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Older Age Reduces Upper Esophageal Sphincter and Esophageal Body Responses to Simulated Slow and Ultraslow Reflux Events and Post-Reflux Residue

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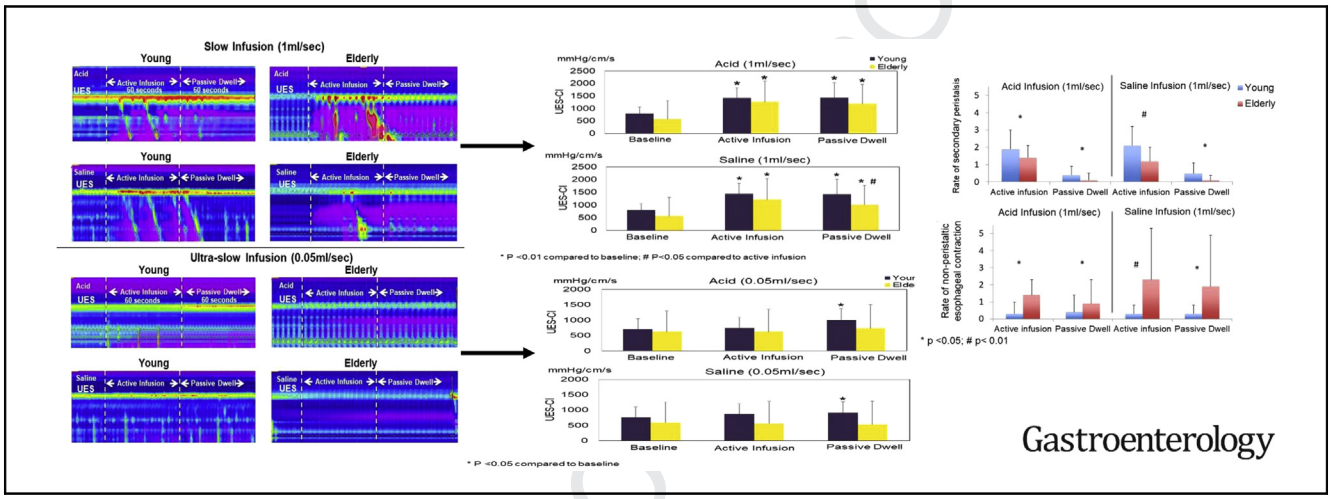

BACKGROUND & AIMS: It is not clear how age affects airway protective mechanisms. We investigated the effects of aging on upper esophageal sphincter (UES) and esophageal body pressure responses to slow and ultraslow simulated reflux events and post-reflux residue. **METHODS:** We performed a prospective study of 11 elderly (74 ± 9 years old) and 11 young (28 ± 7 years old) healthy volunteers. Participants were placed in a supine position and evaluated by concurrent high-resolution manometry, impedance manometry, and by an infusion technique. Potential conditions of gastroesophageal reflux were simulated, via infusion of 0.1 N HCl and saline. UES and esophageal pressure responses were measured during the following: slow infusion (1 mL/s) for 60 seconds; 60 seconds of postinfusion dwell period; ultraslow infusion (0.05 mL/s) for 60 seconds; or 60 seconds of a postinfusion dwell period. All infusions were repeated 3 times. We used the UES high-pressure zone contractile integral (UES-CI) to determine responses of the UES. **RESULTS:** Young and elderly subjects each had a significant increase in the UES-CI during slow infusions and during entire passive dwell intervals compared with baseline ($P < .01$, both groups). Ultraslow infusions were associated with a significant increase in UES-CI in only the young group, in the late infusion period, and into the dwell interval ($P < .01$). During the slow infusions and their associated dwell periods, young subjects had a higher frequency of secondary peristalsis than elderly subjects ($P < .05$). There was more secondary peristalsis during active infusions than dwell intervals. Secondary peristalsis was scarce during ultraslow infusions in both groups. **CONCLUSIONS:** UES and esophageal body pressure responses to low-volume ultraslow reflux and associated post-reflux residue are reduced in elderly individuals. This deterioration could have negative effects on airway protection for people in this age group.

Keywords: Reflux; Upper Esophageal Sphincter; Secondary Peristalsis; Post-Reflux Period.

