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ELECTROMYOGRAPHIC ASSESSMENT OF MASSETER MUSCLE AFTER MANDIBULAR THIRD MOLAR SURGICAL EXTRACTION.

Physiology

Dr. Parag Rastogi MD(Physiology); Assistant Professor: Venkateshwar Institute of Medical sciences, Gajraula

Dr. Sameer Srivastava* MD(Physiology); Assistant Professor: Venkateshwar Institute of Medical sciences, Gajraula *Corresponding Author

ABSTRACT

Purpose: This study aimed at evaluation of the masseter muscle electromyographies (EMGs) after mandibular third molar surgery and the relationships between clinical variables and EMG results.

Patients and methods: Sixty patients were included in the study. Masseter muscles parameters were measured using EMG prior to operation and 1 week and 3 weeks post-operation. Before and after the third molar surgery the clinical variables were also recorded.

Results: Significant differences in the areas of voltage, power spectral densities and median frequencies ($p=0.010$, 0.018 and 0.043, respectively) were found 1 week postoperatively when comparing the EMG results of the masseter muscle from the extraction site and non extraction side. Significant associations in clinical variables (postoperative swelling, bone reduction and pericoronitis) and the EMG results 7 days postoperatively, ($p<0.05$) were also noted. However, there were no significant differences 21 days postoperatively.

Conclusion: Barring the controversies about the reliability of EMG, this study showed that some EMG variables could be used to evaluate postoperative changes in masseter muscle activity as the postoperative changes in EMG activities were transient.

KEYWORDS

Masseter muscle, Third molar surgery . Electromyography.

Introduction

Surgical extraction of the lower third molar is a widely practiced technique in oral and maxillofacial surgery. Complications related to such third molar surgery have been well documented. Major complications can be defined as complications that require further treatment after extraction and that may result in irreversible consequences [1,2,3]. Complications related to third molar extraction have been well documented. Major complications following extraction are defined as those requiring treatment, which sometimes causes irreversible damage. Among these are abscesses, cases of uncontrollable bleeding, neurological damage, and mandibular fracture. Minor complications are defined as those that resolve spontaneously without treatment: pain, trismus, and inflammation. Minor complications are more frequent than major complications but the methods used to evaluate them are sometimes not very objective, particularly with regard to analyzing masticatory muscle function.

Following third molar extraction, many patients report restricted mouth opening, in other words, trismus. Many methods are used to assess patient discomfort and mouth opening capacity after surgery, such as visual analogue scales, quality of life questionnaires, and measurement of inter-incisal distance. But these techniques show little objectivity and do not determine muscle function[2]

There are many methods to evaluate postoperative patient discomfort including assessments of visual analogue scale scores, maximum mouth opening lengths and quality of life. However, these measures are not objective evaluations and cannot assess the severity and/or degree of discomfort[1]

Electromyography (EMG) is a technique for evaluating and recording the electrical activity that is produced by skeletal muscles. An EMG detects the electrical potential generated by muscle cells when those cells are electrically or neurologically activated. The signals can be measured from the skin surface as the sum of the electrical activities of the muscle fibre bundles and can be analysed to detect medical abnormalities, activation levels, recruitment orders and the biomec hanics of human or animal movement[1]

EMG has been used in clinical study for the evaluation of the clinical symptoms that are related to abnormal muscle activity. In dental studies, EMG has been used to evaluate masticatory capacity. However, there has been only one study that has evaluated the EMG activity of masticatory muscles after third molar surgery [1,2]. The sample number of this study was small, and clinical variables that may have influenced the postoperative complications were not evaluated.

The aims of this study were to evaluate changes in the EMG activity of the masseter muscle following mandibular third molar surgery.

MATERIALS AND METHODOLOGY

Sixty patients (29 males and 31 females, average age 30.87± 14.13 years) were included in this study. This study was done at Venkateshwar institute of medical sciences, Gajraula . The patients visited the hospital to undergo mandibular third molar surgery. At check-in, the dentist evaluated the degree of impaction based on panoramic radiograph.

The patient inclusion criteria were as follows:

(1) the patients possessed impacted mandibular third molars that required an incision and flap reflection for their removal
(2) the patients required bone removal for third molar extraction

The patient exclusion criteria were as follows:

(1) patients with muscle-related systemic diseases such as myasthenia gravis
(2) patients with temporomandibular joint disease
(3) patients who had undergone multiple tooth extractions
(4) patients with facial asymmetries

The EMG activities of both masseter muscles in each patient were measured before the tooth extraction operation and 1 and 3 weeks postoperatively. A base-plate wax was provided to each patient. The patients were asked to chew the wax on both sides. Dynamic EMG activity was recorded over 30 s of chewing the base-plate wax.

