Changes in temporomandibular joint sounds after botulinum toxin injection into masticatory muscles

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Changes in temporomandibular joint sounds after botulinum toxin injection into masticatory muscles

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of A-young Chung is approved.

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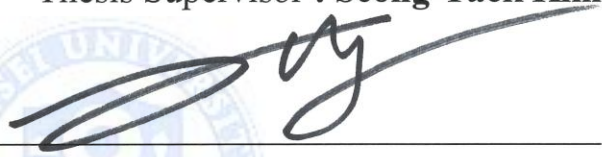

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감사의 글

한 편의 논문이 완성되는 데까지 얼마나 많은 고민이 필요하고, 얼마나 많은 분들의 도움이 절실한지를 깨닫는 시간이었습니다.

무엇보다 부족한 저를 위해 먼저 이것 저것 챙겨주시고 이끌어주신 김성택 지도 교수님께 깊은 감사를 드립니다. 지도 학생으로서 마땅히 해야 할 도리를 다 하지 못한 것 같아 죄송한 마음이 큽니다. 교수님의 관심과 격려 덕에 무사히 마칠 수 있었습니다. 또한 심사 과정에서 아낌없는 조언으로 논문에 생명을 불어 넣어주신 안형준 교수님과 권정승 교수님께도 진심으로 감사 드립니다. 논문뿐만 아니라 의국 생활을 하는데 있어서도 교수님들의 지도와 애정이 항상 큰 힘이 되었습니다. 그리고 구강내과에서 소중한 경험과 추억을 만들 수 있게 해주신 최종훈 교수님, 최영찬 선생님과 3 년의 의국 생활하는 동안뿐 아니라 현재까지도 마음의 안식이 되어주는 선배님, 후배님들, 구강내과 직원 분들께도 고마운 마음이를 데 없습니다. 지금 군대에 있을 동기에게도 힘 내라고 전하고 싶네요.

그 동안 키워주시느라 늘 애쓰신 부모님, 말씀은 못 드렸지만 항상 감사드리고 사랑해요. 이제는 저도 부모님을 이해할 수 있는 나이가 되었어요. 앞으로 잘 할게요. 누구보다도 의지할 수 있는 친구가 된 동생에게도 항상 사랑한다는 얘기 전하고 싶습니다.

지금까지 제 옆에 있어주신 모든 분들께 사랑과 감사의 마음을 보내며 이 글을 마칩니다.

2015 년 6 월

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Changes in temporomandibular joint sounds after botulinum toxin injection into masticatory muscles

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Temporomandibular joint (TMJ) sounds such as clicking/popping or crepitus that are not associated with any pain and do not affect the movement of joint do not need to be treated. And conservative treatments are not successful in reducing the sounds generally. However, some patients find such joint sounds themselves to be very distressing.

This study looked at patients who received botulinum toxin (BoNT) injection into their masseter and/or temporalis muscles for treatment of myofascial pain, bruxism, clenching, or chronic migraine. To identify the related factors underlying changes in production of TMJ sounds, patients who ceased producing TMJ sounds were compared to those who continued producing TMJ sounds following BoNT injection.

This study found that only the degree of cheek ridging differed significantly between the groups. This suggests that weakening the intensity of masticatory muscle contraction by BoNT injection could be responsible for reducing TMJ sounds by decreasing the joint loading or microtrauma. BoNT injection into the masseter and/or temporalis muscles may reduce distressing TMJ sounds and serve as an alternative treatment for patients who have moderate to severe cheek ridging. However, since this study was subject to several limitations, the results need to be confirmed in future well-controlled prospective studies.

Keywords: botulinum toxin A, cheek ridging, masticatory muscle, temporomandibular joint sound

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I. INTRODUCTION

Temporomandibular disorders (TMDs) are common musculoskeletal conditions that cause pain and disability in the orofacial region and can be classified into temporomandibular joint (TMJ) disorders and muscle disorders (Schiffman et al., 2014). TMJ dysfunction usually presents as a disruption of the normal disc-condyle movement, producing joint sounds such as clicking, popping, and crepitus (Okeson, 2013, 137). According to the Diagnostic Criteria for Temporomandibular Disorders (DC/TMD, 2014), clicking or popping sounds may occur with disc displacement with reduction (DDwR), and crepitus can be detected in degenerative joint disease (Schiffman et al., 2014). DDwR can result in decreased joint space that subsequently results in enhanced degrees of arthritis and condylar resorption (Kurtoglu et al., 2008).

A joint sound that is not associated with any pain and does not affect the movement of joint does not need to be treated (Okeson, 2013, 323). However, some patients find such joint sounds themselves to be very distressing.

