

## ·临床研究·

## 单球囊双侧交替扩张后凸成形术治疗骨质疏松性椎体压缩骨折的病例对照研究

何磊, 钱宇, 金以军

(绍兴市人民医院骨科, 浙江 绍兴 312000)

**【摘要】 目的:** 比较椎体后凸成形术治疗骨质疏松性椎体一般压缩骨折与严重压缩骨折的临床疗效。**方法:** 自 2009 年 1 月至 2011 年 2 月, 对 60 例(70 椎)骨质疏松性椎体压缩骨折患者采用单球囊双侧交替扩张后凸成形术结合体位复位治疗, 其中男 10 例, 女 50 例; 年龄 59~90 岁, 平均 72.1 岁。其中一般压缩骨折患者 38 例(44 个椎体), 男 7 例, 女 31 例; 年龄 59~87 岁, 平均(71.8±6.1)岁, 二椎体骨折 6 例, T<sub>9</sub> 1 椎, T<sub>10</sub> 5 椎, T<sub>11</sub> 7 椎, T<sub>12</sub> 13 椎, L<sub>1</sub> 9 椎, L<sub>2</sub> 4 椎, L<sub>3</sub> 4 椎, L<sub>4</sub> 1 椎。严重压缩骨折患者 22 例(26 个椎体), 男 3 例, 女 19 例; 年龄 63~90 岁, 平均(72.6±7.2)岁; 二椎体骨折 4 例, T<sub>9</sub> 1 椎, T<sub>10</sub> 2 椎, T<sub>11</sub> 3 椎, T<sub>12</sub> 9 椎, L<sub>1</sub> 6 椎, L<sub>2</sub> 3 椎, L<sub>3</sub> 2 椎。比较两组患者的手术时间、骨水泥注射量及手术前后椎体高度和 Cobb 角的变化, 计算两组术后椎体高度平均恢复率与 Cobb 角的平均矫正度, 采用视觉模拟评分 VAS 进行疗效评价。**结果:** 所有患者均安全完成手术, 术后 72 h 内疼痛均明显缓解, 两组患者均获得随访, 时间 6~13 个月, 平均 10.1 个月。两组术后椎体高度、Cobb 角、VAS 评分均较术前改善( $P<0.05$ )。椎体一般骨折组手术时间短于严重椎体骨折组( $P<0.05$ ), 而骨水泥注入量大于椎体严重骨折组( $P<0.05$ ), 且椎体一般骨折组在术后椎体平均恢复率与 Cobb 角的平均矫正度均优于椎体严重骨折组( $P<0.05$ ), 而两组患者手术前后 VAS 评分比较差异无统计学意义( $P>0.05$ )。椎体一般骨折组有 3 例(3 椎)发生骨水泥渗漏(6.8%), 椎体严重骨折组有 5 例(5 椎)发生骨水泥渗漏(19.2%), 两组比较差异无统计学意义( $P>0.05$ )。**结论:** 椎体后凸成形术治疗骨质疏松性椎体一般压缩骨折及椎体严重压缩骨折均可获得满意疗效, 椎体一般压缩骨折患者在椎体高度恢复及 Cobb 角矫正上优于椎体严重压缩骨折患者。

**【关键词】** 骨质疏松; 骨折, 压缩性; 病例对照研究

DOI: 10.3969/j.issn.1003-0034.2014.12.020

**Bilateral transpedicular balloon kyphoplasty for the treatment of osteoporotic vertebral compressive fractures** HE Lei, QIAN Yu, and JIN Yi-jun. Department of Orthopaedics, Shaoxing People's Hospital, Shaoxing 312000, Zhejiang, China

