***Original Article / Çalışma - Araştırma***

# Effect of injection of botulinum toxin on lateral pterygoid muscle used together with the arthroscopy in patients with anterior disk displacement of the temporomandibular joint

## Temporomandibüler eklemin anteriyor disk deplasmanında artroskopiyle beraber kullanılan lateral pterigoid kas botulinum toksin enjeksiyonunun etkisi

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**Objectives:** In this study, we aimed to study the effects of an additional lateral pterygoid muscle (LPM), botulinum toxin-A (BTX-A) injection on arthroscopic lysis, lavage and posterior band coagulations. Subjective and objective measures have been documented.

**Patients and Methods:** Fourty three subjects (6 females, 37 males; mean age 35 years; range 15 to 48 years) with 52 joints were enrolled in the study. Patients were divided into two groups. The first group was treated with arthroscopic lysis, lavage and posterior band coagulation. The second group received an injection of 20 U of BTX-A to the LPM in addition to the former treatment. Patients were assessed statistically in the first week, and in the first, third and sixth months postoperatively with the measures of lateral deviations, protrusions and visual analogue scale (VAS) values using Student-t test.

**Results:** Group 1 and group 2 showed significant results within themselves with the exception of the third month values of right deviations in group 1. When groups were compared with each other; significant results were observed in left deviation values only in the third month, protrusion in the first month, and most importantly VAS values starting from the first month.

**Conclusion:** Botulinum toxin-A injection to the LPM mostly improved subjective measures starting from the first month. Other objective measures like protrusions, and deviations were not found to be affected generally. These findings suggest the improvement of symptoms with BTX-A injections in additon to the standard arthroscopy. However, diminishing effect of BTX-A and lack of information on the exact mechanism of action of toxin on temporomandibular joint necessitate further studies on this topic.

*Key Words:* Botox; lateral pterygoid muscle; temporomandibular joint.

**Amaç:** Bu çalışmada artroskopik lizis, lavaj ve posterior band koterizasyonu yapılan hastalara uygulanan ek lateral pterigoid kası (LPK), botulinum toksin-A (BTX-A) enjeksiyonunun etkisi araştırıldı. Subjektif ve objektif değerler ortaya kondu.

**Hastalar ve Yöntemler:** Çalışmaya 43 hastanın (6 kadın, 37 erkek; ort. yaş 35 yıl; dağılım 15-48 yıl) toplam 52 eklemi dahil edildi. Hastalar iki gruba ayrıldı. İlk grup (grup 1; n=21) artroskopik lizis, lavaj ve posterior band koterizasyonuyla tedavi edildi. İkinci gruptaki hastalara (grup 2; n=22) ise ilk tedaviye ek olarak 20 U LPK BTX-A enjeksiyonu yapıldı. Hastalar birinci hafta ve birinci, üçüncü ve altıncı aylarda olmak üzere lateral deviasyon, protrüzyon ve görsel analog skoru (GAS) bakımından Student t-testi kullanılarak incelendi.

**Bulgular:** Grup 1 ve grup 2'deki hastalar kendi içlerinde, sadece grup 1 içindeki üçüncü ay sağ deviasyon sonuçları dışında, tedaviye anlamlı yanıt verdi. Her iki grubun karşılaştırılmasında; sadece üçüncü ay sola deviasyon, birinci ay protrüzyon ve en önemlisi birinci aydan itibaren başlamak kaydıyla GAS sonuçları anlamlı bulundu.

**Sonuç:** Lateral pterigoid kasına BTX-A enjeksiyonu yapılan hastalarda birinci aydan başlayarak subjektif skorlarda iyileşme gözlendi. Protrüzyon ve deviasyon gibi diğer değerler genel olarak etkilenmemiş bulundu. Bu bulgular BTX-A enjeksiyonuyla azalan subjektif yakınmaların varlığını ortaya koymaktadır ancak, BTX-A etkisinin zamanla azalması ve toksinin temporomandibüler eklem üzerindeki kesin etki mekanizmasının bilinmemesi nedeniyle bu konuda daha fazla çalışmaya ihtiyaç vardır.

