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吞咽功能障碍的超声评估及研究进展

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摘　要

吞咽功能一直是人们热议的话题，而吞咽功能障碍在脑卒中患者中发生率高达37%~78%，可导致误吸、肺炎甚至死亡。传统评估工具VFSS和FEES存在辐射、侵入性等局限，超声因无创、无辐射、可重复等优势成为研究热点。超声通过评估舌肌横截面积与回声强度反映肌肉数量与质量，通过测量颏舌骨肌等舌骨上肌群的厚度、位移及收缩率评估吞咽功能，其中颏舌骨肌收缩 < 22%、舌骨上移 < 3.3 mm提示吞咽困难高风险。超声测量具有良好的信度，并可指导持舌吞咽、吸气肌训练等康复训练。超声技术虽无法完整观察吞咽全过程，但在吞咽功能筛查、肌少性吞咽困难识别及康复效果评估方面展现出良好应用前景。未来需建立标准化的超声评估参数体系，开展大样本临床研究，推动超声在吞咽功能障碍临床诊疗中的规范化应用。

关键词

吞咽功能障碍，超声评估，舌骨上肌群，颏舌骨肌，康复训练

Ultrasonic Evaluation and Research Progress of Swallowing Dysfunction

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Abstract

Swallowing function has been a hot topic, and the incidence of swallowing dysfunction in stroke patients is as high as 37%~78%, which can lead to aspiration, pneumonia and even death. Traditional assessment tools VFSS and fees have limitations such as radiation and invasiveness. Ultrasound has

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become a research hotspot due to its advantages of noninvasive, non-radiation and repeatability. Ultrasound reflects the quantity and quality of muscles by evaluating the cross-sectional area and echo intensity of tongue muscle. Swallowing function is evaluated by measuring the thickness, displacement and contraction rate of suprahyoid muscles such as Geniohyoid muscle. The contraction of Geniohyoid muscle < 22% and the upward displacement of hyoid bone < 3.3 mm suggest a high risk of dysphagia. Ultrasound measurement has good reliability, and can guide tongue swallowing, inspiratory muscle training and other rehabilitation training. Although ultrasound technology cannot completely observe the whole process of swallowing, it shows good application prospects in swallowing function screening, sarcopenic dysphagia recognition and rehabilitation effect evaluation. In the future, it is necessary to establish a standardized ultrasound evaluation parameter system, carry out large sample clinical research, and promote the standardized application of ultrasound in the clinical diagnosis and treatment of swallowing dysfunction.

Keywords

Swallowing Dysfunction, Ultrasound Evaluation, Suprahyoid Muscle Group, Geniohyoid Muscle, Rehabilitation Training

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1. 引言

吞咽是指人体从外界经口摄入食物并经咽腔、食管传输到达胃的过程，是维持人生命的重要活动之一，通常分为口腔期、咽期、食管期，其中任何一个阶段出现问题都可能会出现吞咽功能障碍的情况。吞咽困难在急性脑血管意外疾病患者的发生率较高，临床发病率为 37%~78% [1]。吞咽功能障碍可以引起一系列问题，如营养摄入不足、水电解质平衡紊乱、心理问题等，还有可能发生误吸、吸入性肺炎等，不仅降低患者生活质量，严重者还可导致死亡[2]。吞咽功能障碍的“金标准”评估工具：电视 X 线透视吞咽功能检查(video fluoroscopic swallowing study, VFSS)和纤维内镜吞咽功能检查(flexible endoscopic evaluation of swallowing, FEES) [3]，VFSS 具有敏感、直观、广泛、无痛等特点，但具有辐射，短期内可重复性低，并有一定的误吸风险，FEES 能清晰显示吞咽后残留物的具体位置和数量，但属于侵入性操作，存在一定风险，且不能观察完整的吞咽过程。超声方法评估吞咽功能具有无辐射损伤、无侵入性、可使用真正食物进行评估、短时间内可重复操作的优点。自 1978 年 Stevens [4]等利用超声对吞咽运动进行评估后，超声方法越来越多地应用于吞咽的评估。

