

# 经皮椎体成形二次骨水泥注射治疗弥散不良的 Kümmel 病

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**【摘要】** 目的: 探讨经皮椎体成形手术二次注射骨水泥治疗术中骨水泥弥散不良的 Kümmel 病的临床疗效。方法: 对 2014 年 2 月至 2017 年 12 月收治的 88 例 Kümmel 病患者的临床资料进行回顾性分析, 其中 16 例术中发现骨水泥弥散不良采用二次骨水泥注射, 男 1 例, 女 15 例; 年龄 63~82 岁, 平均 72.7 岁; T<sub>10</sub> 1 例, T<sub>11</sub> 1 例, T<sub>12</sub> 3 例, L<sub>1</sub> 8 例, L<sub>2</sub> 1 例, L<sub>3</sub> 2 例。观察术前、术后 2 d、末次随访时的 VAS 评分、ODI 评分, 伴有椎体裂隙骨折椎后凸角和椎体前缘高度矫正情况并记录并发症发生情况。结果: 16 例患者均获得随访, 时间 5~22 个月, 平均 14.1 个月。术前、术后 2 d、末次随访时的 ODI 评分分别为 72.3±12.1、56.8±5.0、12.1±5.3, 术后 2 d 较术前、末次随访较术后 2 d 均有显著改善 (P<0.01); 术前、术后 2 d、末次随访时的 VAS 评分分别为 7.8±0.6、3.0±0.4、2.4±0.7, 术后 2 d 较术前改善 (P<0.01), 末次随访较术后 2 d 改善 (P<0.05)。术前、术后 2 d、末次随访时的椎体前缘压缩率分别为 (37.8±5.4)%、(4.7±1.4)%、(4.9±1.5)%, 术后 2 d 较术前改善 (P<0.01), 末次随访时较术后 2 d 无明显丢失 (P>0.05); 术前、术后 2 d、末次随访时的裂隙椎 Cobb 角分别为 (15.1±2.0)°、(4.4±2.2)°、(4.8±2.4)°, 术后 2 d 较术前改善 (P<0.01), 末次随访较术后 2 d 无明显丢失 (P>0.05)。骨水泥渗漏 3 例, 无肺栓塞及神经损伤发生, 邻椎骨折发生 4 例, 手术后随访无手术椎再塌陷发生。结论: 采用经皮椎体成形手术治疗 Kümmel 病, 首次骨水泥注射发现骨水泥弥散不良, 采用二次补救骨水泥注射, 仍能取得满意的临床疗效, 可以有效预防手术椎再塌陷发生。

**【关键词】** 椎体成形术; 骨水泥成形术; 注射, 关节内

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**Application of percutaneous vertebroplasty with the second injection for poor dispersion bone cement of Kümmel disease** LI Chi\*, WANG Jing, ZHU Ming-yu, ZHOU Yang, WANG Jian-hong, and TENG Hong-lin. \* Department of Orthopaedics, the First Affiliated Hospital of Wenzhou Medical University, Wenzhou 325000, Zhejiang, China

**ABSTRACT Objective:** To investigate clinical effect of percutaneous vertebroplasty with second injection for poor dispersion bone cement of Kümmel disease. **Methods:** Eighty-eight patients with Kümmel disease were treated with vertebroplasty from February 2014 to December 2017, and 16 patients were found cement dispersion unsatisfactory during initial cement injection and were undertaken second cement injection during operation. Among patients, there were 1 male and 15 females aged from 63 to 82 years old with an average age of 72.7 years old. Distribution of fractured vertebrae were followed: 1 patient was on T<sub>10</sub>, 1 patient was on T<sub>11</sub>, 3 patients were on T<sub>12</sub>, 8 patients were on L<sub>1</sub>, 1 patient was on L<sub>2</sub>, and 2 patients were on L<sub>3</sub>. VAS and ODI score were compared before operation, 2 days after operation and the latest following-up, anterior vertebral height and local kyphosis angle of fractured vertebrae with intravertebral cleft were also observed. Postoperative complication was recorded. **Results:** All patients were followed up from 5 to 22 months with average of 14.1 months. ODI score before operation, 2 days after operation and the latest following-up were 72.3±12.1, 56.8±5.0 and 12.1±5.3 respectively; VAS score before operation, 2 days after operation and the latest following-up were 7.8±0.6, 3.0±0.4 and 2.4±0.7, respectively; ODI score at 2 days was improved compared with before operation, while ODI and VAS score at the latest following-up was improved than that of 2 days after operation. Vertebral anterior compression rate and Cobb angle of the fractured vertebrae with intravertebral cleft were respectively corrected from (37.8±5.4)% and (15.1±2.0)° preoperative, to (4.7±1.4)% and (4.4±2.2)° at 2 days after operation, (4.9±1.5)% and (4.8±2.4)° at the latest following-up, there was significant difference between before operation and 2 days after op-