Mechanisms of airway protection against aspiration of gastric contents are complex and are not completely understood. The dual function of the pharynx as both the air and food passage allows luminal contiguity between the lung/airway and stomach, which provides the anatomic basis for aspiration of gastric contents. Our understanding of airway protection is evolving and there are

Abbreviations used in this paper: **EUCR, esophago-UES contractile reflex; LES, lower esophageal sphincter; REM, rapid-eye movement; UES, upper esophageal sphincter; UES-CI, UES high-pressure zone contractile integral.**

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WHAT YOU NEED TO KNOW

BACKGROUND AND CONTEXT

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NEW FINDINGS

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LIMITATIONS

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currently 2 sets of mechanisms identified: the basal and reflex responses that can interrupt this anatomical contiguity and prevent pharyngeal transposition of gastric contents and aspiration.[1–3] Basal mechanisms include the lower esophageal sphincter (LES) and upper esophageal sphincter (UES) that maintain sustained although fluctuating pressure barriers between the stomach and esophagus as well as the esophagus and pharynx, respectively. The reflex response mechanisms include several reflexes emanating from the esophagus, pharynx, and larynx that result in either transient fortification of the UES pressure barrier and closure of the airway or clearance of the refluxate from the pharynx and esophagus.[4–7]

A number of studies have documented alterations of these reflex mechanisms in different conditions. For example, pharyngo-UES contractile, pharyngo-glottal closure, and laryngo-UES contractile reflexes as well as the reflexive pharyngeal swallow were found to deteriorate with aging.[8–10] The esophago-UES contractile reflex (EUCR), secondary esophageal peristalsis, and esophago-esophageal reflex have been reported to be abnormal and unable to prevent pharyngeal reflux of esophageal infusate in patients with reflux-attributed supraesophageal symptoms and regurgitation.[11–12] An exaggerated esophago-UES relaxation reflex has been reported in similar patient groups.[13]

Theoretically, when gastric contents traverse the LES barrier and enter the esophagus, the EUCR and secondary esophageal peristalsis play a pivotal role in airway protection. The UES contractile reflex enhances the UES pressure barrier and secondary esophageal peristalsis clears the volume of refluxate from the esophagus, preventing entry of refluxate into the pharynx.[2,14–16] Despite these observations, there remain significant gaps in our understanding of UES physiology as it relates clinically to gastroesophageal reflux. For example, although it is known that there is significant variability among reflux events in terms of volume, rate of entry into the esophagus, physical and chemical composition of refluxed material,[16,17] and potential modulation of the reflex mechanisms through the life span,[18,19] it is not known how the UES responds to slow and ultraslow reflux events that can occur during decumbency and sleep when the airway is most vulnerable or whether aging affects these responses. Another important question about the relationship of gastroesophageal reflux and airway protection is how pharyngeal reflux is prevented if refluxate is not cleared from the esophageal lumen. Does the UES continue to remain contracted following cessation of reflux without clearance of refluxate and does age affects the UES response under these conditions, rendering the elderly more vulnerable to pharyngeal reflux.

Therefore, the aim of the present study was to (1) determine whether the UES continues to remain contracted following cessation of reflux without clearance of refluxate, and (2) compare, between healthy young and elderly, the UES and esophageal pressure responses to well-defined slow and ultraslow simulated acid-reflux and non–acid-reflux events during active infusion and postinfusion dwell periods mimicking the post-reflux residue.

Methods

Subjects

We studied 11 elderly (74 ± 9 years) and 11 young (28 ± 7 years) healthy volunteers in the supine position. The study was approved by the Medical College of Wisconsin institutional review board and all participants signed written informed consent before their studies. Participants had no history of known gastrointestinal disorders and were not taking any medications that might affect the function of the gastrointestinal tract. Participants with a history of neuromuscular or neurocognitive diseases, such as stroke, dementia, Parkinson disease, myasthenia gravis, and multiple sclerosis, as well as C-spine disorders, head or neck surgery, and substance abuse, were excluded from the study.

Study Protocol

For monitoring UES and esophageal pressure responses as well as the perfusate, we used a combined solid-state high-resolution manometry and impedance catheter with 36 circumferential pressure sensors, spaced 1 cm apart, measuring at a sample rate of 50 Hz and 18 impedance sensor couplets spaced 2 cm apart (Given imaging, Los Angeles, CA).

For intraesophageal slow and ultraslow infusions, we used a catheter with a 3-mm outer diameter. To minimize the number of intubations, the infusion tube was affixed to the manometry catheter by a small band of thermoplastic, self-sealing laboratory film (Parafilm M; Pechiney Plastic Packaging, Menasha, WI). The manometric catheter and infusion tube were arranged such that the infusion port was located approximately 5.5 cm proximal to the most distal pressure sensor.