Cite as: Li Y, Dai J, Ma J, et al. Effect of sagittal imbalance of the spine on the new fracture in osteoporotic vertebral compression fractures after percutaneous kyphoplasty [J]. Chin J Clin Res, 2024, 37(5):699-702, 708.

DOI: 10.13429/j.cnki.cjcr.2024.05.010

Effect of sagittal imbalance of the spine on the new fracture in osteoporotic vertebral compression fractures after percutaneous kyphoplasty

LI Yao*, DAI Jian, MA Jian, YANG Zhaoqi, SU Yu, TANG Xiaoming

Department of Orthopedics, The Affiliated Huai'an No.1 People's Hospital of Nanjing Medical University, Huaian, Jiangsu 223300, China

Corresponding author: TANG Xiaoming, E-mail: 13905239800@163.com

Abstract: Objective To explore the correlation between sagittal imbalance of the spine and new vertebral fractures after percutaneous kyphoplasty (PKP) in patients with osteoporotic vertebral compression fractures(OVCF), providing a new idea for preventing new fractures. **Methods** Patients with OVCF admitted to The Affiliated Huai'an No.1 People's Hospital of Nanjing Medical University for PKP surgery between February 2020 and June 2023 were included in this retrospective study. Sixty-four patients with new fractures after surgery were selected as the study group, and 64 patients without new fractures were selected as the control group. The differences of sagittal spinal parameters between the two groups at 1 year after operation were analyzed and compared. Meanwhile, postoperative VAS Scores, Japanese Orthopaedic Association Scores (JOA) and Oswestry disability index (ODI) of the two groups were analyzed and compared. **Results** The age, postoperative VAS score and ODI of the study group were significantly higher than those of the control group, while postoperative JOA score was significantly lower than that of the control group (P<0.05). The pelvic tilt (PT) (22.66°±2.41° vs 20.36°±3.68°, t=4.18, P<0.01) and thoracic kyphosis (TK) (45.95°±4.87° vs 40.22°±4.22°, t=7.12, P<0.01) of the study group were higher than those of the control group, while the sacral slope (SS) (23.44°±6.35° vs 28.47°±5.46°, t=4.81, P<0.01), pelvic incidence (PI) (46.09°±5.57° vs 48.83°±5.46°, t=2.80, P<0.01) and lumbar lordosis (LL) (39.06°±6.08° vs 44.30°±6.20°, , t=4.83, P<0.01) were lower than those of the control group. **Conclusion** Sagittal imbalance of the spine is closely related to the occurrence of new vertebral fractures after PKP in patients with OVCFs, which significantly increases the incidence of new fractures.

Keywords: Osteoporotic Vertebral Compression Fractures; Sagittal Imbalance of the Spine; New Fractures; Complications after Percutaneous Kyphoplasty

Osteoporosis is a chronic progressive disease primarily characterized by decreased bone density and mass, leading to increased bone fragility and the risk of fractures, especially in the spine, hips, and wrists [1]. Many factors can induce osteoporosis, including age, gender, medications, and metabolism [2-3]. Osteoporotic vertebral compression fractures (OVCFs) are secondary to primary osteoporosis and account for about 70% of all osteoporotic fractures. They are primarily characterized by chest, lumbar, or back pain following minor trauma or even without apparent trauma, severely affecting the patient's quality of life [4]. Surgery is the main treatment for OVCFs. Percutaneous kyphoplasty (PKP) has gradually become the preferred surgical treatment for OVCFs due to its minimal surgical trauma, low economic burden, short hospital stay, and significant surgical outcomes [5]. The complications of PKP after surgery are increasing, particularly the occurrence of new vertebral fractures, including adjacent vertebral fractures [6-7]. Scholars believe that various factors such as age, BMI, bone density, and bone cement distribution may contribute to the occurrence and development of new vertebral fractures after PKP [8-10]. Studies have shown a close relationship between sagittal spinal parameters and OVCFs [11]. Even after PKP surgery, varying degrees of loss in the height of the fractured vertebrae's anterior edge can lead to kyphotic deformity in the sagittal plane, with severe cases resulting in sagittal spinal imbalance. Sagittal spinal imbalance is associated with various orthopedic conditions, but there is limited research on whether it affects the occurrence of new vertebral fractures after OVCFs surgery [12]. This study aims to explore the correlation between sagittal spinal imbalance and the occurrence of new vertebral fractures after PKP surgery for OVCFs, providing new insights for clinical prevention of new fractures and ensuring the health of elderly patients.