*Anahtar Sözcükler:* Botox; lateral pterigoid kası; temporomandibüler eklem.

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In spite of the many etiologies that have been proposed, the precise mechanism of temporomandibular joint disease (TMJD) is still controversial at present. However, it is accepted that it originates from two interdependent sources: joint and the muscles.[1]

For the joint counterpart, arthroscopy, which has become more popular, enables surgeon to visualize intraarticular structures, diagnose and even treat specific pathologies with varying success.[2-5] In terms of disk repositioning, other than surgery, a good alternative was found to be creation of a scar tissue at the posterior disk attachment aiming at the stabilization of the disk in the correct position. Different agents such as laser with various subtypes, and thermal techniques have been tried for this purpose.[6]

On the other hand, from the myogenic point of view, Botulinum toxin A has been shown to be effective in treating the muscular component of TMJD.[7-12] Although it has been studied in different periarticular muscles, lateral pterygoid muscle (LPM) injections in anterior disk displacements together with arthroscopy hasn't been studied in detail.

It is known that superior head of lateral pterygoid muscle has a tendinous insertion into the meniscus and its spasm has been proposed to play a role in anterior disk displacement. This anatomical fact strongly suggests that the spasm and the instability of the LPM might be involved in the pathogenesis of anterior disk displacement.[11,13-17]

In this study we aimed to study the effects of lateral pterygoid botulinum toxin injections together with arthroscopy in patients with anterior disk displacements of the TMJD.

## PATIENTS AND METHODS

We enrolled a total of 43 patients (6 females, 37 males; mean age 35 years; range 15 to 48 years) in the study between 2005 November and 2007 December.

We classified patients with anterior disk displacements into two groups. The first group was treated with arthroscopic lysis, lavage and posterior band coagulation. The second group received a LPM botulinum toxin-A (BTX-A) injections in addition to the former therapy.

Arthroscopy and posterior band coagulation group (group 1) contained 21 patients, four of whom had bilateral displacements. Group 2 received an additional BTX-A injection and included 22 patients, five of whom had bilateral displacements. A total of 43 patients and 52 joints were studied (Table 1).

The temporomandibular disorder fulfilled the classification of the American Academy of Orofacial Pain of Disk Displacement with or without reduction.[18] The inclusion criterion was presence of an anterior disk displacement whether reducted or not, verified radiologically by magnetic rezonance imaging (MRI; Siemens, Erlangen, Germany). Patients had complained of pain and remained refractory to nonsurgical treatment at least for three months without any cure (Table 2, 3). Exclusion criteria included severe illness, mental or pyhsical disability. All patients were examined by the same group of physicans and a standard-protocol was followed. On enrollment, each patient was given an informed consent and rated before assessment. Measures were visual analogue score (VAS), inter-incisal opening, right and left lateral deviations and finally protrusions. Patients were assessed preoperatively as well as by the end of first week, and the first, third and sixth months.

Under general anesthesia with nasoendotracheal intubation, the same two plastic surgeons attended the operation with the same equipment. The equipment consisted of 1.7 mm diameter wide field arthroscope, camera with 30 mm lense, double flow cannula, probes, forceps and microknives (Fig. 1). The landmarks of the surgery were drawn.

**Table 1.** Classification of patient groups

| | Patients with bilateral joint involvement | Patients with unilateral joint involvement | Total joint number |
|---|---|---|---|
| Arthroscopy and posterior coagulation | 4 (8 joints) | 17 (17 joints) | 25 joints |
| Arthroscopy and posterior coagulation plus BTX-A injection | 5 (10 joints) | 17 (17 joints) | 27 joints |
| *Total* | 9 (18 joints) | 34 (34 joints) | 52 joints |

BTX-A: Botulinum toxin-A.