**ABSTRACT Objective:** To compare clinical outcomes of bilateral transpedicular balloon kyphoplasty for the treatment of ordinary osteoporotic vertebral compressive fracture(OVCF) and severe osteoporotic vertebral compressive fracture. **Methods:** From January 2009 to February 2011, 60 patients (70 vertebrae) with osteoporotic vertebral compressive fracture were included. All patients were treated by bilateral transpedicular balloon kyphoplasty combined with postural reduction, including 10 males and 50 females aged from 59 to 90 years old with an average of 72.1 years old. In ordinary osteoporotic vertebral compressive fracture group, there were 38 patients (44 vertebrae) including 7 males and 31 females aged from 59 to 87 years old with an average of (71.8±6.1) years old. There were 6 patients with two vertebral fractures, 1 vertebra in T<sub>9</sub>, 5 vertebrae in T<sub>10</sub>, 7 vertebrae in T<sub>11</sub>, 13 vertebrae in T<sub>12</sub>, 9 vertebrae in L<sub>1</sub>, 4 vertebrae in L<sub>2</sub>, 4 vertebrae in L<sub>3</sub>, 1 vertebra in L<sub>4</sub>. While in severe osteoporotic vertebral compressive fracture group, there were 22 patients (26 vertebrae) including 3 males and 19 females aged from 63 to 90 years old with an average of (72.6±7.2) years old. There were 4 patients with two vertebral fractures, 1 vertebra in T<sub>9</sub>, 2 vertebrae in T<sub>10</sub>, 3 vertebrae in T<sub>11</sub>, 9 vertebrae in T<sub>12</sub>, 6 vertebrae in L<sub>1</sub>, 3 vertebrae in L<sub>2</sub>, 2 vertebrae in L<sub>3</sub>. Operative time, volume of bone cement injection, and vertebral height and changes of Cobb angle before and after operation were observed and compared. Postoperative average recovery rate of vertebral height and correct degree of Cobb angle were calculated and compared, VAS scoring were used to evaluate therapeutic effect. **Results:** All operations were completed successfully, and pain were relieved at 72 h after operation. All patients were followed up from 6 to 13 months with an average of 10.1 months. Postoperative vertebral height, Cobb angle and VAS score were improved better than that of before operation ( $P<0.05$ ). Operative time in ordinary group was shorter than severe group, while volume of bone cement injection was more than that of severe

基金项目: 国家自然科学基金(编号: 81271974)

Fund program: National Natural Science Foundation of China (No.81271974)

通讯作者: 何磊 E-mail: doctor312000@gmail.com

Corresponding author: HE Lei E-mail: doctor312000@gmail.com

group. Average recovery rate of vertebral height and correct degree of Cobb angle in ordinary group was better than that of in severe group ( $P < 0.05$ ). There was no significant differences between two groups in VAS scores before and after operation ( $P > 0.05$ ). Three cases (3 vertebrae) occurred bone cement leakage in ordinary group, while 5 cases (5 vertebrae) occurred bone cement leakage in severe group, and there was no meaning between two groups ( $P > 0.05$ ). **Conclusion:** Kyphoplasty could receive satisfied curative effect in treating ordinary and severe patients with osteoporotic vertebral compressive fracture, but recovery of vertebral height and correct degree of Cobb angle in ordinary group was better than that of in severe group.

**KEYWORDS** Osteoporosis; Fractures, compression; Case-control studies

Zhongguo Gu Shang/China J Orthop Trauma, 2014, 27(12): 1056-1061 www.zggszz.com

脊柱压缩性骨折是骨质疏松症的重要并发症之一,严重影响老年人的生活质量,甚至危及生命。Kado 等<sup>[1]</sup>报道椎体压缩骨折 5 年内死亡率为 23%~34%。经皮椎体后凸成形术(percutaneous kyphoplasty, PKP)由于在即时止痛、恢复椎体高度、纠正后凸畸形等方面疗效显著,为骨质疏松性椎体压缩骨折的治疗开辟了一条重要途径<sup>[2-4]</sup>。然而,椎体严重压缩性骨折被认为是此类手术的禁忌证或相对禁忌证,尤其是当骨折椎体压缩超过 70%以上时<sup>[5-6]</sup>。近年来陆续有文献报道<sup>[7-9]</sup>通过椎体后凸成形术治疗椎体严重压缩骨折,但目前尚缺乏后凸成形术治疗椎体严重压缩骨折与一般压缩骨折的比较性研究。自 2009 年 1 月至 2011 年 2 月,采用椎体后凸成形术治疗骨质疏松性椎体严重压缩骨折,并与同期行椎体后凸成形术治疗的椎体一般压缩骨折患者进行临床疗效比较,现报告如下。