1 Material and methods

1.1 General data

Patients with OVCF admitted to The Affiliated Huaian No.1 People's Hospital of Nanjing Medical University for PKP surgery between February 2020 and June 2023 were included in this retrospective study. Sixty-four patients with new fractures after surgery were selected as the study group, and 64 patients without new fractures were selected as the control group. This study was

approved by the Ethics Committee of the The Affiliated Huaian No.1 People's Hospital of Nanjing Medical University (Ethics No.: KY-2023-222-01), and all included patients signed informed consent forms.

Inclusion criteria: (1) Postmenopausal women over 50 years old and men over 60 years old; (2) Diagnosis of OVCF with planned PKP treatment; (3) Newly occurred fractures caused by low-energy injuries.

Exclusion criteria: (1) Pathological fractures due to tumors or infections; (2) Symptoms of neurological damage; (3) Patients with a history of spinal surgery.

1.2 Methods

1.2.1 Measurement of bone density

All patients underwent bone density tests before surgery, and T-values were recorded. A T-value < -2.5 SD was diagnosed as osteoporosis. Even if the patient's bone density T-value was ⩾ -2.5 SD, osteoporosis was diagnosed if they experienced fragility fractures [13].

1.2.2 Surgical procedure

Patients were placed in the prone position, and routine disinfection of the surgical field was performed. The fractured vertebrae were confirmed under C-arm fluoroscopy. After local anesthesia, percutaneous puncture was performed, and the puncture needle tip was placed at the upper edge of the pedicle shadow of the fractured vertebra. The C-arm was adjusted to the lateral position, and the needle was drilled into the vertebral body. After reaching halfway through the pedicle, fluoroscopy in the lateral position continued the drilling. When the needle tip reached the posterior wall of the vertebral body, fluoroscopy in the anterior-posterior position showed the needle tip at the inner edge of the pedicle shadow, and drilling was stopped 3 mm beyond. The inner core was removed, and a guiding needle was inserted. The puncture needle was removed, and sequentially, dilation and working cannulas were inserted. The fine drill was slowly advanced through the working cannula using finger pressure. When the drill tip reached halfway into the vertebral body in the lateral position and did not exceed half the distance between the pedicle shadow and the line connecting the spinous processes in the anterior-posterior position, drilling was stopped. After the drill tip reached the anterior edge of the vertebral body in the lateral position, it was close to the edge of the spinous process in the anterior-posterior position. The fine drill was removed with the same rotational direction as during insertion. Bone cement with a core was injected into the cannula to confirm that the cortical bone of the anterior edge of the vertebral body was not ruptured. The bone cement was prepared and injected into the cannula. Under continuous fluoroscopy, when the bone cement was in a dough-like state, the filling needle was slowly injected. When satisfactory reduction of the fracture and filling of the bone cement were achieved, injection was stopped. Before the bone cement solidified, the injection catheter was rotated several turns to separate it from the bone cement, then the injection device was removed, and the wound was dressed. Both groups of patients underwent PKP surgery performed by the same group of surgeons, using the same consumables during surgery. After surgery, all patients received regular osteoporosis treatment and were allowed to mobilize 24 hours after bed rest.

1.2.3 Measurement and calculation of sagittal spinal parameters

Normal sagittal spinal balance is closely related to various sagittal parameters [14]. All patients underwent chest/lumbar lateral X-ray examination postoperatively to measure various sagittal spinal parameters, including sacral slope (SS), pelvic tilt (PT), pelvic incidence (PI), thoracic kyphosis (TK), and lumbar lordosis (LL). SS is the angle formed between the upper endplate of the S1 vertebra and the horizontal line. PT is the angle formed between the line connecting the midpoint of the upper endplate of the S1 vertebra and the midpoint of the acetabulum and the vertical line. PI is the angle between the line connecting the midpoint of the upper endplate of the S1 vertebra and the center of the femoral head and the perpendicular line to the upper endplate of the S1 vertebra. TK is the Cobb angle between the upper endplate of the T4 vertebra and the lower endplate of the T12 vertebra. LL is the Cobb angle between the upper endplate of the L1 vertebra and the upper endplate of the S1 vertebra [15].