TMJ sounds do not generally disappear with conservative treatments including therapeutic exercises and splint treatment (Vichaichalermvong et al., 1993). Only a few randomized controlled trials (RCTs) have investigated the treatment effects of DDwR (Naeije et al., 2012). The RCT study by Yoda et al. (2003) found that, a therapeutic mouth-opening and mouth-closing exercises for maintaining the disc repositioning mandibular position on the painless reciprocal clicking of DDwR diagnosed by magnetic resonance imaging (MRI) significantly reduced the clicking sound compared with a no-treatment group. However, a recaptured disc was only seen on MRI in a minority of the cases with clicking reduction, and no convincing explanation of the exact mechanism underlying this reduction was provided (Yoda et al., 2003). In two RCT studies, Lundh compared the short-term effects of an anterior repositioning splint (Lundh et al., 1985) and disc-repositioning onlays (Lundh et al., 1988) with the effects of a flat occlusal splint and a no-treatment group. The results showed that anterior repositioning splints or onlays could reduce or even eliminate reciprocal clicking for as long as they were used (which was for 6 weeks and 6 months, respectively, in that study). However, reciprocal clicking recurred within 6 weeks after removing the anterior repositioning splints or onlays. Also, flat occlusal splints did not eliminate the reciprocal clicking. In a double-blind, controlled RCT, Conti et al. (2006) compared the efficacies of three treatments for patients who experience painful joint clicking interventions: (1) a modified (bilaterally balanced) stabilization splint, (2) a conventional stabilization splint with canine guidance, and (3)a nonoccluding splint. The entire sample showed a reduction in the frequency of joint clicking while wearing oral splints, with no significant differences among the groups. However, changes in clicking after removing the oral splints were not evaluated. The effects of intra-articular

(upper joint space) injection of sodium hyaluronate were compared with the effects of physiologic saline in two RCT studies (Bertolami et al., 1993; Hepguler et al., 2002). Bertolami et al. (1993) reported significant improvements in the perceived noise level [visual analog scale (VAS)] and the frequency of noise occurrence for the hyaluronate group compared with the placebo group. Moreover, Hepguler et al. (2002) detected improvement in the sound intensity (as measured using VAS) induced by two intra-articular injections of hyaluronate. However, the objective effects of injecting sodium hyaluronate on DDwR are difficult to interpret.

A few studies have suggested that botulinum toxin (BoNT) treatment can be effective against TMJ sounds (Bakke et al., 2005; Emara et al., 2013), DDwR, and TMJ dislocation (Bouso et al., 2010; Fu et al., 2010; Martínez-Pé rez and García Ruiz-Espiga, 2004; Mendes and Upton, 2009). Most of these studies have injected BoNT into the lateral pterygoid muscles, which appear to be responsible for TMJ clicking (Emara et al., 2013), or DDwR (Wongwatana et al., 1994). Bakke et al. (2005) assumed that BoNT injection provides transient chemodenervation and reduces the function of the lateral pterygoid muscle by blocking the gamma motor neurons supplying the muscle spindles in the lateral pterygoid. Those studies showed slight improvements in the disc-condyle relationship and reduction of the clicking sound. However, the precise underlying mechanisms were unclear. Also, none of the studies included controls, and all had small samples and short follow-up periods.

In contrast, BoNT injection into the masticatory closing muscles (masseter and/or temporalis muscles) has been more generally proposed as an effective treatment option for TMD, bruxism, and masseter hypertrophy (Kurtoglu et al., 2008), as well as for other approved indications including chronic migraine. However, there have been no reports of changes in TMJ sounds in those conditions. BoNT injection into the masticatory closing muscles can be expected

to reduce the intra-articular pressure and resistance during mouth opening (or reducing the displaced disc), and thereby affect the joint sounds.

This study looked at patients who received BoNT injection into their masseter and/or temporalis muscles for treatment of myofascial pain, bruxism, clenching, or chronic migraine. To identify the related factors underlying changes in production of TMJ sounds, patients who ceased producing TMJ sounds were compared to those who continued producing TMJ sounds following BoNT injection.

II. SUBJECTS AND METHOD

This study performed a retrospective chart review of patients with myofascial pain, parafunctional habits such as bruxism or clenching, or chronic migraine who had been injected with BoNT (Botox, Allergan, Irvine, United States of America (USA)) between June 2013 and October 2014 at the Department of Orofacial Pain and Oral Medicine, College of Dentistry, Dental Hospital of Yonsei University.