## 1 资料与方法

**1.1 纳入标准** ①影像学表现与临床特征完全吻合;②年龄 55 岁以上;③病程在 6 周以内,其中将骨折引起的椎体最大塌陷处 $\geq$ 椎体原高度的 2/3 的患者纳入严重骨折组<sup>[10]</sup>,将塌陷 $<$ 2/3 的患者纳入一般骨折组。

**1.2 排除标准** ①其他病变导致的椎体骨折或背部疼痛无法排除其他病变所致者;②有中风、痴呆、恶性肿瘤、严重心肺疾病、长期服用类固醇激素者;③全身或穿刺局部感染者;④无法纠正的凝血功能障碍者。

**1.3 临床资料** 本组 60 例(70 椎),骨密度检测均符合骨质疏松症的诊断标准,且均为新鲜骨折。致伤原因主要为跌倒伤或轻微外力作用,病史为 3 d~6 周,平均 2.7 周。主要症状是腰背部疼痛,行走、坐立、翻身及咳嗽时疼痛加重,生活不能完全自理。椎体一般骨折组 38 例(44 椎),男 7 例,女 31 例;年龄 59~87 岁,平均 71.8 岁;二椎体骨折 6 例, T<sub>9</sub> 1 椎, T<sub>10</sub> 5 椎, T<sub>11</sub> 7 椎, T<sub>12</sub> 13 椎, L<sub>1</sub> 9 椎, L<sub>2</sub> 4 椎, L<sub>3</sub> 4 椎, L<sub>4</sub> 1 椎。椎体严重骨折组 22 例(26 椎),男 3 例,女 19 例;年龄 63~90 岁,平均 72.6 岁;二椎体骨折 4 例, T<sub>9</sub> 1 椎, T<sub>10</sub> 2 椎, T<sub>11</sub> 3 椎, T<sub>12</sub> 9 椎, L<sub>1</sub> 6 椎, L<sub>2</sub> 3 椎, L<sub>3</sub> 2 椎。术

前做胸腰椎正侧位 X 线片、伤椎 CT 及脊柱 MR 检查以评估骨折情况。两组患者术前一般资料比较差异无统计学意义,具有可比性( $P < 0.05$ ),结果见表 1。

表 1 两组骨质疏松性椎体压缩骨折患者术前一般资料比较  
Tab.1 Comparison of clinical data of patients with osteoporotic vertebral compressive fracture between two groups before operation

组别	例数	年龄 ( $\bar{x} \pm s$ , 岁)	性别(例)		VAS 评分 ( $\bar{x} \pm s$ , 分)
			男	女	
一般骨折组	38	71.8 $\pm$ 6.1	7	31	7.24 $\pm$ 1.20
严重骨折组	22	72.6 $\pm$ 7.2	3	19	6.91 $\pm$ 1.19
检验值	-	$t = -0.455$	$\chi^2 = 0.230$		$t = 1.025$
P 值	-	0.651	0.461		0.310

**1.4 手术方法** 患者俯卧于手术床上,予全身静吸复合麻醉。以伤椎为中心调节手术床使伤椎过伸,由助手分别牵引双下肢及腋下,并保持牵引数分钟后再过伸、按压复位。C 形臂 X 线机透视复位效果后,采用美国 Kyphon 公司提供的微创器械和球囊,每步操作均在 C 形臂 X 线机透视下完成。所有患者选择经双侧椎弓根植入途径,左侧一般选 10 点钟左右位置进针,右侧选 2 点左右位置进针,进针点根据骨折情况适当调整,在 X 线机引导下经椎弓根穿刺进入伤椎,拔出穿刺针内芯,循序置入导针、扩张管和工作套管,应用精细钻在伤椎内建立工作通道,将球囊经工作套管置入伤椎。理想位置为球囊位于椎体前 2/3,连接高压注射器缓慢扩张球囊,扩张 2~3 min,然后换至对侧工作套管相同深度扩张,再交换至对侧,如此反复交换缓慢扩张 2~3 次。期间通过 C 形臂 X 线机监视球囊扩张和骨折复位情况。当后凸畸形矫正和椎体高度恢复满意或球囊到达椎体皮质时停止扩张,取出球囊,将处于拉丝期的骨水泥注入椎体,观察确认骨水泥充填空腔并渗入周围松质骨时停止注射,待骨水泥固化后抽出工作通道。其中 10 例同法完成另一椎体手术。术后观察患者腰背部疼痛变化,仰卧 2 h,常规使用抗生素 1 次,第 2 天允许下地行走,术后 2~3 d 出院。