1.2.4 Observation indicators

(1) Analyze and compare the differences of various parameters between two groups of patients after surgery.

(2) Analyze and compare the postoperative Visual Analog Scale (VAS) scores, Japanese Orthopaedic Association Scores (JOA), and Oswestry Disability Index (ODI) scores between two groups of patients.

1.3 Statistical methods

SPSS 26.0 software was used for data analysis. Measurement data were described as $x \pm s$, and intergroup comparisons were made using independent sample *t*-tests or one-way analysis of variance (ANOVA). Count data were expressed as case(%), and intergroup comparisons were made using the chi-square test. A *P*-value less than 0.05 was considered statistically significant.

2 Results

2.1 Comparison of clinical data between two groups

The clinical data of the two groups were shown in **Table 1**. There was no statistically significant difference in gender, BMI, or bone density between the two groups ($P > 0.05$). The age of the study group was significantly higher than that of the control group. Postoperative VAS and ODI scores were higher in the study group compared to the control group, while postoperative JOA scores were lower in the study group compared to the control group, with statistically significant differences ($P < 0.05$).

Tab.1 Comparison of clinical data between two groups
（n=64, $\bar{x}\pm s$）

Indicator	Study group	Control group	t/χ^2 value	P value
Age（year）	74.31±7.61	70.31±6.77	3.14	＜0.01
male/female（case）	7/57	5/59	0.37	0.54
BMI（kg/m^2）	23.09±4.68	23.88±3.43	1.09	0.28
bone density（SD）	-3.48±1.12	-3.40±0.94	0.45	0.65
Postoperative VAS	4.16±1.49	2.34±1.14	7.71	＜0.01
Postoperative JOA	20.16±2.37	24.75±2.89	9.82	＜0.01
Postoperative ODI	7.92±2.82	4.64±2.10	7.46	＜0.01

2.2 Comparison of sagittal parameters of the spine between two groups of patients

The pelvic tilt (PT) and thoracic kyphosis (TK) were greater in the study group than in the control group, while sacral slope (SS), pelvic incidence (PI), and lumbar lordosis (LL) were all smaller in the study group compared to the control group, with statistically significant differences (P < 0.05). **See Table 2.**

Tab.2 Comparison of sagittal spinal parameters between the two groups
（n=64, $\bar{x}\pm s$）

Indicator	Study group	Control group	t/χ^2 value	P value
SS（°）	23.44±6.35	28.47±5.46	4.81	＜0.01
PT（°）	22.66±2.41	20.36±3.68	4.18	＜0.01
PI（°）	46.09±5.57	48.83±5.46	2.80	＜0.01
TK（°）	45.95±4.87	40.22±4.22	7.12	＜0.01
LL（°）	39.06±6.08	44.30±6.20	4.83	＜0.01

3 Discussion

OVCFs are a common type of fracture clinically, especially among the elderly [16-18]. However, the complications and poor efficacy of conservative treatment have become challenging issues for patients [19]. Currently, PKP surgery is still the preferred treatment for OVCFs. After PKP treatment, the majority of patients can achieve good surgical outcomes, including pain relief, restoration of vertebral height, prevention of spinal deformity, and early return to normal life. However, it has been reported domestically and internationally that there are still some complications after PKP surgery, such as cement leakage, residual postoperative low back pain, vertebral re-fracture, and new vertebral fractures [20-21]. Among them, new vertebral fractures after PKP surgery cause a secondary blow to patients both psychologically and physiologically, seriously affecting their quality of life and even increasing mortality.

There are many reasons for new vertebral fractures after PKP surgery. According to literature reports, factors such as gender, age, BMI, bone density, distribution of bone cement, and recovery of fractured vertebral height are closely related to new vertebral fractures. However, in this study, significant differences were found in the sagittal parameters of the spine between the study group and the control group, indicating that sagittal imbalance of the spine deserves attention in relation to new fractures. Previous studies have shown that new vertebral fractures after PKP surgery may be related to sagittal imbalance of the spine [22-23].

