

# 骨质疏松性椎体压缩骨折经皮椎体后凸成形术后 脊柱后凸畸形改善程度的影响因素分析

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**摘要** 目的: 探讨骨质疏松性椎体压缩骨折(osteoporotic vertebral compression fracture, OVCF)经皮椎体后凸成形术(percutaneous kyphoplasty, PKP)后脊柱后凸畸形改善程度的影响因素。方法: 收集 2018 年 11 月至 2020 年 11 月在余姚市中医医院接受 PKP 治疗的 OVCF 患者的病例资料, 包括患者的性别、年龄、骨折节段、病程、骨密度 T 值、体质量指数、骨水泥注入量、骨水泥渗漏椎体数等资料。提取患者手术前后的脊柱 X 线片, 测量手术前后的伤椎椎体高度和 Cobb 角, 计算伤椎椎体前缘高度比、伤椎椎体中间高度比和脊柱后凸畸形改善程度。比较手术前后伤椎椎体前缘高度比、伤椎椎体中间高度比、伤椎 Cobb 角的变化情况。观察年龄、病程、骨密度 T 值、体质量指数、骨水泥注入量、骨水泥渗漏椎体数、术前伤椎椎体前缘高度比、术前伤椎椎体中间高度比、术前伤椎 Cobb 角与脊柱后凸畸形改善程度的相关性, 并采用多因素 Logistic 回归分析研究 OVCF 患者 PKP 术后脊柱后凸畸形改善程度的影响因素。结果: ①一般结果。纳入研究的患者共 150 例, 男 79 例、女 71 例, 年龄  $(71.51 \pm 5.65)$  岁, 骨折节段为 T<sub>9</sub>55 例、T<sub>10</sub>42 例、T<sub>11</sub>53 例, 病程  $(9.90 \pm 4.72)$  d, 骨密度 T 值  $-3.12 \pm 0.34$ , 体质量指数  $(21.35 \pm 1.73) \text{ kg} \cdot \text{m}^{-2}$ , 骨水泥注入量  $(4.18 \pm 0.56) \text{ mL}$ , 骨水泥渗漏椎体数 3 个。患者术前、术后 24 h、术后 6 个月伤椎椎体前缘高度比、伤椎椎体中间高度比、伤椎 Cobb 角的比较, 总体差异有统计学意义  $[(62.13 \pm 10.27)^\circ, (75.85 \pm 12.11)^\circ, (76.12 \pm 12.09)^\circ, F = 50.620, P = 0.000; (66.15 \pm 11.34)^\circ, (80.26 \pm 12.63)^\circ, (81.33 \pm 12.17)^\circ, F = 74.045, P = 0.000; 18.01^\circ \pm 7.74^\circ, 12.52^\circ \pm 6.39^\circ, 12.01^\circ \pm 6.31^\circ, F = 24.802, P = 0.000]$ , 术后 24 h、术后 6 个月的伤椎椎体前缘高度比、伤椎椎体中间高度比、伤椎 Cobb 角均较术前改善  $(P = 0.000, P = 0.000, P = 0.000, P = 0.000, P = 0.000, P = 0.000)$ 。②影响脊柱后凸畸形改善程度的单因素分析结果。年龄、病程、体质量指数、骨水泥渗漏椎体数与脊柱后凸畸形改善程度均不存在直线相关关系  $(r = 0.652, P = 0.086; r = -0.162, P = 0.073; r = 0.057, P = 0.528; r = -0.103, P = 0.276)$ , 骨水泥注入量、术前伤椎 Cobb 角与脊柱后凸畸形改善程度均呈正相关关系  $(r = 0.211, P = 0.024; r = 0.625, P = 0.000)$ , 骨密度 T 值、术前伤椎椎体前缘高度比、术前伤椎椎体中间高度比与脊柱后凸畸形改善程度均呈负相关关系  $(r = -0.521, P = 0.000; r = -0.236, P = 0.004; r = -0.342, P = 0.000)$ 。③影响脊柱后凸畸形改善程度的多因素 Logistic 回归分析结果。以骨密度 T 值、术前伤椎 Cobb 角、术前伤椎椎体前缘高度比、术前伤椎椎体中间高度比、骨水泥注入量为自变量, 以脊柱后凸畸形改善程度为因变量, 进行多因素 Logistic 回归分析。结果显示, 骨密度 T 值、术前伤椎 Cobb 角是脊柱后凸畸形改善程度的影响因素  $(b = -1.339, P = 0.000, OR = 0.262; b = 0.195, P = 0.000, OR = 1.215)$ 。结论: 术前伤椎 Cobb 角和骨密度是 OVCF 患者 PKP 术后脊柱后凸畸形改善程度的影响因素。

