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## **Type A Botulinum Toxin in Myofascial Facial Pain and Dysfunction**

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Dysfunctions of the masticatory organ are often characterized by dysfunctions of the masticatory muscles, temporomandibular joint function and occlusion [1–4]. While occlusal disturbances used to be regarded as the key aetiological factor in the genesis of dysfunctions of this kind, muscular and psychological factors are coming increasingly to the fore today. Also discussed are inadequate stress management, as well as changes in the proprioceptors and disorders in the area of the motor pathways [5, 6].

The predominant causes of muscular pain in the maxillofacial area are the jaw-closing and protracting muscle groups. The jaw-opening muscles, as well as the muscles of the tongue and larynx may also be affected in the context of oromandibular dystonia. Table 1 shows an overview of the causal muscle groups.

The fact that tension of the masticatory muscles can also result from disorders of the extrapyramidal motor pathways is illustrated by the example of cervical and facial dystonia induced by neuroleptic drugs. This is thought to be caused by an imbalance between the neurotransmitters dopamine and acetylcholine, where the excessive release of acetylcholine leads to the undesirable, involuntary muscle contraction [5].

The genesis of pain in the context of myalgia of the masticatory muscles can be explained by chronic nociceptive irritation of the tendons and fascias of the muscles, on the one hand, and by secondary irritation of adjacent tissue, on the other (e.g. irritation of the periosteum, overloading of the temporomandibular joint) [7, 8]. At the same time, pain can also result from contractions, ischaemic and hyperaemic conditions, and microtraumas in the muscles. This pain is generally described as a sensation of non-throbbing, variable and partly diffuse pain. There is a more or less constant background of pain, which

**Table 1.** Overview of the causal muscle groups in myofascial facial pain and dysfunction

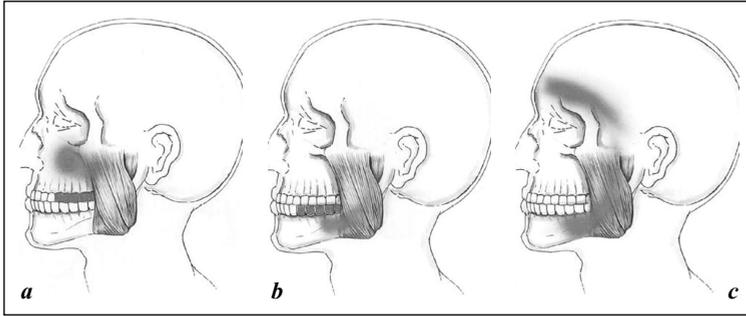
Dysfunction	Causal muscle/group of muscles
Painful myalgia of the masticatory muscles	Masseter, temporalis, medial pterygoid muscle
Hypermobility disorders	Lateral pterygoid, temporalis muscle (anterior part)
Hypertrophy of the masseter and temporalis muscle	Masseter, temporalis muscle
Trismus	Masseter, temporalis, medial pterygoid muscle
Oromandibular dystonia	
Type jaw-opening	Lateral pterygoid, digastric, suprahyoidal, platysma muscle
Type jaw-closing	Masseter, temporalis, medial pterygoid muscle
Lingual dystonia	Hypoglossus, pharyngeal muscles

can be interspersed with attacks of violent pain. The pain is frequently perceived not only in topographic connection with the muscle of origin, but also characteristically with the radiation typical of every masticatory muscle. For example, some patients report the pain radiating into the mandible, the mandibular teeth and the ear region. Others report radiation into the maxilla, the lateral and front maxillary teeth, above the eye and into the temporal region (fig. 1, 2). Functional impairment, such as restricted mandibular movement, is rare.

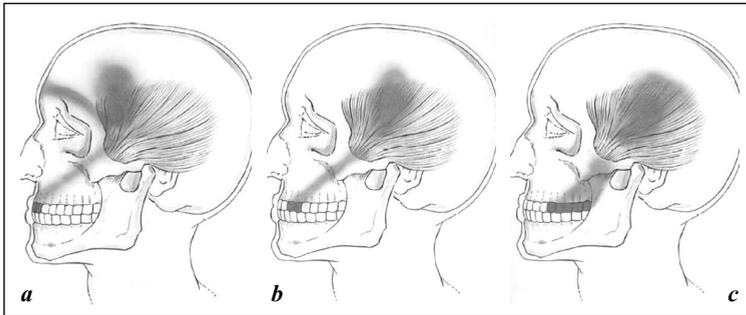
Precise differentiation of the individual causal aetiological factors is generally not possible. Consequently, diagnosis and therapy mainly aim to reduce and eliminate pathological findings obtained in a functional analysis of the masticatory system.

Symptomatic therapy involves both dental and medical measures. The dental measures applied are occlusal appliances and the grinding or reconstruction of teeth, tooth groups or the entire masticatory system.

