

# 身体质量指数对围手术期疼痛影响的研究进展

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## 摘要

身体质量指数(Body Mass Index, BMI)是评估体重状态的常用工具, 其计算公式为体重(kg)除以身高(m<sup>2</sup>)的平方。BMI可以分为正常体重(18.5~24.9 kg/m<sup>2</sup>)、超重(25~29.9 kg/m<sup>2</sup>)和肥胖( $\geq 30$  kg/m<sup>2</sup>)。肥胖不仅增加了多种健康风险, 如心血管疾病、糖尿病和高血压, 还对围手术期的疼痛管理产生了重要影响。围手术期疼痛管理涵盖术前评估、术中疼痛控制以及术后疼痛管理, 对患者的恢复和生活质量有着深远的影响。因此, 研究BMI对围手术期疼痛的影响具有重要的临床意义。本综述旨在系统总结BMI对围手术期疼痛的影响。通过回顾当前研究成果, 为临床实践提供改进疼痛管理策略的参考, 以提高肥胖患者的术后恢复质量。

## 关键词

身体质量指数, 肥胖, 围手术期疼痛

# Research Progress on the Effect of Body Mass Index on Perioperative Pain

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## Abstract

Body Mass Index (BMI) is a common tool for assessing weight status. Its calculation formula is

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weight (kg) divided by the square of height (m<sup>2</sup>). BMI can be classified into normal weight (18.5~24.9 kg/m<sup>2</sup>), overweight (25~29.9 kg/m<sup>2</sup>) and obesity ( $\geq 30$  kg/m<sup>2</sup>). Obesity not only increases a variety of health risks, such as cardiovascular disease, diabetes and hypertension, but also has an important impact on pain management during the perioperative period. Perioperative pain management covers preoperative evaluation, intraoperative pain control and postoperative pain management, which has a profound impact on patients' recovery and quality of life. Therefore, it is of great clinical significance to study the effect of BMI on perioperative pain. This review aims to systematically summarize the impact of BMI on perioperative pain. By reviewing the current research results, it provides references for clinical practice to improve pain management strategies to improve the quality of postoperative recovery of obese patients.

## Keywords

Body Mass Index, Obesity, Perioperative Pain

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## 1. 围手术期疼痛

围手术期疼痛管理的重要性在全球范围内日益凸显, 包括“疼痛作为第五大生命体征” [1]。提供服务标准由疼痛医学学院在《英国疼痛管理服务核心标准》 [2]和皇家麻醉师学院在《2019年住院患者疼痛管理麻醉服务指南》 [3]中制定。

急性术后疼痛, 是指在手术后立即发生, 通常持续 3~7 天 [4]。根据一项美国全国调查, 大约 80% 的手术患者经历急性术后疼痛, 其中 86% 报告中度、重度或极度疼痛 [5]。如果控制不当, APSP 可延长住院时间, 增加阿片类药物的使用, 并增加卫生保健费用 [6] [7]。例如, 2014 年至 2016 年, 中国三级医院阿片类药物的采购数据显示, 药品使用量总体呈现上升趋势, 其中口服剂型药品使用量约为注射剂型的 2 倍, 且差距逐年扩大。此外, APSP 与不良预后相关, 包括术后谵妄、心血管事件、血栓栓塞、肺部并发症和慢性疼痛综合征 [8]-[12]。

然而, 一些患者术后持续疼痛, 可能发展为长期慢性疼痛。《国际疾病分类 - 第 11 次修订版》(世界卫生组织, 2022 年)将慢性术后疼痛定义为手术后发生或强度增加并持续超过愈合过程的疼痛, 通常被认为是术后 3 个月 [13]。慢性术后疼痛的患病率估计差异很大, 可能取决于手术类型 [13]。一项针对 21 家欧洲医院的调查显示, 在不同类型的手术干预后 12 个月, 出现任何疼痛的患者的慢性术后疼痛发生率为 35%, 中度至重度疼痛发生率为 12% [14]。考虑到每年进行的手术数量, 慢性术后疼痛可以被认为是一种迫切需要关注的普遍情况。鉴于疼痛一旦成为慢性疼痛尤其难以治疗, 应探索预防方法以减少慢性术后疼痛的负担。