**关键词** 骨质疏松性骨折; 骨折, 压缩性; 脊柱骨折; 后凸成型术; 脊柱后凸

## Analysis of factors influencing the degree of improvement of spinal kyphosis deformity after percutaneous kyphoplasty for treatment of osteoporotic vertebral compression fracture

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**ABSTRACT** **Objective:** To explore the factors influencing the degree of improvement of spinal kyphosis deformity in patients with osteoporotic vertebral compression fracture (OVCF) after percutaneous kyphoplasty (PKP). **Methods:** The medical records of patients who underwent PKP for treatment of OVCF in Yuyao Hospital of TCM from November 2018 to November 2020 were collected, and their information including gender, age, fractured segment, disease course, T-value of bone mineral density (BMD), body mass index (BMI), consumption of bone cement and the number of vertebrae with bone cement leakage was extracted from the electronic medical record system, and the spinal X-ray films taken before and after the PKP were extracted for measuring presurgical and postsurgical height and Cobb's angle of injured vertebrae and calculating injured vertebrae anterior border height ratio, injured vertebrae middle height ratio and degree of improvement of spinal kyphosis. The changes of anterior border height ratio, middle height ratio and Cobb's angle of injured vertebrae were compared between pre-PKP and post-PKP. The correlations between the degree of improvement of spinal kyphosis and the factors including age, disease

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course, T - value of BMD, BMI, consumption of bone cement, the number of vertebrae with bone cement leakage, presurgical injured vertebrae anterior border height ratio, presurgical injured vertebrae middle height ratio, presurgical injured vertebrae Cobb's angle were analysed, and a multi - factor logistic regression analysis was conducted for researching the factors influencing the improvement degree of spinal kyphosis in OVCF patients after PKP. **Results:** ①One hundred and fifty OVCF patients were enrolled in the study, including 79 males and 71 females with age, disease course, T - value of BMD, BMI, consumption of bone cement and the number of vertebrae with bone cement leakage as  $71.51 \pm 5.65$  years,  $9.90 \pm 4.72$  days,  $-3.12 \pm 0.34$  SD,  $21.35 \pm 1.73$  kg/m<sup>2</sup>,  $4.18 \pm 0.56$  mL and 3; and the fractures located at T<sub>9</sub> (55 cases), T<sub>10</sub> (42 cases) and T<sub>11</sub> (53 cases). There was statistical difference in anterior border height ratio, middle height ratio and Cobb's angle of injured vertebrae between pre-PKP, postsurgical hour 24 and postsurgical month 6 in general ( $62.13 \pm 10.27$ ,  $75.85 \pm 12.11$ ,  $76.12 \pm 12.09\%$ ,  $F = 50.620$ ,  $P = 0.000$ ;  $66.15 \pm 11.34$ ,  $80.26 \pm 12.63$ ,  $81.33 \pm 12.17\%$ ,  $F = 74.045$ ,  $P = 0.000$ ;  $18.01 \pm 7.74$ ,  $12.52 \pm 6.39$ ,  $12.01 \pm 6.31$  degrees,  $F = 24.802$ ,  $P = 0.000$ ), and the anterior border height ratio, middle height ratio and Cobb's angle of injured vertebrae were improved at postsurgical hour 24 and month 6 compared to pre-PKP ( $P = 0.000$ ,  $P = 0.000$ ;  $P = 0.000$ ,  $P = 0.000$ ;  $P = 0.000$ ,  $P = 0.000$ ). ②There was no linear correlations between the improvement degree of spinal kyphosis and the factors including age, disease course, BMI and the number of vertebrae with bone cement leakage ( $r = 0.652$ ,  $P = 0.086$ ;  $r = -0.162$ ,  $P = 0.073$ ;  $r = 0.057$ ,  $P = 0.528$ ;  $r = -0.103$ ,  $P = 0.276$ ). The improvement degree of spinal kyphosis was positively correlated with the consumption of bone cement and presurgical injured vertebrae Cobb's angle ( $r = 0.211$ ,  $P = 0.024$ ;  $r = 0.625$ ,  $P = 0.000$ ), while was negatively correlated with the T - value of BMD, presurgical injured vertebrae anterior border height ratio and presurgical injured vertebrae middle height ratio ( $r = -0.521$ ,  $P = 0.000$ ;  $r = -0.236$ ,  $P = 0.004$ ;  $r = -0.342$ ,  $P = 0.000$ ). ③The multi - factor logistic regression analysis was conducted by taking T - value of BMD, presurgical injured vertebrae Cobb's angle, presurgical injured vertebrae anterior border height ratio, presurgical injured vertebrae middle height ratio and consumption of bone cement as independent variable and the improvement degree of spinal kyphosis as dependent variable respectively, and the results showed that the T - value of BMD and presurgical injured vertebrae Cobb's angle were the factors influencing the improvement degree of spinal kyphosis ( $b = -1.339$ ,  $P = 0.000$ ,  $OR = 0.262$ ;  $b = 0.195$ ,  $P = 0.000$ ,  $OR = 1.215$ ). **Conclusion:** The presurgical injured vertebrae Cobb's angle and BMD are the factors influencing the improvement degree of spinal kyphosis in OVCF patients after PKP.