A wireless EMG recording system with disposable Ag/AgCl2 electrodes was used. EMG recordings were obtained from both sides simultaneously. The reference electrode was located on the patient's back, and the two test electrodes were attached to the patient's masseter muscles on both sides. The electrode signal was digitised at a sampling rate of 960 Hz and was transmitted to a computer wirelessly.

The acquired signals were processed to calculate seven relevant parameters. Each recording was 30 s in duration and consisted of more than 30 bites. After filtering, rectifying, smoothing (with a time constant of 30 ms), the envelope was detected. Based on this envelope, the biting epoch was set as the time interval in which the value was greater than 20 % of each peak. Four parameters in the time domain and three parameters in the frequency domain were recorded. The peak value, mean value, area and width of the voltage peak were calculated for each bite. Because the signal was recorded during mastication, semi-periodic bite movements were clearly specified. For the frequency-domain parameters, power spectral density (PSD) was first

estimated. From the PSD, the peak frequency, median frequency and the area of frequency were calculated.

The patients received instructions for postoperative care. Cold packs were applied for 24 h after extraction. A nonsteroidal anti-inflammatory drug was prescribed for 5 days, and prophylactic antibiotics were not prescribed. The patients were instructed to rinse with warm saline frequently. Postoperative swelling was assessed by measuring the distance between the corner of the mouth and the intertragic notch following the bulge of the cheek before and 7 days after the operation. Additionally, the patients provided subjective assessments of postoperative swelling (0, no swelling; 1, mild swelling; 2, severe swelling). The presence of postoperative swelling was defined by the subjective recognition of swelling and an increase in the measured distance. Postoperative pain was assessed on a visual analogue scale (VAS) that ranged from 0 (no pain) to 10 (extreme pain).

The recorded data were analysed using SPSS software (SPSS, Inc., Chicago, Illinois, USA). The differences between EMG values between the extraction and non-extraction sides were analysed with paired t tests. The grouping variables were postoperative swelling, smoking, degree of impaction, bone reduction, use of a gelatine sponge and the presence of pericoronitis. The grouping variables were selected based on the possibility that they could influence postoperative swelling and muscle activity. The use of a gelatine sponge and the presence of pericoronitis were related to postoperative swelling. The grouping variables were dichotomised. The differences between groups were evaluated with independent samples t tests. The significance level for all tests was $p<0.05$.

RESULTS

EMG activity differences between the extracted and non-extracted sides.

A summary of the clinical variables is shown in Table 1. Three weeks after surgery, there were no significant differences in the EMG activities of the extracted and non-extracted sides ($p>0.05$). The descriptive statistics of the EMG values 7 days after the third molar extraction surgery are shown in Table 2. There were significant differences between the extracted and non-extracted sides in area.

TABLE 1 Summary of patients

Variables		Frequency
Gender	Male	31(51.66%)
	Female	29(48.33%)
Post operative swelling 7th day	Yes	23(38.6%)
	No	37(61.4%)
Smoking	Yes	7(12.9%)
	No	53(87.1%)
Impaction	A	23(38.33)
	B	26(43.33%)
	C	11(18.33%)
Bone levels	Yes	28(46.66%)
	No	32(53.33%)
Gel Foam used	Yes	52(86.66%)
	No	8(13.33%)
Pericoronitis	Yes	19(31.66%)
	No	41(68.33%)

TABLE 2 : electromyography value of the masseter muscle at 7 days postoperatively

Variables	Extracted	Non Extracted	*P* value
Voltage domain (μV)	502.9±283.3	535.1±299.5	NS
Peak	87.6±45.5	93.2±46.5	NS
RMS	27.9±15.2	30.6±16.1	0.011
Area	342.8±54.0	353.1±58.9	NS
Width			
Frequency domain(Hz)	58.0±17.7	63.9±21.1	NS
Peak	82.4±14.3	89.6±13	0.017
Median	2.50±4.04	0.92±0.92	0.041
PSD			

DISCUSSION

Few reports have described changes in jaw muscle EMG activity after third molar extraction surgery [4]. This study demonstrated the relationships between clinical variables and masseter muscle EMG activities. Some of the EMG variables were significantly different between the extraction and non extraction sides 7 days after extraction ($p<0.05$). Comparisons of the clinical variables revealed that the presence of swelling, bone reduction and pericoronitis were significantly associated with some of the EMG variables 7 days after extraction ($p<0.05$).

There have been many reports on postoperative complications related to third molar surgery. The most common complications are trismus, swelling, infection and nerve damage [5,6]. Muscle-related complications, such as trismus and swelling, are subjective parameters that are difficult to quantitatively assess [7]. As EMG can measure the duration and shape of muscle action potentials [8] and the firing frequency of each motor unit [9], EMG may be used to assess masticatory muscle activity after third molar extraction. In this study, many EMG variables were significantly altered on the third molar extraction side. In our study, EMG activities after third molar extraction were analysed in the frequency domain (Table 2).

