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经皮穿刺椎弓根螺钉内固定治疗胸腰段脊柱骨折的疗效及对患者氧化应激与术后疼痛的影响*

黄凤琪[1] 甘荣坤[2] 韦 超[3] 王剑敏[1] 李小荣[1]

（1 厦门大学附属成功医院骨科三区 福建 厦门 361000；2 厦门大学附属成功医院医学影像科 福建 厦门 361000；
3 福建医科大学附属第一医院脊柱外科 福建 厦门 350005）

摘要 目的：探讨经皮穿刺椎弓根螺钉内固定治疗胸腰段脊柱骨折的疗效及对患者氧化应激及术后疼痛的影响。**方法：**选取本院2017年4月到2021年4月在本院诊治的胸腰段脊柱骨折患者126例作为研究对象，依据手术方式的不同将其分为微创组与开放组各63例。微创组给予经皮穿刺椎弓根螺钉内固定治疗，开放组给予开放式椎弓根内固定术治疗。**结果：**微创组的切口长度等围手术指标均少于开放组（P<0.05）；微创组术后1 d、3 d、5 d与7 d的疼痛视觉模拟评分（VAS）低于开放组（P<0.05）；微创组术后7 d的的感染、切口愈合不良、内固定移位、神经根脊髓压迫等并发症发生率为3.2 %，低于开放组的22.2 %（P<0.05）；两组术后7 d的血清P物质（SP），和β-内啡肽（β-EP）含量高于术前1 d，微创组高于对照组（P<0.05）；两组术后7 d的血清谷胱甘肽过氧化物酶（GSH-Px）与晚期氧化蛋白产物（AOPP）含量高于术前1 d，微创组高于开放组（P<0.05）。**结论：**经皮穿刺椎弓根螺钉内固定治疗胸腰段脊柱骨折可有效控制氧化应激指标、疼痛介质水平，减少创伤，减轻术后疼痛，降低并发症，有利于患者康复。

关键词：经皮穿刺椎弓根螺钉内固定；胸腰段脊柱骨折；氧化应激；术后疼痛

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The Effects of Percutaneous Pedicle Screw Fixation in the Treatment of Thoracolumbar Spine Fractures and Its Influence on Patients' Oxidative Stress and Postoperative Pain*

HUANG Feng-qi[1], GAN Rong-kun[2], WEI Chao[3], WANG Jian-min[1], LI Xiao-rong[1]

*(1 Department of Orthopaedic three areas, Cheng Gong Hospita,Xiamen University, Xiamen, Fujian, 361000, China;
2 Department of Imaging,Cheng Gong Hospita, Xiamen University, Xiamen, Fujian, 361000, China;
3 Department of Spine Surgery, The First Affiliated Hospital of Fujian Medical University, Xiamen, Fujian, 350005, China)*

ABSTRACT Objective: To investigate the effects of percutaneous pedicle screw internal fixation in the treatment of thoracolumbar spine fractures and its influence on patients' oxidative stress and postoperative pain. **Methods:** A total of 126 patients with thoracolumbar spinal fractures treated in our hospital from April 2017 to April 2021 were selected as the research subjects. According to different surgical methods, the patients were divided into minimally invasive group and open group, 63 patients in each group. Minimally invasive group was treated with percutaneous pedicle screw internal fixation, and open group was treated with open pedicle internal fixation. **Results**: The incision length and other perioperative indexes in the minimally invasive group were less than those in the open group (P<0.05). The VAS of pain in the Minimally invasive group at 1 d, 3 d, 5 d and 7 d after operation were lower than that of the open group (P<0.05). The incidence of complications such as infection, poor incision healing, internal fixation displacement, and nerve root and spinal cord compression in the minimally invasive group at 7 d after surgery were 3.2%, which were lower than 22.2% in the open group (P<0.05). The serum Substance P (SP) and β-endorphin (β-EP) levels in the two groups at 7 d after surgery were higher than those on the 1 day before operation, and the minimally invasive group were higher than the control group (P<0.05). The levels of serum glutathione peroxidase (GSH-Px) and Advanced Oxidized Protein Products (AOPP) on the 7th day after operation in the two groups were higher than those on the 1 day before operation, the minimally invasive group were higher than the open group (P<0.05). **Conclusion:** Percutaneous pedicle screw internal fixation for thoracolumbar spinal fracture can effectively control oxidative stress index and pain medium level, reduce trauma, relieve postoperative pain, reduce complications, and benefit patients' recovery.

