

术前MRI对经皮椎体强化术中骨水泥渗漏风险的预测价值

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【摘要】目的:探讨术前磁共振成像(MRI)对经皮椎体强化术(PVA)中骨水泥渗漏风险的预测价值。**方法:**选择广东省中医院珠海医院2016年5月~2018年5月收治的60例(共88个手术椎体)骨质疏松性椎体压缩性骨折患者,均行PVA术。术前行MRI检查,术后行DR进行复查。计算骨水泥渗漏发生率,比较临床因素[包括不同性别、不同年龄(≤ 70 岁、 > 70 岁)、手术方式[经皮椎体后凸成形术(PKP)、经皮椎体成形术(PVP)]、椎体部位(胸椎、胸腰段、腰椎)、骨水泥注入量[(≤ 4 mL、 > 4 mL)]及MRI征象(包括终板损伤、达终板骨折线、椎间盘损伤、椎体裂隙)对骨水泥渗漏发生率的影响。绘制受试者工作特征曲线分析MRI征象对骨水泥椎间盘渗漏的预测价值。**结果:**性别、年龄、椎体部位及骨水泥注入量对骨水泥渗漏发生率的影响无统计学差异($P>0.05$);PKP的骨水泥渗漏发生率为26.67%(16/60),低于PVP的50%(14/28),差异有统计学意义($P<0.05$)。术前MRI检查显示椎体终板损伤、椎体裂隙、椎间盘损伤、达终板骨折线的骨水泥渗漏发生率分别为27.40%、57.89%、30.30%、54.55%,高于无上述征象椎体的14.73%、27.54%、15.22%、27.27%,差异有统计学意义($P<0.05$)。同时合并上述任意两种MRI征象、任意3种MRI征象、任意4种MRI征象患者的骨水泥渗漏发生率分别高达43.59%、56.00%、100%。同时合并任意两种MRI征象预测骨水泥渗漏的敏感度与特异度分别为0.818、0.553;同时合并任意3种MRI征象预测骨水泥渗漏的敏感度与特异度分别为0.727、0.763;同时合并4种MRI征象预测骨水泥渗漏的敏感度与特异度分别为0.727、1.000。**结论:**PKP术后的骨水泥渗漏风险低于PVP,推荐骨质疏松性椎体压缩性骨折采取PKP术。另外,术前行MRI检查,通过患者MRI征象对骨水泥渗漏风险进行预测。

【关键词】经皮椎体强化术;骨水泥;渗漏风险;磁共振成像;预测价值

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Predictive value of preoperative MRI for risk of bone cement leakage during percutaneous vertebral augmentation

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Abstract: Objective To explore the value of preoperative magnetic resonance imaging (MRI) to predict the risk of bone cement leakage in percutaneous vertebral augmentation (PVA). **Methods** A total of 60 patients (88 surgical vertebral bodies) with osteoporotic vertebral compression fractures admitted to Zhuhai Hospital, Guangdong Provincial Hospital of Traditional Chinese Medicine from May 2016 to May 2018 were treated with PVA. MRI was performed before operation and DR was performed after operation for reexamination. The rate of bone cement leakage was calculated. The influencing factors, including gender, age (≤ 70 years old, > 70 years old), surgical methods [percutaneous kyphoplasty (PKP), percutaneous vertebroplasty (PVP)], vertebral body (thoracic vertebrae, thoracolumbar vertebrae, lumbar vertebrae), volume of bone cement injection [(≤ 4 mL, > 4 mL)] and MRI signs (endplate damage, endplate fracture line, intervertebral disc injury, vertebral body fissure) were compared. The receiver operating characteristic curve (ROC) was used to analyze the predictive value of MRI signs for cement intervertebral disc leakage. **Results** The effects of gender, age, vertebral body and volume of bone cement injection on the rate of bone cement leakage were marginal, without statistical differences ($P>0.05$). The rate of bone cement leakage was 26.67% (16/60) in patients treated with PKP, lower than 50% (14/28) in patients receiving PVP, and the differences were statistical ($P<0.05$). Preoperative

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MRI examination showed that the incidences of bone cement leakage in vertebral body with MRI signs of vertebral endplate injury, vertebral fissure, disc injury, and endplate fracture line were 27.40%, 57.89%, 30.30% and 54.55%, respectively, which were higher than 14.73%, 27.54%, 15.22%, 27.27% in the vertebral body without the above signs, and the difference was statistically significant ($P<0.05$). The incidences of bone cement leakage in patients with any 2, 3 and 4 kinds of the above MRI signs were up to 43.59%, 56.00% and 100.00%, respectively. The sensitivity of combining any 2, 3 and 4 kinds of the MRI signs to predict bone cement leakage was 0.818, 0.727 and 0.727, respectively, and the specificity was 0.553, 0.763 and 1.000, respectively.