Sagittal imbalance of the spine may be influenced by various factors such as congenital spinal deformities, degenerative changes in the spine, trauma, and surgical complications. Some studies have found that the strength of paraspinal muscles in patients with OVCFs decreases significantly after PKP surgery. Additionally, elderly patients have varying degrees of degeneration of the intervertebral disc system, making it relatively difficult to maintain spinal stability, which may lead to sagittal imbalance of the spine.

The relationship between spinal-pelvic parameters (SS, PT, PI, TK, and LL) and sagittal balance of the spine is inseparable [24-26]. PI depends on the shape of the pelvis, and SS reflects the position of the sacrum. PI is the basis of pelvic parameters and is closely related to PT, SS, and the physiological curvature of the spine. PI is a fixed angle, and a larger PI is often associated with a larger SS, which may lead to excessive lumbar lordosis and affect sagittal balance of the spine. PT and SS are two variable angles that change with changes in body posture. An increase in PT indicates pelvic anterior tilt, leading to sagittal imbalance of the spine. TK and LL together maintain the balance and stability of the spine and share the load. When TK or LL changes, the sagittal balance of the spine may be disrupted. For example, thoracic kyphosis may cause the head to tilt forward to maintain the line of sight, and the lumbar spine may compensatorily overextend to minimize center of gravity displacement. However, such changes increase pressure on the spine, especially in the lumbar spine, which may lead to spinal pathology. Similarly, excessive lumbar lordosis may cause the upper body to lean backward to maintain balance, with the thoracic spine bearing greater load at this time.

The results of this study indicate that the PT and TK of the study group were greater than those of the control group, while the SS, PI, and LL were all smaller than those of the control group, suggesting a close relationship between changes in sagittal spinal parameters and the occurrence of new vertebral fractures. The relationship between each parameter and sagittal spinal balance is inseparable, suggesting a possible connection between sagittal spinal imbalance and the occurrence of new vertebral fractures. Specifically, in patients with OVCFs

undergoing PKP, sagittal spinal imbalance may potentially trigger new vertebral fractures. Therefore, for patients with OVCFs, whether undergoing conservative treatment with bed rest or surgical treatment with PKP, how to restore and maintain sagittal spinal balance during the fracture recovery period is a question worth pondering for clinicians.

Due to the small sample size of this study, and the finding that the age of the study group compared to the control group also showed statistically significant differences, it is evident that age factors also play a significant role in the occurrence of new fractures. This inevitably introduces certain limitations to the research findings. Increasing the sample size in future studies and eliminating the influence of age factors may make the research conclusions more persuasive.

Sagittal spinal imbalance is closely related to the occurrence of new vertebral compressive fractures after PKP surgery in patients with OVCFs, increasing the probability of new fractures. Therefore, for patients with OVCFs, in addition to standardized treatment for osteoporosis, attention should be paid to the balance of sagittal spinal alignment postoperatively to effectively prevent new vertebral fractures. It is worth noting that since sagittal spinal balance is related to multiple parameters, clinicians should provide individualized treatment plans based on the specific parameters of each patient's condition

Conflict of interest None

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Submission received:2024-01-16 / Revised: 2024-02-10

·论　著·

脊柱矢状位失衡对骨质疏松性椎体压缩性骨折行椎体后凸成形术后新发骨折的影响

李瑶[1]，戴健[1]，马健[1]，杨钊琦[2]，孙宇[2]，唐晓明[1]
1. 南京医科大学附属淮安第一医院骨科，江苏 淮安 223300；
2. 南京医科大学，江苏 南京 211100

