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SRF Project: Strabismus Injection Treatment for Children

Injection Treatments For Strabismus

Strabismus, an array of variously-caused disorders of eye alignment and movement, is mostly treated surgically by shortening or repositioning one or more of the 12 *extraocular muscles* (EOMs) which rotate the eyes. Surgery generally restores function by compensatory impairment of healthy muscles, rather than by correcting the underlying disorder.

We have long been interested in pharmacologic injection treatments to supplement or provide alternatives to surgery. Oculinum® (now called Botox®) was originally developed in our lab to relax and lengthen abnormally short eye muscles (Scott 1980). It temporarily weakens them, allowing *antagonist muscles* (muscles pulling opposite) to stretch them out. We've now turned our attention to the opposite problem. In a recently completed NIH project, we treated 45 volunteer patients with bupivacaine (BPX), demonstrating the first practical method for strengthening weak eye muscles, causing them to shorten and correct eye misalignments (eg, Miller, Scott, et al 2013). Work continues on improving BPX injection effectiveness, and on better understanding its mechanism of action. [For more, see *Recent Findings* and *Current Projects* at srfsf.org]

The Special Problems of Strabismus in Children

Most strabismus patients are children. Early treatment of infantile strabismus facilitates normal development of *stereopsis* (depth perception from binocular vision), prevents *amblyopia* (suppression of vision in one eye), and improves cosmesis. But surgical correction in young children can be problematic. First, in 25-33% of cases additional surgery is later needed, which is made difficult by scarring from the initial surgery; it would be better if injection treatment were used, at least initially. Second, strabismus surgery requires prolonged general anesthesia, which can cause enduring cognitive deficits in a developing brain (eg, Rappaport et al 2015).

Our Project

EOMs lie deep in the orbit, not normally visible, so a technique is needed to accurately place the injection needle within the target muscle. In cooperative adults, electromyography (EMG) signals are recorded from the tip of the injection needle, which is advanced until the relationship of the EMG signal to the patient's voluntary eye movement indicates proper placement, whereupon the injection is completed. Children, however, would have to be briefly anesthetized during the injection, and anesthetized muscles show no movement-related electrical activity. They will, however, contract in response to electrical stimulation. Thus, we are developing a method to accurately target electrically silent muscles using the tip of the injection needle to stimulate the target muscle, causing contraction and movement of the eye in a characteristic direction. Having demonstrated efficacy in animals, we now need to compare stimulation against EMG guidance in adults, documenting injection accuracy using MRI examinations of the muscle following injection, as is routine with our adult injection patients. Application in children would follow, under protocols defined by these results.

Benefits

To treat infantile strabismus early enough for vision to develop normally, while minimizing neurotoxic anesthesia and orbital scarring, there is clear need for a minimally invasive treatment with long-term benefits, such as that provided by BPX injection, with a delivery system suitable for children.

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