表 3 两组骨质疏松性椎体压缩骨折患者术后疗效指标比较( $\bar{x}\pm s$ )

Tab.3 Comparison of recovery rate of clinical effective indexes of patients with osteoporotic vertebral compressive fracture after operation( $\bar{x}\pm s$ )

组别	例数	椎体前缘高度恢复率(%)	椎体中部高度恢复率(%)	Cobb 角矫正度(°)	VAS 评分(分)	VAS 改善值(分)	手术时间(min)	骨水泥注射量(ml)
一般骨折组	38	57.4±15.3	52.1±17.8	8.75±1.99	1.76±0.71*	5.4±1.4	39.1±4.0	4.8±0.6
严重骨折组	22	19.7±7.1	20.6±8.8	7.71±1.17	1.95±0.83#	5.3±1.2	51.1±7.2	3.2±0.6
检验值	-	$t=11.774$	$t=8.396$	$t=2.429$	$t=-0.897$	$t=0.497$	$t=-8.410$	$t=10.931$
P 值	-	0.000	0.000	0.018	0.578	0.621	0.000	0.000

注:与表 1 中术前比较, \* $t=23.284, P=0.000$ ; # $t=20.567, P=0.000$

Note: Compared with preoperative data in table 1, \* $t=23.284, P=0.000$ ; # $t=20.567, P=0.000$