摘要：目的　探讨脊柱矢状位失衡与骨质疏松性椎体压缩性骨折（OVCF）患者接受经皮椎体后凸成形术（PKP）后新发椎体骨折的相关性，为临床预防新发骨折提供新的思路。**方法**　回顾性选择南京医科大学附属淮安第一医院 2020 年 2 月至 2023 年 6 月因 OVCF 入院行 PKP 手术的患者，以术后有新发骨折的 64 例患者作为研究组，无新发骨折的 64 例作为对照组。分析比较两组患者术后 1 年随访时各脊柱矢状位参数之间的差异，同时比较两组患者术后 VAS 评分、日本骨科协会（JOA）评分、Oswestry 功能障碍指数（ODI）。**结果**　研究组的年龄、术后 VAS 评分、术后 ODI 评分显著高于对照组，而术后 JOA 评分显著低于对照组，差异有统计学意义（$P<0.05$）。研究组的骨盆倾斜角（PT）（22.66°±2.41° *vs* 20.36°±3.68°，$t=4.18$，$P<0.01$）和胸椎后凸角（TK）（45.95°±4.87° *vs* 40.22°±4.22°，$t=7.12$，$P<0.01$）大于对照组，而骶骨倾斜角（SS）（23.44°±6.35° *vs* 28.47°±5.46°，$t=4.81$，$P<0.01$）、骨盆入射角（PI）（46.09°±5.57° *vs* 48.83°±5.46°，$t=2.80$，$P<0.01$）和腰椎前凸角（LL）（39.06°±6.08° *vs* 44.30°±6.20°，$t=4.83$，$P<0.01$）小于对照组。**结论**　脊柱矢状位失衡和 OVCF 患者行 PKP 术后新发椎体骨折具有密切的相关性。

关键词：骨质疏松性椎体压缩性骨折；脊柱矢状位失衡；新发骨折；经皮穿刺椎体后凸成形术
中图分类号：R683　**文献标识码：**A　**文章编号：**1674-8182(2024)05-0699-05

Effect of sagittal imbalance of the spine on the new fracture in osteoporotic vertebral compression fracture after percutaneous kyphoplasty

LI Yao*, DAI Jian, MA Jian, YANG Zhaoqi, SUN Yu, TANG Xiaoming
** Department of Orthopedics, The Affiliated Huai'an No.1 People's Hospital of Nanjing Medical University, Huai'an, Jiangsu 223300, China*
Corresponding author: TANG Xiaoming, E-mail: 13905239800@163.com

Abstract: Objective　To explore the correlation between sagittal imbalance of the spine and new fractures after percutaneous kyphoplasty (PKP) in patients with osteoporotic vertebral compression fracture (OVCF), providing a new idea for preventing new fracture. **Methods**　Patients with OVCF admitted to The Affiliated Huai'an No.1 People's Hospital for PKP surgery between February 2020 and June 2023 were included in this retrospective study. Sixty-four patients with new fracture after surgery were selected as the study group, and 64 patients without new fracture were selected as the control group. The differences of sagittal spinal parameters between the two groups at 1 year after operation were analyzed and compared. Meanwhile, postoperative VAS scores, Japanese Orthopaedic Association (JOA) score and Oswestry disability index (ODI) of the two groups were analyzed and compared. **Results**　The age, postoperative VAS score and ODI of the study group were significantly higher than those of the control group, while postoperative JOA score was significantly lower than that of the control group ($P<0.05$). The pelvic tilt (PT) (22.66°±2.41° *vs* 20.36°±3.68°, $t=4.18$, $P<0.01$) and thoracic kyphosis (TK) (45.95°±4.87° *vs* 40.22°±4.22°, $t=7.12$, $P<0.01$) of the study group were higher than those of the control group, while the sacral slope (SS) (23.44°±6.35° *vs*

DOI: 10.13429/j.cnki.cjcr.2024.05.010
通信作者：唐晓明，E-mail：13905239800@163.com
出版日期：2024-05-20

QR code for English version

28.47°±5.46°, t=4.81, P<0.01), pelvic incidence (PI) (46.09°±5.57° *vs* 48.83°±5.46°, t=2.80, P<0.01) and lumbar lordosis (LL) (39.06°±6.08° *vs* 44.30°±6.20°, t=4.83, P<0.01) were lower than those of the control group. **Conclusion** Sagittal imbalance of the spine is closely related to the occurrence of new vertebral fracture after PKP in patients with OVCFs.