**Keywords** osteoporotic fractures; fractures, compression; spinal fractures; kyphoplasty; kyphosis

骨质疏松症是一种以骨强度降低、骨折风险增高为特点的骨骼系统疾病,多见于 50 岁以上人群<sup>[1]</sup>。骨质疏松症病情严重时,患者可因提拉重物、滑倒等低能量损伤发生脊柱骨折<sup>[2]</sup>。随着我国社会老龄化程度的加重,骨质疏松性椎体压缩骨折(osteoporotic vertebral compression fracture, OVCF)患者逐渐增多<sup>[3-4]</sup>。经皮椎体后凸成形术(percutaneous kyphoplasty, PKP)是治疗 OVCF 的常用方法,可有效减轻疼痛等症状,有利于改善患者的生活质量<sup>[5]</sup>。但是有研究<sup>[6]</sup>发现,PKP 术后 OVCF 患者可因脊柱后凸畸形而再次骨折。目前有关 PKP 治疗 OVCF 综合疗效的研究相对多见,但是有关 PKP 术后脊柱后凸畸形改善情况的研究相对少见。为了探讨 OVCF 患者 PKP 术后脊柱后凸畸形改善程度的影响因素,我们进行了相关研究。现报告如下。

## 1 临床资料

**1.1 一般资料** 选取 2018 年 11 月至 2020 年 11 月在余姚市中医医院接受 PKP 治疗的 OVCF 患者为研究对象,试验方案经医院医学伦理委员会审查通过。

**1.2 纳入标准** ①符合 OVCF 的诊断标准<sup>[7]</sup>;②年龄  $\geq 60$  岁;③骨密度 T 值  $\leq -2.5$ ;④首次接受 PKP 手术;⑤治疗及随访资料完整。

**1.3 排除标准** ①先天性脊柱畸形者;②骨质疏松性椎体爆裂骨折者;③椎体压缩程度  $> 75\%$  者;④合并其他部位骨折者。

## 2 方法

**2.1 数据提取和分析** 由 2 名研究人员按照纳入和排除标准筛选病例。从病历系统中提取患者的性别、年龄、骨折节段、病程、骨密度 T 值、体质量指数、骨水泥注入量、骨水泥渗漏椎体数等资料。提取患者手术前后的脊柱 X 线片,测量手术前后的伤椎椎体高度和 Cobb 角,计算伤椎椎体前缘高度比[(伤椎前缘高度/伤椎上下相邻椎体前缘高度的平均值)  $\times 100\%$ ]、伤椎椎体中间高度比(伤椎与上方相邻椎体的椎间隙高度与椎体高度比值)和脊柱后凸畸形改善程度(术前伤椎 Cobb 角 - 术后 24 h 伤椎 Cobb 角)。比较手术前后伤椎椎体前缘高度比、伤椎椎体中间高度比、伤椎 Cobb 角的变化情况。观察年龄、病程、骨密度

T 值、体质量指数、骨水泥注入量、骨水泥渗漏椎体数、术前伤椎椎体前缘高度比、术前伤椎椎体中间高度比、术前伤椎 Cobb 角与脊柱后凸畸形改善程度的相关性,并分析脊柱后凸畸形改善程度的影响因素。