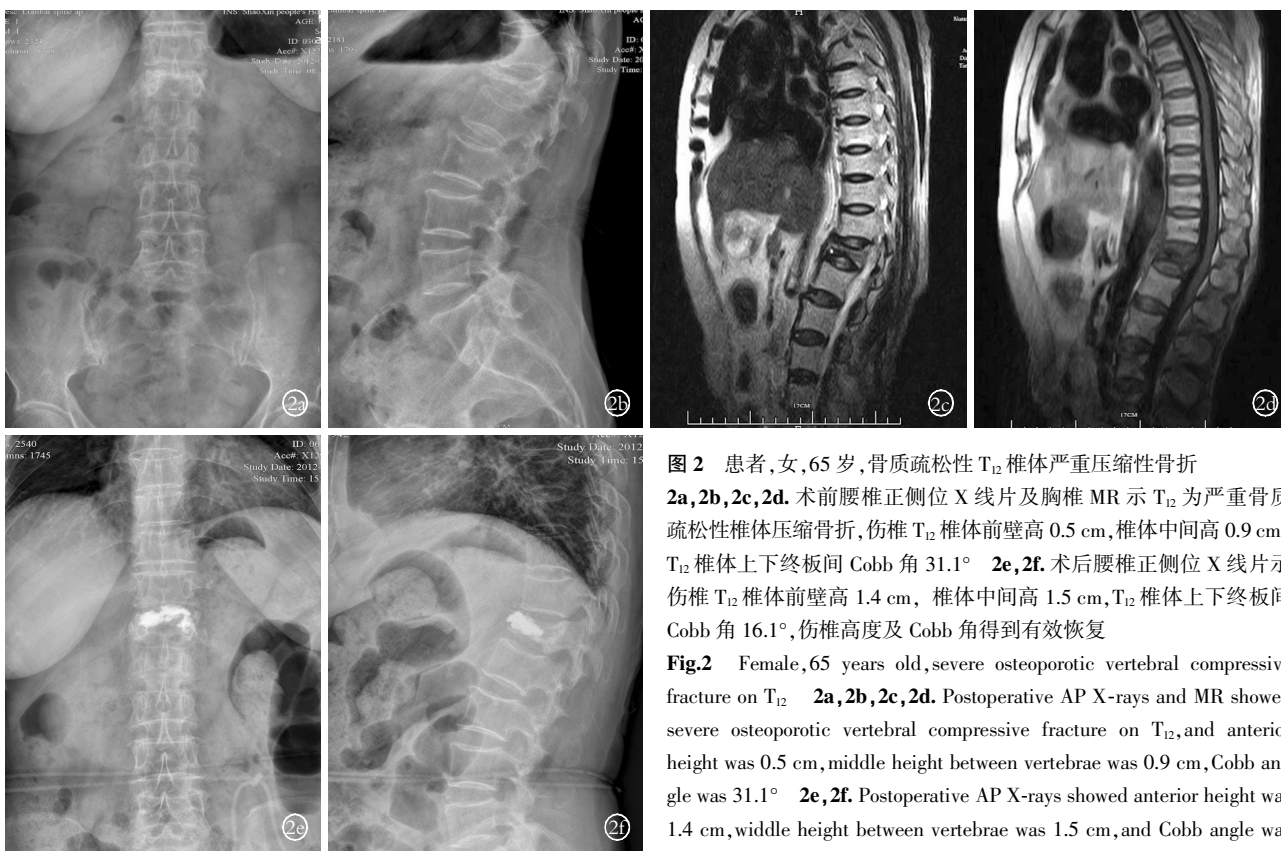


图 2 患者,女,65 岁,骨质疏松性 T<sub>12</sub> 椎体严重压缩性骨折 2a,2b,2c,2d. 术前腰椎正侧位 X 线片及胸椎 MR 示 T<sub>12</sub> 为严重骨质疏松性椎体压缩骨折,伤椎 T<sub>12</sub> 椎体前壁高 0.5 cm,椎体中间高 0.9 cm, T<sub>12</sub> 椎体上下终板间 Cobb 角 31.1° 2e,2f. 术后腰椎正侧位 X 线片示伤椎 T<sub>12</sub> 椎体前壁高 1.4 cm,椎体中间高 1.5 cm, T<sub>12</sub> 椎体上下终板间 Cobb 角 16.1°,伤椎高度及 Cobb 角得到有效恢复

Fig.2 Female, 65 years old, severe osteoporotic vertebral compressive fracture on T<sub>12</sub> 2a, 2b, 2c, 2d. Postoperative AP X-rays and MR showed severe osteoporotic vertebral compressive fracture on T<sub>12</sub>, and anterior height was 0.5 cm, middle height between vertebrae was 0.9 cm, Cobb angle was 31.1° 2e, 2f. Postoperative AP X-rays showed anterior height was 1.4 cm, middle height between vertebrae was 1.5 cm, and Cobb angle was 16.1°

效。但对于椎体严重压缩性骨折, Cotton 等<sup>[5]</sup>和 Deramond 等<sup>[6]</sup>认为在手术技术上有难度,是该方法的相对适应证,应慎重操作。本研究患者术前 VAS 疼痛评分与术后比较明显改善( $P<0.05$ ),而术后两组疼痛 VAS 评分改善值比较差异无统计学意义( $P>0.05$ )。笔者认为,体位复位单侧球囊双侧交替扩张后凸成形术治疗骨质疏松性椎体压缩骨折安全有效,尤其对于椎体严重压缩骨折患者可以获得与一般压缩骨折患者相似的临床效果。

首先,经双侧椎弓根入路较单侧椎弓根入路对于治疗骨质疏松性骨折具有以下优势:①双侧椎弓根入路两侧球囊扩张可使塌陷终板均匀受力复位,

可避免由于单侧入路引起的术后椎体两侧不对称或倾斜。Chung 等<sup>[13]</sup>发现双侧手术在矫正后凸畸形和维持复位方面优于单侧手术。②双侧入路注入骨水泥量可较单侧入路相对多些,可更好地恢复椎体高度维持椎体强度。③双侧入路球囊扩张后可创造更大空间,骨水泥注入时压力相对小,可降低骨水泥渗漏风险。④双侧入路骨水泥分布较单侧更均匀可获得更好生物力学效应。Steinmann 等<sup>[14]</sup>应用有限元法进行模拟分析,发现椎体单侧承重可引起脊柱不稳。