In total, 102 patients were injected with BoNT during the study period. The patients were initially screened to ensure that they had a record of a repeated visit at least once during the follow-up period of 1-3 months after the injection. This initial screening resulted in 57 patients being excluded since they did not revisit the clinic or the chart records of their conditions were incomplete. The remaining 55 patients were reviewed by checking their chart records for TMJ sounds (clicking, popping, or crepitus) during active mouth opening (AMO) before the injection. This resulted in the further exclusion of 27 patients who exhibited no TMJ sounds preinjection. Therefore, 28 patients were finally included, and their chart records were reviewed for TMJ sounds detected during AMO at least once during the follow-up period of 1-3 months after the injection.

The TMJ sounds during AMO did not change in making sound postinjection in 18 patients (group A), while they disappeared in the other 10 patients (group B). In order to identify the related factors for a reduction in TMJ sounds, the several parameters were compared between groups A and B (see Table 1). Degenerative or pathologic bony change includes bony irregularity(erosion) or flattening of condylar bony surface, osteophyte formation, thickening of articular surface(osteosclerosis) and subchondral cyst in the subarticular bone (Okeson, 2013, 208-209). The squareness of the face was evaluated using a facial photograph and a PA skull projection view.

BoNT was reconstituted with 2 ml of sterile saline to a concentration of 5 units/0.1mL. A total of 50–60 units of BoNT was injected into the bilateral masseter muscles, and/or 30–40 units of BoNT was injected into the bilateral temporalis muscles.

Table 1. Parameters compared between groups A and B

[a]Type of temporomandibular joint (TMJ) sound (clicking/popping and crepitus) Age Sex Total dose of botulinum toxin (BoNT; in units) injected into the masseter and temporalis muscles [b]Degree of active mouth opening (AMO) (mm) [c]Site of subjective pain during AMO [d]Degree of tenderness to palpation of the masseter and temporalis muscles and TMJ	
[e]Occlusion	Degree of overjet (OJ) (mm) Degree of overbite (OB) (mm) Total number of centric occlusion (CO) stops Bilateral balance of CO stop (this was considered to be balanced when numbers of stops on the right and left sides differed by less than 2)
[f]Anatomic muscular and skeletal pattern	Squareness of the face, as evaluated in a facial photograph and a posteroanterior (PA) skull projection view (subjective evaluation of the degree of squareness by one examiner)
[g]Bony change	Degenerative or pathologic bony change in the condylar head in computed tomography (CT) or cone-beam CT (CBCT) images of the temporomandibular joint (TMJ)
[h]Parafunctional habit	Subjective (self-aware or heard by others) parafunctional habits such as clenching and bruxism during daytime and/or nighttime Degree of cheek and tongue ridging

[a,b,c]: at preinjection and postinjection
[d,e,f,g,h]: at preinjction

III. STATISTICAL ANALYSIS

The results were analyzed with SPSS (version20.0, SPSS, Chicago, Illinois, USA). The independent *t*-test was used to compare the total number of CO stops, degree of OJ, OB, and AMO (all in mm), and total dose of BoNT injected into the masseter and temporalis muscles. Differences between the groups were assessed by applying the chi-square test (Fisher's exact test) to the following parameters: the bilateral balance of CO stops, the degree of tenderness to palpation on the masseter and temporalis muscles and TMJ, the site of subjective pain during AMO, the squareness of the face, degenerative or pathologic bony change in the condylar head, subjective parafunctional habits, and the degree of cheek and tongue ridging. Differences with a probability value of less than 0.05 were considered statistically significant.

IV. RESULTS

Before the injection, 16 subjects (88.9%) in group A had clicking, one (5.55%) had crepitus, and one (5.55%) had both crepitus and clicking. One subject who had only clicking before the injection had both clicking and crepitus after the injection during the follow-up period (1-3 months). While another subject showed the opposite result, with both clicking and crepitus before the injection and only clicking after the injection. There were no changes in the type of joint sound in the other subjects in group A. In group B, eight subjects (80.0%) had clicking (6)/popping (2), and two (20%) had crepitus during AMO at preinjection (Figure 1).

