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Can in vitro and in silico studies help us undestanding the motor control of swallowing?

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Difficulties with food oral processing and swallowing are increasingly prevalent among elderly and patients affected by neurodegenerative diseases. Design of food products and oral medications for improved swallow ability requires an in-depth understanding of swallowing. The existence of an adaptation mechanism of the swallowing motor control pattern to the different perceived structural attributes of the bolus is still debated.

Clinical studies reported greater velocity of the hyoid bone and higher surface electromyography amplitudes when swallowing thicker liquids [1, 2]. The oral and pharyngeal transit time of the bolus is also affected by its rheology [3, 4]. In recent years, in vitro and in silico models have been proposed to gain relevant insights on the role of bolus rheology in geometries relevant to the oral and pharyngeal phases of swallowing. These models simplify the in vivo swallowing dynamics either by imposing strains (displacements) or stresses (forces). This leads to inconsistent results among different studies and sheds doubts about the true predictive power of these models. The alternative approaches of imposing strains or applying stresses are confronted and compared to the in vivo dynamics. The extent to which these simple approximations hold is discussed based on the scientific literature, considering different rheological properties of the bolus. The potential role of the preparatory phase of the bolus is also discussed.

Opportunities for future in vivo studies to bridge the current knowledge gap are also discussed, together with the impact that these studies would have on in vitro and in silico simulations of swallowing.

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