## 2. 急性术后疼痛的影响因素

### 2.1. 人口特征因素

#### 2.1.1. 年龄

疼痛敏感性随年龄而变化。Liu 等 [15] 报道, 随着年龄的增长, 术后休息时中重度疼痛的发生率下降了 4%, 但活动时疼痛的发生率没有下降。术后中度至重度静息疼痛的发生率随着年龄的增长每 5 年下降 20%, 但运动疼痛的发生率没有下降 [16]。

### 2.1.2. 性别

通过大多数临床相关的疼痛模型观察, 女性对疼痛更敏感, 术后疼痛比男性更严重[17]。

### 2.1.3. 肥胖

在一项回顾性研究中, 体重指数(BMI)  $\geq 30 \text{ kg/m}^2$  的肥胖患者需要更高的麻醉剂量来控制全关节置换术后的早期疼痛[18]。两项前瞻性队列研究和一项横断面研究表明, BMI 可以独立预测膝关节置换术后的急性疼痛强度或严重程度[19]-[21]。此外, 据报道, BMI 是开放式根治性胃切除术[22]、胸腔镜手术[23]、乳腺癌手术[24]后中至重度急性疼痛的重要危险因素。

### 2.1.4. 吸烟

在一项回顾性研究中, 有吸烟史的患者术后 24 小时和 48 小时的中重度疼痛发生率分别增加了 86% 和 53% [23]。

## 2.2. 围手术期因素

### 2.2.1. 术前疼痛史

慢性疼痛患者通常术前疼痛阈值较低, 术后疼痛强度较高。两项前瞻性队列研究、一项横断面研究和一项回顾性研究报道了术前慢性疼痛史独立预测中度或重度急性术后疼痛[23] [25]-[27]。

### 2.2.2. 术后镇痛药消耗

研究表明, 年龄[28] [29]肥胖[30]、疼痛敏感性[31]和遗传[32]与术后镇痛药的使用有较强的相关性, 一般与急性术后疼痛显著相关。

## 2.3. 心理因素

一项荟萃分析表明, 特别是疼痛灾难, 手术恐惧和状态焦虑和特质焦虑可能与慢性术后疼痛的发展有潜在的关联[33]-[35]。基于慢性疼痛的恐惧 - 回避模型[36], 高度疼痛灾难和对手术影响的恐惧评估的患者可能倾向于通过限制他们的身体活动来保护自己免受预计的伤害。这种限制活动可能对康复过程起反作用, 特别是在建议恢复肌肉力量和柔韧性的情况下(如关节置换术或脊柱手术后)。此外, 还提出了一种心理生物学解释, 认为心理状态会影响手术应激反应, 导致应激激素水平升高和持续的炎症反应[37]。动物研究表明, 手术前和手术后应激暴露会导致啮齿动物长时间的痛觉过敏, 这似乎是由糖皮质激素受体的激活介导的[38]。此外, 促炎细胞因子与疼痛超敏反应有关, 因为它们作用于疼痛神经轴的几个层面, 包括外周伤害感受器、脊柱和脊柱上区域[39]。长时间的应激反应也会导致皮质边缘回路的变化, 这对伤害传递和疼痛意识有直接影响[37]。其他消极的情绪和认知状态和特征, 如疼痛相关的恐惧和疼痛灾难, 也与内源性疼痛调节失调有关, 通过改变促进和抑制性中枢下降机制的平衡[40]。一项随机对照试验, 证实了围手术期心理干预对慢性术后疼痛的保护作用的总体发现[41]。本研究考察了在骨科创伤手术后 3 个月内, 一个简短的数字干预对减少疼痛相关结果的影响。这项干预研究被称为“我的手术成功”, 旨在通过向患者展示 45 分钟的在线心理教育视频和工作表, 帮助他们制定个性化的手术后疼痛管理计划。该视频解释了认知和情感过程如何影响疼痛, 以及如何下调生理唤醒。患者可以将治疗信息合并到可下载的工作表中。他们还可以随时使用一款放松应用程序。虽然研究的主要目的是评估干预的可行性和可接受性, 但结果表明, 与健康教育方案相比, 该方案在手术后 1、2 和 3 个月的疼痛强度降低幅度更大。这项研究表明, 即使是简短的、完全在线的干预也可能有效地减轻慢性术后疼痛的风险。Lanini 等人[42]进行的荟萃分析发现, 围手术期心理干预可以对代谢手术应激反应产生影响, 这与减轻疼痛有关。综上, 心理干预可以通过减少已确定的心理风险因素来潜在地减轻这些不良后果的风险。