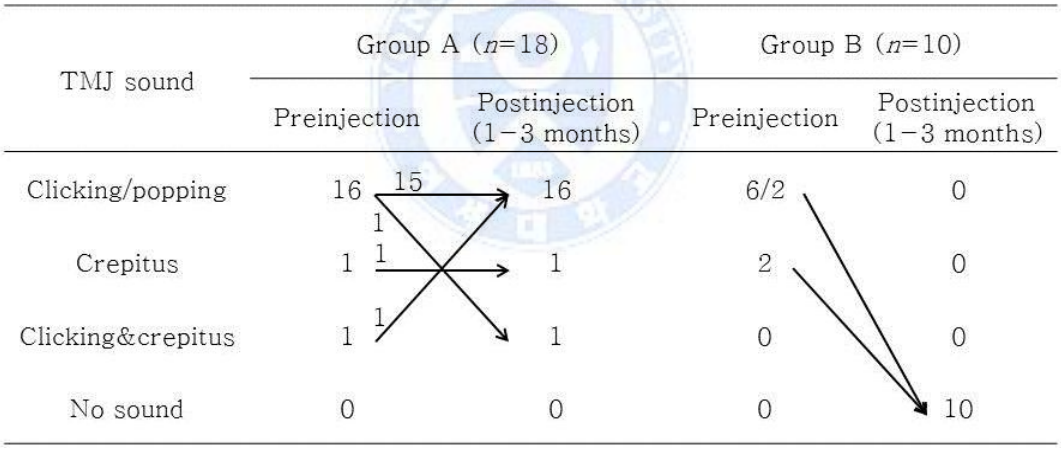

Figure 1. Changes in temporomandibular joint (TMJ) sounds in groups A and B

The age of the subjects was 35.94 ± 8.49 years (mean±SD; range, 25 to 52 years) in group A (all females) and 32.70 ± 6.94 years (range, 23 to 42 years) in group B (eight females and two males).

The results presented in Table 2 indicate that there were no significant differences between groups A and B in age, the total dose of BoNT injected into the masseter and temporalis muscles and degree of AMO at pre- and postinjection, OJ and OB and the total number of CO stops at preinjection. The bilateral balance of CO stops had no significant differences (Table 3). Comparison of the squareness of the face revealed the most frequent type in group A to be moderate face squareness (n=12, 66.7%) and in group B, to be severe face squareness (n=7, 70%); however, this difference was not statistically significant (Table 4). There were also no significant differences in the degree of tenderness to palpation on the masseter and temporalis muscles and TMJ at preinjection (Table 5), or the location of subjective pain during AMO at pre- and postinjection (Table 6) between the two groups.

With regard to degenerative or pathologic bony change in the condylar head observed in CT/CBCT images of the TMJ, eight subjects (53.3%) in group A had normal condylar heads and seven (46.7%) showed pathologic bony changes (CT/CBCT was not performed on three subjects). CT/CBCT images were obtained in nine subjects in group B, of which two (22.2%) showed normal anatomy and seven (77.8%) showed condylar bony changes. There was no significant difference between groups A and B (P=0.210) (Table 7). Subjective (self-aware or heard by others) parafunctional habits such as clenching and bruxism during daytime and/or nighttime were reported by all 10 subjects in group B and 15 subjects (83.3%) in group A (Table 8).

According to Table 9, the degree of cheek ridging differed significantly between the groups (P=0.022). Mild cheek ridging predominated in group A (n=13, 72.2%) while moderate cheek ridging predominated in group B (n=7, 70%). Likewise, mild tongue ridging was frequent (n=12, 66.7%) in group A and

moderate tongue ridging was dominant (n=7, 70%) in group B. However, there were no significant group differences between these results (P=0.050).

Table 2. Group comparison of mean change in age, the total dose of BoNT (untis) injected into the masseter and temporalis muscles, the degree of AMO (mm) at pre- and postinjection, OJ (mm) and OB (mm) and total number of CO stops at preinjection

	Group	*n*	Mean	SD	Independent *t*-test: *P*
Age	A	18	35.94	8.49	0.313
	B	10	32.70	6.94	
BoNT dose into masseter muscles	A	18	60.00	9.55	0.431
	B	10	62.80	7.44	
BoNT dose into temporalis muscles	A	18	37.78	7.32	0.596
	B	10	36.20	7.68	
Degree of AMO at preinjection	A	18	45.83	4.50	0.911
	B	10	46.10	8.09	
Degree of AMO at postinjection	A	18	45.78	4.54	0.751
	B	9*	45.00	8.17	
Degree of OJ	A	18	2.14	1.61	0.719
	B	10	2.40	2.17	
Degree of OB	A	18	1.59	1.78	0.386
	B	10	2.20	1.75	
CO stops	A	18	6.39	1.75	0.864
	B	10	6.50	1.35	

*: No record for 1 subject

Table 3. Group comparison of the bilateral balance of CO stops at preinjection

		Bilateral CO stops		
		Balance*	Imbalance	
Group	*n*	*n* (%)	*n* (%)	
A	18	14 (77.8)	4 (22.2)	*P*=0.891
B	10	8 (80)	2 (20)	

*: this was considered to be balanced when numbers of stops on the right and left sides differed by less than 2

Table 4. Distribution across the two groups in degree of face squareness at preinjection