Keywords: Osteoporotic vertebral compression fracture; Sagittal imbalance of the spine; New fracture; Percutaneous kyphoplasty

骨质疏松症是一种以骨密度及骨质量降低、骨量减少为主要特征的慢性进行性疾病,可以使骨的脆性增加,骨折的发生率增加,尤其是脊柱、髋部和手腕部位[1]。引起骨质疏松的原因很多,包括年龄、性别、药物及代谢等[2-3]。骨质疏松性椎体压缩性骨折(osteoporotic vertebral compression fracture, OVCF)继发于原发性骨质疏松,约占所有骨质疏松性骨折的70%,以轻微外伤甚至无明显外伤即出现胸腰背部疼痛为主要临床特征,严重影响患者的生活质量[4]。OVCFs 主要采取手术治疗。经皮椎体后凸成形术(percutaneous kyphoplasty, PKP)因其手术创伤小、经济负担轻、住院时间短、手术效果显著而逐渐成为 OVCF 治疗的首选手术方式[5]。PKP 术后并发症的报道也越来越多,尤其是术后发生包括临近椎体骨折在内的新发椎体骨折[6-7]。有学者认为年龄、身体质量指数(body mass index, BMI)、骨密度、骨水泥分布等多种原因均可导致 PKP 术后椎体新发骨折的发生[8-10]。有研究表明脊柱矢状位参数与 OVCF 的发生有着密切的关系[11]。即使患者接受 PKP 手术治疗,骨折椎体前缘的高度也会存在不同程度的丢失,导致椎体在矢状位上出现后凸畸形,严重者出现脊柱矢状位失衡。脊柱矢状位失衡与各种骨科疾病有关,而关于脊柱矢状位失衡是否影响 OVCF 术后新发骨折发生的研究较少[12]。本文通过分析临床上因 OVCF 行 PKP 手术治疗的患者,旨在探究脊柱矢状位失衡与 OVCF 行 PKP 术后新发骨折的相关性,为临床预防新发骨折、保障高龄患者的健康提供新的思路。

1　资料与方法

1.1　一般资料　回顾性选择南京医科大学附属淮安第一医院 2020 年 2 月至 2023 年 6 月因 OVCF 入院行 PKP 手术的患者,以术后有新发骨折的 64 例患者作为研究组,无新发骨折的 64 例作为对照组。本研究得到南京医科大学附属淮安第一医院伦理委员会的批准(伦理号:KY-2023-222-01),所有纳入研究的患者都签署知情同意书。

纳入标准:(1) 50 岁以后绝经的女性患者及 60 岁以上的男性患者;(2) 诊断为 OVCF,拟行 PKP 治疗;(3) 新发生的骨折是由低能量损伤引起的。排除标准:(1) 因肿瘤或感染等引起的病理性骨折;(2) 有神经损伤症状;(3) 既往有脊柱手术史的患者。

1.2　*方法*

1.2.1　骨密度的测量　所有患者术前均在本院行骨密度检查并记录 T 值,并将 T 值<−2.5 SD 诊断为骨质疏松症。若患者骨密度 T 值≥−2.5 SD,但发生脆性骨折,仍诊断为骨质疏松症[13]。

1.2.2　手术方法　患者取俯卧位,常规消毒术野,铺无菌巾单。在 C 臂透视下确认骨折椎体。局部麻醉后经皮穿刺,将穿刺针针尖置于骨折椎体椎弓根影的上缘,将 C 臂机调至侧位,钻入带芯穿刺针,当针尖至椎弓根的 1/2 时,透视正位,见针尖位于椎弓根影的中线处,在侧位透视下继续钻入。侧位显示针尖到达椎体后壁时,透视正位显示针尖位于椎弓根影的内侧缘继续钻入 3 mm 后停止。抽出内芯,置入导针,拔出穿刺针,按序置入扩张套管和工作套管,再将精细钻经工作套管用手指的力量缓缓钻入。侧位显示钻头尖到达椎体 1/2 时,正位显示钻头尖不超过椎弓根影与棘突连线的 1/2,当侧位显示钻头尖到达椎体前缘时,正位显示钻头尖靠近棘突边缘。采用与钻入时相同的旋转方向边旋边取出精细钻,用带芯的骨水泥推入管核实椎体前缘皮质未破裂。调制骨水泥将其灌入推入管。连续透视下在骨水泥处于团状期时缓慢注入推体,透视下见骨折复位满意,骨水泥充填满意时停止注射。于骨水泥凝固前旋转注射导管数圈,使之与骨水泥分离,然后拔出注射装置。敷料覆于针眼处。两组患者 PKP 手术均由同一组手术医师完成,术中所用耗材相同,且术后均接受正规的抗骨质疏松治疗,并且均在卧床 24 h 后下床活动。

