

Electromyographic Analysis of Masseter Muscle after Surgical Correction of Mandibular Prognathism

Majid Eshghpour, Seyed Amir Danesh Sani

ABSTRACT

Sagittal split ramus osteotomy (SSRO) is commonly used for treatment of mandibular prognathism. This study evaluated masseter muscle activity using electromyography device, in patients with mandibular prognathism before and after bilateral SSRO of the mandible.

Twelve prognathic patients (five males and seven females; mean age 20.6 years) were examined. Initial phase of orthodontic treatment was completed in all included patients. Electromyographic activity of masseter muscle was recorded during maximum voluntary clenching as follows: First evaluation: 7 days prior to surgery, second evaluation: 3 months after surgery and third evaluation: 6 months after surgery. Electromyography quantities were significantly decreased 3 months after surgery. Electromyographic activity of masseter muscle was recovered to the preoperative level 6 months after bilateral SSRO of the mandible. SSRO of the mandible is a safe technique for correction of mandibular prognathism and not seriously affects masticatory muscle electromyographic activity.

Keywords: Electromyography, Masseter muscle, Mandibular prognathism.

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INTRODUCTION

Over the past 20 years sagittal split ramus osteotomy (SSRO) has been recognized as the main surgical procedure for treatment of mandibular prognathism.^{1,2} In 1849, anterior subapical osteotomy was first introduced as a technique of mandibular osteotomy by Hüllihen.³ Obwegeser and Trauner,⁴ identified SSRO for surgical correction of mandibular deformities in 1955.

Orthognathic surgery can change not only esthetic and occlusion but also have some effects on morphology, physiology and biomechanics of craniofacial skeleton and mastication muscles.⁵

Till now, many studies have been demonstrated effects of orthognathic surgery on masticatory muscles activity.^{1,6-8} SSRO can result in significant changes in thickness and cross-sectional area of masticatory muscles after SSRO which affected the properties of facial morphology.⁹⁻¹³

Contributing factors to these morphologic changes are those related to surgical procedure or postoperative

complications.¹⁴ Therefore, evaluation of muscle activity determine the effects of SSRO on masticatory function. Electromyography is a noninvasive method that shows electrical potential of muscles recorded during activity in order to evaluate the amount of dysfunction, impairment and disharmony.¹⁵ Electromyography (EMG) recordings also help practitioners in application of physical therapy to improve muscle activity.^{16,17}

The goal of the current study was to analyze the effect of SSRO on masseter muscle activity by means of EMG in patients with mandibular prognathism.

MATERIALS AND METHODS

Twelve patients (five males and seven females; mean age 20.6 years), all with mandibular prognathism and a dental angle class III needed mandibular retraction surgery were admitted to the Department of Oral and Maxillofacial Surgery.

The Ethics Committee of the Dental School approved the study protocol. Initial phase of orthodontic treatment was completed in all included patients. Exclusion criteria were defined as history of trauma, neuromuscular disease, administration of drugs affecting neuromuscular system, orthognathic surgery, postoperative infection and malocclusion.

Lateral cephalography was obtained for the patients, while in the resting position, 1 week before surgery and 3 months after the surgery to find out mandibular changes. Cephalometric assessment was done by same investigators. An acceptable occlusion was obtained in all included patients after surgery.

The EMG activity of masseter muscle was recorded with an electromyographic device (Miotec, Porto Alegre, Brazil) by a neurologist. The skin was disinfected with an alcohol pad to decrease impedance between electrode and body surface. Angle of the mouth and inferior surface of the ear tragus are the main reference points for correct positioning of the electrodes. The distance between electrodes was 3 cm.

The total examination time was subdivided to activity phase and voluntary relaxation period. Patients are in the rest position when sit on the chair with feet flat on the ground. Maximum voluntary clenching of masseter muscle was obtained by biting a piece of cotton roll.

A series of altering phases occurs during EMG recordings: relaxation: 20 seconds > contraction: 10 seconds > relaxation: 20 seconds > contraction: 10 seconds.

Electromyographic (EMG) activity of masseter muscle was recorded during maximum voluntary clenching as follows: First evaluation: 7 days prior to surgery, second evaluation: 3 months after surgery, and third evaluation: 6 months after surgery.

EMG analysis was performed by routine methods of electromyography amplitude processing include root mean square (RMS), average rectified value (ARV) and integrated EMG (IEMG) activity value.¹⁸ These values illustrate the degree of the physiological activities in the masseter muscle during maximum voluntary clenching. All data were collected and analysis was performed applying SPSS version 15 (SPSS Inc., Chicago, IL, USA).

RESULTS

In all evaluation sessions, RMS and ARV values were significantly decreased during contraction period showing that muscle gradually becomes fatigued during the isometric contraction (Figs 1 and 2).

Regarding RMS values, Wilcoxon test revealed that there was a statistically significant difference between first and second sessions ($p = 0/01$). Second and third evaluation sessions showed significant difference in RMS values ($p = 0/01$). No significant difference was observed in RMS values of first and third sessions ($p = 0/77$) (Fig. 1).

The same results were observed regarding ARV and IEMG values in different evaluation sessions (Fig. 2).

EMG analysis of masseter muscle revealed that RMS, ARV and IEMG values were significantly decreased 3 months after surgery; but these values showed no significant difference to the preoperative values 6 months after surgery.

