Medical and Surgical Management of Drooling

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Systemic Pharmacotherapy

Historically, anticholinergic medications have been the most commonly used pharmacotherapy to control sialorrhea. As mentioned previously, the parasympathetic nervous system and its primary neurotransmitter, acetylcholine, are responsible for the higher volume secretions in the drooling patient. These medications, which include glycopyrrolate, scopolamine, benztropine, and benzhexol hydrochloride, act to block cholinergic receptors, thereby decreasing salivary flow rates. Systemic side effects are very common, however, as their effects are not site-specific. These include urinary retention, tachycardia, headache, blurred vision, constipation, and excitation. Measurement of efficacy can be difficult and is often subjective. Glycopyrrolate has repeatedly been proven to significantly decrease drooling, but the rate of adverse effects ranges from 40-70% with 20-30% of subjects withdrawing secondary to these adverse effects.[1,2] Transdermal scopolamine has also been shown to be effective and has the advantage of only needing to be placed every 3 days,[3] however, because it is another systemic anticholinergic, long term side effects are still significant.[4] Antireflux therapy has also been used in sialorrhea, but a randomized controlled trial with ranitidine showed no difference when compared with placebo.[5] More recently, modafinil, a psychostimulant used to treat spasticity in cerebral palsy patients, was shown to have beneficial effects on drooling found incidentally in two patients.[6] These two cases are the only published reports and further study in certainly needed before any conclusions can be drawn.

Botulinum Toxin

Botulinum toxin is a neurotoxin harvested from the bacteria *Clostridium botulinum*, and acts by inhibiting presynaptic release of the parasympathetic neurotransmitter acetylcholine into the synaptic cleft. It is via this mechanism that botulinum toxin is a potential treatment agent. The first published uses of injectable purified botulinum toxin were for strabismus and blepharospasm.[7,8] Other published uses now include cervical dystonia, facial rhytids, spasmodic dysphonia, and hemifacial spasm. Because of the high rate of adverse effects with systemic anticholinergic medications, the use of botulinum toxin in drooling was introduced into the literature by Bushara in 1997 in adult patients with amyotrophic lateral sclerosis.[9] It was published for use in children with cerebral palsy in 2001,[10] and since then has drastically grown in popularity. An additional 40 papers in children alone have been published at the time of this printing.

Several studies have shown a reduction in sialorrhea in children with cerebral palsy with injection into either the parotid glands, the submandibular glands, or both.[11-13] It appears that the peak effect occurs between about 2-6 weeks after injection, and then begin to wear off, although the length of benefit appears to be variable in each particular child.[4] There has been very little agreement or stan-

dardization regarding the dosage into each salivary gland, with different studies using between 10-30 U in each submandibular gland and 15-40 U in each parotid gland.[4,12,13] Injections generally are performed at 2 sites per gland. The side effects that have been reported in the literature include temporary difficulty swallowing, neck pain, diarrhea, and altered gait.[4] Although systemic paralysis and even death has been reported in cosmetic injections of botulinum, no cases have been reported in the drooling patient. Reduction of adverse effects is thought to be possible by using ultrasound guidance of the needle in each gland.[11,14] In a controlled trial comparing botulinum with an oral anticholinergic agent, there was a similar reduction in drooling (49-53%), but nearly ¾ of patients on the anticholinergic developed systemic side effects, compared with only temporary local side effects in 5% of the botulinum group.[4] Furthermore, there may be atrophy of the salivary glands with repeated injections which theoretically could lead to much longer injection intervals. This will need to be proven with better long term controlled data.

It should be noted that botulinum toxin is not FDA approved for injectable use in sialorrhea. Obtaining clear written consent is strongly recommended. Outside of the side effects, there are certain disadvantages to using injectable botulinum in sialorrhea. In children, general anesthesia is usually required. Children who are good responders will need repeated injections, which may need to occur as frequently as every three to four months. In addition, there may be resistance and subsequent decreased efficacy with repeated injections, although the extent to which this occurs remains largely unknown. In summary, injectable botulinum toxin is not a panacea for the drooling child, but certainly offers significant advantages, particularly when compared to other pharmacologic choices.

Surgical Treatment

Surgical intervention is not recommended until a child has failed intensive oral motor therapy for at least 6 months. If ongoing improvement is seen with oral motor therapy avoidance of surgery should be considered as this is an indication that terminal maturation of oromotor function is not complete. Surgical therapy is generally deferred until at least 5-6 years of age for this reason. In cases of recurrent and chronic pneumonitis from chronic aspiration, however, surgery is considered at much younger ages. Most surgical candidates will have profuse drooling and neurologic impairment to a degree that precludes compliance with nonsurgical therapy. Pharmacologic failure is not a prerequisite, but many patients who present to an otolaryngologist for drooling will have failed oral anticholinergic therapy in the past, most commonly secondary to the side effects.