Due to their wide range of indications, occlusal appliances are the primary form of dental therapy after informing and instructing the patient. The action principle is based on various neuromuscular mechanisms aimed at harmonizing the functions of the teeth, jaw, muscles and joint. The main objective in this context is to eliminate parafunctions, such as grinding and clenching of the teeth.



**Fig. 1.** *a* Typical radiation of the upper part of the masseter muscle. *b* Typical radiation of the middle part of the masseter muscle. *c* Typical radiation of the lower part of the masseter muscle.



**Fig. 2.** *a* Typical radiation of the anterior part of the temporalis muscle. *b* Typical radiation of the middle part of the temporalis muscle. *c* Typical radiation of the posterior part of the temporalis muscle.

The adjuvant medical measures include not only exercises and behavioural regimens, but particularly also targeted physiotherapy. Alternatives include all relaxation techniques, acupuncture and acupressure, as well as biofeedback methods.

In the past, up to 80% of patients with painful myalgia of the maxillofacial muscles could be treated successfully using these conventional, conservative methods. Despite appropriate measures of the kind described above, 20% of patients failed to benefit from conventional treatment methods, meaning that different therapeutic options had to be discussed.

A temporary, positive therapeutic effect on dysfunctions and pain symptoms has been known for a long time from the treatment of cervical dystonia

**Table 2.** Overview of literature in the treatment of myofascial facial pain and dysfunction

Author/year	Indication	Patients	Substance/dose	Design	Results
Freund et al., 2000 [20]	TMD	46	Botox/50 U masseter muscle, 25 U temporalis muscle	Open label	Significant decrease of pain
Freund et al., 1999 [13]	TMD	15	Botox/50 U masseter muscle, 25 U temporalis muscle	Open label	Significant decrease of pain
von Lindern, 2001 [16]	Facial pain and TMD	41	Dysport/200 U masseter, muscle, temporalis muscle	Open label	Decrease of pain
von Lindern et al., 2000 [15]	Pain trismus	55	Dysport/200 U masseter muscle, temporalis, muscle	Open label	Decrease of pain
Kunig et al., 1998 [12]	Facial pain	1 case	Perioral muscles		Decrease of pain

with botulinum toxin (BTX) [9, 10]. It thus seems logical that the targeted chemical partial denervation of the affected masticatory muscles using BTX can improve the pain symptoms in patients with painful myalgia, should conventional, conservative measures prove ineffective.

### Overview of the Literature

Type A botulinum toxin (BTX-A) has long been familiar as a local muscle relaxant in the treatment of focal dystonia [10] and also pain [11]. Numerous new potential applications have emerged recently. These also include the use of BTX in dysfunctions of the masticatory organ ('temporomandibular disorders') and chronic facial pain [12–16]. An overview can be found in table 2: Although all the scientific studies show that the local injection of BTX-A has a positive effect on pain and dysfunctions in the maxillofacial area, this cannot be taken as a general indication for the treatment of chronic, muscle-induced pain. Rather, the injection of BTX-A must constitute an alternative for refractory patients at the end of the therapeutic chain when all conventional therapeutic options have been exhausted. At the same time, all other causes must be ruled out in advance, especially arthrogenic factors in the region of the temporomandibular joints.

The following indication system for BTX-A has proven successful in clinical routine: (1) chronic, function-independent pain in relation to the

**Table 3.** Overview of treated muscles, doses and approaches

Muscle	Botox MU per muscle	Dysport MU per muscle	Approach
Masseter muscle	35–50	150–200	Extraoral/intraoral
Temporalis muscle	35–50	150–200	Extraoral
Lateral pterygoid muscle	50	200	Extraoral simultaneous with EMG
Medial pterygoid muscle	5	20	Extraoral
Frontalis muscle	20	80	Extraoral

affected masticatory muscles; (2) typical radiation analogous to the insertions of the masticatory muscles; (3) general signs of general hyperactivity of the masticatory muscles (attrition of the teeth, muscular hypertrophy, etc.); (4) interdigitation disorders and arthrogenic causes ruled out; (5) resistance to therapy, despite appropriate conventional, conservative therapy for at least 3 months, and (6) no findings contraindicating BTX therapy.

Under the above conditions, it is our experience that the targeted injection of BTX-A in refractory patients is capable of improving pain symptoms by up to 80%.

Both the injection technique and the dosage vary in the studies to date. For this reason, the topography, the injection technique and the dosage for each muscle will be specifically presented in detail below (table 3).