Conclusion PKP, with a lower risk of bone cement leakage than PVP, is recommended for osteoporotic vertebral compression fractures. In addition, preoperative MRI can be used to predict the risk of bone cement leakage through MRI signs.

Keywords: percutaneous vertebral augmentation; bone cement; risk of leakage; magnetic resonance imaging; predictive value

前言

骨质疏松性椎体压缩性骨折为老年人常见病,主要采取手术治疗。经皮椎体强化术(Percutaneous Vertebral Augmentation, PVA)创伤轻,可有效缓解疼痛,并改善活动能力,疗效显著,是治疗骨质疏松性椎体压缩性骨折的有效手术方式^[1]。骨水泥渗漏为PVA常见并发症,发生率可达30%~80%^[2]。据报道PVA术后有16%~28%的患者出现疼痛复发,多与邻近椎体骨折有关,骨水泥渗漏被认为是主要原因之一^[3]。目前,术前X线、CT、MRI均为PVA术患者的术前常见检查,其中MRI可判断椎体骨折的区域、范围^[4],但目前尚缺乏术前MRI预测PVA患者骨水泥渗漏风险的研究。本研究以60例骨质疏松性椎体压缩性骨折行PVA的患者作为研究对象,探讨术前MRI对PVA术中骨水泥渗漏风险的预测价值。

1 资料与方法

1.1 临床资料

选择广东省中医院珠海医院2016年5月~2018年5月收治的60例(共88个手术椎体)骨质疏松性椎体压缩性骨折患者进行前瞻性研究,所有患者均行PVA。其中男23例、女37例;年龄53~86岁,平均(71.25±7.36)岁;骨折疼痛发生至手术时间2~4月,平均(2.95±0.65)月;涉及节段:胸椎(T₅~T₁₀)12例、胸腰段(T₁₁~L₂)34例、腰椎(L₃~L₅)14例。手术方式:经皮椎体后凸成形术(PKP)40例(共60个椎体)、经皮椎体成形术(PVP)20例(共28个椎体)。共涉及终板168个及椎间盘158个。

1.2 检查方法

(1)术前检查:术前1周采用GE HDX 1.5T MR扫描仪进行胸腰椎扫描,扫描参数:矢状位T₁WI:TR 420 ms, TE 9.7 ms;矢状位T₂WI:TR 2 440 ms, TE 98.0 ms;矢状位T₂FS:TR 2 820 ms, TE 111.5 ms;轴位:TR 3 600 ms, TE 108 ms;层厚4 mm,层间距0.4 mm,FOV 32×32,矩阵:256×128。(2)术后检查:术后采用Siemens Aristos

MX-R DR进行胸腰椎正侧位复查。

1.3 图像分析

术前图像分析:由2名经验丰富的影像科医师进行图像分析,评估患者终板损伤、椎体裂隙、椎间盘损伤、达终板骨折线。①终板损伤:矢状位T₁WI及T₂WI显示椎体终板连续性中断,矢状位T₂FS显示终板区存在高信号或出现椎间盘组织疝入终板。②椎体裂隙:术前胸腰椎平片示线形或半月形的透亮影,MRI T₂WI及矢状位T₂FS呈边缘清晰的脑脊液样高信号、低信号或高低混杂信号。③椎间盘损伤:矢状位T₂WI及矢状位T₂FS上责任椎体邻近椎间盘存在明显高的条、片状信号。④达终板骨折线:责任椎体内与终板相连续的线状或带状异常信号,T₁WI与T₂WI低信号,矢状位T₂FS可为低信号或高信号。

术后图像分析:由另外2名主治医师分析患者术后胸腰椎正侧位片。骨水泥椎间盘渗漏:术后胸腰椎正侧位片示PVA椎体邻近椎间隙内出现超过终板皮质致密线的骨水泥样高密度影。