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eration, while there was no difference between 2 days after operation and the latest following-up. Three patients occurred cement leakage without pulmonary embolism and neurological impairment. Four patients occurred adjacent vertebrae fracture. There was no incidence of recollapsed vertebrae during follow-up period. **Conclusion:** Percutaneous vertebroplasty for Kümmel disease could receive satisfactory clinical results when cement dispersion was inadequate during initial cement injection by the second injection, and effectively prevent occurrence of vertebral re-collapse.

**KEYWORDS** Vertebroplasty; Cementoplasty; Injections, intra-articular

Kümmel 病, 又称为“椎体内真空裂隙征”, 多发生于脊椎骨质疏松性骨折后, 发生机制为椎体骨折后骨小梁发生缺血性坏死改变, 死骨形成, 形成无骨组织的空腔裂隙<sup>[1]</sup>, 患者表现为胸腰背痛。经皮椎体成形手术被认为能有效缓解 Kümmel 病患者疼痛的方法<sup>[2-3]</sup>。由于椎体空腔周围为纤维硬化骨, 部分患者骨水泥只是充填于空腔而未弥散到空腔周围椎体骨质。骨水泥在手术椎体内弥散不良是导致手术椎体塌陷<sup>[4]</sup>、骨水泥移位<sup>[5]</sup>的重要原因; 临床上患者椎体成形手术后再次出现剧烈背痛, 部分患者需要进行第 2 次手术治疗。国内未见报道关于椎体成形术中发现脊椎骨水泥弥散不良的处理。本文总结我院经皮椎体成形手术治疗的 Kümmel 病患者, 其中 16 例手术中发现骨水泥充填于空腔内, 空腔周围骨水泥未弥散, 采用二次注射骨水泥改善椎体骨水泥弥散, 现报告如下。

## 1 资料与方法

### 1.1 一般资料

2014 年 2 月至 2017 年 12 月, 采用经皮椎体成形手术治疗 88 例 Kümmel 病患者, 均为两侧椎弓根穿刺; 其中 16 例脊椎手术中发现骨水泥弥散不良, 采用二次补救注射骨水泥。16 例患者中, 男 1 例, 女 15 例; 年龄 63~82 岁, 平均 72.7 岁; T<sub>10</sub> 1 例, T<sub>11</sub> 1 例, T<sub>12</sub> 3 例, L<sub>1</sub> 8 例, L<sub>2</sub> 1 例, L<sub>3</sub> 2 例。16 例患者术前 CT 见椎体裂隙, 且术前 MRI 提示 T1 相低信号和 T2 相高或低信号<sup>[1,6]</sup>。排除 Kümmel III 期<sup>[7]</sup>、脊椎感染或肿瘤<sup>[1]</sup>及存在手术禁忌证的患者。

### 1.2 治疗方法

采用局麻加静脉麻醉 10 例, 全身麻醉 6 例。直径 4.0 mm 穿刺针进行两侧椎弓根穿刺, 穿刺定位于椎体空腔处, 正侧位透视证实穿刺方向正确。注入骨水泥填满空腔, 但骨水泥未突破空腔周围。

若术中透视见骨水泥填满空腔并已达到上下终板, 但未弥散至周围骨质, 将骨水泥推杆退至空腔后缘, 再次注入骨水泥(见图 1)。

若术中透视见骨水泥填满空腔, 但未达到上下终板, 再次注射骨水泥仍未突破空腔; 穿刺针退到原穿刺通道口位置, 注意保持原穿刺外展角度, 侧位透视见穿刺针达到椎体骨水泥未弥散处, 用螺旋钻攻至接近终板位置, C 形臂 X 线透视下注入骨水泥(见