2. 超声评估舌

舌运动在吞咽口腔期的食物处理以及食团运送具有重要作用，可以通过评估舌的运动学和形态学结构，从而评估吞咽功能。Shuai [5]通过 B + M 型超声测量老年脑卒中患者舌头运动的径向位移和持续时间，为吞咽运动的初步评估提供了一种快速安全的技术，也可以作为吞咽困难临床筛查的定量和无创方法。Yamaguchi [6]等分析舌的肌肉数量以及质量，超声下舌横截面积(CSA)表示肌肉数量，超声下舌回声强度(EI)值表示肌肉质量，以阐明吞咽相关肌肉特征和力量与肌肉减少参数的关系。Ogawa [7]等研究发现，超声下舌肌面积及其亮度面积是肌肉减少性吞咽困难的独立危险因素，肌肉减少性吞咽困难患者的舌肌量小于无肌肉减少性吞咽困难患者，肌肉减少性吞咽困难也与舌肌强度增加有关。由于食团在舌背运送的过程中存在一定压力，国外研究者首先设计出特定仪器进行舌压的测定。Stierwalt [8]、Konaka [9]、

Hori [10]等发现，吞咽困难患者有不同程度的舌压降低。Yamaguchi、Hara [11]等发现老年男性舌压与超声下舌 CSA 呈显着正相关，在多元回归分析中，年龄，BMI 和 SMI 与男性超声下舌 CSA 也显着相关，因此预防与衰老相关的吞咽困难的干预措施应针对特定的肌肉，舌肌质量和功能的维持以及舌头的训练需要注意确保最佳的营养状况。Nakao [12]等同样认为舌压可以作为评估吞咽相关肌肉质量的参数。

3. 超声评估舌骨上肌群

舌骨上肌群由四块肌肉组成，主要负责舌骨向前向上运动和吞咽功能，包括二腹肌、茎突舌骨肌、下颌舌骨肌和颏舌骨肌，而舌骨下肌群则负责牵拉舌骨复位。Pearson [13]等发现下颌舌骨肌主要作用于舌骨，使其向上运动，从而让会厌关闭喉口，保证食物顺利通过，保护气道，避免误吸；颏舌骨肌主要作用于舌骨，使其向前运动，从而打开食管上括约肌，保证吞咽顺利进行。Mori [14]等通过超声检查 142 名受检者的颏舌骨肌横截面积，从而识别肌肉减少性吞咽困难，女性颏舌骨肌超声横截面积的临界值为 172.5 mm^2，男性为 194.7 mm^2。Umay [15]通过超声评估咬肌(MM)、颏舌肌(GGM)、颏舌骨肌(GHM)、舌骨肌(MH)和前二腹肌(ADM)等肌肉发现，就诊断性能而言，GHM 的敏感性最高(92.3%)，收缩 MM 厚度的特异性最高(90.3%)。随着收缩 MM 厚度的减少，吞咽困难的可能性从 54%增加到 80%~89%，随着收缩 GGM 厚度的减少，吞咽困难的可能性从 48%增加到 72%。Liao [16]则通过颏下超声比较有吞咽困难的癌症幸存者与无吞咽困难的志愿者在收缩时颏舌骨肌大小，颏舌骨肌大小增加百分比，静息时颏舌骨肌长度，颏舌骨肌长度增加百分比，舌骨前移位和舌骨上移方面存在显着差异；GH 长度收缩 < 22%和舌骨上移位 < 3.3 mm 的比例与吞咽困难的发生风险较高有关。Ichikawa [17]等研究吞咽相关肌肉剪切波弹性成像的肌内状态发现颏舌肌的僵硬度与 BMI 呈正相关，颏舌骨肌的僵硬度与 BMI 呈负相关。Huang [18]等通过超声测量吞咽运动参数评估慢性阻塞性肺疾病患者吞咽功能，舌骨肌厚度、舌骨位移、颏舌骨肌运动距离、舌骨－甲状软骨间缩短距离(HLAS)、舌骨－甲状软骨间距离缩短率(CSR)，与 COPD 相关吞咽问题呈负相关；颏舌骨肌运动时间和最小舌骨距离(NHLA)较高，与 COPD 相关的吞咽功能障碍呈正相关。这些参数在评估 COPD 患者吞咽功能障碍的存在和严重程度方面具有良好的诊断效用。Ogawa [19]用超声评估二腹肌发现，与无肌肉减少性吞咽困难相比，肌肉减少性吞咽困难的二腹肌质量较小，肌肉强度较大。Mori [20]则发现老年人超声下颏舌骨肌的面积较小，亮度较大，提示其量较小，脂肪浸润较大。Miura [21]发现超声下颏舌骨肌厚度与颌骨张开强度呈正相关，回声强度与颌骨张开强度呈负相关；而 Kajisa [22]研究健康老年人得出相同结果，下颌张开力与超声下颏舌骨肌的横截面积呈正相关。目前，大部分相关研究的评估方案没有太大差异，对于特定人群，如脑卒中患者、COPD 患者、心力衰竭患者、头颈部放化疗患者等的研究仍然较少，有效的诊断标准仍然需要更进一步的研究。目前大量研究均聚焦于超声各指标与肌肉的关系、超声各指标与“金标准”VFSS 和 FEES 的相关性，对于超声各指标之间的关联与优劣的研究仍需进一步探索。