1.4 观察指标

1.4.1 临床因素对骨水泥渗漏的影响 计算所有患者的骨水泥渗漏发生率。比较临床因素,包括不同性别、不同年龄(≤70岁、>70岁)、手术方式(PVP、PKP)、椎体部位(胸椎、胸腰段、腰椎)、骨水泥注入量(≤4 mL、>4 mL)患者的骨水泥渗漏发生率的差异。

1.4.2 不同术前MRI征象骨水泥渗漏差异 比较不同MRI征象(包括终板损伤、达终板骨折线、椎间盘损伤、椎体裂隙)的骨水泥渗漏发生率的差异。

1.4.3 MRI征象预测骨水泥椎间盘渗漏的ROC曲线 绘制受试者工作特征(ROC)曲线分析MRI征象对骨水泥椎间盘渗漏的预测价值。

1.5 统计学方法

采用SPSS 19.0软件处理数据,计数资料用 $n(\%)$ 表示,比较行 χ^2 检验, $P<0.05$ 为差异有统计学意义。绘制ROC曲线分析MRI征象对骨水泥椎间盘渗漏的预测价值。

2 结果

2.1 临床因素对骨水泥渗漏的影响

60例(88个椎体)患者中共20例患者(33.33%, 20/60)、30个椎体(34.09%, 30/88)发生骨水泥漏入邻近椎间盘,34个椎间盘(21.52%, 34/158)出现骨水泥渗漏。性别、年龄、椎体部位及骨水泥注入量对骨水泥渗漏发生率的影响差异无统计学意义($P>0.05$);PKP的骨水泥渗漏发生率为26.67%(16/60),低于PVP的50%(14/28),差异有统计学意义($P<0.05$)。详见表1。

表1 不同临床资料患者的骨水泥渗漏比较[例(%)]			
Tab.1 Comparison of bone cement leakage with different clinical data [cases(%)]			
Clinical factor	Bone cement leakage	χ^2 value	P value
Gender		0.035	0.851
Male (23 cases)	8(34.78)		
Female (37 cases)	12(32.43)		
Age		0.313	0.576
≤70 years old (24 cases)	7(29.17)		
>70 years old (36 cases)	13(36.11)		
Surgical approach		4.626	0.031
PKP (60 vertebral bodies)	16(26.67)		
PVP (28 vertebral bodies)	14(50.00)		
Position of the vertebral body		0.868	0.648
Thoracic (18 vertebral bodies)	7(38.89)		
Thoracolumbar (50 vertebral bodies)	15(30.00)		
Lumbar spine (20 vertebral bodies)	8(40.00)		
Volume of bone cement injection		0.903	0.342
≤4 mL (53 vertebral bodies)	16(30.19)		
>4 mL (35 vertebral bodies)	14(40.00)		

PKP: Percutaneous kyphoplasty; PVP: Percutaneous vertebroplasty

2.2 不同MRI征象的骨水泥渗漏比较

骨折患者术前MRI检查显示椎体终板损伤、椎体裂隙、椎间盘损伤、达终板骨折线的骨水泥渗漏发生率分别为27.40%、57.89%、30.30%、54.55%,高于无上述征象的14.73%、27.54%、15.22%、27.27%,差异有统计学意义($P<0.05$)。同时合并上述任意2种MRI征象、任意3种MRI征象、任意4种MRI征象的患者中骨水泥渗漏发生率分别高达43.59%、56.00%、100%。详见表2。

表2 不同MRI征象患者的骨水泥渗漏比较[例(%)]
Tab.2 Comparison of bone cement leakage with different MRI signs [cases(%)]

MRI sign	Bone cement leakage	χ^2 value	P value
Endplate injury		4.099	0.043
Yes (73 cases)	20(27.40)		
No (95 cases)	14(14.73)		
Vertebral fissure		6.111	0.013
Yes (19 cases)	11(57.89)		
No (69 cases)	19(27.54)		
Disc injury		5.179	0.023
Yes (66 cases)	20(30.30)		
No (92 cases)	14(15.22)		
Endplate fracture line		5.462	0.019
Yes (22 cases)	12(54.55)		
No (66 cases)	18(27.27)		
Combining any 2 kinds of the MRI signs		8.242	0.004
Yes (39 cases)	18(46.15)		
No (21 cases)	2(9.52)		
Combining any 3 kinds of the MRI signs		18.137	<0.001
Yes (25 cases)	16(64.00)		
No (35 cases)	4(11.43)		
Combining 4 kinds of the MRI signs		43.636	<0.001
Yes (16 cases)	16(100.00)		
No (44 cases)	4(9.09)		

