Original Article

EFFECT OF SAGITTAL SPLIT OSTEOTOMY WITH MEDPOR® POROUS POLYETHYLENE IMPLANT ON MASTICATORY REFLEX

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ABSTRACT

The purpose of this report was to provide data regarding whether the use of alloplastic implants to the mandibular body and angle as an occasional adjunct to orthognathic surgery affects the jaw reflex. Two patients to whom sagittal split osteotomy with Medpor porous polyethylene implant was performed due to severe mandibular asymmetry were included. To elucidate alterations in reflexes, serial surface electromyographic data were collected from the masseter muscle. The latencies and durations of the silent period were measured. In both patients, massetery inhibitory reflex response on the Medpor-augmented side was not elicited at the postoperative first month. Although postoperative masticatory inhibitory reflex latencies, durations, and configurations were similar between the right and left sides in both patients, we did not elicit the first silent period response following porous polyethylene implant placement at the postoperative sixth month. In conclusion, porous polyethylene implants may decrease masticatory reflex activity. The clinical use of implants made of porous polyethylene seems to be safe; however, indications, chances, and risks should be carefully evaluated prior to application.

Key words: Sagittal split osteotomy, Medpor, Porous polyehylene, Masseter inhibitory reflex.

Introduction

Many patients with facial asymmetry have unilateral hypoplasia of the mandible which is crucially important for the attractive appearance. Changes in the center of the chin, leveling of lip commissures, gonial angles, and mandibular body contours may cause facial asymmetry. Therefore, various techniques have been introduced to improve mild or moderate mandibular deficiency [1]. For the skeletal asymmetry of the mandible, distraction osteogenesis, conventional osteotomies, costochondral grafts, and alloplastic implants have been used. Among the artificial graft materials, porous polyethyle (PPE) has been widely used and suggested as the best available facial bone substitute because of their biocompatibility, stability, ease of handling, and reduced operation time [2].

The Medpor® implant is a commercially available nonabsorbable porous polyethylene implant used to reconstruct many surgical defects. Two studies have been published supporting the safety and efficacy of the Medpor® implant. The primary advantage of porous materials is that they allow for tissue ingrowth into the pores with collagen deposition [3]. Even though augmentation with PPE is widely accepted as a useful adjunctive method for orthognathic surgery, evaluation of the outcomes has usually focused on postoperative morbidity, and histologic integration or has presented the esthetic or treatment outcomes [4-7].

To our knowledge, no research confirms the functional integration of sub-periosteal PPE augmentation to the overlying soft tissue and demonstrates the suitability of the mandibular body and angle augmentation with PPE in order to improve mild or moderate mandibular deficiency.

The purpose of this report was to provide data regarding whether the use of alloplastic implants to the mandibular body and angle as an occasional adjunct to orthognathic surgery affects the jaw reflex. To elucidate alterations in reflexes, serial surface electromyographic (EMG) data were collected from the masseter muscle.

Materials and Methods

Subjects

Two patients to whom sagittal split osteotomy with Medpor porous polyethylene implant was performed due to severe mandibular asymmetry at our clinic between 2015 and 2019 were included in our study **(Table 1)**. The augmentation amount required for the patients was planned via the computed tomographic analysis and informed consent of the patients was taken. This study was approved by the institutional review board. All subjects signed informed consent to participate voluntarily.

Both patients received computed tomography scans and the data of digital imaging and communication in medicine (DICOM) format was processed with Mimics software version 12.0. The craniofacial skeleton was visualized with a slice reconstruction interval of 0.5 mm in a 3D display for evaluation of the mandible. The mandibular contour was reconstructed by mirroring the normal contralateral mandible. Medpor implants' visualized and the accurate implanted location was designed to reconstruct a symmetric mandibular contour.

Surgical technique

Surgical procedures were performed under general anesthesia using nasotracheal intubation. The outer cortex of the ramus, the mandibular body region, and the inferior margin of the mandible were fully exposed through an intraoral incision. SSRO was first performed to correct the malocclusion. Prefabricated Medpor implants were first trimmed according to the surgical template. Then we soaked the implants in 90°C normal saline and bent them to fit the outer cortex of the ramus and the mandibular body. After cooling, internal fixation was achieved using titanium screws. Normal anti-infection and support therapy was adopted postoperatively. The surgery produced an enhanced level of satisfaction by improving symmetry on quantitative measurements **(Figure 1)**.

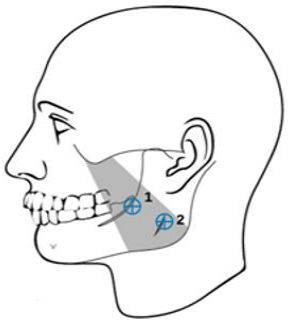
Masseter inhibitory reflex

Each subject was instructed to clench their teeth at maximum strength. Electrical stimuli were delivered to the mental nerve and EMG signals were recorded through surface electrodes from the bilateral masseter muscles **(Figure 2a)**. The threshold intensity was determined at which stimulus reliably evoked the supraorbital blink reflex (SBR) response. The mental nerve was stimulated transcutaneously over the mental foramen with two different intensities: 5*SBR threshold and 8*SBR threshold. Each subject repeated 5 trials per side with 10 s rest intervals. Electrophysiological tests were studied at T1, just before surgery, and postoperative 1st (T2) and 6th (T3) months. The recordings were averaged, and the averaged signals provided the background EMG activity. The latencies and durations of silent periods (SP1 and SP2) were measured **(Figure 2b)**.

