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Drooling in developmentally normal children: a review

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Review Article

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Abstract

Objective. Drooling or saliva spillage has been explored widely among children with neurodevelopmental conditions. Yet, the approach to drooling in an otherwise developmentally normal child remains unexplored, as it is regarded as self-limiting. Nonetheless, drooling beyond age 4 in the awake stage should raise concern.

Methods. This narrative review aims to shed light on drooling in developmentally normal children, also known as 'healthy droolers', and the available evidence on its management.

Results. Most notable factors causing saliva spillage include poor oral-motor control and impaired oral sensation. Delayed saliva acquisition may be an early indicator of developmental or intellectual delay. Drooling impairs both the children's and parents' overall quality of life significantly.

Conclusion. Healthy droolers can be managed by simple behavioural therapy and reassurance.

Introduction

Unintentional loss of saliva, also termed drooling, has traditionally been linked with neurodevelopmental conditions in children, notably cerebral palsy. Salivary continence, which is typically attributed to the control of the tongue and bulbar muscles, is achieved between 15 and 18 months of age in a child with normal development.[1] In a recent consensus paper on the management of anterior drooling by the International Paediatric Otorhinolaryngology Group (IPOG),[2] saliva control is attributed to oromotor and sensory function maturation, which is thought to be between 18 and 24 months of age.[2]

Drooling can be further subclassified into anterior and posterior drooling, whereby saliva leakage beyond the oral cavity over the lower lips and chin is regarded as anterior drooling, while salivary spillage into the hypopharynx beyond the oropharyngeal isthmus is termed posterior drooling. Developmentally healthy children are thought to develop anterior rather than posterior drooling, although the exact causes of anterior drooling in healthy children beyond four years of age remain unexplored.

Approximately 0.6 per cent of the general population has been reported to drool,[1] although the reported incidence of drooling in children diagnosed with cerebral palsy is 30–53 per cent.[3] Nonetheless, in an otherwise healthy child, drooling in the awake stage beyond four years of age should raise concern.[3] Although studies have acknowledged this issue, drooling in developmentally normal children has not gained adequate attention and is oftentimes overlooked. This article aims to shed light on the evidence available on drooling in developmentally normal children.

Physiology of swallowing saliva

Saliva is produced by three major paired glands: parotid, submandibular sublingual, as well as minor salivary glands scattered throughout the aero-digestive tract. Ninety per cent of saliva is produced by the major salivary glands. In the resting stage, the submandibular gland produces 70 per cent of high-viscous saliva, whereas the parotid gland produces 70 per cent under taste stimulation.[4]

Saliva's role in human physiology has always been limited to lubricating the oral cavity, maintaining oral hygiene and facilitating deglutition. However, it is worth noting that saliva also plays an important role in neutralising oesophageal acidity,[5] wound healing, blood clotting, buffering properties that protect against infection and inflammation,[6] and digestion.[1]

A non-conditioned reflex mediates the secretion of saliva. The afferent nerve signal reaches the central nervous system once the chemoreceptors and mechanoreceptors in the oral cavity are stimulated, resulting in the transmission of the efferent action potential through sympathetic and parasympathetic pathways to the respective salivary gland to produce saliva.

Swallowing saliva incorporates volitional and reflexive actions that require the integrity of five nerves and 30 muscles.[7] Salivary flow in childhood is influenced by several factors,

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including teeth eruption, dietary changes, transition to oral that requires chewing, age,[8] environmental factors and conditions such as temperature and humidity.[9] In a healthy child, the salivary flow changes are adapted through implicit motor learning, which entails practice and refinement, leading to spontaneous saliva swallowing.[10] It is worth noting that drooling in children is generally unrelated to increased saliva production and is more related to oromotor incoordination.[11]

Pathomechanism of drooling

Drooling is considered part of a swallowing disorder, specifically the oral phase of swallowing.[11,12] As a part of normal swallowing development, oromotor control is attained by refining oromotor skills by moving the jaw, lips, and tongue to form a bolus in children from 12 to 36 months of age.[13] The oral phase of swallowing encompasses two stages: the preparatory or suction stage and the propulsion stage.[14] The preparatory stage mainly depends on the intraoral pressure, which is achieved by movements on the tongue and mandible to collect saliva or liquids to form a bolus.[14] Negative intraoral pressure[15] and lip seal are required to collect saliva above the tongue and to facilitate bolus propulsion.