1.2.3　脊柱矢状位参数的测量与计算　正常的脊柱矢状位平衡与各矢状位参数密切相关[14]。所有患者术后均行胸/腰椎正侧位片检查,在 X 线上测量各脊柱矢状位参数,包括:骶骨倾斜角(sacral slope, SS)、骨盆倾斜角(pelvic tilt, PT)、骨盆入射角(pelvic inci-

dence, PI)、胸椎后凸角(thoracic kyphosis, TK)和腰椎前凸角(lumbar lordosis, LL)。SS 是 S_1 椎体上终板和水平线之间形成的夹角;PT 是 S_1 椎体上终板和髋轴中点的连线和铅垂线之间所形成的夹角;PI 是 S_1 椎体上终板中点和股骨头中心的连线与垂直于 S_1 椎体上终板的直线所形成的角度。TK 是 T_4 椎体上终板与 T_{12}椎体下终板之间的 Cobb 角;LL 是 L_1 椎体上终板和 S_1 椎体上终板的前凸 Cobb 角[15]。

1.2.4　观察指标　(1) 分析比较两组患者术后各脊柱矢状位参数之间的差异;(2) 分析比较两组患者术后的 VAS 评分、日本骨科协会(Japanese Orthopaedic Association, JOA)评分、Oswestry 功能障碍指数(Oswestry disability index, ODI)评分。

1.3　*统计学方法*　使用 SPSS 26.0 软件分析数据。计量资料使用 $\bar{x}\pm s$ 描述,组间比较采用独立样本 t 检验或单因素方差分析;计数资料以例数表示,组间比较行 χ^2 检验。$P<0.05$ 为差异有统计学意义。

2　结　果

2.1　*两组患者临床资料比较*　两组患者性别、BMI、骨密度差异无统计学意义($P>0.05$)。研究组的年龄显著高于对照组,术后 VAS、ODI 评分显著高于对照组,而术后 JOA 评分显著低于对照组,差异有统计学意义($P<0.05$)。见表 1。

2.2　*两组患者脊柱矢状位参数的比较*　研究组的 PT 和 TK 大于对照组,而 SS、PI 和 LL 均小于对照组,差异有统计学意义($P<0.05$)。见表 2。

表 1　两组患者临床资料比较　($n=64, \bar{x}\pm s$)
Tab. 1　Comparison of clinical data between two groups　($n=64$, $\bar{x}\pm s$)

项目	研究组	对照组	t/χ^2 值	P 值
年龄(岁)	74.31±7.61	70.31±6.77	3.14	<0.01
男/女(例)	7/57	5/59	0.37	0.54
BMI(kg/m^2)	23.09±4.68	23.88±3.43	1.09	0.28
骨密度(SD)	−3.48±1.12	−3.40±0.94	0.45	0.65
术后 VAS(分)	4.16±1.49	2.34±1.14	7.71	<0.01
术后 JOA(分)	20.16±2.37	24.75±2.89	9.82	<0.01
术后 ODI(分)	7.92±2.82	4.64±2.10	7.46	<0.01

表 2　两组患者的脊柱矢状位参数比较　($n=64, \bar{x}\pm s$)
Tab. 2　Comparison of sagittal spinal parameters between the two groups　($n=64$, $\bar{x}\pm s$)

组别	SS(°)	PT(°)	PI(°)	TK(°)	LL(°)
研究组	23.44±6.35	22.66±2.41	46.09±5.57	45.95±4.87	39.06±6.08
对照组	28.47±5.46	20.36±3.68	48.83±5.46	40.22±4.22	44.30±6.20
t 值	4.81	4.18	2.80	7.12	4.83
P 值	<0.01	<0.01	<0.01	<0.01	<0.01