图 2)。术后应用抗生素 1 d。术后 2 d 开始下地活动。

### 1.3 观察项目与方法

**1.3.1 临床症状观察** 分别于术前、术后 2 d 及末次随访时采用疼痛视觉模拟评分<sup>[8]</sup>(visual analogue scale, VAS) 进行疼痛评估, Oswestry 功能障碍指数(ODI)<sup>[9]</sup>进行腰椎功能评价。

**1.3.2 影像学观察** 分别于术前、术后 2 d 及末次随访时测量伴有裂隙的骨折椎椎体前缘高度压缩率和后凸角。椎体前缘高度压缩率<sup>[10]</sup>以 $[1 - \text{伴有裂隙骨折椎体前缘高度} / (\text{伴有裂隙骨折椎体上下各一正常椎前缘高度的平均值})] \times 100\%$ 表示; 后凸角<sup>[4]</sup>采用伴有裂隙骨折椎上一椎体上终板与下一椎下终板连线角度表示。

### 1.4 统计学处理

应用 SPSS 10.0 软件进行统计学分析。定量资料采用均数±标准差( $\bar{x} \pm s$ )表示。手术前后的 VAS 评分、ODI 评分和椎体裂隙征椎体前缘高度、后凸角度的比较采用配对设计定量资料的 *t* 检验。以  $P < 0.05$  为差异有统计学意义。

## 2 结果

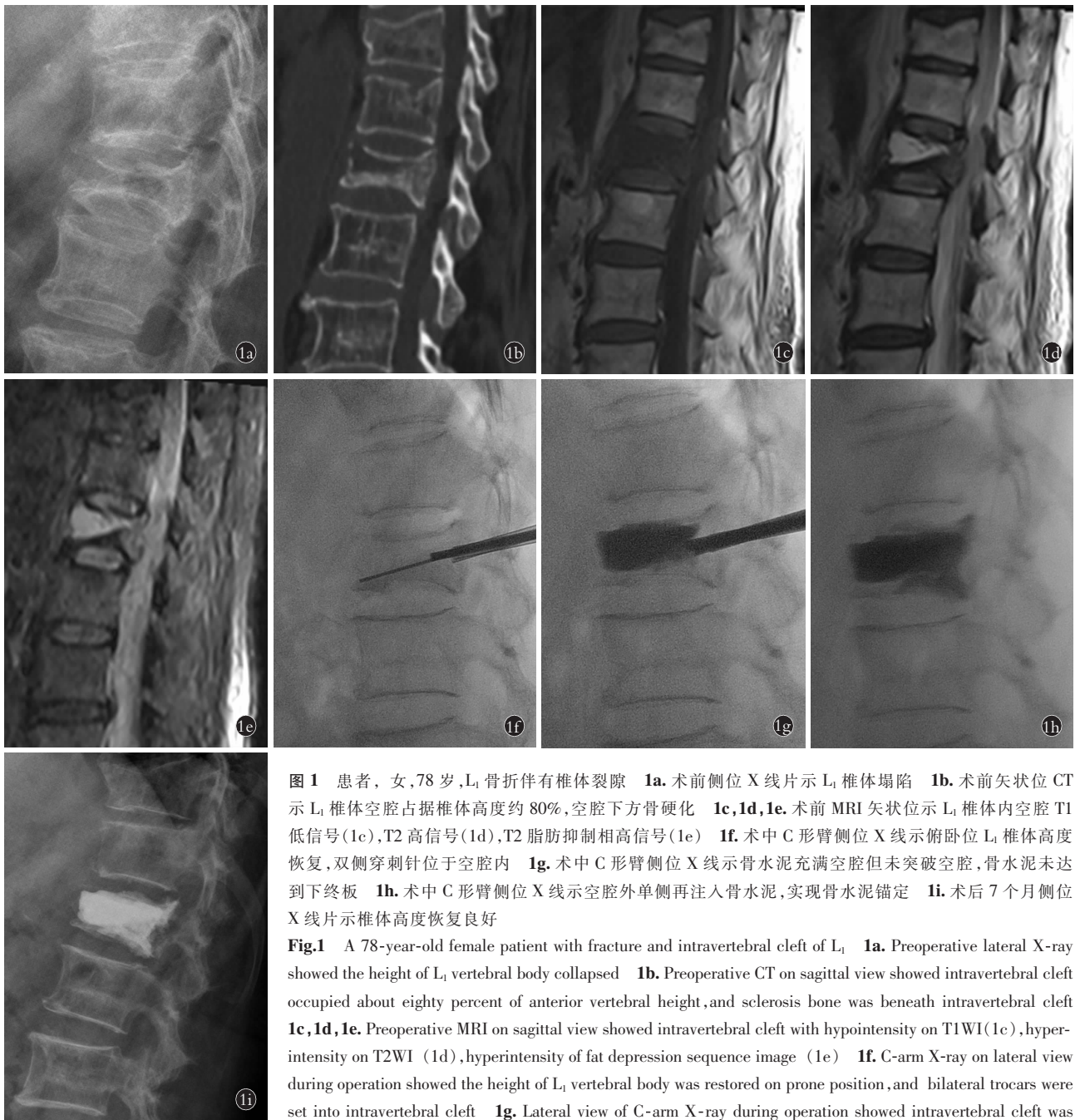
本组患者均获得随访, 时间 5~22 个月, 平均 14.1 个月。本组 3 例患者发生骨水泥漏, 均为椎旁骨水泥渗漏, 无肺栓塞、椎管内漏导致脊髓损伤等严重并发症出现。4 例发生邻椎骨折。末次随访无手术椎再塌陷发生。