			Degree			
			Mild	Moderate	Severe	
	Group	*n*	*n* (%)	*n* (%)	*n* (%)	
Face squareness	A	18	1 (5.6)	12 (66.7)	5 (27.8)	*P*=0.050
	B	10	0 (0)	3 (30)	7 (70)	

Table 5. Group comparison of the degree of tenderness to palpation at preinjection

Site			Tenderness to palpation				
			None	Mild	Moderate	Severe	
	Group	*n*	*n* (%)	*n* (%)	*n* (%)	*n* (%)	
TMJ	A	18	6 (33.3)	4 (22.2)	8 (44.4)	0 (0)	*P*=0.271
	B	10	4 (40)	0 (0)	6 (60)	0 (0)	
Masseter	A	18	2 (11.1)	4 (22.2)	11 (61.1)	1 (5.6)	*P*=0.539
	B	10	0 (0)	1 (10)	8 (80)	0 (0)	
Temporalis	A	18	6 (33.3)	7 (38.9)	4 (22.2)	1 (5.6)	*P*=0.865
	B	10	3 (30)	4 (40)	3 (30)	0 (0)	

Table 6. Group comparison of the location of subjective pain during AMO at pre- and postinjection

			Painful site during AMO				
			None	TMJ	Muscle	TMJ & muscle	
	Group	*n*	*n* (%)	*n* (%)	*n* (%)	*n* (%)	
Preinjection	A	17[a]	8 (47.1)	5 (29.4)	4 (23.5)	0 (0)	*P*=0.494
	B	10	3 (30)	4 (40)	2 (20)	1 (10)	
Postinjection	A	16[b]	8 (50.0)	6 (37.5)	2 (12.5)	0 (0)	*P*=0.301
	B	8[c]	2 (25.0)	3 (37.5)	3 (37.5)	0 (0)	

[a]: No record for 1 subject, [b]: No records for 2 subjects, [c]: No records for 2 subjects

Table 7. Group comparison of degenerative or pathologic bony change in the condylar head observed in CT/CBCT images of the TMJ at preinjection

		Condylar head			
		No image	Normal	Bony change*	
Group	*n*	*n*	*n* (%)	*n* (%)	
A	18	3	8 (53.3)	7 (46.7)	*P*=0.210
B	10	1	2 (22.2)	7 (77.8)	

*: degenerative or pathologic bony change includes bony irregularity(erosion) or flattening of condylar bony surface, osteophyte formation, thickening of articular surface(osteosclerosis) and subchondral cyst in the subarticular bone (Okeson, 2013, 208-209)

Table 8. Group comparison of subjective (self-aware or heard by others) parafunctional habits (clenching and bruxism) during daytime and/or nighttime

		Subjective parafunctional habits		
		No	Yes	
Group	*n*	*n* (%)	*n* (%)	
A	18	3 (16.7)	15 (83.3)	*P*=0.286
B	10	0 (0)	10 (100)	

Table 9. Group comparison of the degree of objective cheek and tongue ridging at preinjection

			Degree				
			None	Mild	Moderate	Severe	
	Group	*n*	*n* (%)	*n* (%)	*n* (%)	*n* (%)	
Cheek ridging	A	18	0 (0)	13 (72.2)	5 (27.8)	0 (0)	*P*=0.022*
	B	10	1 (10)	2 (20)	7 (70)	0 (0)	
Tongue ridging	A	18	1 (5.6)	12 (66.7)	5 (27.8)	0 (0)	*P*=0.050
	B	10	0 (0)	3 (30)	7 (70)	0 (0)	

*: the only significant different factor is cheek ridging

V. DISCUSSION

Factors that can increase the joint loading are susceptible to causing changes in the articular surface and inducing the friction (Okeson, 2013, 155) or resistance of disc–condyle movement, and then increasing the joint sounds.

This study looked at patients who received BoNT injection into the masticatory muscles and divided them into two groups: patients who ceased producing TMJ sounds were compared to those who continued producing TMJ sounds following BoNT injection. The two groups were then compared for factors that may affect joint loading. Such factors included total dose of BoNT injected, site and degree of pain, occlusion, face squareness, degenerative bony change in the condylar head observed in CT/CBCT images of the TMJ and parafunctional habits between groups.

TMJ sounds can disappear as the degree of mouth opening decreases, or can newly appear as the degree of mouth opening increases, depending on the location from which the sound originates. In the present study, no significant differences were found between groups A and B in the degree of AMO at pre– and postinjection and thus, the disappearance of sounds was probably not due to a reduction in the degree of AMO.