In healthy droolers, it is postulated that saliva spillage occurs because of failure of the full lip seal. Nonetheless, ineffective coordination of swallowing muscles and poor head position can worsen the severity of drooling.[16]

Drooling in developmentally normal children

It is worth noting that, to date, there is no consensus regarding the exact age at which a developmentally normal child should achieve saliva control. Physiological drooling has been reported in children up to 18 months of age,[17] while drooling up to the age of 4 years is acceptable by many authors.[18] van Hulst *et al.* advocated that a small group of children may drool beyond the age of four years, which is considered normal variability,[19] although they found in their series that approximately three per cent of these "healthy droolers" were at risk of pathological drooling.[19]

Drooling in healthy children can be attributed to several factors, including (1) nasal obstruction, (2) poor oral motor control, (3) impaired swallowing, (4) lack of sensation, (5) poor postural control or head position, (6) dental caries/infection, and (7) habitual. Table 1 summarises the aetiological factors causing drooling in healthy children.

Pathological drooling is ascribed to issues related to (1) sensory processing within the oral region, (2) oral motor difficulty during swallowing, and (3) lack of coupling between the sensation present upon saliva spillage and the swallowing process.[20]

What does the evidence show?

The literature on developmentally normal droolers is scarce. Johnson *et al.* found that "typically" developing children may have delayed saliva control.[21] They reported on 21 healthy children with normal development who had been referred to a saliva control clinic. The study looked at the long-term outcome of this group of children, factors contributing to the drooling behaviour and parents' perceptions of the usefulness of the clinic. These children had a mean age of 4.9 years and were followed up for a mean period of 3.4 years (range 1–8.2 years). Open-mouth posture was reported in 15 of the included children. Johnson *et al.* found that saliva control was achieved between 3.1 and 8.3 years or age (mean of 5 years) with a statistically significant improvement in saliva control ($p < 0.01$). Additionally, 17 of 21 parents found the clinic to be useful.[21]

Table 1. Summary of aetiology of drooling among developmentally normal children

Postural/head positioning
Poor lip closure
Poor oromotor control

Mouth breathers
• Nasal obstruction
  ○ Adenotonsillar hypertrophy
  ○ Deviated nasal septum
  ○ Nasal polyp
  ○ Macroglossia
• Malocclusion

Poor sensation around mouth
Teething
Ankyloglossia
Impaired and/or delayed swallowing – Oropharyngeal incoordination
Jaw instability
Reflux
Thumb sucking and/or pacifier
Habitual
Impaired concentration and/or lack of social awareness
Unknown cause

An earlier study by Talmon *et al.* reported on the surgical management of drooling among healthy children and demonstrated that saliva control was achieved with unilateral salivary duct transposition in 86 per cent of the children.[22] Talmon *et al.* advocated transposition of Wharton's duct as an ideal mode of treatment because it does not interfere with the normal physiology of the salivary gland. As a result of this technique, saliva is ejected directly into the oropharynx where the swallowing process becomes involuntary, requiring no prompting to swallow.[22] Crysdale *et al.* recommended no treatment for drooling in healthy children,[18] although the specifics and severity of drooling in these children were not mentioned.

Drooling in developmentally normal children has been mentioned in recent publications (after the 2010s), although specific management and outcome details were not outlined.[19,23,24] van Hulst *et al.* found that 3–15 per cent of healthy children above 4 years of age in their study were still drooling, among which 3 per cent were regarded as pathological drooling.[19] Chen *et al.* reported that 22 droolers in their study were without any diagnosis, which could indicate that these children were healthy or had normal development.[24]

Gender variation is postulated to affect saliva control. van Hulst *et al.* reported variation in the period of saliva control between boys and girls, whereby girls were reported to stop drooling earlier than boys.[19] This is not surprising as girls have been found to develop complex oral–motor skills earlier. A sonographic study of healthy foetuses revealed significant differences in the development of specific lingual and pharyngeal structures and orolingual movements, suggesting a sex-specific trajectory of motor development.[25] Hence, saliva control, which requires refined oral–motor control and swallowing coordination, will be achieved later in boys. It is also worth

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noting that stimulated saliva secretion has been reported to be lesser in females than in their male counterparts across all age groups,[26] although whether this contributes to the smaller number of female droolers is still unknown.

Adenotonsillar hypertrophy can cause a range of issues related to obstruction, including drooling. It is hypothesised that it is not just nasal obstruction from adenoid hypertrophy that can lead to drooling but also the effect of enlarged tonsils. Lundeborg *et al.* reported improvement in oromotor function in patients undergoing adenotonsillectomy, including both extracapsular and intracapsular tonsillectomy techniques.[27] Most patients with adenotonsillar hypertrophy ($n = 67$) had oromotor dysfunction prior to surgery, including open mouth posture, drooling, masticatory and swallowing problems. These problems improved following adenotonsillar surgery to levels equal to those in controls.

Why should we address drooling in developmentally normal children?

As gracefully stated by Wikie *et al.*,[28] "Drooling warrants treatment when it interferes with the patient's well-being." Despite the postulation that saliva control will eventually be achieved due to the maturation of oral–sensory–motor functions causing fine-tuning and coordination of swallowing,[29] the duration, outcome and ramifications from drooling in an otherwise healthy child remain unknown.