When classifying surgeries aimed at controlling sialorrhea, there are two broad categories: those that decrease the overall amount of saliva produced (tympanic neurectomy, submandibular gland excision, submandibular and parotid duct ligation) and those that redirect salivary flow more posteriorly so it is more readily swallowed (submandibular duct relocation, parotid duct relocation). There is controversy as to which type of procedure is superior. Those who favor relocation argue that the problem is not overproduction of saliva but difficulty with transfer from the mouth to the oropharynx. Directing flow posteriorly maintains normal saliva production, reducing complications such as xerostomia and dental caries.[15]

Surgeons who favor flow-decreasing procedures argue that directing flow posteriorly with relocation increases the risk of lower airway problems in children who may already be prone to aspiration secondary to neurologic impairment. They also argue that in most instances adequate salivary flow to prevent xerostomia and dental caries is maintained by minor salivary glands.[16]

Tympanic Neurectomy

Postganglionic parasympathetic fibers to the sublingual, submandibular, and parotid glands all run through the middle ear space. Via a transcanal tympanomeatal flap, the tympanic plexus and Jacobson's nerve (parotid gland) and the chorda tympani nerve (submandibular and sublingual glands) are divided bilaterally.[17] Although this is a relatively simple procedure to perform, the bilateral otologic surgery does bring the attendant risk of permanent sensorineural hearing loss. Altered taste is also associated with transaction of the chorda tympani. More importantly, however, is that within 6 months most patients will have sialorrhea return to preoperative levels. This procedure has largely been abandoned in the treatment of drooling for this reason.

Submandibular Gland Excision and Submandibular/Parotid Duct Ligation

Bilateral external submandibular gland excision with or without parotid duct ligation is the most common flow reducing procedure for sialorrhea. A review of nearly one hundred children showed significant improvement in 65% of patients at an average follow up of over 4 years.[16] The complication rate was 13%, most of which were related to xerostomia and dental caries. Other potential complications include marginal mandibular, hypoglossal, and lingual nerve injury, as well as hematoma. It also requires a hospital stay and leaves external neck scars. Some authors argue that parotid duct ligation is unnecessary in most cases as basal saliva is produced primarily by the submandibular gland: the Drooling Control Clinic in Toronto reported that only 5% of patients needed parotid duct ligation secondary to persistent drooling after submandibular duct relocation.[18]

Submandibular duct ligation, instead of gland excision, has recently been described.[19] This technique eliminates many of the complications and morbidity of open excision of the submandibular glands, in addition to decreasing operative time. Functional atrophy of the gland is thought to be the physiologic basis for the success of this procedure. In the aforementioned review of 5 patients, there was substantial improvement with a median follow up of 13 months, with only temporary postoperative neck swelling described.[19] No cases of xerostomia were observed. Ranula formation, although not described in this study, is a possible risk and larger long term data will be needed to address this.

Intraoral submandibular gland excision has also recently been published as an alternative to open excision.[20] A review of 77 patients, mainly adults with sialadenitis, who underwent this technique showed good long term results without external neck scar or risk of marginal mandibular nerve injury. There was a high incidence of decreased tongue mobility (70%) and lingual nerve paresis (74%) but these complications were temporary in all cases, resolving by 6 weeks without intervention. One disadvantage to this technique is the more difficult surgical dissection when compared to an external approach.

Parotid Duct Relocation

Parotid intervention is controversial in the drooling patient. As mentioned previously, some authors argue that intervention is unnecessary in most cases. What is fairly clear, however, is that parotid gland/duct surgery should never be performed without concurrent or previous submandibular gland/duct surgery. Parotid duct relocation in conjunction with tonsillectomy and submandibular gland excision was previously described in the late 1970's.[21] Although control of sialorrhea was adequate, a 35% complication rate was reported, which included wound breakdown, duct stenosis, and infections, including septic parotitis. This procedure has been largely abandoned, particularly given the lower morbidity and decreased operative time of ductal ligation.

Submandibular Duct Relocation/Sublingual Gland Excision

Submandibular duct relocation was first described in 1969 and has been the workhorse in saliva-diverting procedures for the past 30 years. This procedure involves creating a mucosal island with an oval incision around both ductal papillae. The ducts are then identified and dissected back to the level of the submandibular gland. The mucosal islands are then separated and each duct with its own papilla is brought posteriorly submucosally and sutured in place in the ipsilateral tonsillar fossa. This is often performed in conjunction with tonsillectomy, particularly in cases of tonsillar hypertrophy or those with deep debris-filled crypts. This procedure was reported with excellent results and little morbidity from two large drooling centers, but ranula and lateral neck cyst formation necessitating sublingual gland excision occurred in 8-13% of cases.[22,23] In an effort to eliminate ranula formation, sublingual gland excision was added to ductal relocation in the late 1980's.[22] Long term data showed control of drooling in 2/3 of patients at 5 years with no postoperative ranulae noted.[15] A complication rate of about 10% has been reported, including airway obstruction secondary to tongue swelling, lingual nerve injury, abscess, and aspiration pneumonia.

Conclusion

Management of the drooling child is challenging and an individualized approach must be taken with each patient and family. There is no "one size fits all" treatment. It is critical that a multidisciplinary approach be employed to exclude easily reversible causes of sialorrhea. Determination of clinical complications of drooling, particularly aspiration pneumonias and chronic lung disease, are important in assessing the aggressiveness of potential intervention. In the absence of complications, parent distress and treatment expectations need to be gauged when determining if intervention is prudent. After control of situational factors, oral motor therapy remains the first line remedy. Consideration can also be given to biofeedback in the right subset of patients. Systemic pharmacotherapy has yielded good short term results with long term effectiveness limited by side effects and tachyphylaxis. Injectable botulinum toxin has yielded promising short term results with a low side effect profile, but the effects are temporary and require repeated injection. Some data suggest that glandular atrophy occurs with multiple injections, but long term data will be necessary to confirm this hypothesis. Surgery is the final treatment option and is usually deferred until the above options have all failed.

There are two general types of procedures: those that redirect normal salivary flow, and those that diminish salivary flow. Each of these types has advantages and disadvantages, and no good data exists to support one procedure over another.

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