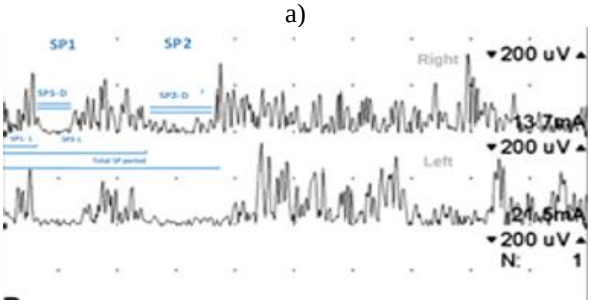
a)

b)

Figure 1. a) Patient I, b) Patient II. Preoperative photographs demonstrating a poorly defined left gonial angle on Patient I and right gonial angle on Patient II. Postoperative photographs after the BSSO + mandibular implant resulting in bold symmetrical gonial contour.



a)



b)

Figure 2. Masseter inhibitory reflex recordings and evaluations. a) EMG recordings were performed through surface electrodes; 1:active electrode over the lower third of muscle belly; 2: reference electrode about 2 cm above the angle of the mandible. b) After recording five reflex, one side and excitation intensity in the masseter inhibitor recordings, these records were averaged according to rectification. Sensitivity of the display is 200 μV / division. In the EMG registers, the first occurrence of the suppression periods is silent period SP1; the latter is defined as SP2. The period in which the EMG activity occurring in both periods decreased by 80% was marked as the starting latency (SP1-L, SP2-L) of the silent period. In the period when EMG amplitude was suppressed in both periods, the condition with which the condition was increased by 80% was accepted as SP duration (SP1-D, SP2-D). SP1 and SP2 latencies and durations, measured in ms.

Results and Discussion

Regarding Patient I, although SPs were elicitable bilaterally with similar latency and duration, SP1 and SP2 merged in a single long-lasting SP were seen on left-side stimulation with x8 threshold preoperatively. At postoperative 1st month, MIR was inelicitable with x5 threshold on the augmented left side, whereas it elicited normal configuration including SP1 and SP2 with x8 threshold. On the right side, SP1 could not be elicited, duration of the SP2 was shortened from T1 to T2. At postoperative 6th month, on the left side, SP1 was absent with x5 threshold stimulus, but SP2 was elicited. The duration of the late and total silent periods was longer with the x8 threshold when compared to those at T2. On the right side, SP1 is still not available and the duration of SP2 was shorter **(Table 1)**.

Table 1. Patient Details

Patient No	Age, year / Sex	Cause	Type of surgery
I	32/M	Development	Left sided augmentation with BSSO
II	26/M	Development	Right sided augmentation with BSSO

In Patient II, during preoperative measurements, SP1 and SP2 were shorter in duration with x5 threshold bilaterally, and x8 threshold on the right side. At postoperative 1st month, SP1 was inelicitable on both sides. SP2 could not be elicited with x5 threshold stimulus on the augmented right side. On the 6th month examination, SP1 was still inelicitable with the x5 threshold on the right side, but it was obtained normally with the x8 threshold. The duration of the SP2 and total inhibitory period elicited on the right side were shorter than those on the left side **(Table 2)**.

Table 2. Findings of the masseter inhibitory reflex

Patient		**1**			**2**		
		T1	T2	T3	T1	T2	T3
Left	SP1 x5 latency	13,8	-	-	8,2	-	13,6
	SP1 x5 duration	14	-	-	7,2	-	11,2
	SP2 x5 latency	45,2	-	50,4	54,2	46,2	65,4
	SP2 x5 duration	46,4	-	50,1	30,4	20,8	42,2
	SP total duration	**60,4**	**-**	**50,1**	**37,4**	**20,8**	**53,4**
	SP1 x8 latency	14,2	12,8	17	14,6	-	18,8
	SP1 x8 duration	-	13,2	10,8	8,8	-	12,8
	SP2 x8 latency	-	48	52,8	49,8	55,6	67,6
	SP2 x8 duration	-	50	58,2	55,8	54,2	64,2
	SP total duration	**85,6**	**63,2**	**69**	**64,6**	**54,2**	**77**
Right	SP1 x5 latency	14,2	-	-	12,8	-	-
	SP1 x5 duration	15,4	-	-	8,4	-	-
	SP2 x5 latency	43	48,2	51	55,4	-	64,2
	SP2 x5 duration	46,4	14,4	38,4	31,2	-	40,6
	SP total duration	**61,8**	**14,4**	**38,4**	**39,6**	**-**	**40,6**
	SP1 x8 latency	14	-	-	14,2	-	11,8
	SP1 x8 duration	16,2	-	-	6,2	-	12,6
	SP2 x8 latency	44,2	45,8	54,4	54,4	51,6	63,6
	SP2 x8 duration	44,4	31,2	25,8	32,4	48,4	38,8
	SP total duration	**60,6**	**31,2**	**25,8**	**38,6**	**48,4**	**61,4**