3　讨　论

OVCF 是老年人常见的一种骨折类型[16-18]。保守治疗的并发症多、效果差[19]。目前对于 OVCF 的治疗首选 PKP 手术,绝大部分的患者可获得良好的手术效果,包括缓解疼痛、恢复椎体高度、防止脊柱后凸畸形。报道显示,PKP 术后仍会有一些并发症,如:骨水泥渗漏、术后残余腰痛、椎体再骨折及新发椎体骨折等[20-21]。其中新发椎体骨折严重影响患者生活质量,甚至增加死亡率。

PKP 术后发生新发椎体骨折的原因较多,性别、年龄、BMI、骨密度、骨水泥分布情况及骨折椎体高度恢复情况等都与新发椎体骨折有着密切的联系。但本研究发现,脊柱矢状位失衡对于新发骨折的影响值得重视。已经有研究表明,PKP 术后新发椎体骨折可能与脊柱矢状位失衡有关[22-23]。

脊柱矢状位失衡可能受多种因素影响,如先天性脊柱畸形、脊柱的退行性改变、外伤及手术并发症等。有研究发现,OVCF 患者行 PKP 后,椎旁肌肉的力量明显减弱,加之老年患者存在不同程度的椎间盘系统的退变,使得脊柱稳定性的维持相对困难,容易出现脊柱矢状位失衡。

脊柱-骨盆参数与脊柱矢状位平衡的关系密不可分,包括 SS、PT、PI、TK 和 LL 等[24-26]。PT 能够反映出骨盆前倾的程度,PI 取决于骨盆的形态,SS 则可以反映骶骨的位置。PI 作为骨盆参数的基础,与 PT、SS 和脊柱的生理曲度关系密切,较大的 PI 和较大的 SS 有关,可能会导致腰椎过度前凸,影响脊柱矢状位的平衡。PT 和 SS 随着身体姿势的改变而发生变化。当 PT 增大时,说明骨盆前倾,将导致脊柱矢状位失衡。TK 和 LL 共同维持脊柱的平衡和稳定,共同分担应力负荷,当 TK 或者 LL 发生变化的时候,脊柱的矢状位平衡可能就会受到破坏。例如,胸椎后凸可能会引起头部向前倾斜,以保持视线方向,腰椎可能会代偿性地过度前凸,以尽量减少重心偏移。然而,这样的变化会增加脊柱的压力,特别是在腰椎部分。长期下去,可能会引起脊柱病变。同样,腰椎前凸也可能引起上身后倾,以保持平衡,此时胸椎部分可能会承受更大的应力。

本研究结果显示,研究组的 PT 和 TK 大于对照组,而 SS、PI 和 LL 均小于对照组,表明脊柱矢状位参数的变化与新发椎体骨折的密切关系。而各参数与脊柱矢状位平衡的关系密不可分,提示脊柱矢状位失衡与新发椎体骨折可能存在联系,即 OVCF 的患者行

PKP 后,脊柱矢状位失衡可能会诱发新发椎体骨折。因此,对于 OVCF 的患者,无论采取卧床休息的保守治疗,还是 PKP 手术治疗,如何在骨折治疗恢复期恢复并保持脊柱矢状位的平衡是临床医生值得深思的一个问题。

本研究由于样本量较小,且研究中发现研究组的年龄与对照组相比差异同样有统计学意义,说明年龄因素对新发骨折的发生同样具有意义,研究结果难免存在一定缺陷,今后增加样本含量并排除年龄因素的影响,可能会使研究结论更具说服力。

脊柱矢状位失衡与 OVCF 患者行 PKP 术后新发椎体压缩性骨折的发生密切相关。对于 OVCF 的患者,术后除了需进行规范的抗骨质疏松治疗外,更应该重视脊柱矢状位的平衡状态,有效预防术后新发椎体骨折。由于脊柱矢状位平衡与多个参数有关,临床医生应根据患者的参数不同,为患者提供个体化的治疗方案。

利益冲突　无

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收稿日期:2024-02-02　**修回日期**:2024-03-05　**编辑**:叶小舟

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收稿日期:2024-01-16　**修回日期**:2024-02-10　**编辑**:李方