

# 腰椎融合术后终板囊性变的研究进展

申素昊<sup>1</sup>, 孔鹏<sup>2</sup>, 汲长蛟<sup>2</sup>, 慈吉辰<sup>1</sup>, 孙昌宇<sup>1</sup>, 温旭<sup>1</sup>, 张建新<sup>2</sup>

(1. 山东中医药大学第一临床医学院, 山东 济南 250014;

2. 山东中医药大学附属医院, 山东 济南 250014)

**摘要** 终板囊性变是腰椎融合术后假关节形成的潜在危险因素, 影响手术预后。为进一步了解腰椎融合术后终板囊性变, 本文从其发生机制、影响因素、影像特征、与腰椎融合术后其他骨丢失因素的鉴别及防治措施等方面进行了综述。

**关键词** 脊柱融合术; 腰椎; 手术后并发症; 终板; 囊性变; 综述

腰椎融合术是治疗由发育不良、退行性病变、感染、肿瘤或创伤导致的各种腰椎疾病的常用手术方法<sup>[1]</sup>。腰椎融合术后会并发终板囊性变, 而终板囊性变是腰椎融合术后假关节形成的潜在危险因素, 影响手术预后<sup>[2]</sup>。但目前关于此方面的研究较少, 为进一步了解腰椎融合术后终板囊性变的发生机制、影响因素、影像特征、与腰椎融合术后其他骨丢失因素的鉴别及防治措施, 我们对腰椎融合术后终板囊性变的研究进展进行了综述。

## 1 终板囊性变的发生机制与影响因素

腰椎融合术后发生终板囊性变的具体机制目前尚不清楚。有学者<sup>[2-3]</sup>推测终板囊性变的形成与骨关节炎骨囊性变的形成具有相似的机制, 即完整的软骨层可以均匀分担骨的载荷, 而一旦某一部位的软骨变薄或出现完全退化, 其周围的压力就会增加, 引起应力性微骨折, 继而发生骨吸收, 最终形成骨的囊性缺损<sup>[2]</sup>。微骨折损伤理论也可以用于解释 Schmorl 结节的形成<sup>[4]</sup>。Schmorl 结节可以说是终板囊性变的另一种病理结果。种植体与骨界面之间存在微间隙和微动, 会造成骨的机械性损伤<sup>[5]</sup>。腰椎融合术后早期, 患者站立活动时, 椎间融合器与终板直接接触, 压力及融合器的微动可导致接触面微骨折, 继而出现骨吸收, 形成囊性缺损; 再加上长期吸烟、骨质疏松等因素对手术节段融合的影响, 终板囊性变会逐渐扩大。性别、年龄、术前存在终板囊性缺损均不是终板囊性变形成或增大的危险因素<sup>[3, 6]</sup>。骨质疏松是否会影响终板囊性变的发生发展目前尚存争议。Lin 等<sup>[3]</sup>认为骨质疏松不是终板囊性变的危险因素。但骨密度被

认为是影响椎体终板生物力学性能的重要因素<sup>[7]</sup>, 且骨质疏松与椎间融合器下沉及假关节形成具有相关性<sup>[8-10]</sup>。吸烟也会影响骨代谢, 长期大量吸烟可影响新生血管形成及成骨细胞的分化<sup>[11-12]</sup>, 不利于椎体融合, 是导致腰椎融合术后假关节形成的危险因素<sup>[13]</sup>。腰椎支具可以限制腰椎活动, 减轻腰椎的负荷<sup>[14]</sup>。腰椎融合术后早期未佩戴支具下床活动, 可能会影响融合节段的稳定性, 增大椎体终板与椎间融合器之间的微动。

椎间融合器对于腰椎融合术后椎间隙高度的恢复和骨质生长起着至关重要的作用<sup>[15]</sup>。Sasaki 等<sup>[16]</sup>比较了腰椎融合术中置入不同类型的椎间融合器, 术后发生终板囊性变的差异, 发现术中置入聚醚醚酮椎间融合器、钛椎间融合器、钛涂层聚醚醚酮椎间融合器和多孔钽椎间融合器, 术后并发终板囊性变的概率分别为 65%、44%、69% 和 23%。Sakaura 等<sup>[17]</sup>研究发现, 钛涂层聚醚醚酮椎间融合器与碳纤维增强聚醚醚酮椎间融合器相比, 可以明显降低腰椎融合术后发生终板囊性变的风险。腰椎融合术后终板囊性变的发生与融合节段的稳定性密切相关<sup>[2]</sup>。维持融合节段的稳定是减少椎体间微动以促进骨形成和融合的必要条件。融合器的大小也会影响着腰椎融合节段的稳定性<sup>[18]</sup>。多次腰椎手术可能影响椎体的骨性愈合, 也是导致终板囊性变的一个显著因素<sup>[6, 19]</sup>。另外, 术中对终板的破坏也可能导致终板囊性变的发生<sup>[20]</sup>。

## 2 终板囊性变的影像特征

腰椎终板囊性变位于椎间融合器的头侧或尾侧, 在矢状位或冠状位 CT 图像上可见圆形或椭圆形低密度区<sup>[2]</sup>, 故有学者将其称为椎体终板“空洞”<sup>[21]</sup>。影