T1, preoperative; T2, postoperative 1st month; T3, postoperative 6th months (T3), MIR, masseter inhibitory reflex, SP1, early silent period; SP2, late silent period; x5, 5 times threshold; x8, 8 times threshold; (-) response was inelicited

The relation between surgical correction of the mandible and altered MIR pattern has been described previously, and the results indicated that the most common MIR abnormalities during the early postoperative period were either complete or partial loss of the silent period [8]. In the current report, we found that placing PPE implants as an

adjunct treatment for asymmetry of the mandible led to the loss of SP1 response on the augmented side in the late postoperative period.

The main purpose of this study was to investigate any possible effects of PPE implants on MIR. This reflex response prevents the jaws from hitting each other and damaging the teeth and supporting structures [9] Liu *et al*. [10] conducting an EMG examination of jaw muscles in patients with temporomandibular dysfunction, observed that muscle and joint pain were positively associated with the duration of the silent period of the masseter muscle. In our report, in the first patient, the right inhibitory reflex response was elicited at baseline, while early and late reflex periods were not differentiated on the augmented site. In the second patient, the baseline masseter inhibitory reflex parameters were within the normal range, but the durations were shorter than the right side. These conditions may indicate that asymmetry can influence reflex responses.

Stimulation of the trigeminal nerve fibers elicits suppression of the voluntary contraction in the human masseter and temporalis muscles and this reflex has been called silent period or exteroceptive suppression [11]. The present findings showed that in both patients, MIR response on the Medpor-augmented side was not elicited with the x5 threshold at the postoperative first month. After six months, SP1 was inelicitable with x5 threshold stimulus on the augmented sides in both patients, other parameters showed subsequent improvement. Although the silent period in human jaw-closing muscles has been extensively studied, the physiological modulation of this reflex is still not fully understood. The underlining mechanism was speculated to be hyperactivity of the central nervous system and abnormal cortical or reticular activity that would enhance the excitability of the trigeminal motor neurons through the modulation of the multisynaptic reflexes [12, 13].

Early inhibition may take part during normal chewing movements, whereas late inhibition may have a protective role to avoid biting oral mucosa or perioral tissues [14]. In the present study, although postoperative MIR latencies, durations, and configurations were similar between the right and left sides in both patients, we did not elicit SP1 response following PPE implant placement at the postoperative sixth month. Based on this information, one may not be expected to have the same chewing pattern after augmentation with PPE. However, although the pattern of masticatory reflex was different, we were still able to elicit MIR response in both patients in the late postoperative period. This may be due to the fact that the amplitudes of EMG signals depend on the propagation of the muscle potentials to the electrode (amount of fat and connective tissue and the skin impedance) [15]. Moreover, periodontal mechanoreceptors, intraoral mucosal receptors, and muscle spindle receptors all contribute to MIR response [16]. The early phase of MIR is an oligosynaptic reflex, whereas the late phase of MIR is polysynaptic, that is, even a very little signal transmission allows this reflex to show up. In both patients, muscle injury, PPE implant placement, and direct damage to the inferior alveolar nerve may contribute to the delayed formation of the oligosynaptic early reflex. There is also supranuclear control of this reflex in the brainstem that can cause the shortening of SP2 and prolong its latency [9, 17].

Santos *et al*. showed that PPE implants allow bone repair by incorporation of the material with ingrowing tissues 145 days after surgery [18]. Also, the rate of complication following augmentation with PPE implants was reported as 36.9% and the main cause of the failure was incidence of prominence requiring re-operation and/or removal [19]. The low complication rate and demonstrated tissue ingrowth in experimental studies propose the PPE implants as highly accepted treatment alternative for craniofacial reconstructions [20]. However, as far as we know, there is no study reporting how the use of PPE in the mandible affects the chewing function. Our results show that the use of PPE implants prevents the return of muscle electrical activity, structural damage occurs in the muscle due to surgery, and PPE placement causes less recovery of this reflex. It may be advisable for clinicians to include the possibility of functional damage on chewing in consent forms. These materials do provide satisfactory results for both patients and surgeons, but benefits should be considered individually for each patient. Besides, it is important to evaluate how bone surrounding structures recover histologically following augmentation with PPE and thus, further research which investigate that effect should be considered.

Conclusion

To conclude, porous polyethylene implants may decrease masticatory reflex activity. Although clinical use of implants made of porous polyethylene seems to be safe, indication, chances and risks should be carefully evaluated prior to application.

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Conflict of interest: None

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Ethics statement: The study conforms to the provisions of the Declaration of Helsinki (as revised in Tokyo 2004) and had been approved by the Institutional Review Board for Human Studies of the Dentistry Faculty of the Istanbul University, Turkey (Study 2015/69).

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