Key words: Percutaneous pedicle screw fixation; Thoracolumbar spine fracture; Oxidative stress; Postoperation pain

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作者简介：黄凤琪（1982-），男，硕士，副主任医师，研究方向：骨科创伤及脊柱微创，电话：13799258426，E-mail：hfq733@163.com

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前言

胸腰段脊柱骨折在骨折患者中的发生率较高，主要为外伤所致，90.0 %左右的椎体骨折发生在胸腰椎段。同时胸腰段脊柱骨折患者大多遭受严重创伤，多伴随有神经功能及脏器损伤，对于治疗的要求较高[1]。胸腰段脊柱骨折治疗的原则是及时纠正骨折状态、恢复骨折部位，进而降低因骨折所造成的损伤[2,3]。开放手术治疗胸腰段脊柱骨折具有操作简单、成熟方便等优点，但对患者的创伤较大，不利于患者预后恢复[4]。随着医学技术的发展，经皮穿刺椎弓根螺钉内固定治疗得到了广泛应用，其能有效复位并稳定骨折，可最大程度降低对患椎软组织的损伤，最终达到稳定脊柱的效果，该手术方式具有创伤小、术后恢复快等优点，能促进患者术后康复[5-7]。研究表明：血清 P 物质（Substance P, SP）和 β- 内啡肽（β-endorphin, β-EP）与谷胱甘肽过氧化物酶（Glutathione peroxidase, GSH-Px）与高级氧化蛋白产物（Advanced Oxidized Protein Products, AOPP）在胸腰段脊柱骨折的发生与发展中发挥重要作用，上述因子的表达水平是评价创伤严重程度的常用指标[8,9]。手术、麻醉的刺激均为机体的一种持续应激因素，而持续的应激状态能引起血清 SP、β-EP、GSH-Px、AOPP 表达水平的升高，而后者可进一步加剧机体氧化应激反应，从而形成恶性循环[10,11]。本文具体探讨了经皮穿刺椎弓根螺钉内固定治疗胸腰段脊柱骨折的疗效及对患者氧化应激及术后疼痛的影响，以明确经皮穿刺椎弓根螺钉内固定治疗的应用效果。现报道如下。

1 资料与方法

1.1 一般资料

选取本院 2017 年 4 月到 2021 年 4 月在本院诊治的胸腰段脊柱骨折患者 126 例作为研究对象。

纳入标准：确诊为胸腰椎脊柱骨折者；患者生命体征稳定，意识清楚下签署了对本研究的知情同意书；年龄 20-60 岁，具有手术指征；择期手术；骨折到手术时间 <7 d；经 CT 检查可见较为清晰椎体骨折线，患者脊柱 X 线侧位片提示椎体压缩情况；未见明显骨质疏松；单发胸腰段脊柱骨折者；未见明显神经受损。

排除标准：病理性骨折患者；严重椎体压缩患者；神经功能受损及具有后方韧带复合体损伤史的患者；妊娠与哺乳期妇女；下肢残疾者。

将患者随机分为微创组与开放组各 63 例，两组患者的骨折到手术时间、骨折部位等资料对比无差异（P>0.05）。

表 1 一般资料对比

Table 1 Comparison of general data

Groups	n	Gender (Male/female)	Fracture to operation time (d)	Cause (traffic accident injury/fall injury/smash injury)	Fracture type (A1/A2/A3)	Age (years)	Body mass index (kg/m^2)
Minimally invasive group	63	43/20	4.21±0.28	33/17/13	24/26/13	43.19±3.28	22.87±1.24
Open group	63	41/22	4.22±0.33	34/16/13	25/27/11	44.22±3.51	22.98±1.33

1.2 手术方法

微创组：给予经皮穿刺椎弓根螺钉内固定治疗，患者取俯卧位，进行全麻。术前采用 C 臂透视进而对骨折位置、相邻椎体的椎弓根投影位置进行定位。每个置钉区域纵形切开约 1.5 cm，切开腰背筋膜，放置工作通道。C 臂透视下，选择合理角度，使用穿刺针进针，经椎弓根进入目标椎体，观察正侧位透视位置，若满意则拔出针芯并插入导丝，开口，攻丝，通过导丝将合适椎弓根螺钉拧入椎体，依次放置余椎弓根螺钉。透视判断螺钉位置理想后，将固定棒放入椎弓根螺钉的尾部槽。撑开恢复伤椎高度，紧固所有螺帽并折断软通道尾帽，缝合伤口。

开放组：给予开放式椎弓根内固定术治疗，患者俯卧悬空腹部进行全麻。在胸腰椎脊柱正后方做适当长度切口，使得伤椎及相邻椎体暴露。暴露选取合适进钉点，将椎弓根螺钉置入椎体，固定椎体后并置入连接棒，对伤椎进行纵向撑开，并拧紧固定螺帽，复原椎体前缘高度及后凸角度。并对患者进行切口关闭操作。

患者在术后可进行床上轻微活动，14 d 后患者可佩戴支具后轻微坐起，术后 1 个月后在佩戴支具的情况下可进行简单下地活动，但不宜剧烈运动。所有患者均由本院同一组骨科医师进行上述操作。

