Novel Primitive Swallowing Reflex: Facial Receptor Distribution and Stimulus Characteristics*

Susan R. Orenstein, M.D.,1 Ira Bergman, M.D.,2 Roy Proujansky, M.D.,1 Samuel A. Kocoshis, M.D.,1 and Vicki S. Giarrusso, B.S.N.1
1Divisions of Pediatric Gastroenterology and 2Pediatric Neurology, University of Pittsburgh School of Medicine, and Children’s Hospital of Pittsburgh, Pittsburgh, Pennsylvania, USA

Abstract. We recently described a primitive swallowing reflex: swallowing as a response to a puff of air administered to the face. To identify the facial afferent distribution of this response, the necessary characteristics of the stimulus, and the role of the infant’s antecedent behavior, we studied 13 infants who had demonstrated this reflex.

We evaluated nine infants by clinically observing for swallowing in response to a total of 135 stimulus applications. All nine had consistently positive responses to the maxillary-ophthalmic area and to the maxillary-mandibular area. Two had consistent responses to stimulation of the mandibular area alone; these were positive. Six had consistent responses to stimulation of the ophthalmic area alone; these were negative.

Four infants, evaluated by manometric documentation of swallowing (a total of 137 stimulus applications) demonstrated 47 of 79 (59%) positive responses to stimuli applied to facial areas including any parts of the lips, but only 7 of 28 (25%) positive responses to stimuli applied to facial areas excluding all parts of the lips (chi-square $P = 0.002$).

Light touch to any facial area, including the cornea, failed to produce a swallow in any infant. Crying and sleep were incompatible with the reflex. This newly identified primitive swallow reflex seems to require diffuse stimulation, possibly thermal, to the perioral area of the face in an awake and noncrying infant.

Key words: Reflex, primitive — Swallow — Trigeminal — Deglutition — Deglutition disorders.

We recently described a primitive swallowing reflex which occurs in young infants and neurologically abnormal older individuals as a response to a puff of air administered to the face [1]. This reflex is of interest both as a component of normal developmental physiology and as a useful method to induce swallowing in neurologically immature or abnormal humans.

The efferent arc of the reflex is a manometrically complete primary peristaltic sequence beginning with a normal swallow starting within a few seconds of the stimulus application. We sought to identify the characteristics of the stimulus required to induce the reflex, especially the sensory distribution of the receptors on the face. Our secondary goals were to clarify the necessary characteristics of the stimulus itself and to determine the role of the subject’s antecedent behavior state.
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Fig. 1. Results: clinical observation of swallow. Results of segmental trigeminal stimulation in nine infants scored by clinical observation of swallowing. Shaded areas were shielded from stimulation. Positive signifies the number of subjects with consistently positive responses, divided by the number of subjects with consistent responses (either positive or negative). Negative signifies the number of subjects with consistently negative responses, divided by the number of subjects with consistent responses (either positive or negative). As shown, stimulation of the perioral area was required for consistent positive responses; stimulation which did not involve this area was consistently negative in all subjects demonstrating a consistent response.

Methods

A total of 13 infants was studied. First, nine infants younger than 8 months of age (range 4 to 34 weeks) who had demonstrated the reflex with the standard stimulus were studied. The stimulus used was an abrupt puff of air of 100 to 300 cc administered to the subject's face from a distance of approximately 30 cm using a self-filling ventilating bag. After their parents had consented to their testing, the infants each had at least three trials of the stimulus directed at the entire face, followed by at least three puffs directed at each of the three trigeminal nerve branches. The rest of the face was shielded by specially cut sheets of X-ray film, held curved around the face but not touching it. The trigeminal branches were evaluated, singly or in pairs of adjacent branches, in random order as determined by lottery for each child: the ophthalmic branch excluding the eyes and nasal bridge (the forehead), the mandibular branch (the chin and lower lip), the maxillary-ophthalmic area (the face excluding the chin and lower lip), and the maxillary-mandibular area (the face excluding the eyes and forehead); see Figure 1. Thus, each of these nine infants had a total of 15 stimulus applications. A positive response for these nine infants was a swallow observed visually or palpated at the infant's neck.

The second part of the study involved four other infants with the reflex who were studied during esophageal motility testing done for clinical indications ( gagging with feedings or identification of the lower esophageal sphincter for pH probe placement). The protocol had been approved by the Children's Hospital of Pittsburgh Human Rights Committee. These infants were aged 2 months, 4 months, 4 months, and 22 months; the 22-month-old was neurologically abnormal due to carnitine deficiency and therefore demonstrated the primitive swallow reflex despite her greater age. The triple-lumen motility catheter (ports at 1-cm intervals, total outer diameter 4 mm, perfusion rate 0.6 ml/min, response rate 250 mm Hg/s) was located with its most proximal port below the upper esophageal sphincter, to avoid stimulating swallowing by pharyngeal perfusion. It was perfused by a low compliance hydraulic capillary perfusion system (Arndorfer Medical Specialties, Greendale, Wis.) and linked by Cobe strain gauge transducers (Cobe Laboratories, Lakewood, Col.) to a Sandhill Esophageal Motility System multichannel polygraph (Model DMSA, Sandhill Scientific, Littleton, Col.). A total of 137 stimulus applications of varying attributes were used to clarify the necessary characteristics of the antecedent behavior and of the stimulus itself. Various areas of the face were shielded with cut sheets of film for this testing. Because the earlier nonmanometric testing had suggested a focus on the maxillary and mandibular areas of the face, particular attention was given to whether stimulation of the lips was required to elicite the response. A positive response to a given stimulus for these four infants was defined as a manometrically identified peristaltic wave calculated to have occurred at the upper esophageal sphincter within 3 s of the stimulus application and propagated from there to the ports at which it was detected at a rate between 1 cm/s and 5 cm/s. On several occasions artifact from crying obliterated the manometric peristaltic wave in the distal esophageal body ports, but lower esophageal sphincter relaxation was documented and/or swallowing was clearly observed to occur. These responses were also scored as positive.

Results

All nine infants whose swallows were identified by observation or palpation of their neck (Fig. 1) had positive responses to stimulation of the maxillary-ophthalmic area and the maxillary-mandibular area. Response to stimulation of the ophthalmic branch alone was consistently negative in six infants and was variable in each of the other three. Response to stimulation of the mandibular branch alone was consistently positive in two infants and was variable in each of the other seven.

Manometric study of the four further infants included a total of 137 stimulus applications (Fig. 2). Twenty-five of these stimuli were applied during sleep, resulting in an associated swallow in only one of them. Five additional puffs of air produced uninterpretable responses due to crying artifact. The other 107 applications were to varied areas of the face. Of these, 79 were to portions of the face including one or both lips; 47 of them resulted in a