### 2.1 临床症状改善

术前、术后 2 d、末次随访时的 ODI 评分分别为  $72.3 \pm 12.1$ 、 $56.8 \pm 5.0$ 、 $12.1 \pm 5.3$ , 术后 2 d 较术前、末次随访较术后 2 d 均有改善( $P < 0.01$ )。见表 1。术前、术后 2 d、末次随访时的 VAS 评分分别为  $7.8 \pm 0.6$ 、 $3.0 \pm 0.4$ 、 $2.4 \pm 0.7$ , 术后 2 d 较术前改善( $P < 0.01$ ), 末次随访较术后 2 d 改善( $P < 0.05$ )。见表 2。

### 2.2 影像学观察

术前、术后 2 d、末次随访时椎体前缘压缩率分别为  $(37.8 \pm 5.4)\%$ 、 $(4.7 \pm 1.4)\%$ 、 $(4.9 \pm 1.5)\%$ , 术后 2 d 较术前改善( $P < 0.01$ ), 末次随访较术后 2 d 无明显丢失( $P > 0.05$ )。术前、术后 2 d、末次随访时的裂隙椎 Cobb 角分别为  $(15.1 \pm 2.0)^\circ$ 、 $(4.4 \pm 2.2)^\circ$ 、 $(4.8 \pm 2.4)^\circ$ , 术后 2 d 较术前改善( $P < 0.01$ ), 末次随访较术后 2 d 无明显丢失( $P > 0.05$ )。见表 2。



**图 1** 患者,女,78岁,L<sub>1</sub>骨折伴有椎体裂隙 **1a.**术前侧位X线片示L<sub>1</sub>椎体塌陷 **1b.**术前矢状位CT示L<sub>1</sub>椎体空腔占据椎体高度约80%,空腔下方骨硬化 **1c,1d,1e.**术前MRI矢状位示L<sub>1</sub>椎体内空腔T1低信号(1c),T2高信号(1d),T2脂肪抑制相高信号(1e) **1f.**术中C形臂侧位X线示俯卧位L<sub>1</sub>椎体高度恢复,双侧穿刺针位于空腔内 **1g.**术中C形臂侧位X线示骨水泥充满空腔但未突破空腔,骨水泥未达下终板 **1h.**术中C形臂侧位X线示空腔外单侧再注入骨水泥,实现骨水泥锚定 **1i.**术后7个月侧位X线片示椎体高度恢复良好