其次,笔者采用术前的体位复位。椎体复位一般有牵引复位和球囊扩张两种方法:牵引复位是通过一对一定方向施加牵引力,依靠伤椎周围的韧带,肌肉

等软组织的紧张、牵拉、挤压使骨折块恢复正常位置；而球囊扩张复位是在椎体内部通过膨胀压力对骨折进行撑开复位，是从内向外多方向立体复位。牵引复位作用于整个椎体外部，而球囊复位仅可作用于局部。体位复位可使脊柱前柱前伸，前纵韧带牵张，即类似韧带整复作用复位，严重压缩性骨折椎体压缩超过 2/3，直接穿刺相对难度较大，一定程度的复位降低了穿刺难度，也更容易使穿刺到达椎体的前中 1/3。本组严重压缩骨折病例穿刺成功率为 100%。另外过伸同时也使椎体后部压力加大，椎体后方受压形成一个相对完整的致密后壁骨壳，由此封闭了原来可能有的骨折小裂隙及静脉渗漏通道，可降低骨水泥向椎管内及静脉丛内渗漏的发生率，本组无一例发生向椎管内及静脉丛内渗漏现象。最后，牵张复位可使压缩区的骨密度恢复正常或降低，甚至在压缩区局部形成空腔，可降低在骨水泥注射时的压力，降低骨水泥渗漏的风险。

再次，采用单球囊双侧交替扩张技术可有效降低骨水泥渗漏的发生率。以往认为，骨质疏松性椎体严重压缩骨折患者禁用 PKP 技术，因为穿刺针很难到达理想位置，且球囊容易将骨质涨破，从而引起注射时骨水泥的渗漏，导致严重并发症<sup>[15]</sup>。采用单球囊双侧交替扩张技术，可缓慢动态观测椎体复位过程，避免单侧一步到位的复位，及椎体扩张复位时受力的不均，从而降低扩张时椎体破裂风险，最终可有效避免因骨水泥渗漏引起的严重并发症，本组发生 8 例渗漏(11.4%)，与通常 PKP 手术渗漏的发生率相近<sup>[16-18]</sup>，其中椎体严重骨折组发生 4 例骨水泥渗漏(19.2%)，渗漏率低于其他骨质疏松性椎体严重压缩骨折的报道<sup>[19-21]</sup>，且本组严重压缩骨折病例未出现症状性并发症，也从侧面说明严重椎体压缩骨折的 PKP 手术可行，并非手术禁忌证。

最后，单球囊的使用可显著降低患者医疗费用。PKP 经典的操作方法需要双球囊双侧放入，并在椎体内协调扩张，均衡地使塌陷地终板复位。但 PKP 专用球囊价格昂贵，且为一次性消耗品，同时，骨质疏松性椎体压缩骨折常为多椎体病变，严重制约了许多患者采用此项技术进行治疗。杨惠林等<sup>[22]</sup>也报道单球囊与双球囊治疗骨质疏松性压缩骨折临床疗效比较差异无统计学意义。本组 10 例双节段病例均仅采用单球囊完成手术。

**3.2 椎体后凸成形术中骨水泥注入量与伤椎椎体高度恢复及临床疗效的关系** 本组病例，椎体严重压缩骨折组椎体前缘及中部高度恢复率均低于一般压缩骨折组。分析原因主要有以下几点：首先，对于骨质疏松性椎体严重压缩骨折，伤椎骨量丢失较一

般压缩骨折多，球囊撑开时更易触及椎体壁而使扩张停止；其次，受压严重的椎体壁撑开后较一般受压椎体壁会产生更多裂隙，使骨水泥渗漏的风险增加，也是严重压缩骨折高度恢复受限的重要原因。

本组椎体严重骨折组骨水泥注射量为(3.2±0.6) ml，一般骨折组骨水泥注射量为(4.8±0.6)ml，两组比较差异有统计学意义。首先，椎体严重骨折组，球囊撑开较一般骨折组受限明显，故椎体内可容纳骨水泥的空间较一般骨折组少；其次，严重骨折组撑开后椎体壁的裂隙多与一般骨折组，为降低骨水泥渗漏发生风险，骨水泥注射量受到限制，也是造成骨水泥注射量较一般骨折组少的原因。