There were significant differences in some EMG variables 7 days after surgery. The areas of voltage and median frequencies between the extracted and non-extracted masseter muscles were significantly different ($p<0.05$). The area of voltage and median frequency were significantly reduced on the extracted side compared with the non-extracted side ($p=0.011$ and 0.017, respectively). The EMG activity of the masseter muscle on extracted side has been reported to decrease during agonist function in the presence of either ipsilateral or contralateral painful mastication [10]. Moreover, increases in the EMG activity of the muscle that is antagonistic to the painful muscle may be a functional adaptation of muscle coordination that limits movement [11]. Therefore, the greater values for the masseter muscle of the non-extracted compared with the extracted side might be due to a functional adaptation that occurs following third molar surgery. As the motor units that contribute to surface the EMG signal are superficial, decreases in EMG activity may be due to reductions in the activity of the superficial fibre [12]. However, the attached muscle that is adjacent to the third molar is located in a deep layer. Therefore, the direct effect of muscular damage after surgery may not be detected by surface-based EMG recording. Resting EMG activity is not affected by pain, but pain is reported to result in reduced EMG activity in the agonist muscle and increased EMG activity in the antagonist muscle during motion [13]. Thus, an uncomfortable feeling on the extracted side might result in reduced EMG activity.

EMG activity at 7 days after the third molar surgery was also compared according to differences in selected clinical variables. The patients with postoperative swelling had significantly lower RMS values than did the patients without postoperative swelling ($p=0.013$). The release of an inflammatory mediator causes pain and oedema, which limits jaw movement [14]. Additionally, acute inflammation during oral surgery may result in spasms of the jaw-closing muscles [15]. Moreover, pain intensity has been reported to be related to decreases in surface EMG amplitude when subjects perform constant force contractions [14].

Although subjective pain was measured using a VAS, it is difficult to standardise these results between individuals. However, the patients with postoperative swelling reported significantly higher VAS scores (4.59±2.53) than did the patients without postoperative swelling (2.70±1.47, $p=0.001$). Therefore, the decreased EMG activities of patients with postoperative swelling might have been due to postoperative pain. The presence of bone reduction in patients who underwent third molar extraction surgery also influenced postoperative EMG activity. The area of voltage was significantly lower 7 days after third molar surgery in patients with bone reduction compared with patients without bone reduction ($p=0.043$). The patients with bone reduction reported significantly higher VAS scores than did the other group 7 days after the operation ($p=0.045$). Therefore, the reason underlying the decreases in EMG activity in the patients who exhibited bone reduction might be similar to the reason underlying this phenomenon in the postoperative swelling group. The presence of pericoronitis also influenced postoperative EMG activity. The peak voltage was significantly lower 7 days after third molar extraction surgery among the patients with pericoronitis compared with the patients without pericoronitis ($p=0.036$). The patients with pericoronitis exhibited more swelling and pain than did the patients

without pericoronitis [16]. Reduced EMG activity in the masseter muscle during painful contraction has been well documented in several human studies [17,18]. However, VAS scores were not significantly different between these groups ($p>0.05$). Additionally, pericoronitis likely gradually subsided after the extraction. Because the physiological relevance of peak voltage has been controversial, this variable should be studied further. There is controversy concerning the reproducibility of surface recording EMG [19]. The reproducibility of EMG readings can be influenced by electrode location, the detection system used and subjective factors. Regarding masseter muscle EMG, the distance between the electrodes can influence the reproducibilities of EMG variables [20]. In this study, a fixed inter-electrode distance system was used to avoid this confound. Additionally, patients with mandibular asymmetry have been shown to exhibit strong asymmetries in the EMG activities in their masseter muscles during dynamic movement compared with healthy controls [21]. Thus, patients with mandibular asymmetries were excluded from this study. Patients who exhibited asymmetrical EMG activities prior to the third molar extraction surgery were also excluded. In conclusion, third molar extraction surgery altered some postoperative EMG variables in the masseter muscle of the extraction side when measured 7 days after the operation. Given that there were no significant differences 21 days after the operation, these alterations in postoperative EMG variables seemed to be transient. There were few methods that can quantitatively evaluate masticatory muscle activity. Although the reliability of EMG recordings has been controversial, this study showed that new EMG variables should be considered for the evaluation of postoperative changes in masticatory muscle activity. Although our patients exhibited only transient symptoms, our new evaluation methods were well correlated with clinical progress. Therefore, these methods can be used to evaluate decreases in masticatory capacity and discomfort during mastication after third molar extraction.

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