**Fig.1** A 78-year-old female patient with fracture and intravertebral cleft of L<sub>1</sub> **1a.** Preoperative lateral X-ray showed the height of L<sub>1</sub> vertebral body collapsed **1b.** Preoperative CT on sagittal view showed intravertebral cleft occupied about eighty percent of anterior vertebral height, and sclerosis bone was beneath intravertebral cleft **1c,1d,1e.** Preoperative MRI on sagittal view showed intravertebral cleft with hypointensity on T1WI(1c), hyperintensity on T2WI (1d), hyperintensity of fat depression sequence image (1e) **1f.** C-arm X-ray on lateral view during operation showed the height of L<sub>1</sub> vertebral body was restored on prone position, and bilateral trocars were set into intravertebral cleft **1g.** Lateral view of C-arm X-ray during operation showed intravertebral cleft was filled with bone cement, but did not break through cleft margin and bone cement did not reach lower endplate of

L<sub>1</sub> **1h.** Lateral view of C-arm X-ray during operation showed bone cement was injected outside intravertebral cleft, and got adequate dispersion of vertebrae **1i.** Postoperative lateral X-ray at 7 months showed height of L<sub>1</sub> vertebrae was restored and maintained

### 3 讨论

#### 3.1 椎体成形手术治疗 Kümmel 病现状

经皮椎体成形术能有效治疗 Kümmel 病,缓解疼痛<sup>[2]</sup>。Kümmel 病需在责任区域穿刺<sup>[11]</sup>,不在责任区域注射骨水泥会导致术后疼痛缓解不佳<sup>[12]</sup>。而责任区域穿刺,由于椎体内空腔周围为纤维硬化骨,出现部分患者骨水泥只是填充于空腔而椎体内空腔周围未充分弥散。

椎体成形术后手术椎再骨折近年来被广泛报

道,原因与骨质疏松<sup>[13]</sup>、注入的骨水泥量少<sup>[14]</sup>、骨水泥未同时弥散到上下终板<sup>[4]</sup>、Kümmel 病<sup>[4]</sup>有关,其中 Kümmel 病<sup>[4,15]</sup>和骨水泥未接触上下终板<sup>[4]</sup>是术后手术椎再塌陷发生的高危因素。Heo 等<sup>[15]</sup>报道椎体成形术后再塌陷发生率为 3.2%,Kümmel 病发生再塌陷的概率大于普通压缩性骨折;考虑到手术椎再塌陷的高发生率,作者认为椎体成形手术可能是治疗 Kümmel 病的相对禁忌证。

PMMA 骨水泥与骨生物相容性差。Kümmel 病骨



**图 2** 患者,女,69岁,L<sub>1</sub>及T<sub>12</sub>骨折,T<sub>12</sub>伴有椎体裂隙 **2a.**术前侧位X线片示L<sub>1</sub>及T<sub>12</sub>椎体塌陷,局部后凸畸形 **2b.**术前矢状位CT示L<sub>1</sub>及T<sub>12</sub>椎体塌陷,T<sub>12</sub>椎体内空腔形成,空腔下方无骨硬化 **2c,2d,2e.**术前MRI T2侧位影像示MRI矢状位见T<sub>12</sub>椎体内空腔T1低信号(2c),T2高信号(2d),T2脂肪抑制相高信号(2e),L<sub>1</sub>椎体T1低信号(2c),T2低信号(2d),T2脂肪抑制相高信号(2e) **2f.**术中C形臂侧位X线片示俯卧位T<sub>12</sub>椎体高度恢复,T<sub>12</sub>双侧穿刺针方向指向空腔 **2g.**术中C形臂侧位X线片示T<sub>12</sub>骨水泥充满空腔但未突破空腔,未弥散至下终板 **2h.**术中C形臂侧位X线示T<sub>12</sub>单侧改变穿刺针方向,到达空腔下方骨水泥未被填充处 **2i.**术中C形臂侧位X线穿刺针改变方向后骨水泥注入,弥散至下终板 **2j.**术后15个月见椎体高度恢复良好

