

椎弓根螺钉对于邻近关节突关节损伤的影响因素分析

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摘要

椎弓根螺钉是常用的脊柱内固定方法, 但置钉过程中可能会损伤小关节, 导致小关节退变或融合, 影响脊柱的功能和邻近节段的稳定性。减少术中对小关节的破坏对于减少术后邻近节段的退变具有重要意义。椎弓根螺钉置入导致小关节损伤的主要原因包括置钉方式的不同, 置钉点选取差异以及椎旁软组织干扰等。此外, 术中小关节损伤的发生率还受到置钉节段和解剖变异等风险因素的影响。传统的X线引导下置入螺钉容易对小关节造成损伤, 而经皮椎弓根置入螺钉、开放式椎弓根置入螺钉, 甚至机器人辅助下置入螺钉都能更好地保护小关节。本文分析了椎弓根螺钉置入术对邻近关节突关节损伤的危险因素, 为减少关节损伤和术后并发症提供参考。

关键词

椎弓根螺钉, 关节突关节, 邻近节段退变

Analysis of Influencing Factors of Pedicle Screws on Injury of Adjacent Facet Joints

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Abstract

Pedicle screws are commonly used for internal spinal fixation, but they may damage facet joints, lead to degeneration or fusion of facet joints, and affect the function of the spine and the stability

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of adjacent segments. Reducing the destruction of facet joints during operation is of great significance for reducing the degeneration of adjacent segments after operation. The main reasons for the injury of facet joints caused by pedicle screw implantation include different nailing methods, different nailing points and paravertebral soft tissue interference. In addition, the incidence of intraoperative joint injury is also affected by risk factors such as nailing segment and anatomic variation. Conventional X-ray guided screw placement is prone to damage to the facet joints, but percutaneous pedicle screw placement, open pedicle screw placement, and even robotic screw placement can better protect the facet joints. The risk factors of proximal facet joint injury after pedicle screw insertion were analyzed to provide reference for reducing joint injury and post-operative complications.

Keywords

Pedicle Screws, Facet Joint, Adjacent Segments Degeneration

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1. 引言

椎弓根螺钉内固定技术广泛应用于治疗各种脊柱退行性疾病、脊柱骨折、脊柱感染等疾病中。然而术后邻近节段退变(Adjacent Segments Degeneration, ASD)是椎弓根螺钉置入的常见并发症之一。既往有临床研究证实,椎弓根螺钉对于近端相邻关节突关节的损伤是加快关节突关节蜕变从而导致 ASD 出现的重要危险因素之一。关节突关节的损伤可能会导致椎体间的相对位移和成角增大,从而导致脊柱失稳,并且易发生分离,进而加速椎间盘的退变,增加术后邻近节段退变的发病率。笔者对于椎弓根螺钉置入对临近关节突关节损伤的影响因素研究进展综述如下。

2. 关节突关节损伤的评价标准

临床上对于椎弓根螺钉对于关节突关节损伤的分级方法很多。临床上常通过 Babu 分级来评估脊柱椎弓根螺钉对于临近关节突关节的损伤情况, Babu 分级[1]共分为 0~3 级: 0 级, 螺丝或螺帽没有触及关节突关节; 1 级, 触及关节突关节侧缘, 但未进入关节腔内; 2 级, 进入关节突关节腔内, 但进入距离 < 1 mm; 3 级, 进入关节突关节腔内, 进入距离 ≥ 1 mm。同时也有学者认为, 对于腰椎椎弓根螺钉损伤关节突关节的标准, 符合下列其中一项, 即可纳入其中: ① 邻接关节突关节; ② 侵入关节突关节腔内, 但 < 1 mm; ③ 明显侵入关节突关节腔内[2]。大多数关节突关节损伤是由钉帽引起的, 而由螺钉或连接杆引起的则相对较少。

3. 影响因素

3.1. 置钉方式

Hyun [3]等对 30 例患者在开放手术下置入了共 140 枚椎弓根螺钉, 结果仅有 0.71% 的关节突关节发生损伤。Patel [4]等学者对总计 225 例患者(450 枚螺钉)分别行开放手术与 MIS-TLIF 置钉, 邻近节段关节突关节损伤的总发生率在 MIS-TLIF 组(41.25%)高于开放手术组(30.4%)。Zhang Q, Han X 等学者的研究中开放置钉由于其能够清晰显露关节囊和进钉点的解剖标志, 使术者可以对关节突关节采取较好的保护