### 2.3.1. 焦虑

术前焦虑一直被认为是 APSP 的重要预测因素, 特别是在妇科、产科和胃肠手术中[43]。12 项前瞻性队列研究证实术前焦虑与 APSP 密切相关。其中, 7 项研究表明术前焦虑独立预测术后不同时期 APSP 强度[44]-[50]。5 项研究表明, 术前焦虑独立预测剖宫产或乳腺癌手术后中度至重度急性疼痛[51]-[55]。根据一项系统综述, 术前焦虑独立预测乳腺癌手术后 APSP [56]。

### 2.3.2. 抑郁

根据一项回顾性队列研究, 术前抑郁独立预测乳房切除术后中度至重度急性疼痛[57]。两项前瞻性队列研究表明, 术前抑郁是根治性前列腺切除术、全膝关节置换术和腹部手术后中度至重度急性疼痛的重要危险因素[52] [54]。

### 2.3.3. 剧烈疼痛

两项前瞻性队列研究表明, 疼痛灾难化独立预测中度至重度急性疼痛[58] [59]。根据 Pinto 等[60]人的研究, 疼痛灾难化是子宫切除术后 48 小时中至重度疼痛(OR 3.37, 95% CI 1.63~6.95)和急性疼痛强度的重要危险因素( $\beta = 0.245, P < 0.01$ )。

### 2.3.4. 预期疼痛

在前瞻性队列研究中, 预期的术后疼痛(VAS > 40 mm)增加了门诊手术后 0~4 天[61]和择期手术后 1~4 天中度至重度疼痛的发生率[59]。

### 2.3.5. 对手术的恐惧

事实上, 在 1490 例接受不同选择性门诊手术的患者中, 术前手术恐惧被发现是 APSP 的独立危险因素[59]。在日间手术中, Gramke 等人报[61]道, 对短期后果的恐惧显著预测了术后 0~2 天的中度至重度疼痛(以 VAS 定义为 40 mm)。

## 3. 肥胖对围手术期疼痛的影响

### 3.1. 基础研究: 脂肪因子

脂肪组织不仅仅是一个能量储存库, 也是一个活跃的内分泌器官, 分泌着一系列生物活性因子被称为“脂肪因子”。脂肪因子虽然是在脂肪组织发现的生物活性因子, 但是它也可以在其他组织产生并且行使与脂肪组织无关的功能, 如调控能量的摄入和消耗、也参与炎症调节。现在学者普遍认为肥胖提高了促炎因子的产生, 因此, 肥胖被认为可以促进炎症的发生发展。到目前为止, 已有 50 多个脂肪因子被确认, 在炎症过程中最重要的脂肪因子包括瘦素(Leptin)、脂联素(Adiponectin)、抵抗素(Resistin)和内脂素(Visfatin)。

瘦素是由脂肪细胞分泌的蛋白质类激素, 主要功能是控制能量的摄入和消耗, 但是同时它也对促炎反应时先天性和获得性免疫具有调节作用。瘦素能直接抑制下丘脑弓状核(ARN)的 NPY 和 AGRP 间接抑制黑色素聚集激素(MCH)和食欲素并激活阿片黑色神经元(POMC)从而抑制食欲、减少摄食。单独下丘脑 POMC 神经元中瘦素受体缺失亦可导致肥[62]。研究证实, 瘦素可以增强 CCK 的饱感效应。向脑内注射阈下剂量的瘦素不足以引起摄食量的明显改变; 但相同的处理与外周注射 CCK 相结合则可以显著增强 CCK 抑制食欲的作用[63]。在部分肥胖者体内存在瘦素抵抗。瘦素抵抗时瘦素的能量和体重平衡作用减弱 NPY 释放增加, 增强食欲导致体重增加和肥胖。脂联素能增加脂肪酸氧化, 同时减少肝脏葡萄糖合成, 它对心血管疾病、胰岛素抵抗和 II 型糖尿病有重要的保护作用。