**Fig.2** A 69-year-old female patient with fractured vertebrae of L<sub>1</sub> and T<sub>12</sub> with intravertebral cleft of T<sub>12</sub> **2a.** Preoperative lateral X-ray showed

collapsed of L<sub>1</sub> and T<sub>12</sub> vertebral bodies, and local kyphosis existed **2b.** Preoperative CT on sagittal view showed collapsed of L<sub>1</sub> and T<sub>12</sub> vertebral bodies, intravertebral cleft existed on T<sub>12</sub>, without sclerosis bone beneath the intravertebral cleft **2c, 2d, 2e.** Preoperative MRI on sagittal view showed intravertebral cleft of T<sub>12</sub> with hypointensity on T1WI(2c), hyperintensity on T2WI(2d), hyperintensity on fat depression sequence image (2e), while L<sub>1</sub> vertebral body with hypointensity on T1WI(2c), hypointensity on T2WI(2d), hyperintensity of fat depression sequence image(2e) **2f.** Lateral view of C-arm X-ray during operation showed vertebral body height was restored in prone position on T<sub>12</sub> and the direction of trocars was aimed to intravertebral cleft of T<sub>12</sub> **2g.** Lateral view of C-arm X-ray during operation showed intravertebral cleft of T<sub>12</sub> was filled with bone cement, but bone cement did not break through cleft margin and did not reach lower endplate of T<sub>12</sub> **2h.** Lateral view of C-arm X-ray during operation showed the trocar direction was changed and located on bone cement, but unfilled area beneath the cleft **2i.** Lateral view of C-arm X-ray during operation showed PMMA was injected and reached lower endplate of T<sub>12</sub> vertebrae **2j.** Postoperative lateral X-ray at 15 months showed height of T<sub>12</sub> vertebrae was maintained and restored

水泥成团块状局限于空腔内,未充分弥散。在未被骨水泥充填的区域,骨水泥压迫周围骨质疏松的骨小梁及与周围骨小梁炎症反应<sup>[11]</sup>,骨水泥凝固散热烫

伤周围骨导致骨坏死<sup>[16]</sup>,空腔内骨水泥不能与周围骨质形成锚定,导致骨水泥塌陷、移位<sup>[5]</sup>。

发生手术椎再塌陷的患者往往出现剧烈背痛,

**表 1 Kümmel 病 16 例患者手术前后 ODI 评分比较**  
( $\bar{x} \pm s$ , 分)

**Tab.1 Comparison of ODI score of 16 patients with Kümmel disease before and after operation** ( $\bar{x} \pm s$ , score)

项目	术前	术后 2 d	末次随访
疼痛程度	3.3±0.9	1.8±0.7	0.3±0.4
日常活动自理能力	3.5±1.1	2.9±0.5	0.3±0.5
提物	3.6±0.7	3.1±0.3	0.7±0.4
行走	3.5±0.8	2.3±0.6	0.6±0.6
坐	3.8±0.6	3.0±0.5	0.8±0.5
站立	3.8±0.6	2.7±0.4	0.3±0.4
睡眠	2.9±0.7	2.3±0.4	0.6±0.5
社会活动	3.4±0.6	3.0±0.0	0.8±0.5
旅行	4.5±0.5	4.1±0.3	0.8±0.5
总分	72.3±12.1	56.8±5.0*	12.1±5.3**

注:与术前比较, \* $t=7.668, P<0.01$ ;与术后 2 d 比较, \*\* $t=29.760, P<0.01$

Note: Compared with preoperative data, \* $t=7.668, P<0.01$ ; compared with postoperative data at 2 days, \*\* $t=29.760, P<0.01$

**表 2 Kümmel 病 16 例患者手术前后影像学测量指标及 VAS 评分比较**( $\bar{x} \pm s$ )

**Tab.2 Comparison of radiographic and VAS score of 16 patients with Kümmel disease before and after operation**

( $\bar{x} \pm s$ )

时间	Cobb 角(°)	椎体前缘压缩率(%)	VAS 评分(分)
术前	15.1±2.0	37.8±5.4	7.8±0.6
术后 2 d	4.4±2.2*	4.7±1.4♦	3.0±0.4■
末次随访	4.8±2.4**	4.9±1.5♦♦	2.4±0.7■■