**Table 2.** Preoperative symptoms of the patients

| Symptoms | % |
|---|---|
| Pain | 100 |
| Clicking, crepitation | 55 |
| Limitation of movement | 95 |
| Pain | 99 |

**Table 3.** Types of treatments received by patients

| Types of treatment | % |
|---|---|
| Medicine | 97 |
| Splint | 40 |
| Orthodontics | 25 |
| Arthrocentesis | 20 |

Local anesthetic xylocaine with epinephrine was placed and the superior joint space was insufflated using a 18-gauge catheter with normal saline. A sharp trocar and a cannula was introduced in the superior joint space. Surgical technique involved lysis and lavage together with release of adhesions. A complete irrigation of the joint was done with removal of all debris (Fig. 2). After visualization of the posterior disk attachments, coagulation by radiofrequency probe (Celon-Olympus, Teltow-Berlin Germany) was done. A total of 15 joules were automatically conducted for 4-7 seconds for scarification (Fig. 3). Finally, 2 cc of betametazone, 1 cc of bupivacaine with epinephrine 1:200000 and 1 cc of sodium hyaluronate were placed in the superior joint space. An occlusal splint was placed finally. All patients remained on a liquid diet for one week and a soft diet for further three weeks. An occlusional splint was worn constantly for three weeks postoperatively.

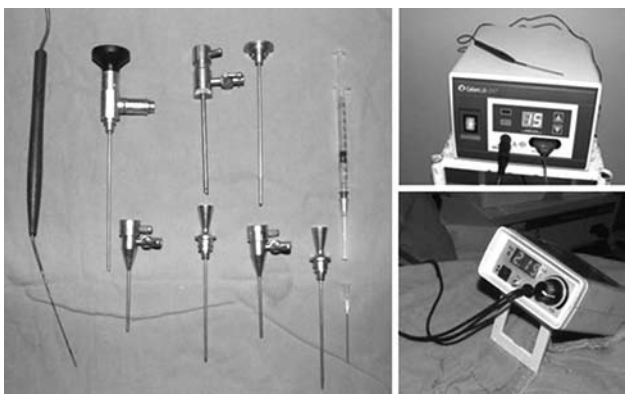

***Fig. 1.*** *Arthroscopic equipments used during the study (left side). Radiofrequency device (Celon-Olympus, Teltow-Berlin Germany (upper right) and the stimulator (Stimuplex A, B. Braun, Melsungen AG, Germany (bottom right).*

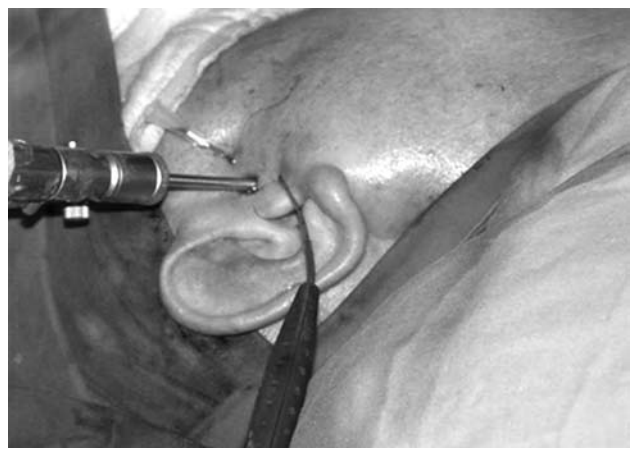

***Fig. 3.*** *Posterior coagulation performed by the help of a radiofrequency probe (Stimuplex A, B. Braun, Melsungen AG, Germany) inserted into the joint.*

***Fig. 2.*** *Arthroscopic lavage performed with saline.*

***Fig. 4.*** *Stimulation of the lateral pterygoid muscle by the stimulator probe.*

### Injection technique

Lateral pterygoid muscle injection criterion was proposed to be 5-10 U according to previous experiences with personal variations.[1] A commercially available BTX-A (Botox: Allergan, Irvine, Calif) was diluted with normal saline to a concentration of 10 U per 0.1 mL, and a 20 U was decided to be used for the injection. Access was intraorally, posterior to the maxillary tuberosity in an angle of 45 degrees although variations of different techniques have been described.[1] Accurate placement of the 22-gauge needle was determined by the help of a stimulator (Stimuplex A, B. Braun, Melsungen AG, Germany). A 2 mA current was used and the action of lateral pterygoid muscle was confirmed (Fig. 4). A total of 20 U of toxin injection was done. Other muscles like masseter and temporalis were not included even if the patient described pain on these locations.