所有这些脂肪因子与促炎性细胞因子的产生有关, 如 TNF- $\alpha$ 、IL-1、IL-6 和 C 反应蛋白。这些炎症因



子可直接刺激神经系统中的痛觉受体, 增强疼痛敏感性。且脂肪组织的机械压迫可对周围神经造成影响, 肥胖患者的神经末梢可能出现病理性变化如神经纤维增生或脱髓鞘, 这些变化可能进一步加重疼痛感受和增强疼痛的持久性。也有发现脂肪组织产生的 TNF- $\alpha$  与肥胖的程度有关, 尤其是腹部肥胖的人群。脂肪组织分泌的 IL-6, 在肥胖人群的水平更高, 它的功能之一是增加 C 反应蛋白的分泌。

### 3.2. 临床研究: 肥胖与各类疼痛

肥胖已成为全球性的社会公共卫生问题, 不仅在发达国家如此, 在发展中国家也同样。随着我国社会经济的发展, 人们的膳食行为和生活方式的改变, 超重和肥胖日趋流行。目前关于肥胖与疼痛的关系已成为一个重要的研究领域, 但作用机制尚不完全清楚。探究肥胖与疼痛的关系及其作用机制, 采取相应的一级预防是减少疼痛相关疾病发病率和患病率的重要方法和措施。

#### 3.2.1. 肥胖与腰痛(Low Back Pain)

近年来关于肥胖与腰痛关系的研究越来越多, 虽然较高的体重指数(body mass index, BMI)或者肥胖和腰痛的因果关系目前尚有争议, 但是许多研究表明肥胖与腰痛发病率升高存在相关性[64]。一份来自亚洲、欧洲、非洲和拉丁美洲九个国家的横断面研究发现, 在不同的国家, 肥胖与腰痛都存在一定的相关性, 表现为在中国腰痛的发病率最低(21.5%), 发病率最高的是波兰(57.5%), 而且 BMI  $\geq 35$ 、30.0~34.0、25.0~29.9 时, 患腰痛的概率明显大于 BMI 为 18.5~24.9 时[65]。美国一项 15,974 例脊椎患者横断面研究发现, 与非肥胖患者比较, 体重指数越大或者肥胖的患者, 疼痛症状越严重, 越容易造成残疾[66]。丹麦的一项横断面研究也表明肥胖和腰痛尤其是慢性腰痛的发生存在正相关的关系[67]。通过观察研究, 患有腰痛的老年患者在走路和爬楼梯时, 肥胖者相比超重者承受更剧烈的疼痛, 腰部力量相对较弱, 增加了疼痛和致残率的出现。

#### 3.2.2. 肥胖与骨关节炎(Osteoarthritis)

挪威的一项队列研究发现, 体重指数和髌关节炎发病之间存在剂量 - 反应关系[68], 体重指数越大, 患髌关节炎的可能性越大, 而且髌关节炎疼痛和高体重指数有关, 肥胖患者疼痛感更强烈, 生活质量更低, 疾病程度更严重。一些研究也表明体重增加和手关节炎有关系, 超重或肥胖可以增加男性和女性患手关节炎的发生。

#### 3.2.3. 肥胖与类风湿性关节炎(Rheumatoid Arthritis)

Cynthia 等应用队列研究分析了 1985~2007 年类风湿性关节炎患者与对照组情况, 排除其他混杂因素后, 肥胖与类风湿性关节炎强烈相关[69]。一项前瞻性病例对照研究发现, 肥胖人群增加患类风湿性关节炎的风险是非肥胖人群的四倍(比值比 OR 值为 3.74), 其中女性 OR 为 4.96, 男性 OR 为 1.15 [70]。临床试验表明肥胖还可以降低英夫利昔等治疗类风湿性关节炎的疗效[71]。