措施, 因此造成的关节突关节损伤率相对较低(2.1%~15.8%) [5] [6] [7] [8] [9]。故认为开放椎弓根置钉对关节突关节有较好的保护作用。但因开放手术存在的一些术后并发症如肌肉血管损伤以及切口愈合周期延长等[3] [10]。更为微创的置钉方式如经皮椎弓根置钉技术(Percutaneous Pedicle Screw, PPS)已在临床广泛应用, 与传统开放手术相比, PPS 技术治疗腰椎疾病的疗效相当, 但同时能在极大程度上减少术中对于肌肉及软组织的分离, 从而实现减短手术时间、减少术中出血、减轻术后疼痛等目的[8] [11] [12] [13]。然而, 在 PPS 置钉的过程中, 相邻的小关节在 X 线上不清晰可见。因此与开放手术相比, PPS 技术是否有可能增加关节突关节损伤的风险, 但仍需要进一步考证。Marengo [8]和 Lee [9]等研究人员比较了经皮椎弓根置钉技术与传统开放式置钉的临床疗效和安全性, 发现皮质骨通道内钉能更好地保护小关节。同时也有学者[14]对 69 例行微创腰椎内固定椎间融合术的患者进行回顾性观察, 研究表明关节突关节损伤的发生率达到 25.4%。差异颇大的发生率可能与不同手术医师对于经皮椎弓根置钉技术的熟练程度相关。Baird [15]等人采用 X 线引导下经皮置钉, 将 120 颗螺钉置入 10 具尸体的 L1~S1 节段, 发现经验丰富的外科医师造成的关节破坏率明显较低。同时 Park [16]等采用 X 线引导下经皮置钉 92 例, 共 184 枚螺钉, 发现关节突破坏率随着医师手术经验的增加而降低。综上所述而言, 在评估关节突关节损伤的概率时, 应充分考虑“学习曲线”的影响。

3.2. 置钉点的选择

术中置钉点的选择与关节突关节损伤率息息相关, 置钉点距离相邻关节突关节越近, 发生关节突关节损伤的可能性则越大。目前临床上, 开放手术中, 常见的置钉术式有 Weinstein 术式、人字嵴法, 和十字交叉法等。Chen 等[2] [17] [18]研究发现, 采用 Weinstein 术式的患者螺钉损伤关节突关节的概率较低, 为 15%~28.3%。其次为人字嵴法(23.8%) [19]。可能因为 Weinstein 法以上关节突外下缘凹陷处作为进钉点, 与临近的关节突关节距离较远, 同时进钉点更加靠外, 使得椎弓根螺钉能够获得足够的倾斜角度[17]。Chung [20]和 He [21]等学者, 分别通过对尸体标本研究和临床回顾研究均得出结论: 置钉点距离关节突关节越近, 发生临近关节突关节损伤的可能性越大, 其中在 He 等学者的研究中, 置钉点远离关节突关节组的患者临床症状的改善更明显, 长期随访出现影像学术后邻近节段退变和有症状的术后邻近节段退变的概率也均低于置钉点靠近关节突关节组[21]。同时, Chen 等学者在研究中还发现侧锁螺钉对近端相邻关节突关节的损伤率明显高于顶锁螺钉系统[19]。

而在经皮椎弓根钉置入手术中, 临床上广泛采用的置钉的方法通常为外 - 内侧通道法(Lateral-to-Medial Trajectory, LMT): 及置钉点为右侧椎弓根影的 1~3 点和左侧 9~11 点位置。Tannous [22]等学者研究表明, 外 - 内侧通道法置钉对于关节突关节的破坏率较低, 为 16%。这是因为关节突关节在 X 线透视下的正、侧位片上显示较为清晰, 较容易定位, 同时 LMT 法置钉点的距离与关节突关节相距较远。因而使得 LMT 法置钉导致关节突关节损伤的概率较低, 进而在临床上广泛使用。

传统开放手术中椎弓根螺钉置入与经皮椎弓根钉置入的最大区别之一就是置钉点的选择。经皮椎弓根钉置钉点在椎板外侧的峡部区域, 而非位于关节突上, 增加了置钉点与关节突之间的距离, 相较于开放手术置钉, 能更好的避免损伤关节突关节。综上所述, 置钉点的选择非常重要, 与关节突关节的距离越远, 损伤关节突关节的概率则越小。

3.3. 置钉节段

有学者[23]发现, 随着椎弓根内固定的节段从上腰椎往下逐渐降低, 关节突关节损伤的发生率逐渐增加, 下腰椎(特别是 L4、L5)比上腰椎更容易发生关节突关节的损伤, 且 L5 节段关节突关节损伤发生数占总的关节突关节损伤发生数的 37%。Moshirfar [2]等中在开放手术中对 204 例患者通过 Weinstein 法置