BoNT is a neurotoxic protein that prevents the release of acetylcholine in presynaptic terminals of neuromuscular junctions (CDER, 2014; Kurtoglu et al., 2008), and subsequently interrupts neuromuscular transmission. This partial chemical denervation of the muscle causes muscle relaxation and, eventually paralysis (CDER, 2014). The degree of joint loading may differ according to the dose of BoNT, determining the paralysis of the injected muscles. However, no significant difference was observed between the groups in total dose of BoNT injected into the masseter and temporalis muscles, suggesting that the dose of BoNT does not play a role in the reduction of joint sounds.

There were no significant differences between the groups in degree of OJ and OB, total number of CO stops, and bilateral balance of CO stops which were related to the static occlusion. Changes in CO stops at pre- and postinjection could not be evaluated due to the lack of records. When only the static relationship of teeth was assessed, no insight was given into the risk for TMD; however when load was applied, dental malocclusion could affect the force distribution (Okeson, 2013, 119). BoNT injection into masticatory muscles could possibly result in the precise occlusal change through muscle paralysis, inducing changes in the joint sounds and loading. Change in acute sensory input may also cause changes in joint loading by prompting protective co-contraction (muscle splinting). Therefore, evaluation of occlusal change before and after BoNT injection using occlusal analysis system such as T-scan could be a meaningful trial to indentify the relationship with reducing sound.

Anatomic muscular and skeletal pattern may be associated with force distribution, while face squareness was found to have no remarkable association with reductions in joint sounds.

There were also no significant differences between the two groups in the location of subjective pain during AMO and in the degree of tenderness to palpation on the masseter and temporalis muscles, and TMJ. Constant deep pain input can increase joint loading by producing protective co-contraction, demonstrating increased muscle activity (Okeson, 2013, 109, 131). However, data on the continuity of pain could not be retrieved from the records. If it eliminates continuous spontaneous pain, BoNT injection probably contributes to the reduction in joint sounds, decreasing protective co-contraction.

There was no significant difference in comparing degenerative or pathologic bony change in the condylar head observed in CT/CBCT images of the TMJ which was analyzed as a positive indication of joint loading. The amount or duration of overloading affects bony changes. However, the existence of factors inducing overloading does not always cause bony change. Furthermore,

radiographic changes are seen only in later stages of osteoarthritis and may not reflect recent stages accurately (Okeson, 2013, 155). Therefore, it is insufficient to determine whether these stages are progressive or adaptive or whether overloading exists at the moment of taking CT/CBCT image.

One of the most common factors that can lead to joint overloading is microtrauma associated with muscle hyperactivity including bruxism or clenching (Okeson, 2013, 147). History of clenching and bruxism during daytime and/or nighttime was examined before injection. This did not necessarily mean that patients had such habits at the time of injection. Furthermore, as these activities often occurred at subconscious levels and were easy to be underestimated, the severity of the parafunctional habits could not be assessed.

On the other hand, the degree of cheek ridging is considered as objective findings related to parafunctional habits (Okeson, 2013, 110) and can guess the severity of the habits. A greater severity in the degree of cheek ridging was associated with parafunctional habits that were more frequent or intense. This was the only factor that differed significantly between the groups.

The following mechanism can be hypothesized as underlying the reduction in TMJ sounds induced by BoNT injection into masticatory muscles. The sound reduction could result from reduced pressure inside the joint space through weakening of the intensity of contractions during parafunctional habits such as clenching or bruxism and even during functional activities and resting state by the paralyzing effect of BoNT. This would be expected to decrease the stresses on the TMJ and related tissues (Freund et al., 2000). Freund et al. (2000) injected BoNT into the masseter and temporalis muscles to treat TMD in an uncontrolled study, and reported that the maximum voluntary clenching decreased from after 2 weeks to after 8 weeks. Kortoglu et al. (2008) conducted a prospective, randomized, double-blind, placebo-controlled study, and concluded that injecting BoNT into the bilateral masseter and anterior temporalis muscles decreased the muscle action potentials as measured by

electromyography in the rest position after 14 days and at maximal clenching after 14–28 days. Shim et al. (2014) evaluated the effect of BoNT injection on sleep bruxism using video–polysomnography. The results showed that injecting BoNT into the masseter and temporalis muscles did not change the occurrence of rhythmic masticatory muscle activity episodes, but it did reduce the intensity of the muscle contractions.

Tongue ridging is a similar parameter associated with parafunctional habits. However, there was no significant difference in the degree of tongue ridging. Anatomical differences such as macroglossia (large tongue beside the dental arch) can produce tongue ridging regardless of the parafunctional habits. Chart records were insufficient in attaining such conclusions.

From this study, it is considered that joint sounds are easier to decrease in people who have more severe parafunctional habits (in terms of their frequency of occurrence or intensity), showing moderate to severe cheek ridging as the effect of weakening the intensity of the muscle contraction by BoNT injection would be more apparent.