#### 3.2.4. 肥胖与纤维肌痛综合征(Fibromyalgia)

许多研究表明肥胖可能会导致纤维肌痛或者提高纤维肌痛的强度[72]。

#### 3.2.5. 肥胖与偏头痛(Migraine)

随着现代生活节奏加快, 偏头痛成为一种常见病、多发病, 严重影响患者的生活质量和工作。关于偏头痛的发病机制目前尚不完全清楚, 包括血管源学说、三叉神经血管学、神经源学、生化因素和遗传因素等。最近研究发现肥胖与偏头痛具有一定的相关性, 表现为肥胖与偏头痛的发作频率、严重程度及致残性呈正相关[73]。Meta 分析研究发现肥胖可以增加患慢性偏头痛的风险[74]。减轻体重可改善偏头痛的症状。肥胖与偏头痛联系的作用机制可能与一些神经递质或多肽类物质、脂肪组织分泌的炎症介质或

脂肪因子, 以及肥胖与偏头痛共有的病理生理因素有关。炎症在偏头痛的发生机制中起重要作用, 研究表明肥胖可以促进炎症的发生发展。最近研究发现低水平的脂联素与控制偏头痛患者的血小板聚集和水平升高有关。肥胖也与降钙素基因相关肽(CGRP)水平增加有关, 肥胖个体中, 血浆 CGRP 水平升高, 而 CGRP 具有较强的扩血管作用, 在偏头痛的发病中起重要作用。

综上所述, 肥胖已经成为全球严重的公共卫生问题。

#### 4. 围手术期镇痛应关注身体质量指数

肥胖对术中疼痛管理有显著影响。首先, 肥胖患者体内脂肪组织的增加可能改变麻醉药物的分布和代谢, 导致麻醉药效和作用时间与正常体重患者不同, 因此需要调整药物剂量。此外, 肥胖可能影响肝脏和肾脏功能, 改变药物的代谢速率。术中麻醉管理策略包括根据体重调整剂量和考虑使用神经阻滞或局部麻醉以减少全身麻醉药物的需求。体位调整和组织暴露问题可能影响疼痛管理, 因此可使用超声引导技术进行局部麻醉或神经阻滞, 以及采用持续麻醉技术如镇痛泵来改善术中疼痛控制。

最新研究成果显示, 肥胖患者疼痛管理正受到新兴生物标志物的关注, 这些标志物有助于评估疼痛风险和治疗效果。同时, 新型药物和治疗方法的开发, 特别是针对肥胖相关炎症的治疗, 可能提升疼痛管理效果。未来的研究应重点评估肥胖患者围手术期疼痛管理的长远效果, 并探讨新兴技术如虚拟现实治疗和个性化医疗在疼痛管理中的应用, 以进一步优化治疗方案。

临床工作中, 我们可以从以下几方面入手:

一、药物选择与调整: 根据患者的体重、药物代谢和潜在副作用, 选择和调整药物剂量。

二、联合用药: 使用非甾体抗炎药(NSAIDs)、阿片类药物和局部麻醉药物的联合方案, 以提高疼痛管理效果。

三、物理治疗: 包括术后的康复训练和物理治疗, 以改善功能和减轻疼痛。

四、心理支持: 提供心理支持和咨询, 帮助患者应对术后的心理压力和疼痛感。

五、多学科团队: 建立包括麻醉医生、外科医生、疼痛管理专家、营养师和心理医生在内的多学科团队, 共同制定和实施个体化的疼痛管理计划。

六、跨学科研究: 推动跨学科研究, 探索肥胖、疼痛及其管理的综合机制和最佳实践。

七、根据最新研究成果, 制定和更新肥胖患者围手术期管理的临床指南, 以提高治疗效果和患者安全。并加强对医疗人员的健康教育与培训, 提高对肥胖患者疼痛管理的认识和技能提升。

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