Int. J. Oral Maxillofac. Surg. 2015; 44: 127–131
http://dx.doi.org/10.1016/j.ijom.2014.09.021, available online at http://www.sciencedirect.com

International Journal of Oral & Maxillofacial Surgery

Clinical Paper
Clinical Pathology

Electrical activity of the orbicularis muscles before and after installation of ocular prostheses

M. C. Goiato, M. R. Santos, B. C. Z. Monteiro, A. Moreno, L. C. Bannwart, A. J. V. Filho, A. M. Guiotti, M. F. Haddad, A. A. Pesqueira, D. M. dos Santos
Oral Oncology Centre, School of Dentistry of Araçatuba, UNESP, Universidade Estadual Paulista, Araçatuba, São Paulo, Brazil

M. C. Goiato, M. R. Santos, B. C. Z. Monteiro, A. Moreno, L. C. Bannwart, A. J. V. Filho, A. M. Guiotti, M. F. Haddad, A. A. Pesqueira, D. M. dos Santos: Electrical activity of the orbicularis muscles before and after installation of ocular prostheses. Int. J. Oral Maxillofac. Surg. 2015; 44: 127–131.

Abstract. This study examined the electrical activity of the superior (SO) and inferior (IO) orbicularis oculi muscles before and after installing ocular prostheses in patients who had undergone unilateral enucleation. Twelve volunteers requiring prostheses were selected. Their electrical activity was monitored at rest and during normal opening and closing of the eyelids, rapid opening and closing of the eyelids, and squeezing. Data were recorded before and 7, 30, and 60 days after the ocular prosthesis was installed. Two-way analysis of variance was performed to verify whether there were any significant differences between the muscles and periods, and means were compared by Tukey–Kramer honestly significant difference (HSD) tests ($P < 0.05$). Results from the initial period differed significantly from those after prosthesis installation in all clinical situations. The SO had significantly higher electrical activity levels than the IO in all clinical situations but squeezing. The authors observed the same values during the initial period for the condition of rest (SO 8.42/IO 5.93) and the highest values for the condition of squeezing after 60 days (SO 131.50/IO 117.12). Rehabilitative treatment promoted an increase in the electrical activity of the orbicularis oculi muscles, restoring part of the muscle tone and motor function to muscles of the affected area.

Key words: eye enucleation; eye; artificial; electromyography.

Accepted for publication 19 September 2014
Available online 3 November 2014

Orbital defects are embarrassing to patients because they affect the face, which is essential to human relationships.[1–3] The absence of an ocular globe can lead to atrophy of the orbicularis muscles of the eye, thereby altering the muscle tone of the facial area.[4,5] The palpebral cutaneous musculature is of supreme importance to facial appearance and expression, and it protects the ocular cavities.[6–8] Three ocular–orbital–palpebral surgeries are related to ocular bulb removal: evisceration, comprising the partial removal of the ocular bulb with conservation of the sclera; enucleation, comprising the total removal of the bulb with only the capsule and oculomotor muscles remaining; and exenteration, comprising the removal of all contents of the orbital cavity and the circumjacent tissue.[9–14]

To rehabilitate patients with deformities of the ocular bulb, an ocular prosthesis may be used.[15–20] Prosthesis use improves the patient's aesthetic appearance, helping their psychosocial development and improving their quality of life.[1–3] The prosthesis does not restore the original function of vision, but it keeps the anophthalmic cavity filled, restoring lacrimal direction and preventing lacrimal fluid accumulation in the cavity.[15–20]

Few studies in the literature have examined the activity of the orbicularis oculi muscles after prosthesis installation,[21] and all of them have been based solely on clinical observations. Thus, the purpose of this study was to determine whether the muscle tone is influenced by prosthesis installation. Accordingly, the electrical activities of the superior and inferior orbicularis muscles (SO and IO, respectively) were evaluated before and after ocular prostheses were installed in patients with unilateral enucleation of the ocular bulb. The study hypothesis was that rehabilitative treatment with an ocular prosthesis would affect the electrical activity of the orbicularis muscles.