This study was a retrospective review that was subject to several limitations:

1. The dose of BoNT injected was not uniform.
2. There were differences in injection methods (number of injected muscles and injection location), valuation criteria for determining the degree of cheek/tongue ridging, and follow–up periods according to the operators (clinician).
3. Other confounding factors such as other types of conservative treatment (e.g., medication, splint therapy, and physical therapy) and influencing factors (e.g., emotional stress and, behavior control) could not be controlled.
4. The disc displacement or dislocation was not confirmed using MRI before or after the injection.
5. The sample was small.

Future well–controlled prospective studies are needed to address the limitations of the present study.

VI. CONCLUSION

This study reviewed the chart of patients who received BoNT injection into their masseter and/or temporalis muscles for the treatment of myofascial pain, parafunctional habits such as bruxism and clenching, and chronic migraine. And patients who ceased producing TMJ sounds were compared to those who continued producing TMJ sounds following BoNT injection. The results showed that only the degree of cheek ridging differed significantly between the groups. This suggests that weakening the intensity of masticatory muscle contraction by BoNT injection could be responsible for reducing TMJ sounds by decreasing the joint loading or microtrauma. BoNT injection into the masseter and/or temporalis muscles may reduce distressing TMJ sounds and serve as an alternative treatment for patients who have moderate to severe cheek ridging. However, since this study was subject to several limitations, the results need to be confirmed in future well-controlled prospective studies.

REFERENCES

Bakke M, Møller E, Werdelin LM, Dalager T, Kitai N, Kreiborg S. 2005. "Treatment of severe temporomandibular joint clicking with botulinum toxin in the lateral pterygoid muscle in two cases of anterior disc displacement." *Oral Surgery, Oral Medicine, Oral Pathology, Oral Radiology, and Endodontology*. 100(6):693-700.

Bertolami CN, Gay T, Clark GT, Rendell J, Shetty V, Liu C, et al. 1993. "Use of sodium hyaluronate in treating temporomandibular joint disorders: a randomized, double-blind, placebo-controlled clinical trial." *J Oral Maxillofac Surg*. 51(3):232-242.

Bouso OV, González GF, Mommsen J, Grau VG, Fernández JR, Micas MM. 2010. "Neurogenic temporomandibular joint dislocation treated with botulinum toxin: report of 4 cases." *YMOE*. 109(3):e33-e37.

CDER HF. 2014. "FDA Response to Citizen Petition on botulinum."1-19.

Conti PCR, dos Santos CN, Kogawa EM, de Castro Ferreira Conti AC, de Araujo CdRP. 2006. "The treatment of painful temporomandibular joint clicking with oral splints: a randomized clinical trial." *Journal of the American Dental Association (1939)*. 137(8):1108-1114.

Emara AS, Faramawey MI, Hassaan MA, Hakam MM. 2013. "Botulinum toxin injection for management of temporomandibular joint clicking." *International Journal of Oral & Maxillofacial Surgery*. 42(6):759-764.

Freund B, Schwartz M, Symington JM. 2000. "Botulinum toxin: new treatment for temporomandibular disorders." *Br J Oral Maxillofac Surg*. 38(5):466-471.

Fu K-Y, Chen H-M, Sun Z-P, Zhang Z-K, Ma X-C. 2010. "Long-term efficacy of botulinum toxin type A for the treatment of habitual dislocation of the temporomandibular joint." *British Journal of Oral & Maxillofacial Surgery*. 48(4):281-284.

Hepguler S, Akkoc YS, Pehlivan M, Ozturk C, Celebi G, Saracoglu A, et al. 2002. "The efficacy of intra-articular sodium hyaluronate in patients with reducing displaced disc of the temporomandibular joint." *J Oral Rehabil*. 29(1):80-86.

Kurtoglu C, Gur OH, Kurkcu M, Sertdemir Y, Guler-Uysal F, Uysal H. 2008. "Effect of Botulinum Toxin-A in Myofascial Pain Patients With or Without Functional Disc Displacement." *Journal of Oral and Maxillofacial Surgery*. 66(8):1644-1651.

Lundh H, Westesson PL, Jisander S, Eriksson L. 1988. "Disk-repositioning onlays in the treatment of temporomandibular joint disk displacement:

comparison with a flat occlusal splint and with no treatment." *Oral surgery, oral medicine, and oral pathology*. 66(2):155-162.

Lundh H, Westesson PL, Kopp S, Tillström B. 1985. "Anterior repositioning splint in the treatment of temporomandibular joints with reciprocal clicking: comparison with a flat occlusal splint and an untreated control group." *Oral surgery, oral medicine, and oral pathology*. 60(2):131-136.