目前大量临床研究已证实，骨水泥注射量以及椎体高度恢复比例与临床止痛疗效无直接关系<sup>[23]</sup>。本研究中，椎体严重骨折组椎体高度恢复率及骨水泥注射量均少于一般骨折组，但术后两组 VAS 评分改善值比较差异无统计学意义。同时，有研究证实<sup>[24]</sup> 2~3 ml 的骨水泥即可恢复椎体强度，4~6 ml 可恢复椎体刚度。本组 22 例椎体严重骨折患者，骨水泥平均注射量为(3.2±0.6) ml，患者疼痛症状均得到有效缓解。

总之，体位复位结合单球囊双侧交替扩张椎体后凸成形术治疗骨质疏松性椎体一般压缩骨折及椎体严重压缩骨折均可获得满意疗效，椎体一般压缩骨折患者在椎体高度恢复及 Cobb 矫正方面优于椎体严重压缩骨折患者。对于严重骨质疏松性椎体压缩性骨折，由于其极易发生骨水泥渗漏，操作时需要谨慎耐心，不应过分追求椎体高度的恢复及骨水泥的填充量。

#### 参考文献

- [1] Kado DM, Duong T, Stone KL, et al. Incident vertebral fractures and mortality in older women: a prospective study[J]. *Osteoporos Int*, 2003, 14(7): 589-594.
- [2] Taylor RS, Fritzell P, Taylor RJ. Balloon kyphoplasty in the management of vertebral compression fractures: an updated systemic review and meta-analysis[J]. *Eur Spine J*, 2007, 16(8): 1085-1100.
- [3] Bouza C, López T, Magro A, et al. Efficacy and safety of balloon kyphoplasty in the treatment of vertebral compression fractures: a systemic review[J]. *Eur Spine J*, 2006, 15(7): 1050-1067.
- [4] Layton KF, Thielen KR, Koch CA, et al. Vertebroplasty, first 1 000 levels of a single center: evaluation of the outcomes and complications[J]. *AJNR Am J Neuroradiol*, 2007, 28(4): 683-689.
- [5] Cotten A, Boutry N, Cortet B, et al. Percutaneous vertebroplasty: state of the art [J]. *Radiographics*, 1998, 18: 311-320.
- [6] Deramond H, Derprier C, Galibert P, et al. Percutaneous vertebroplasty with polymethylmethacrylate. Technique, indications, and results[J]. *Radiol Clin North Am*, 1998, 36(3): 533-546.
- [7] O'Brien TP, Sims JT, Evans AI. Vertebroplasty in patients with severe vertebral compression fractures: a technical report [J]. *AJNR Am J Neuroradiol*, 2000, 21(8): 1555-1558.