Chronic drooling has been linked to skin irritation and erythema, particularly in the lips and chin area, halitosis, oral infection, interference with feeding and swallowing, dehydration, aspiration and chest infection.[1] Due to drooling, damage to electronic equipment, such as mobile phones and computers, causes significant distress to children and caretakers. Droolers have been reported to have difficulty with speech as saliva interferes with articulation, leading to saliva spray during speech. Speech intelligibility is reduced in children with poor saliva control as saliva pooling at the floor of the mouth may interfere with articulation.

Nevertheless, many may not be aware of the significant social embarrassment, rejection and isolation resulting from drooling for the patient and the entire family. Children attending preschool and school are prone to being bullied and harassed due to frequently having saliva dribbling or having to wear a bib in the classroom. In the long term, this may cause psychological disturbance to the child, which may have a long-lasting effect on the child's general wellbeing.

What's next?

Developmental assessment in children does not assess the acquisition of saliva control. Evidence shows that drooling may not be self-limiting, as previously thought, and should be addressed earlier.[21]

Developmentally normal children with poor saliva control should be referred to and managed in a saliva control clinic, in which a multidisciplinary team (MDT) involving a paediatric otorhinolaryngologist, paediatric dental specialist, and speech and language therapist ensure a holistic approach. The role of a paediatric otorhinolaryngologist is to provide expertise to diagnose ear, nose and throat conditions that can cause drooling in children. Paediatric dental specialists can provide information regarding dental hygiene assessments, need for dental treatment and the suitability of the child for oral appliances. Speech and language therapists can assess swallowing and speech disorders and oromotor skills, as well as develop individualised strategy plans such as positioning, oromotor, behavioural, biofeedback and reinforcement therapy.

Following the initial assessment by individual team members, paediatric otorhinolaryngologists chair the MDT by discussing the case history and findings, followed by each team member discussing the strategy suitable for the child in a stepwise manner. We recommend referral to a paediatric developmental specialist and paediatric physiotherapist for assessment as this may be an early warning sign or indicator of developmental or intellectual delay, such as autism or attention deficit hyperactivity disorder (ADHD).

We have no evidence as to what the ideal approach for drooling in developmentally normal children is to date. Despite the scarce literature, saliva control in these groups of children can be managed successfully through a stepwise approach as performed in most children with drooling:[30] observation and reassurance, rehabilitation and pharmacological and surgical options.

Observation and reassurance[31] may be adequate for children and their parents or guardians, as drooling in older children may result in significant parental anxiety and isolation. Simple behavioural therapy by prompting the child to swallow and wipe their chin is a good start. Johnson *et al.* reported that 81 per cent of parents of "healthy droolers" were satisfied after attending a saliva control clinic.[21] Along these lines, the authors mentioned that behavioural strategies were helpful in 71 per cent of the children, although interestingly, no surgical intervention was mentioned in this paper.

Recent papers have touted that nasal obstruction and mouth breathing[32] secondary to adenoid/adenotonsillar hypertrophy contribute to drooling in healthy children. Therefore, a full assessment of adenotonsillar symptoms and physical examination of tonsillar size, followed by surgical intervention, such as adenotonsillectomy where indicated, should be carried out if behavioural strategies fail in saliva control.

- Healthy droolers are drooling in children who are otherwise developmentally normal
- Drooling or unintentional loss of saliva beyond 4 years needs to be investigated
- Most notable factors causing saliva spillage include poor oral-motor control and impaired oral sensation
- Delayed saliva acquisition may be an early indicator of developmental or intellectual delay
- Drooling impairs both the children's and parents' overall quality of life significantly
- Healthy droolers can be managed by simple behavioural therapy and reassurance

Nonetheless, the role of pharmacological therapy, including scopolamine patches, atropine drops, oral glycopyrrolate, and botulinum toxin injections to the salivary glands should be kept in mind, especially among children who failed behavioural therapy or oromotor therapy and couldn't tolerate oral appliances with significant drooling which affects the quality of life, or in children who present with complications as a result of drooling. Pharmacological treatment, especially in oral or patch form, can be effective in helping these children return to their everyday lives without being afraid of social embarrassment. Having said that, there are no published papers on pharmacological therapy among healthy children who drool, possibly due to the side effects resulting from these medications.

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Conclusion

Studies on healthy droolers, risk factors, the role of genetics and epigenetics, as well as long-term outcomes remain elusive. Given the consequences of drooling, especially the long-standing psychological effects, we urge children with poor saliva control to be referred to a saliva control clinic as early as four years of age. Parallel to that, saliva control should be included in a child's developmental milestones. A multidisciplinary team should assess healthy droolers to ensure holistic assessment and management, as failure to control saliva could be an early indicator of developmental or intellectual delay.

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