钉, 研究发现 L5 椎体近端关节突关节的破坏率显著高于其他各个节段, 为 48%。而在 X 线引导下经皮穿刺置入椎弓根螺钉时, L5 椎体近端关节突关节的损伤率仍然最高[24], 为其他节段的 3.3 倍[16]。究其原因, 根据腰椎的解剖特点, 其主要原因可能一方面是因为随着手术操作节段的下降, 椎体关节突关节的关节面逐渐向外侧和冠状面偏移, 因而导致置钉点越来越靠近关节突关节, 从而增加损伤的风险。Teles [25]和 Patel [4]等学者通过比较 X 线引导下置钉和开放手术下置钉时分别发现, 当椎弓根平面上的小关节角(Facet Angle, FA)大于 45°和小关节角度大于 35°时, 关节突关节损伤的概率明显增加, 小关节角度大于 35°是关节突关节损伤的独立危险因素。徐正宽[26]等学者回顾了 115 例经皮椎弓根钉内固定手术患者置钉时腰椎关节突关节角对邻近关节突关节破坏的影响, 结果表明, 随着关节突关节角度的增加, 关节突关节的损伤率和严重程度增加。因为在置入椎弓根螺钉时, 置钉的方向和通道在椎弓根中始终保持不变。随着关节突关节面角度的增大, 关节突关节的关节面会向冠状位移位, 进而阻挡置钉通道, 导致小面关节损伤加重, 造成更严重的关节突关节损伤[26]。另一方面, 下腰部的椎旁软组织的厚度和密度较大, 置钉的阻力增大, 分离、暴露置钉点以及沿最佳的螺钉通道置钉的难度增大, 因而导致了关节突关节损伤的风险[1]。同时, 由于骶尾部的生理性后凸, 以及髂嵴位置的阻挡, 更是会给予腰部, 特别是 L5、S1 节段的椎弓根螺钉增加相当大的难度。因此, 术者在进行此类手术时, 需要对患者的影像学资料进行细致的评估, 并配合优秀的透视技术, 或使用计算机导航技术和机器人辅助置钉, 来减小在置钉过程中损伤关节突关节的风险。

3.4. 个体化因素

常见的个体化因素如年龄、BMI 等对于关节突关节损伤的影响目前仍存在很大争议。有学者认为腰椎椎弓根螺钉置入后出现的关节突关节损伤的发生与年龄无明显相关性[16]。也有不忍学者认为年龄大于 70 岁的高龄患者因年龄过大, 大多在术前已经出现了相邻关节突关节的增生、骨赘形成, 进而导致无论是开放手术置钉亦或是 X 线引导下置钉时, 解剖结构不清晰, 从而影响椎弓根螺钉的置入, 增加造成关节突关节损伤的风险[27]。

患者皮肤弹性、肌肉密度和肌肉厚度的不同, 会导致患者椎旁软组织阻力的不同[1]。虽然开放手术置钉前可以剥离周围组织以清晰显露解剖标志, 但由于椎弓根钉置入过程中椎旁软组织阻力的影响, 置钉点容易向内侧偏移, 螺钉外展角度减小, 因此更容易对关节突关节造成损伤。而在经皮置钉时, 使用套筒的逐级扩张肌肉、软组织, 可以减少软组织的压力, 并且在置钉过程中保护螺钉不受软组织的影响, 从而减少损伤关节突关节的风险。

而肥胖患者由于椎旁软组织阻力较大, 关节突关节损伤率也会随之升高。Babu 等[1]学者回顾分析了 279 例椎弓根螺钉置入的病例, 并得出结论年龄小于 65 岁, 肥胖时关节突关节损伤的独立危险因素。Zeng 等[14]学者及 Patel 等[4]学者通过研究也得出类似的结论。患者腰背部肌肉较发达, 皮肤弹性较好, 肥胖患者椎旁软组织弹性和厚度较大, 可导致椎旁软组织压力增大, 不仅解剖标志难以清晰暴露, 而且在置钉过程中容易因软组织的推动导致螺钉移位, 增大关节突关节损伤的风险[28]。所以对于腰背部肌肉发达、肥胖的患者, 经皮椎弓根钉置入技术能更好的保护关节突关节。

4. 总结

腰椎椎弓根螺钉置入可能对近端相邻的关节突关节造成损伤, 并加速相邻节段退变。随着脊柱外科的蓬勃发展, 腰椎椎弓根螺钉在临床已广泛应用, 这一问题越来越受到重视。综上所述, 在腰椎椎弓根螺钉置入时建议采用后外侧置钉点的 Weinstein 入路手术, 使置钉点远离关节突关节, 置钉时螺钉深度不宜过深。对于有下腰椎(尤其是 L5、S1)病变的患者, 手术时医生更应注意充分的暴露置钉点和充分透视,

必要时运用机器人导航, 以降低关节突关节损伤的风险。对于肥胖患者或既往有邻节段退变患者, 应充分考虑其发生关节突关节损伤的风险性[29]。针对不同患者制定安全合理的置钉方法。在钉入技术的选择上, 应根据不同患者、不同节段的个体化原则, 灵活运用各种置钉技术。同时努力提高自身操作技术从多方面降低关节突关节的损伤率, 减少术后 ASD 的发生。

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