**2.2 数据统计** 采用 SPSS24.0 软件对所得数据进行统计学分析。术前、术后 24 h、术后 6 个月伤椎椎体前缘高度比、伤椎椎体中间高度比、伤椎 Cobb 角的比较均采用单因素方差分析。年龄、病程、骨密度 T 值、体质量指数、骨水泥注入量、骨水泥渗漏椎体数、术前伤椎椎体前缘高度比、术前伤椎椎体中间高度比、术前伤椎 Cobb 角与脊柱后凸畸形改善程度的相关性分析采用 Pearson 相关分析,将其中存在相关关系的因素作为自变量、将脊柱后凸畸形改善程度作为因变量进行多因素 Logistic 回归分析。检验水准  $\alpha = 0.05$ 。

### 3 结果

**3.1 一般结果** 共纳入 150 例接受 PKP 治疗的 OVCF 患者。男 79 例、女 71 例,年龄( $71.51 \pm 5.65$ )岁,骨折节段为 T<sub>9</sub>55 例、T<sub>10</sub>42 例、T<sub>11</sub>53 例,病程( $9.90 \pm 4.72$ )d,骨密度 T 值  $-3.12 \pm 0.34$ ,体质量指数( $21.35 \pm 1.73$ ) kg · m<sup>-2</sup>,骨水泥注入量( $4.18 \pm 0.56$ )mL,骨水泥渗漏椎体数 3 个。患者术前、术后 24 h、术后 6 个月伤椎椎体前缘高度比、伤椎椎体中间高度比、伤椎 Cobb 角的比较,总体差异有统计学意义,术后 24 h、术后 6 个月的伤椎椎体前缘高度比、伤椎椎体中间高度比、伤椎 Cobb 角均较术前改善( $P = 0.000, P = 0.000; P = 0.000, P = 0.000; P = 0.000, P = 0.000$ ),见表 1。

**3.2 影响脊柱后凸畸形改善程度的单因素分析结果** 年龄、病程、体质量指数、骨水泥渗漏椎体数与脊柱后凸畸形改善程度均不存在直线相关关系( $r = 0.652, P = 0.086; r = -0.162, P = 0.073; r = 0.057, P = 0.528; r = -0.103, P = 0.276$ ),骨水泥注入量、术前伤椎 Cobb 角与脊柱后凸畸形改善程度均呈正相关关系( $r = 0.211, P = 0.024; r = 0.625, P = 0.000$ ),骨密度 T 值、术前伤椎椎体前缘高度比、术前伤椎椎体中间高度比与脊柱后凸畸形改善程度均呈负相关关系( $r = -0.521, P = 0.000; r = -0.236, P = 0.004; r = -0.342, P = 0.000$ )。

**3.3 影响脊柱后凸畸形改善程度的多因素 Logistic 回归分析结果** 以骨密度 T 值、术前伤椎 Cobb 角、术前伤椎椎体前缘高度比、术前伤椎椎体中间高度比、骨水泥注入量为自变量,以脊柱后凸畸形改善程度为因变量,进行多因素 Logistic 回归分析。结果显示,骨密度 T 值、术前伤椎 Cobb 角是脊柱后凸畸形改善程度的影响因素(表 2)。