## RESULTS

Duration of symptoms of TMJD ranged from eight to 120 months with a median of 92 months. Lateral deviations, visual analog scale (VAS) scores, interincisal openings and protrusion scores were calculated separately for each patient in both groups. Scores among groups were evaluated using Student t-test.

First of all, each group was assessed in itself. There found to be statistically significant values

**Table 4.** Pre- and postoperative comparison of the treatment groups among each other

| | Arthroscopy group | | Arthroscopy plus BTX-A injection | |
|---|---|---|---|---|
| | T | P | T | P |
| Mouth opening | | | | |
| Preoperative 1st week | –2.540 | 0.019 | –5.359 | 0.001 |
| Preoperative 1st month | –3.781 | 0.001 | –6.484 | 0.001 |
| Preoperative 3 month | –3.129 | 0.005 | –7.943 | 0.001 |
| Preoperative 6th month | –2.211 | 0.039 | –6.977 | 0.001 |
| Deviation-right | | | | |
| Preoperative 1st week | –.972 | 0.343 | –3.464 | 0.002 |
| Preoperative 1st month | –2.646 | 0.016 | –5.795 | 0.001 |
| Preoperative 3rd month* | **–.383** | **0.706** | –6.199 | 0.001 |
| Preoperative 6th month | 0.003 | 1.000 | –4.583 | 0.001 |
| Deviation-left | | | | |
| Preoperative 1st week* | **–1.644** | **0.116** | –3.705 | 0.001 |
| Preoperative 1st month | –3.060 | 0.006 | –4.809 | 0.001 |
| Preoperative 3rd month | –3.625 | 0.002 | –5.358 | 0.001 |
| Preoperative 6th month | –2.169 | 0.042 | –3.716 | 0.001 |
| Protrusion | | | | |
| Preoperative 1st week | –2.447 | 0.024 | –3.895 | 0.001 |
| Preoperative 1st month | –4.076 | 0.001 | –4.798 | 0.001 |
| Preoperative 3rd month | –3.873 | 0.001 | –4.765 | 0.001 |
| Preoperative 6th month* | **–1.943** | **0.066** | –5.063 | 0.001 |
| Visual analog scale | | | | |
| Preoperative 1st week | 4.723 | 0.001 | 6.789 | 0.001 |
| Preoperative 1st month | 6.468 | 0.001 | 8.664 | 0.001 |
| Preoperative 3rd month | 6.095 | 0.001 | 9.608 | 0.001 |
| Preoperative 6th month | 5.294 | 0.001 | 8.840 | 0.001 |

T: Student t-test score; P: Probability value; *: Insignificant results obtained. All other values are significant. ($p<0.005$); When we compared both groups among each other; left deviation values in third month, protrusion at the first month, and visual analog scale scores in third and sixth months were found to show significant results showing the effectiveness of additional Botox injections (Table 5). Other values, although seemed to show better values, were statistically insignificant.

between the pre- and postoperative 1st week, and the first, third and sixth month scores of all parameters in group 1 with one exception. Third month values of right deviations, first week values of left deviations and sixth month values of protrusions were insignificant. In contrast, all values were found to be significant in group 2 (Table 4).

When we compared both groups with each other, left deviation values in the third month, protrusion in the first month, and VAS scores in the third and sixth months were found to show significant results showing the effectiveness of additional Botox injections (Table 5). Other values, although seemed to show better values, were statistically insignificant.

