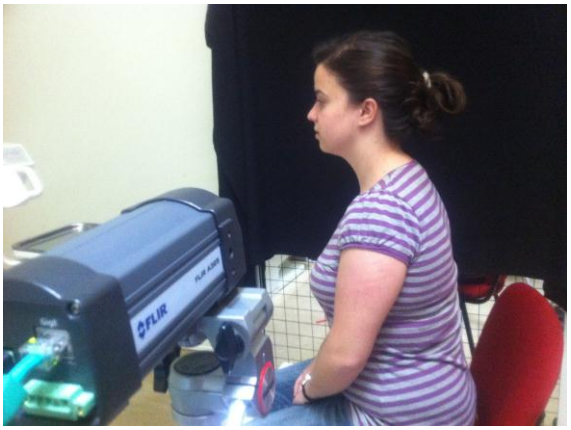

Fig. 2 - Subject at rest position before mastication were infrared thermography examination took place.

Fig. 3 - Camera Flir A325 capturing thermal images during mastication.

3. RESULTS

The different ranges of electromyography values that exist don´t have direct relation with the thermal images obtained. Regardless of the differences that exist in terms of electromyography in the masticatory muscles, namely the masseter and temporal right and left side, these differences do not appear in temperature recorded by the infrared thermography. The facial thermograms obtained at the end of mastication are very similar between participants even when there was differences in the bioelectric potential of the masseter and temporal. The subjects with higher electromyography values do not have higher infrared images.
Regarding the temperature difference between the right and left sides, what happens is that participants with the left side is the preferred side, do not exhibit, invariably, temperatures in left ATM, masseter and temporalis higher than the structures of the right side (tables 1, 2, 3).

Table 1 - Temperature registed before mastication.

Subject	Temperature before mastication °C					
	Left TMJ	Right TMJ	Left Temporal	Right Temporal	Left Masseter	Right Masseter
1	35.4	35.2	36	36	34.4	34.3
2	35	35.5	35.8	35.6	35.5	35.1
3	34.9	36.1	35.4	35.5	35.8	35.9
4	34.8	35.4	35.5	35.7	34.2	34.7
5	35	35.3	34.9	35.3	35.2	34.8
6	35.1	35.5	36	36.1	34.6	34.6
7	35.8	35.9	36.2	35.9	35.9	35.6

Table 2 - Temperature after mastication.

Subject	Temperature after mastication °C					
	Left ATM	Right ATM	Left Temporal	Right Temporal	Left Masseter	Right Masseter
1	35.3	35	36	35.9	34.4	34.2
2	34.9	35.5	35.7	35.5	35.4	35.2
3	35.3	35.6	35.1	35.6	35.7	35.7
4	34.8	35.2	35.5	35.6	34	34.4
5	34.9	35.2	34.9	35.4	35.3	34.9
6	35	35.1	36	36	34.9	35
7	35.6	35.8	35.9	35.8	35.6	35.5

Table 3 - Electromiographic values of each masticatory muscle

Subject	Electromiographyc values µV			
	Left Temporal	Right Temporal	Left Masseter	Right Masseter
1	42.6	28.1	32.3	41.5
2	37.9	30.5	57.3	47.3
3	61.5	49.5	54.7	44.9
4	44.4	39.4	36.8	35.1
5	26.6	25.4	38.8	43.3
6	55.2	33.4	59.2	30.0
7	32.5	36.2	59.3	33.4

4. DISCUSSION

A complete assessment of the orofacial region was obtained with the thermal images, allowing the visualization of determinant structures during mastication, like the TMJ and the jaw elevator muscles. The information obtained showed no asymmetric pattern, before and after mastication, this can be due to the fact that the time concuming during mastication was very short, lasting 1.5min. Like wise in most cases the temperature before mastication is higher than the temperature recorded after chewing. With the thermal images we can evaluate the cutaneuos temperatures of the aboved mentioned structures were the surface temperature is high at the rest position and then reaches lower values at the end of mastication, possiblt due to the fact that the blood supply is "shifted" from the surface to deeper structures that are active and therefore the skin surface notes a lower value of temperature.

5. CONCLUSION

Infrared thermography is a noninvasive, nonionizing diagnostic method that can complement the evaluation of orofacial structures involved in the process of mastication, that are related with the overloading of these anatomic zones. Further studies should me made with the time of 20 minutes of mastication representing an ideal meal; this should be done also testing different food consistency.

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