注:与术前比较, \* $t=13.46, P<0.01$ ; ♦ $t=31.28, P<0.01$ ; ■ $t=23.07, P<0.01$ 。与术后 2 d 比较, \*\* $t=1.34, P>0.05$ ; ♦♦ $t=1.79, P>0.05$ ; ■■ $t=2.61, P<0.05$

Note: Compared with preoperative data, \* $t=13.46, P<0.01$ ; ♦ $t=31.28, P<0.01$ ; ■ $t=23.07, P<0.01$ 。Compared with postoperative data at 2 days, \*\* $t=1.34, P>0.05$ ; ♦♦ $t=1.79, P>0.05$ ; ■■ $t=2.61, P<0.05$

脊柱后凸畸形,骨水泥移位可能导致脊髓损伤。对于此并发症的治疗策略有保守治疗、再次行经皮椎体成形手术、后路椎弓根螺钉固定手术、后路椎弓根螺钉固定加侧前路椎体重建手术<sup>[17]</sup>。由于患者多为高龄,开放手术可能带来很大的手术风险。再次行手术椎体经皮椎体成形,由于手术椎体内骨水泥的阻挡,无法再建立工作通道,部分患者丧失微创手术机会。因此,首次椎体成形手术即达到满意的椎体弥散,是预防手术椎发生再塌陷的最好方法。

**3.2 首次椎体成形术中骨水泥弥散不良治疗策略**  
目前大部分文献集中于手术椎再塌陷后再次穿

刺行椎体成形手术<sup>[12,17]</sup>,对于首次椎体成形手术中骨水泥弥散不良的处理报道较少。Chen 等<sup>[18]</sup>报道手术中骨水泥弥散不良 13 例患者,采用同侧不同穿刺点或同一穿刺点改变穿刺针方向,或单侧穿刺患者改从另外一侧穿刺,可使椎体内骨水泥更好的弥散,随访时间 18.5 个月,未见椎体再塌陷发生。

本文报道 16 例 Kümmel 患者术中发现骨水泥弥散不良,采用二次穿刺或空腔外注射或两者相结合的办法,获得骨水泥较好的弥散,术后随访未见手术椎再塌陷发生。Heo 等<sup>[15]</sup>报道中的再塌陷病例大部分存在骨水泥集中于椎体空腔,周围弥散不良,因此,作者认为取得骨水泥良好的弥散可能会解决手术椎体再塌陷问题,椎体成形手术不是治疗 Kümmel 病的禁忌证。

**3.3 多量骨水泥注入的并发症**

较多量的骨水泥注入可能会导致骨水泥漏,术中透视严密观察可预防因此带来严重后果的骨水泥漏发生,本研究发生骨水泥漏 3 例,但并未导致不良后果。

有文献<sup>[19]</sup>报道注入骨水泥过多会导致邻椎骨折发生概率增加。本文 16 例患者中 4 例出现邻椎骨折,与既往报道邻椎骨折发生率<sup>[19]</sup>类似。骨水泥注入并不是越多越好,关键在于取得良好的椎体内骨水泥弥散。良好的椎体内骨水泥弥散,可有效预防手术椎再塌陷和骨水泥移位的风险。而手术椎再塌陷和骨水泥移位可能导致患者神经损伤,需要开放手术,相比于邻椎骨折并发症,笔者认为取得良好的弥散而注入较多的骨水泥,给患者带来益处要大于坏处。

**3.4 二次注射骨水泥的注意事项**

(1)Kümmel 病患者伤椎不稳定,俯卧位伤椎体位复位;同时空腔内注入的骨水泥一般为团块状,因此注入量较普通骨质疏松性骨折要多,故注射骨水泥前建议准备足够量的骨水泥。(2)穿刺时部分患者要通过已经注入的骨水泥到达未被骨水泥填充的部位,要注意在骨水泥还未凝固时穿刺。由于原有的骨水泥阻挡,新注入的骨水泥流动方向受到阻挡,出现骨水泥弥散方向改变及注射量较小。所以,穿刺针要深入骨水泥或者穿出骨水泥,再用螺旋钻建立通道。

综上所述,首次骨水泥注射发现骨水泥弥散不良,采用二次补救骨水泥注射仍能获得良好的临床效果,能有效预防手术椎再塌陷发生。本次研究不足为病例数少,随访时间短,需要大样本病例研究。

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