## DISCUSSION

Internal derangements, specifically anterior disk displacements, are one of the major findings in TMD.[19] Arthoscopy has become a valuable tool both for the diagnosis and the treatment.[2-5] Although arthrocentesis, lysis and lavage, debridement,

**Table 5.** Comparison of the arthroscopy and the arthroscopy plus BTX-A injection according to postoperative values

| | Arthroscopy (n=21) | Arthroscopy plus BTX-A injection (n=22) | *p* |
|---|---|---|---|
| | Mean±SD | Mean±SD | |
| Mouth Opening | | | |
| Preoperative | 31.05±7.338 | 28.86±5.514 | |
| Postoperative 1st week | 33.14±7.248 | 32.77±5.614 | 0.530 |
| Postoperative 1st month | 34.81±6.242 | 34.18±5.457 | 0.957 |
| Postoperative 3rd month | 34.62±5.766 | 35.64±5.242 | 0.997 |
| Postoperative 6th month | 33.43±5.921 | 34.68±4.745 | 0.377 |
| Deviation-right | | | |
| Preoperative | 7.62±2.655 | 7.77±2.617 | |
| Postoperative 1st week | 7.90±2.119 | 8.68±1.783 | 0.441 |
| Postoperative 1st month | 8.29±2.572 | 9.18±2.062 | 0.207 |
| Postoperative 3rd month | 7.76±2.300 | 9.68±1.729 | 0.186 |
| Postoperative 6th month | 7.62±2.439 | 9.27±2.028 | 0.491 |
| Deviation-left | | | |
| Preoperative | 6.95±2.376 | 7.64±2.300 | |
| Postoperative 1st week | 7.43±1.805 | 8.55±2.176 | 0.100 |
| Postoperative 1st month | 8.10±1.513 | 8.91±1.998 | 0.166 |
| Postoperative 3rd month | **8.33±1.278** | **9.27±2.292** | **0.015*** |
| Postoperative 6th month | 7.71±1.793 | 8.73±1.830 | 0.398 |
| Protrusion | | | |
| Preoperative | 6.33±1.983 | 6.73±2.142 | |
| Postoperative 1st week | 6.86±2.128 | 7.95±1.759 | 0.392 |
| Postoperative 1st month | **7.19±2.502** | **8.41±1.297** | **0.007**** |
| Postoperative 3rd month | 7.19±2.358 | 8.55±1.683 | 0.196 |
| Postoperative 6th month | 6.81±2.400 | 8.59±1.593 | 0.098 |
| Visual analog scale | | | |
| Preoperative | 6.19±2.442 | 5.95±1.676 | |
| Postoperative 1st week | 4.14±2.007 | 3.86±1.754 | 0.598 |
| Postoperative 1st month | 3.38±1.687 | 3.36±1.399 | 0.705 |
| Postoperative 3 rd month | **3.38±1.774** | **2.86±1.125** | **0.031*** |
| Postoperative 6th month | **3.90±1.814** | **3.32±1.171** | **0.021*** |

BTX-A: Botulinum toxin-A; *: Significant results obtained; ($p<0.005$) at postoperative 3rd month left deviations, 1st month protrusions, 3rd and 6th month visual analog scale values; Student t-test; *statistically significant under 95% degree of confidence; $p<0.05$; statistically significant under 99% degree of confidence, $p<0.01$).

capsular releases, intraarticular pharmacotherapy are the basic procedures, disk repositioning has been studied, as well. Surgical repositioning techniques have been tried with different success rates.[20-22] As an alternative, arthroscopic posterior coagulation to form a fibrosis and a scar has been one of the less invasive techniques performed.[6]