DISCUSSION

Orthognathic surgery is the main therapeutic modality for treatment of dentoskeletal deformities which can affect masticatory muscle activity.¹⁹ The current study revealed that the degree of physiological activity in the masseter muscle was significantly reduced after surgery but reached the same magnitude after 6 months. Song et al²⁰ evaluated masseter muscle changes after two different surgical procedures. They observed significant changes in experimental muscle mass only in rabbits undergoing osteotomy procedure.

Raustia and Oikarinen²¹ revealed that activity of masseter muscle was significantly reduced 6 weeks after surgery but increased more clearly 1 year after surgery. Increased activity of masseter muscle 1 year after surgery was probably due to maxillomandibular fixation in these patients. Kim et al²² found that the recovery of bite force was significantly affected by surgical method and duration of maxillomandibular fixation. In order to increase bite force after orthognathic surgery, long periods of maxillomandibular fixation should be avoided.

It seems that the activity of masticatory muscles after surgery will be decreased by stabilizing the bones of the jaw. However, masticatory muscle activity improves after the period of the jaw fixation.²³ In the present work, none of our patients was managed with maxillomandibular fixation which improved masseter muscle activity in 6 months after surgery.

According to Throckmorton et al²⁴ study, postoperative decrease in maximum voluntary bite force disappears after 6 months. However, the patients had significantly lower maximum bite forces than the controls for as long as 2 years after surgery. They revealed that neither vertical ramus osteotomy nor SSRO method affect the improvement of maximum bite force after orthognathic surgery.

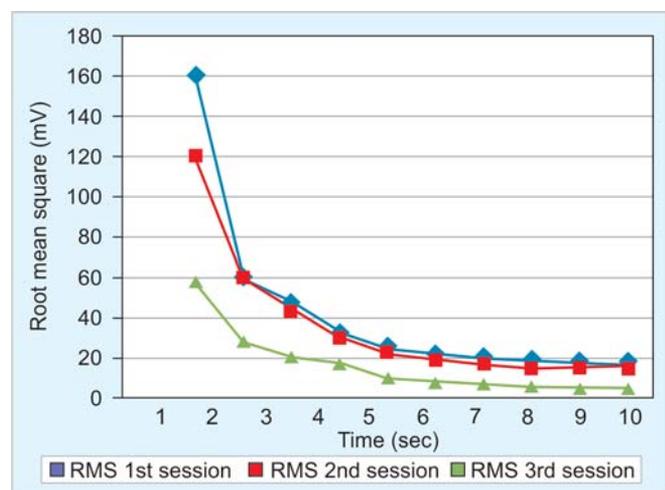


Fig. 1: RMS values of masseter muscle during contraction in different evaluation sessions

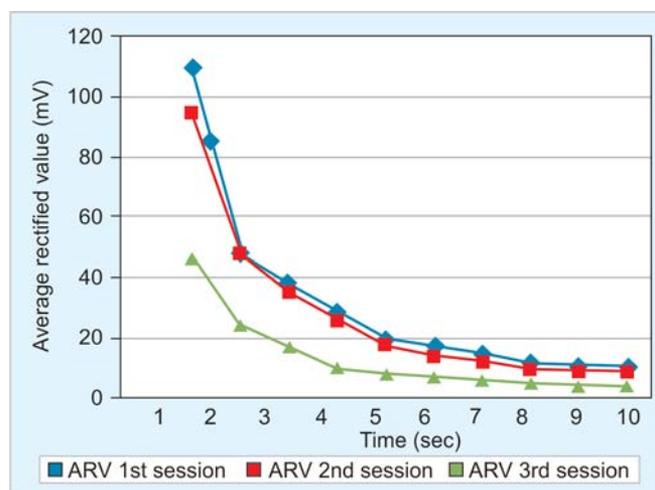


Fig. 2: ARV values of masseter muscle during contraction in different evaluation sessions

Kobayashi et al²⁵ investigated the effect of orthognathic surgery at masticatory function.¹⁷

Vertical ramus osteotomy and SSRO were the surgical methods applied for correction of mandibular prognathism. According to their study, postoperative EMG of masseter and temporalis muscle increased but EMG quantities were significantly lower in these patients than control subjects with normal occlusion.

In an EMG and radiographic follow-up study, Edlund et al²⁶ demonstrated that the postoperative activity of temporal muscle decreased; however, masticatory efficiency was unchanged. It is noteworthy that they mainly investigated the temporomandibular joint function after SSRO.

Boyd et al²⁷ demonstrated that the masseter muscle histological features and physical activity were changed in response to different surgical methods. They assessed changes in muscle volume by use of magnetic resonance imaging. Westerson et al²⁸ observed atrophic changes with reduced muscle size and fatty replacement of muscle tissue after vertical ramus osteotomy of the mandible. However, Throckmorton et al²⁴ observed no significant difference in the amount of physical activity of masseter muscle in patients treated with SSRO and VRO techniques. Therefore, masseter muscle adoptive response to SSRO and VRO might be similar; however, further investigations are required.

CONCLUSION

EMG activity of masseter muscle was recovered to the preoperative level 6 months after bilateral SSRO of the mandible. SSRO of the mandible is a safe technique for correction of mandibular prognathism and does not seriously affect masticatory muscle EMG activity.

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ABOUT THE AUTHORS

Majid Eshghpour

Assistant Professor, Department of Oral and Maxillofacial Surgery
Mashhad Dental School, Mashhad, Iran

Seyed Amir Danesh Sani (Corresponding Author)

Dental Researcher, Department of Dental Research Center, Mashhad
Dental School, Mashhad, Iran, e-mail: amirds_dds@yahoo.com