2.3 MRI征象预测骨水泥椎间盘渗漏的ROC曲线

同时合并任意2种MRI征象预测骨水泥渗漏的曲线下面积0.633,渐进Sig.b为0.089,95%置信区间0.490~0.776,敏感度与特异度分别为0.818、0.553;同时合并任意3种MRI征象预测骨水泥渗漏的曲线下面积0.745,渐进Sig.b为0.002,95%置信区间0.611~0.879,敏感度与特异度分别为0.727、0.763;同时合并4种MRI征象预测骨水泥渗漏的曲线下面积0.864,渐进Sig.b为0.000,95%置信区间0.748~0.980,敏感度与特异度分别为0.727、1.000。

3 讨论

椎间盘内渗漏多不会引起明显临床症状,易被忽视。骨水泥有一定化学毒性并会引起聚合产热效应,使椎间盘生理结构遭到破坏,加速椎间盘退

变^[5-6]。加之骨水泥还可能造成椎间盘应力分布不均,从而诱发邻近椎体终板损伤,增加邻近椎体骨折风险^[7]。故在术前通过有效手段对PVA术中骨水泥渗漏风险进行预测具有重要意义。

本研究中60例(手术椎体88个)患者中共20例(30个椎体、34个椎间盘)出现骨水泥渗漏,骨水泥渗漏发生率33.33%,与相关报道相符^[8]。临床因素的分析结果显示,性别、年龄、椎体部位、骨水泥注入量等均不会对骨水泥渗漏率造成明显影响,但PKP的骨水泥渗漏发生率为26.67%,低于PVP的50%,原因可能在于球囊扩张可使椎体内形成空腔,并促进周围形成致密骨壁,使骨水泥注入压力减小^[9-10]。形成的致密骨壁也可保护椎体周围被骨水泥渗漏,使骨水泥椎间盘渗漏风险降低^[11]。

终板是位于椎体上、下缘的皮质外层结构,完整终板的MRI各序列均呈连续线状低信号带。当各信号序列呈高信号或显示邻近椎间盘组织疝入终板时,往往提示终板损伤^[12]。骨水泥可经损伤终板渗入邻近椎间盘,故终板损伤是骨水泥椎间盘渗漏的危险因素之一。有研究指出,终板损伤患者PVA术后的骨水泥椎间盘渗漏发生率可达65%以上^[13]。本研究中骨水泥椎间盘渗漏发生率为33.33%,远低于相关文献报道^[14],可能与终板损伤严重程度不同有关。椎体裂隙多由缺血性坏死、塌陷,使气体、液体渗出填充其中而形成^[15-16]。笔者认为,椎体裂隙多伴终板损伤,并经骨折的终板与椎间盘相通,骨水泥可通过损伤骨终板渗漏至邻近椎间盘。椎间盘损伤多由椎间盘撕裂或水肿引起,在MRI上多表现为条片状T₂WI高信号^[17-18]。本研究中伴邻近椎间盘损伤椎体的骨水泥渗漏率为30.30%,高于无该征象椎体的骨水泥渗漏率的15.22%,证实损伤椎体的邻近椎间盘损伤也会增加水泥渗漏风险。MRI征象显示存在“达终板骨折线”患者的椎体骨水泥椎间盘渗漏率为54.55%,显著高于无该征象的27.27%,原因可能在于骨水泥可沿达终板骨折线进行弥散而发生渗漏^[19-20]。绘制ROC对术前MRI预测骨水泥椎间盘渗漏的风险进行分析,结果显示同时合并3种MRI征象及4种MRI征象预测骨水泥渗漏具有较大价值,敏感度均为0.727,特异度分别为0.763与1.000。

综上所述,PKP术后的骨水泥渗漏风险更低,推荐骨质疏松性椎体压缩性骨折采取PKP术。另外,术前可行MRI检查,通过患者MRI征象对骨水泥渗漏风险进行预测。

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