On the other hand, BTX-A has become a new tool for management of certain symptoms. Botulinum toxin A is a potent neurotoxin produced by clostridium botulinum acting by temporary chemical denervation of skeletal muscle. It causes dose dependent paralysis in skeletal muscle by blocking the release of acetylcholine from motor nerve endings.[23,24] This particular action led authors to use it for temporomandibular disorders which has a strong musculogenic component. Even algortithms of BTX-A injections for periarticular muscles have been published.[1] These injections were most commonly addressed at decreasing pain and spasm by the action of many supposed mechanisms of this toxin.[7]

Although temporalis, masseters and pterygoid muscles have been studied for BTX-A injections, lateral pterygoid muscle deserves a particular consideration. Lateral pterygoid has two heads with different anatomical variations and functions.[25] Direct attachment to the disk is common, verified by radiological studies.[16] Many anterior displacement cases were shown to be correlated with the uncoordinated action of LPM.[13-17] From this point of view, its incoordinance was suggested to play a role in the anterior displacement of the disk and this led us to use this toxin particularly for this purpose.

Previous studies of BTX-A treatment of TMDs yielded satisfactory results. For example, a study done by Freund et al.[7] suggested the beneficial effects of the toxin on severity of symptoms and functional abilities of patients. Likewise, Bakke et al.[12] showed the elimination of joint clicking by lateral pterygoid injections in two patients.

Botulinum toxin-A injections for the anterior displacements were particulary studied by Karacalar et al.,[11] with injection of toxin specifically on lateral pterygoids. They found satisfactory results with this technique. In the study we performed, we mainly focused on the same purpose and examined the effects of BTX-A on lateral pterygoids together with the arthroscopy.

Actually, we found similar results in this study. Generally both groups showed significant results except the third month values of right deviations in group 1. When we compared each group with each other, benefical effects of BTX-A injections on VAS scores were observed starting from the first month. This finding suggests the improved symptoms of patients with an additional BTX-A injection especially in the third and sixth months. Although left deviations and protrusion at certain times seemed to be improved with an injection, they were not found to be uniform improvements.

The beneficial effects of BTX-A in addition to the arthroscopy, however, didn't satisfy us in certain aspects. They were as follows:

First, from the arthroscopic point of view, there are still debates and unclear points especially in terms of disk repositioning. The long term improvement with disk repositiong with suturing, although yielded success rates between 80% and 90%, hasn't been verified.[20-23] Only a few studies have been performed on arthroscopic disk positioning. Creation of scar tissue with laser in the posterior disk attachment to stabilize the disk also hasn't been studied and proven in detail.[6]

The second unclear point was the exact mechanism of action of BTX-A in temporomandibular disorders. In spite of its use in the treatment of blepharospasm, strabismus, spasmodic torticollis and oromandibular dystonia, its mechanism of action in TMDs in unclear.[26-32] Many hypotheses have been postulated. Pain reduction by alleviating muscle spasm, decrease of the release of inflammatory peptiedes such as substance P and analgesic effects of toxin metabolites have been proposed.[7]

In addition, BTX-A injection is not free of complications. There may be weakness of adjacent muscles which may cause speech and swallowing difficulties.[33] Toxin can move into other planes which particularly necessitates an elektromiyografi (EMG) or a similar equipment guidance for injections.[1] Systemic side effects, although rare, include transient weakness, nausea, and pruritis.[30] In our study, only two patients described weakness which subsided later.

Another point is the disk position following injections. Bakke et al.[12] observed a small but distinct permanent positional improvement in the disk-condyle relationship shown on MRI. He proposed that this might reduce clicking in patients. However, Karacalar et al.[11] did not see any improvement in disk position in five patients chosen randomly. They made the interpretation

that symptom relief was not correlated with the disk position.

Finally, as we experienced in our study, an addition of a BTX-A to the arthoscopy as a combination therapy can improve the symptoms like pain, popping and spasm starting particularly in the first month post-operatively. However, lack of significant results on objective parameters, unproven effects of the toxin on the joint, whether these effects are due to disk repositioning or pain reduction and also questioned efficacy of arthroscopic posterior disk coagulation are still in debate. Diminishing effects of toxin and relatively high cost should be kept in mind, as well.

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