- [8] Theodorou DT, Theodorou SJ, Duncan TD, et al. Percutaneous balloon kyphoplasty for the correction of spinal deformity in painful vertebral body compression fractures[J]. Clin Imaging, 2002, 26(1): 1-5.
- [9] 刘杰, 王建. 椎体后凸成形术治疗骨质疏松胸椎椎体重度压缩性骨折[J]. 中国修复重建外科杂志, 2008, 22(4): 399-403.  
Liu J, Wang J. Treatment of sever osteoporotic thoracic vertebral compression fracture by percutaneous kuphoplasty[J]. Zhongguo Xiu Fu Chong Jian Wai Ke Za Zhi, 2008, 22(4): 399-403. Chinese.
- [10] Peh WC, Gilula LA, Peck DD. Percutaneous vertebroplasty for severe osteoporotic vertebral body compression fractures[J]. Radiology, 2002, 123(1): 121-126.
- [11] Lee ST, Chen JF. Closed reduction vertebroplasty for the treatment of osteoporotic vertebral compression fractures; technical note[J]. J Neurosurg, 2004, 100(4 Suppl Spine): 392-396.
- [12] Huskisson EC. Measurement of pain[J]. Lancet, 1974, 2(7889): 1127-1131.
- [13] Chung HJ, Chung KJ, Yoon HS, et al. Comparative study of balloon kyphoplasty with unilateral versus bilateral approach in osteoporotic vertebral compression fractures[J]. Int Orthop, 2008, 32(6): 817-820.
- [14] Steinmann J, Tingey CT, Cruz G, et al. Biomechanical comparison of unipedicular versus bipedicular kyphoplasty[J]. Spine(Phila Pa 1976), 2005, 30(2): 201-205.
- [15] Jarvik JG, Kallmes DF, Mirza SK. Vertebroplasty learning more, but not enough[J]. Spine(Phila Pa 1976), 2003, 28(14): 1487-1489.
- [16] Taylor RS, Taylor RJ, Fritzell P, et al. Kyphoplasty and vertebroplasty for vertebral compression fractures: a comparative systematic review of efficacy and safety[J]. Spine(Phila Pa 1976), 2006, 31(23): 2747-2755.
- [17] Lee MJ, Dumonski M, Cahill P, et al. Percutaneous treatment of vertebral compression fractures: a meta-analysis of complications [J]. Spine(Phila Pa 1976), 2009, 34(11): 1228-1232.
- [18] 张世民, 张兆杰, 刘昱彰, 等. 球囊扩张经皮椎体后凸成形术治疗老年骨质疏松性椎体压缩骨折[J]. 中国骨伤, 2011, 24(7): 570-573.  
Zhang SM, Zhang ZJ, Liu YZ, et al. Treatment of senile osteoporotic vertebral compression fractures with percutaneous kyphoplasty[J]. Zhongguo Gu Shang/China J Orthopa Trauma, 2011, 24(7): 570-573. Chinese with abstract in English.
- [19] 唐海, 陈浩, 王炳强, 等. 椎体后凸成形术治疗重度骨质疏松性椎体压缩骨折[J]. 中华骨科杂志, 2010, 30(10): 978-983.  
Tang H, Chen H, Wang BQ, et al. Treatment of elderly severe osteoporotic vertebral compressive fractures by kyphoplasty[J]. Zhonghua Gu Ke Za Zhi, 2010, 30(10): 978-983. Chinese.
- [20] Nieuwenhuijse MJ, van Erkel AR, Dijkstra PD. Percutaneous vertebroplasty in very severe osteoporotic vertebral compression fractures: feasible and beneficial[J]. J Vasc Interv Radiol, 2011, 22(7), 1017-1023
- [21] Peh WC, Gilula LA, Peck DD. Percutaneous vertebroplasty for severe osteoporotic vertebral body compression fractures[J]. Radiology, 2002, 223(1): 121-126.
- [22] 杨慧林, 牛国旗, 梁道臣, 等. 单球囊与双球囊后凸成形术对椎体复位作用的研究[J]. 中华外科杂志, 2004, 40(21): 1299-1302.  
Yang HL, Niu GQ, Liang DC, et al. The contrast study between single and double balloon bilateral dilatation of kyphoplasty [J]. Zhonghua Wai Ke Za Zhi, 2004, 40(21): 1299-1302. Chinese.
- [23] Liebschner MA, Rosenberg WS, Keaveny TM. Effects of bone cement volume and distribution on vertebral stiffness after vertebroplasty[J]. Spine(Phila Pa 1976), 2001, 26(14): 1547-1554.
- [24] Belkoff SM, Mathis JM, Erbe EM, et al. Biomechanical evaluation of a new bone cement for use in vertebroplasty[J]. Spine(Phila Pa 1976), 2000, 25(9): 1061-1064.

(收稿日期: 2014-26 本文编辑: 李宜)

## 广告目次

- |  |   |
|--|---|
| 1. 盘龙七片(陕西盘龙药业集团股份有限公司) … (封2)           | 4. 同息通, 曲安奈德注射液(广东省医药进出口公司珠海公司) …… (封3) |
| 2. 祖师麻膏药(甘肃泰康制药有限责任公司)<br>…………… (对中文目次1) | 5. 奇正消痛贴膏(西藏奇正藏药股份有限公司)<br>…………… (封底)   |
| 3. 施沛特, 玻璃酸钠注射液(山东博士伦福瑞达制药有限公司) …… (对封2) |   |