4. 超声评估可靠性

Pauloski [23]让两名检查员在冠状面的三个换能器放置条件下，使用 B 型超声对 40 名参与者的颏舌骨肌进行成像。在每种换能器放置方法中，重复试验之间或检查员之间没有显着差异，这项研究强调无论选择哪种方法，都需要保持放置的一致性，它还强调了研究人员需要提供传感器定位方法的精确描述，以便位置可重复。Ota [24]则通过常规和手持式超声设备评估颏舌骨肌，发现除收缩百分比外，所有参数(纵向直径，纵向横截面积，横向垂直直径，横向横径，横向横截面积)均观察到较高的内部信度。Ishino [25]则发现超声评估年轻健康受试者吞咽相关指标的评估者间和评估者内可靠性良好，对颏舌骨肌和二腹肌前腹部表现出特别高的准确性。

5. 改善吞咽功能的运动训练

Hirata [26]研究持舌吞咽运动发现，经过 8 周训练，低舌压组的舌压显著升高，而高舌压组变化不大，表明该运动训练有助于改善吞咽功能，但运动负荷量对于不同人群仍有所不同，需进一步研究。Zhang [27]研究表明，高强度吸气肌训练可改善吸气肌力量、吞咽肌力量和质量。此外，吸气肌和腹肌联合训练可改善全身肌肉力量、质量和表现。Ogawa [28]发现(FESM)可有效增加颏舌骨肌的面积并降低其强度，并可改善吞咽功能。Pauloski [29]研究呼气肌力量训练(EMST)发现，呼气肌力量增加可能对因舌咽抬高减少，喉闭合减少或 UES 开放减少而导致咽部吞咽困难的患者有益。Hasegawa [30]研究结果表明，下颌回缩运动可以有效改善舌骨的前移。当观察到吞咽障碍的迹象时，这种练习可能对口腔虚弱的个体有效。Yano [31]发现在健康的年轻人中，舌头强化运动有助于增加颏舌骨的肌肉力量以及舌头肌肉，对改善吞咽功能有一定帮助。Hughes [32]研究表明，下巴到胸部运动(CtC)、下巴对抗阻力运动(CTAR)对下颌下舌咽肌运动单位募集的影响提供了支持性证据，进一步论证了其作为康复方式的理论和临床意义。

6. 小结与展望

综上所述，超声具有无辐射损伤、无侵入性、可使用真正食物进行评估、短时间内可重复操作等优点，使其有望成为筛查吞咽功能变化的良好工具。但无法完整观察吞咽运动过程，仍是其最大缺陷。目前虽有研究能证明设备间可靠性、评估参数重复性、评估者内及评估者间可靠性，但是都局限于临床研究且样本量较少。超声不仅可以筛查吞咽困难，而且在吞咽功能康复过程中仍然可以发挥重要作用。随着研究的深入，超声观察吞咽过程中各结构的运动系数将被规范，同时可以尝试将超声指标(如横截面积、厚度等)与临床量表(如洼田饮水试验、标准吞咽功能评价量表)或肌电图相结合，构建更加精准的预测模型，进一步验证相关超声指标的诊断性能；在未来还可以增加剪切波弹性成像方向的研究，其可量化肌肉硬度/僵硬度，反映肌肉痉挛或纤维化程度，使其在吞咽功能障碍筛查、评估以及训练康复领域中发挥更为重要的作用，为诊断吞咽功能障碍提供更加科学的依据；对于特定的人群，如脑卒中患者、COPD 患者、心力衰竭患者、头颈部放化疗患者等可以建立专属的超声诊断阈值，提升筛查诊断的早期识别率，改善患者预后和生活质量。

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