像检查所示的终板囊性变阳性征,即腰椎融合术后出现终板囊性变,或病变影大于术前<sup>[2]</sup>。三维重建 CT 扫描能清晰地显示椎间融合界面骨性结构的变化及是否有桥接骨小梁形成,是评价植骨融合状态最敏感的方法<sup>[22]</sup>。腰椎融合术后 6 个月,在 CT 上可以看到骨小梁桥接,术后 1 年融合部位应出现成熟的骨小梁和坚固的骨皮质桥接<sup>[23]</sup>。因此,对于终板囊性变进行影像评估,可以在腰椎融合术后 3 个月、6 个月、1 年及 2 年进行。MRI 也是腰椎融合术后终板囊性变的重要检查手段。术中过度的终板准备可以导致椎体终板在术后初期出现骨髓水肿, MRI 上表现为 T1 低信号和 T2 高信号<sup>[24]</sup>。机械应力及融合器的微动致使终板微骨折发生时, MRI 上终板的表现与 I 型 Modic 改变相似,也表现为 T1 低信号、T2 高信号。

### 3 终板囊性变与腰椎融合术后其他骨丢失因素的鉴别

感染、金属过敏<sup>[25]</sup>、磨损颗粒刺激、机械应力及融合器微动等均可导致腰椎融合术后椎体的骨丢失。骨丢失可分为炎症性和非炎症性两类。Wahbeh 等<sup>[26]</sup>提出,椎体骨溶解为炎症性骨丢失,而非炎症性骨丢失表现为椎体的侵蚀性重塑,是一个适应力学变化的过程。植入物材料的磨损颗粒会刺激巨噬细胞释放炎症因子导致骨溶解<sup>[27-28]</sup>。因此,由金属过敏、磨损颗粒刺激等引起炎症反应导致的椎体骨丢失,可归为骨溶解。而在腰椎融合术后椎体融合过程中,局部机械应力及融合器微动导致的终板囊性变,无炎症反应的参与,属于非炎症性骨丢失。Takenaka 等<sup>[29]</sup>指出了骨溶解与终板囊性变的一些区别,如骨溶解骨质缺损扩大的速度快且周围没有硬化性骨改变。但导致骨丢失的具体原因很难明确<sup>[26]</sup>。因此,对于并发严重的终板囊性变且有假关节形成需行翻修手术的腰椎融合术后患者,应常规采集微生物样本,以排除隐匿性感染<sup>[30]</sup>;也应常规行病理检查,以排除炎性病变或其他病变。

### 4 终板囊性变的防治

终板囊性变是腰椎融合术融合失败的显著危险因素,是椎体融合延迟或不融合的早期预测指标<sup>[2,4,31]</sup>。Lin 等<sup>[3]</sup>研究发现,腰椎融合术后出现终板囊性变与融合器下沉及融合失败相关,但术前出现终板囊性病变不是融合失败或术后囊性变增大的危险因素。腰椎融合术后无论是在哪个时间点,一旦发现

终板囊性变阳性征,我们都应意识到融合失败的风险。终板囊性变的防治,应以维持腰椎融合节段的稳定性、促进椎体融合为主要目的。腰椎融合术中应使植骨块与终板充分接触,避免植骨块过度吸收,并应减少对终板的损伤,以及选择材料较好、大小合适的融合器。并要去除吸烟等影响椎体融合的不利因素。当发现终板囊性变后,定期复查 CT 是必要的。对于骨质疏松患者,术后应积极地抗骨质疏松治疗。Ushirozako 等<sup>[32]</sup>认为,特立帕肽可以调节骨代谢并增加骨融合率。对于需要手术治疗的终板囊性变,手术方法可参考腰椎融合术后假关节形成的手术治疗方法,并选择合适的手术时机;但对于正处于术后融合期的患者,一般不考虑采用手术治疗。有学者<sup>[33-34]</sup>采用向患侧椎间隙内注入骨水泥的方法治疗腰椎融合术后症状性假关节形成,并取得了良好的临床效果。这对于腰椎融合术后有假关节形成和终板囊性变的老年患者来说,是一种不错的非开放性手术治疗方法。对于终板囊性变和假关节形成且椎体破坏需要行腰椎融合翻修术的患者,可以移除先前置入的融合器,清理硬化骨面,然后置入更大的融合器<sup>[1]</sup>。但对于接受后入路腰椎融合术的患者,由于术后易发生组织粘连,再从后入路取出椎间融合器是一项具有挑战性的任务,发生硬膜撕裂、神经损伤等并发症的风险较大,故改为侧方入路取出椎间融合器不失为更好的选择<sup>[35]</sup>。若原来的腰椎融合手术方式难以达到坚强的固定,可考虑联合或改用其他手术方式。

### 5 小 结

机械应力及融合器的微动导致终板微骨折,是腰椎融合术后终板囊性变发生的主要机制;吸烟、椎间融合器的类型和大小、腰椎手术次数及术中对终板的破坏程度,均是影响终板囊性变形成的重要因素;病变过程无炎症反应的参与,是终板囊性变与其他导致腰椎融合术后骨丢失的因素的主要鉴别点;加强术后腰椎融合节段的稳定性及促进椎体融合是防治终板囊性变的主要目的。采用腰椎融合术治疗腰椎疾病时,应选择合适的融合器,加强融合节段的稳定性,去除不利于椎体融合的因素,以降低术后并发终板囊性变的风险,保障手术效果。

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(上接第 52 页)

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