

# Botulinum Toxin A and Migraine Surgery

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Having observed the safe use of botulinum toxin A (Botox; Allergan, Inc., Irvine, Calif.) in craniofacial patients for correction of strabismus by ophthalmology colleagues, it seemed safe to use it in extraorbital muscles as well. Prompted by the successful use on one of our own (Guyuron) corrugator muscles, several of our staff requested that Botox be injected into their frowning muscles in the late 1980s. Synchronously, two patients who were afflicted with dysfunction of the depressor labii inferioris muscle, one iatrogenically and the other congenitally, sought the lead author's advice. They were treated with Botox and were pleased with their outcomes. Further use of Botox culminated in a reasonable experience that included 30 muscles, of which 28 responded favorably, which was presented during the 1992 meeting of the American Society for Aesthetic Plastic Surgery.<sup>1</sup> It would not have been fathomable then that one day injection of Botox would become the most frequently performed procedure in aesthetic surgery. Our experiences with Botox continued predominantly in the aesthetic arena. Serendipitously, two patients reported elimination of migraine headaches following forehead rejuvenation. A retrospective study was commenced that included 314 patients who had undergone forehead rejuvenation. Of those patients, 39 had been diagnosed with migraine headaches based on the criteria established by the International Headache Society, and 31 of the 39 had experienced either a complete elimination of or significant improvement in the frequency and/or severity of their headaches, with an average follow-up of 47 months.<sup>2</sup>

Concurrently, several articles were published

advocating the use of Botox for treatment of migraine headaches.<sup>3-6</sup> The only common denominator between these two modalities that could potentially affect migraine headaches was elimination of corrugator supercilii muscle function. Contrary to some beliefs, both supratrochlear and supraorbital nerves pierce the corrugator supercilii muscle. While the trunk of the former passes through the muscle, only the branches of the latter penetrate this muscle. Intrigued by these findings, we were compelled to review the literature to find a reasonable explanation as to the mechanism of migraine headaches and the role that Botox and surgery may play. Approximately 30 years ago, a neurology colleague asserted that irritation of the peripheral branches of the trigeminal nerve results in release of substance P and neurokinins which travel along the nerve and produce a localized meningitis.<sup>2</sup> The author, however, did not cite any reason for the inflammation or irritation of the nerve branches. We postulate that this inflammation is caused by continual contraction of the muscle around the nerve. The evidence for this hypothesis was abundant. The most convincing support in favor of a peripheral mechanism role is efficacy of botulinum toxin on migraine headaches.

Botox's effect is predominantly peripheral, although it has been claimed that botulinum toxin may have some central effects as well.<sup>4</sup> The latter, however, has not been substantiated by scientific evidence. Additionally, many of the patients with frontal migraine headaches exhibit deep frown lines with unusually bulky corrugator supercilii muscles. Our report, which was published in the August 2000 issue of *Plastic and Reconstructive Surgery*,<sup>2</sup> was a retro-

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spective report and, as such, was open to criticism. Hence, we designed a prospective study. The patients who claimed to have migraine headaches were examined by the team neurologist to confirm the diagnosis of migraine headaches. After completing an extensive questionnaire, the patients underwent injection of 25 U of Botox into each corrugator supercillii muscle. A second questionnaire was completed a month after injection. Surgery was recommended to those who responded favorably to the injection of botulinum toxin. Twenty-nine patients who experienced two to 12 migraine headaches per month were included in this study, 24 of whom responded favorably to the injection of Botox. Of this group, 16 observed complete elimination of migraine headaches, eight noted significant improvement, and five had minimal to no response. We also observed that irritation of the zygomaticotemporal branch of the trigeminal nerve might have a role in temporal migraine headaches. Some of those patients who did not respond to the injection of Botox with complete elimination of their headaches observed relocation of the headaches from the forehead to the temples. In this group of patients, we detached the zygomaticotemporal branch of the trigeminal nerve in addition to removing the corrugator supercillii muscles. This is a small branch of the trigeminal nerve, which is routinely transected during craniofacial surgery and forehead rejuvenation, often with no lasting functional loss. Twenty-one of 22 patients benefited from the operation. Ten patients noted complete elimination, and 11 reported significant improvements (at least a 50 percent reduction in the severity or frequency of their headaches). The average follow-up was almost 1 year. This study was published in *Plastic and Reconstructive Surgery* in 2002.<sup>7</sup> In preparation for this report, we recently reviewed our results. Nine of the 10 patients who reported complete elimination still remain free of migraines, 12 patients continue to enjoy significant improvement, and one patient reports no change. The average follow-up period currently is 670 days.

Puzzled as to why complete elimination was not achieved in all patients, we investigated other potential trigger sites. Our anatomical investigation on fresh cadavers in Dr. Rohrich's research laboratory unraveled another portion of the enigma. In all 40 sites on 20 cadavers, we noted that the greater occipital nerve pierced the semispinalis capitis muscle to reach the

cutaneous level.<sup>8</sup> We designed a new surgical procedure to free this nerve.

We further discovered that patients who had undergone septoplasty and turbinectomy were noting elimination or improvement of their migraine headaches triggered by the septum and turbinates. A literature search disclosed previous articles reporting significant success with septoplasty and particularly middle turbinectomy on rhinologically triggered migraine headaches.<sup>9</sup> This resulted in the design of another study identifying four trigger sites: the corrugator group, which causes frontal headaches; the temporalis muscle trigger area, which compresses the zygomaticotemporal branch of the trigeminal nerve and induces temporal headaches; the semispinalis capitis muscles, which cause headaches in the occipital area; and septonasal trigger sites, which result in paranasal and retrobulbar migraine headaches. We designed an algorithm that we now use to identify the trigger sites. This ongoing study is producing extremely encouraging results for both identification of the trigger sites and surgical treatment. The details of our follow-up study will be submitted for publication as soon as sufficient and meaningful information is available.

One of the recent observations that we have made is the development of an hourglass deformity subsequent to injection of Botox in the temporal area.<sup>10</sup> This is a disuse atrophy and is temporary in nature. The condition will correct itself as soon as the effects of Botox in the temporalis muscle cease.

The role of Botox and surgery in elimination of migraine headaches is colossal, since 28 million Americans suffer from migraine headaches. We are investigating economic aspects of this treatment in depth. It is also ironic that not only do those patients who undergo removal of the corrugator supercillii muscle benefit medically from both Botox and surgery but at the same time they enjoy rejuvenation of the forehead. Furthermore, for those patients who undergo septoplasty and turbinectomy, in addition to experiencing an improvement in the frequency and/or severity of their migraine headaches, they will often notice improvement in the nasal airway as well. This is highly unusual. Seldom in the surgical field does a procedure that might fail to deliver the intended medical benefits result in an unintended functional or aesthetic benefit. In contrast, a failed operation often results in visible scars and potentially serious complications. All of

the incisions are placed within the hairline and are therefore not readily discernable, another positive attribute of these surgical techniques we have designed to aid patients with migraine headaches.

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