Martínez-Pérez D, García Ruiz-Espiga P. 2004. "Recurrent temporomandibular joint dislocation treated with botulinum toxin: report of 3 cases." *Journal of oral and maxillofacial surgery : official journal of the American Association of Oral and Maxillofacial Surgeons*. 62(2):244-246.

Mendes RA, Upton LG. 2009. "Management of dystonia of the lateral pterygoid muscle with botulinum toxin A." *British Journal of Oral & Maxillofacial Surgery*. 47(6):481-483.

Naeije M, te Veldhuis AH, te Veldhuis EC, Visscher CM, Lobbezoo F. 2012. "Disc displacement within the human temporomandibular joint: a systematic review of a 'noisy annoyance'." *Journal of Oral Rehabilitation*. 40(2):139-158.

Okeson JP. 2013. Management of temporomandibular disorders and occlusion. seventh edition ed. Mosby, p.109, 110, 119, 131, 137, 147, 155, 208-209, 323.

Schiffman E, Ohrbach R, Truelove E, Look J, Anderson G, Goulet JP, et al. 2014. "Diagnostic Criteria for Temporomandibular Disorders (DC/TMD) for Clinical and Research Applications: recommendations of the International RDC/TMD Consortium Network and Orofacial Pain Special Interest Groupdagger." *J Oral Facial Pain Headache*. 28(1):6-27.

Shim YJ, Lee MK, Kato T, Park HU, Heo K, Kim ST. 2014. "Effects of Botulinum Toxin on Jaw Motor Events during Sleep in Sleep Bruxism Patients: A Polysomnographic Evaluation." *Journal of Clinical Sleep Medicine*.

Vichaichalermvong S, Nilner M, Panmekiate S, Petersson A. 1993. "Clinical follow-up with different disc positions." *Journal of orofacial pain*. 7(1):61-67.

Wongwatana S, Kronman JH, Clark RE, Kabani S, Mehta N. 1994. "Anatomic basis for disk displacement in temporomandibular joint (TMJ) dysfunction." *Am J Orthod Dentofacial Orthop*. 105(3):257-264.

Yoda T, Sakamoto I, Imai H, Honma Y, Shinjo Y, Takano A, et al. 2003. "A randomized controlled trial of therapeutic exercise for clicking due to disk anterior displacement with reduction in the temporomandibular joint." *Cranio : the journal of craniomandibular practice*. 21(1):10-16.

국문요약

저작근에 보툴리눔 독소 주사 후 측두하악관절음의 변화

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단순관절음, 거대관절음, 염발음과 같은 측두하악관절음은 통증이 없거나 하악의 운동에 제한을 주지 않는다면 특별히 치료해야 할 필요가 없고, 일반적으로 보존적인 치료로 사라지지 않음에도 관절음 자체에 의해 스트레스를 받는 환자들이 일부 존재한다. 이 연구의 목적은 교근 및 측두근과 같은 저작근에 보툴리눔 독소를 주사한 이후 주사 전에 가지고 있던 관절음에 변화가 있는지를 추적하고, 군간의 비교를 통해서 관절음의 소실과 관련된 요인을 확인하는 데에 있다.

주사 전에 관절음이 관찰되고, 근막통증, 이갈이와 이악물기와 같은 비기능적 습관 혹은 만성편두통을 치료하기 위해 교근/측두근에 보툴리눔 독소 주사요법을 시행한 28 명의 환자의 진료 기록을 후향적으로 분석하여 주사 후에 소리가 잔존하는 군 (A 군, 18 명) 과 소리가 사라진 군 (B 군, 10 명) 간에 여러 요인을 비교하였다. 대부분 군간 비교에서 유의한 차이를 나타내지 않았으나, 유일하게 협점막 압흔의 정도만이 유의한 차이를 보였는데, 이는 보툴리눔 독소를 저작근에 주입함으로써 저작근의 수축 강도를 약화시키고, 결과적으로 관절에 가해지는 부하나 미세 외상을 감소시킨 결과로 추측된다. 이를 바탕으로 관절음으로 인한 고통을 호소하는 환자들 중에서, 중등도에서 심도의 협점막 압흔을 보이는 경우에 저작근에 보툴리눔 독소를 주사하면 관절음이 줄어들 가능성이 있으므로 임상적으로 적용할 수 있을 것으로 사료된다. 그러나, 이 연구가 여러 가지 한계점을 가지고 있어, 추후 잘 설계된 전향 연구를 통한 확인이 필요하다.

핵심되는 말: 보툴리눔 독소, 저작근, 측두하악관절음, 협점막 압흔