### 4 讨论

PKP 和经皮穿刺椎体成形术是治疗 OVCF 的常用术式,与经皮穿刺椎体成形术相比,PKP 具有创伤小、镇痛迅速、安全性高、下床活动时间早等优势<sup>[8-10]</sup>。随着 PKP 的广泛应用,有关 PKP 术后椎体后凸畸形的报道逐渐增多<sup>[11-12]</sup>。邱伟等<sup>[13-15]</sup>研究发现,PKP 术后骨折愈合及脊柱后凸畸形改善情况与骨质疏松程度有关。何伦相等<sup>[16]</sup>研究发现,骨密度和骨折程度是 PKP 术后新发脊柱后凸畸形的影响因素。临床常用双能 X 线骨密度仪测量骨密度,骨密度 T 值是评

表 1 骨质疏松性椎体压缩骨折经皮椎体后凸成形手术前后影像学指标

评定时间	样本量/ 例	伤椎椎体前缘高度比/ ( $\bar{x} \pm s, \%$ )	伤椎椎体中间高度比/ ( $\bar{x} \pm s, \%$ )	伤椎 Cobb 角/ ( $\bar{x} \pm s, ^\circ$ )
术前	150	62.13 ± 10.27	66.15 ± 11.34	18.01 ± 7.74
术后 24 h	150	75.85 ± 12.11	80.26 ± 12.63	12.52 ± 6.39
术后 6 个月	150	76.12 ± 12.09	81.33 ± 12.17	12.01 ± 6.31
F 值		50.620	74.045	24.802
P 值		0.000	0.000	0.000

表 2 骨质疏松性椎体压缩骨折经皮椎体后凸成形术后脊柱后凸畸形改善程度的多因素 Logistic 回归分析结果

自变量	b	SE	Wald	P	OR	95% CI	
						下限	上限
骨密度 T 值	-1.339	0.105	16.383	0.000	0.262	-1.528	1.536
术前伤椎 Cobb 角	0.195	0.023	71.81	0.000	1.215	0.141	0.267
术前伤椎椎体前缘高度比	-0.051	0.136	0.141	0.708	0.950	-0.247	0.269
术前伤椎椎体中间高度比	-0.036	0.134	0.072	0.788	0.965	-0.258	0.186
骨水泥注入量	0.063	0.087	0.524	0.469	1.065	0.114	0.259

价骨质疏松程度的重要指标<sup>[17-18]</sup>。有研究<sup>[19-20]</sup>发现,骨密度 T 值  $\leq -3.5$  的脊柱骨折患者术后再次骨折的发生率较高。脊柱再次压缩骨折后,椎体持续受压变形,可再次出现脊柱后凸畸形。周铁仁等<sup>[21-22]</sup>研究发现,OVCF 患者的骨密度增加后,其再次骨折的风险降低。

由于 OVCF 患者椎体内骨矿物质密度降低、骨小梁数目减小,PKP 术中置入和撑开球囊时操作相对容易,可以顺利置入骨水泥,有助于恢复椎体高度。本研究发现,PKP 术后伤椎高度较术前增加、伤椎 Cobb 角较术前减小,说明 PKP 治疗 OVCF 可以有效改善脊柱后凸畸形。有研究<sup>[23]</sup>发现,PKP 术后部分患者会出现脊柱后凸畸形程度加重,可引起慢性腰背部疼痛。本研究发现,PKP 术前骨密度越低者,术后脊柱后凸畸形改善程度越高;但是本研究的随访时间有限,并未观察新发脊柱后凸畸形情况。我们认为,PKP 手术尤其适合骨密度较低的 OVCF 患者,可以有效矫正脊柱后凸畸形;但是,为了避免术后远期出现新发脊柱后凸畸形,术后应早期规范应用抗骨质疏松药物。

本研究结果显示,术前伤椎 Cobb 角和骨密度是 OVCF 患者 PKP 术后脊柱后凸畸形改善程度的影响因素。

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