### **Masseter Muscle**

With its deep part and its superficial part, the masseter muscle extends from the zygomatic bone attachment to the angle of the mandible. Its primary function is jaw closure, as well as dynamic and static occlusion. This muscle is fundamentally involved in case of dysfunction (e.g. grinding and clenching of the teeth). Pain on pressure mainly exists in the deep part in the insertion area of the muscle on the zygomatic bone and typically tends to radiate into the maxilla and mandible, as well as the lateral teeth. The lower area of the muscle on the angle of the mandible is less often affected, and then frequently in connection with significant masseter hypertrophy. As a result, both extraoral and intraoral injection is possible. Freund et al. [13, 14] prefer the extraoral injection of doses of 5 U Botox distributed over the entire muscle area (total dose: 25 to 50 MU Botox). The injection can be EMG-controlled or performed simultaneously



**Fig. 3.** Injection of the upper part of the masseter muscle with an intraoral approach.



**Fig. 4.** Injection of the lower part of the masseter muscle with an extraoral approach.

with the help of targeted triggering of the muscle. As the majority of patients have pain on pressure in the region of insertion on the zygomatic bone, we consider the intraoral injection of approximately 35 U Botox/150 U Dysport to be clinically more practicable (fig. 3).

In case of extraoral injection, the front parts of the muscle must be avoided owing to the vicinity to the levator anguli oris, as must the lower parts close to the parotid gland (fig. 4).



*Fig. 5.* Injection of the anterior part of the temporalis muscle.

### **Temporalis Muscle**

The temporalis muscle is divided into the anterior part and the posterior part. While the anterior part with its vertical fibre orientation is primarily responsible for protrusive movement of the mandible (protrusion), the posterior part is used for closing the jaw and occlusion. In case of dysfunction, it is generally the anterior part that is affected, often accompanied by hypertrophy. Typical pain on pressure is found in the temporal region, radiating into the front and lateral teeth of the maxilla, as well as above the eye. The temporalis muscle is no doubt also of great significance as regards the genesis and treatment of tense headaches.

The injection is generally given extraorally and predominantly in the anterior part. 35–50 U Botox/150–200 U Dysport can be distributed in a fan shape by administering one or two intramuscular injections at different points in accordance with the maximum pain on pressure. The front insertion of the muscle should be avoided because of its vicinity to the orbicularis oculi and the position of the temporalis blood vessels taken into account (fig. 5).

### **Medial Pterygoid Muscle**

The medial pterygoid muscle runs along the inside of the mandible, similarly to the masseter muscle, from the pterygoid fossa to the angle of the

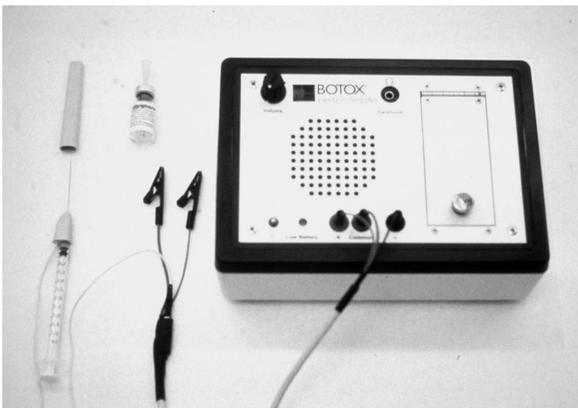
mandible. Although this muscle often causes pain in cases of dysfunction, it should only be included in BTX therapy with very great caution. On account of its exposed location in close proximity to the muscles of the floor of the mouth, the pharynx and the larynx, side effects, such as speech and swallowing disorders, must be expected, even at low doses. If appropriate, a maximum of 5 U Botox/20 U Dysport can be injected immediately at the insertion on the angle of the mandible.

### **Lateral Pterygoid Muscle**

The lateral pterygoid muscle is likewise divided into two parts and originates on the pterygoid lamina. The upper part runs towards the head of the mandible and inserts in the capsule, with some fibres radiating directly into the anterior suspensory ligament of the articular disk. It is thus assigned the function of tensioning and guiding the disk during jaw movement. The lower, much stronger part inserts directly on the condyle and is mainly responsible for protrusive movement of the mandible. Dysfunctions of the lateral pterygoid muscle are to be found in all forms of 'hypermobility disorders'. These are generally accompanied by extensive protrusion and a tendency of the condyle to sublux. This can cause not only pain, but also, in the medium term, disk displacement with cracking joints and, in extreme cases, recurrent, fixed dislocation of the temporomandibular joint. Functional disorders are often to the fore when treating the lateral pterygoid muscle with BTX-A. Above all, neurogenically induced dislocation of the temporomandibular joint in cases of disease of the motor pathways can be treated very successfully. In cases of painful myopathy of the masticatory muscles, injecting the lateral pterygoid muscle should always be considered if the case history and the clinical findings primarily reveal extreme bruxism and/or extensive protrusion of the mandible. The injection should always be given extraorally and monitored by EMG. To this end, the lateral pterygoid muscle is located on an imaginary line from the middle of the tragus to the infraorbital margin, approximately 3–3.5 cm in the anterior direction at a depth of approximately 2.5–3 cm. The patient is then requested to perform protrusive movements with the mandible. After recording the muscle potentials, between 35 and 50 U Botox/150 and 200 U Dysport are injected simultaneously with the help of a Teflon-coated injection needle (fig. 6, 7). The resultant partial denervation becomes apparent after approximately 6–8 days in the form of a reduced protrusion tendency of the temporomandibular joint and, thereafter, by an approximately 1 cm reduction in mouth opening. As in the case of the other masticatory muscles, the patient already perceives a noticeable reduction in pain after 3–5 days.