1.3 观察指标

（1）记录与观察两组的术中出血量、切口长度、术后引流量、手术时间与术后住院时间。（2）在术后 1 d、3 d、5 d 与 7 d 采用视觉模拟评分（Visual Analogue Score, VAS）方法评定患者的疼痛程度，分为 0-10 分评分，分数越高，疼痛越严重。（3）在术前 1 d 与术后 7 d 采取 2-3 mL 空腹静脉血，2500 rpm 离心 5 min，取血液的上层血清，采用化学发光法（赛默飞）检测血清 SP、β-EP 含量，采用酶联免疫法（赛默飞）检测血清 GSH-Px、AOPP 含量。（4）记录与观察两组术后 7 d 出现的感染、切口愈合不良、内固定移位、神经根脊髓压迫等并发症。

1.4 统计方法

本次研究的统计软件为 SPSS22.00，结果提示 P<0.05，则表明差异具有统计学意义，检验水准为α=0.05。计数数据以百分比表示（对比为卡方 χ^2 检验），计量数据以均数±标准差表示（对比为 t 检验）。

2 结果

2.1 围手术指标对比

微创组的切口长度等围手术指标均少于开放组（P<0.05）。见表 2。

2.2 疼痛评分对比

微创组术后 1 d、3 d、5 d 与 7 d 的疼痛 VAS 评分低于开放组（P<0.05）。见表 3。

2.3 术后并发症对比

微创组术后 7 d 的的感染、切口愈合不良、内固定移位、神经根脊髓压迫等并发症发生率为 3.2 %，低于开放组的 22.2 %（P<0.05）。见表 4。

表 2 两组围手术指标对比（均数±标准差）

Table 2 Comparison of perioperative indicators between the two groups (mean ± standard deviation)

Groups	n	Postoperative hospital stay (d)	Postoperative drainage volume (mL)	length of incision (cm)	Intraoperative blood loss(mL)	The operation time (min)
Minimally invasive group	63	10.32±1.40#	16.92±1.33#	6.53±0.29#	95.28±11.56#	54.98±8.27#
Open group	63	15.29±2.00	145.29±12.48	11.13±1.48	272.47±15.29	65.44±8.17

Note: Compared with open group, #P<0.05.

表 3 两组术后不同时间点的疼痛评分对比(分，均数±标准差)

Table 3 Comparison of pain scores between the two groups at different postoperative time points (score, mean ± standard deviation)

Groups	n	Postoperative 1 d	Postoperative 3 d	Postoperative 5 d	Postoperative 7 d
Minimally invasive group	63	3.92±0.34	2.13±0.36	1.33±0.21	0.74±0.14
Open group	63	4.94±0.38	3.93±0.43	2.88±0.33	1.15±0.13

Note: Compared with open group, #P<0.05.

表 4 两组术后并发症发生情况对比(n)

Table 4 Comparison of postoperative complications between the two groups (n)

Groups	n	Infection	Poor incision healing	Internal fixation shift	Nerve root spinal cord compression	summation
Minimally invasive group	63	0	1	0	1	2(3.2%)#
Open group	63	3	5	2	4	14(22.2%)

Note: Compared with open group, #P<0.05.

2.4 血清 SP、β-EP 含量变化对比

两组术后 7 d 的血清 SP、β-EP 含量高于术前 1 d，微创组高于对照组（P<0.05）。见表 5。

表 5 两组手术前后血清 SP、β-EP 含量变化对比(pg/mL，均数±标准差)

Table 5 Comparison of serum SP and β-EP levels between the two groups before and after operation (PG/mL, mean ± standard deviation)

Groups	n	SP		β-EP	
		Preoperative 1 d	Postoperative 7 d	Preoperative 1 d	Postoperative 7 d
Minimally invasive group	63	44.04±1.32	69.15±3.42*#	143.31±10.34	225.48±14.43*#
Open group	63	44.59±1.37	54.64±5.26*	143.02±9.82	192.26±13.37*

Note: Compared with open group, #P<0.05; Compared with preoperative 1 d, *P<0.05.

2.5 血清 GSH-Px、AOPP 含量变化对比

两组术后 7 d 的血清 GSH-Px、AOPP 含量高于术前 1 d，微创组高于开放组（P<0.05）。见表 6。

表 6 两组手术前后血清 GSH-Px、AOPP 含量变化对比(mg/L，均数±标准差)

Table 6 Comparison of changes in serum GSH-Px and AOPP contents between the two groups before and after surgery (mg/L, mean± standard deviation)

Groups	n	GSH-Px		AOPP	
		Preoperative 1 d	Postoperative 7 d	Preoperative 1 d	Postoperative 7 d
Minimally invasive group	63	218.32±28.18	243.99±30.14#*	18.14±1.58	34.28±2.67#*
Open group	63	217.98±19.47	226.98±17.20#	18.22±0.28	24.09±3.11#

Note: Compared with open group, #P<0.05; Compared with preoperative 1 d, *P<0.05.