Patients and methods

Participant selection

The study included 12 volunteers (age range 50–65 years) with unilateral enucleation of the ocular globe (time since ocular globe loss 6–24 months) and an indication for a prosthesis, based on anamnesis and clinical examinations. Exclusion criteria were as follows: prior use of an ocular or expander prosthesis; extreme atresia of the anophthalmic cavity; and an inability to perform the tests due to insufficient cognitive ability. Volunteers received information about the treatment to be used and signed a consent form, in accordance with the recommendations of the institutional ethics committee for human research.

Electromyographic examination

Electromyographic (EMG) examinations were performed with the MyosystemBr1 electromyograph (DataHominis Tecnologia Ltda, Uberlândia, Minas Gerais, Brazil) (Fig. 1). EMG signals were conditioned using instrument amplifiers, which were programmable via software, and analogue band-pass filters with 10-Hz high-band and 1000-Hz low-band frequencies. Signals were digitized with a sampling frequency of 2 kHz, with 12 bits of resolution and simultaneous signal sampling. For data collection, the equipment gain was adjusted to 2000 times. To visualize and process the EMG signal, Myosystem I software version 2.12 was used.

Fig. 1. MyosystemBr1 electromyograph and bipolar surface electrodes.

Bipolar surface electrodes (DataHominis Tecnologia Ltda) were used for EMG recording. Electrodes were positioned on the SO and IO muscles of both eyes (the enucleated eye and the healthy eye) (Fig. 2)[20]. The EMG signal was captured in four clinical situations: rest, normal opening and closing of the eyelids (OCE), rapid opening and closing of the eyelids (ROC), and squeezing. Each situation was recorded for 10 s. EMG examinations were performed before and 7, 14, 30, and 60 days after the ocular prosthesis was installed and in use. The EMG record of the orbicularis muscle of the patient's healthy eye was used as the control.

Manufacture of the ocular prosthesis

An ocular prosthesis was made individually for each patient, according to the technique described by Goiato et al.[22]

Data analysis

Two-way repeated-measures analysis of variance (ANOVA) was performed to verify whether there were statistically significant differences between the muscles and periods (time points) for each clinical condition. The means were compared by Tukey–Kramer honestly significant difference (HSD) tests using SPSS version 19.0 statistical software (SPSS Inc., Chicago, IL, USA). All the results were analysed at a significance level of 0.05.

Fig. 2. Bipolar surface electrodes positioned on the superior (SO) and inferior (IO) orbicularis oculi muscles of the eye.

Results

Table 1 shows the electrical activity values for each clinical condition (rest, OCE, ROC, and squeezing), muscle (location analysed, SO and IO), and time point (initial, 7, 14, 30, 60 days and control).

ANOVA revealed a significant difference ($P < 0.0001$) in the electrical activity values for time point in all clinical conditions (Tables 2–5). There was significantly higher electrical activity according to the muscle in all clinical situations but squeezing (ANOVA, Table 5, muscle $P > 0.05$). In addition there was no significant difference in the interaction of all factors for the clinical conditions of rest, OCE, and squeezing ($P > 0.05$) (Tables 2, 3 and 5). However, there was a statistically significant difference in the interaction of all factors for the ROC condition (Table 4). The electrical activity levels of the ROC condition exhibited significantly higher values for the SO muscle than the IO muscle for each time period, excepting the baseline (Tables 1 and 4).

The electrical activity levels at different times were significantly different from the initial (baseline) value under all four clinical conditions evaluated, regardless of the muscle (Table 6).

Under the clinical conditions of rest, OCE, and ROC, the SO was significantly more active than the IO for all times (initial, 7, 14, 30, and 60 days and control) (Table 7). Under the clinical condition of squeezing, although the SO showed greater activity than the IO, the difference was not statistically significant (Table 7).