*Fig. 6.* Injection of the lateral pterygoid muscle simultaneous with EMG.



*Fig. 7.* EMG for simultaneous injection of the lateral pterygoid muscle.

### **Other Muscle Groups**

In many cases, the BTX injection has to be extended to other facial and, in particular, pericranial and cervical muscles, in order to exploit corresponding synergistic effects. The appropriate injection points and dosages for the nuchal and cervical muscles can be found in the relevant chapters.

It must generally be emphasized that the BTX injection must be adapted to the needs of the individual patient in terms of the type of injection and the dosage administered. The case history and the clinical findings of the patient

are important parameters in this context. Standardized injection schemes must be rejected, since they do not do justice to the individual patient and the treatment is thus doomed to failure before it starts. As the effect of the toxin differs between individuals, a low dose should always be administered in the first injection.

All intramuscular injections should be performed after sufficient skin disinfection and with repeated aspiration. For intraoral injection, brief insertion of a CHX swab in the envisaged injection area will suffice.

Although many scientific studies in the field of pain research have already confirmed a clearly positive effect of local BTX injection, it has not yet been registered in Europe and America for headache and facial pain or pericranial pain syndromes. In view of the enormous scientific efforts in evidence-based neurological research, BTX-A could perhaps be approved for headache in the medium term. For this reason, the treatment of myogenic facial pain with BTX can and must continue to constitute an alternative treatment in refractory patients. An alternative treatment is defined as the use of a method that is not yet established, but gives the affected patient the prospect of a cure, an improvement or some other benefit. It is a treatment and thus to be rated as such in terms of liability law. A new method is only justified if conventional methods are not suitable for reliably bringing about therapeutic success. The newer and less tested the method is, the greater the amount of information that has to be given to the patient. In this context, every patient must be informed, both verbally and in writing, about the treatment, the risks and alternatives, as well as the possible costs before being given the injection. Pre-printed information and consent form has proven effective for this purpose in clinical practice.

### **Analgesic Effect of Botulinum Toxin Type A**

Targeted injection of BTX-A not only leads to direct attenuation of these muscular contractions. An improvement in aerobic muscle metabolism has also been discussed. In the medium term, the chemical partial denervation results in disuse atrophy of the affected muscles, which in turn counteracts the aetiological causes [17–19]. In macroscopic terms, the masseter muscle can be reduced by half, both clinically and in animal experiments. In microscopic terms, there is a change in the myofibrils, muscle cells and neuromuscular end-plates, similar to the changes following axotomy. These changes are entirely reversible after approx. 3 months [18]. In addition, an effect of BTX on muscle fibre afferences is seen, which is in turn said to lead to a central reduction of muscle contraction.

More recent studies show that the above mechanisms alone cannot explain the analgesic effect of BTX and that a far more complex mechanism of action can be assumed.

The muscle-relaxing property of BTX can enable decompression of afferent nociceptive neurons and muscular blood vessels in cases of myogenic pain syndromes. A mechanism of action involving the sensory muscle functions is also apparent [19, 20]. This means that central afferent and efferent control mechanism of muscular activity can also be modulated and reorganized, which could also explain effects in areas outside the injected muscle [21]. Clinical experience also confirms these complex mechanisms of action, since the improvement in the pain symptoms often begins before complete chemical denervation of the muscles and the patients also report improvements in other, adjacent muscle groups.

In addition, BTX is assumed to have a direct inhibitory effect on neurotransmitters. It has been demonstrated that BTX directly inhibits Substance P from trigeminal nerve endings, which is a potent neurotransmitter in the activation of neurogenic inflammations. Aoiki's group [22] was additionally able to demonstrate a direct anti-inflammatory effect of BTX in formalin-induced arthritis in the rat model.

Although not all the analgesic mechanisms of action of BTX have yet been explained conclusively, it can still be said in summary that the local injection of BTX in refractory patients with painful myalgia of the masticatory and facial muscles constitutes an innovative and efficient method for reducing pain. An improvement in the pain symptoms can be observed in approximately 80% of cases.

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