3 讨论

胸腰段骨折在临床上较常见，伴随有胸腰脊柱关节面或活动度异常，多由外伤引起，多需进行手术治疗[12]。手术治疗胸腰段脊柱骨折的原则为：对于骨折所造成脊髓神经的不当压迫进行缓解，有效恢复脊柱正常结构[13]。开放手术为胸腰段脊柱骨

折的主要治疗方法，能有效改善患者预后，但对患者的创伤较大，术中失血较多。同时术中肌肉牵拉与软组织广泛剥离可引起肌肉纤维瘢痕化、脂肪化，导致腰背部肌肉缺血，患者术后出现大量并发症，易产生迟发性脊柱不稳，不利于患者康复[14,15]。

本研究显示微创组的切口长度等围手术指标都少于开放组；微创组术后 1 d、3 d、5 d 与 7 d 的疼痛 VAS 评分低于开放组；微创组术后 7 d 的的感染、切口愈合不良、内固定移位、神经根脊髓压迫等并发症发生率为 3.2 %，低于开放组的 22.2 %，这一结果与 Coric D 等人[16]以及任大江[17]等人的研究结果具有一致性。进一步分析可知：开放式手术方式固定术手术切口较大，需剥离周围软组织，这一操作将会提高术后感染风险，且因术中出血量较多，长时间手术，易造成肌肉坏死，导致患者术后出现腰椎功能障碍、僵硬等，影响患者正常生活。经皮穿刺椎弓根螺钉内固定治疗对于重建伤椎椎体、恢复伤椎高度等具有很好的效果，其可在影像学指导对于手术进行定位及对穿刺点位置进行确定，有效维持肌肉及复合体稳定，手术不需要较大切口的暴露视野，可有效保留腰背功能，减少对患者的创伤，促进缓解术后疼痛，降低并发症[18,19]。

胸腰段脊柱骨折是一种由于高能量外力作用进而造成的脊柱骨折。严重时，将会使脊柱出现生理弯曲消失，严重时患者出现截瘫[20,21]。作为一种微创治疗方法，经皮穿刺椎弓根螺钉内固定治疗具有术后恢复快、创伤小等优势，可有效扩大椎体容积，改善患者术后矫正度丢失的情况[22]。现代研究表明：胸腰段脊柱骨折的发生、发展常伴氧化应激反应及炎性因子水平的异常表达[23]。本研究显示：两组术后 7 d 的血清 SP、β-EP 含量高于术前 1 d，微创组高于对照组；两组术后 7 d 的血清 GSH-Px、AOPP 含量高于术前 1 d，微创组高于开放组，表明经皮穿刺椎弓根螺钉内固定治疗胸腰段脊柱骨折能促进缓解氧化应激状态，促进血清 SP、β-EP、GSH-Px、AOPP 的释放。这一结果与 Huang Z 等人[24]以及 Kocis J[25]等人的研究结果具有一致性。从机制上分析，SP、β-EP 可参与调节体内免疫调节、信息传导和炎症反应。特别是 β-EP 是人体内一种吗啡样物质，在免疫应答时大量表达，具有镇痛效应，其水平的降低将会提高患者的疼痛感受[26]。AOPP 可有效清除机体内氧自由基，血清 AOPP 水平越低表示胸腰段脊柱骨折越严重。作为机体中重要的自由基清除剂，GSH-Px 是解除毒素的特殊物质，血清 GSH-Px 水平越低，表明胸腰段脊柱骨折患者的病情越严重[27]。由于经皮穿刺椎弓根螺钉内固定创伤较小，能减轻患者疼痛应激反应，手术过程中可有效解除病灶对局部组织的压迫、刺激，可有效维持人体免疫平衡，从而改善 SP、β-EP、GSH-Px、AOPP 指标水平[28]。并且经皮穿刺椎弓根螺钉内固定治疗能使伤椎的椎体前缘恢复至正常高度，保护骨折椎体的结构及稳定，降低骨折的破坏，恢复脊椎的生理角度，保护骨折椎体的结构及稳定，不会增加相邻椎体损伤的风险[29,30]。但本研究存在一定不足，未进行长期随访，也没有进行椎体测量分析，设置的组别也比较少，将在后续研究中探讨。

综上所述，经皮穿刺椎弓根螺钉内固定治疗胸腰段脊柱骨折能抑制血清 SP、β-EP、GSH-Px、AOPP 的表达，改善氧化应激反应，减少对患者的创伤，缓解术后疼痛，降低并发症，促进康复。

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