Retrospective Clinical Research Report

Journal of INTERNATIONAL MEDICAL RESEARCH

Journal of International Medical Research
49(1) 1–6

DOI: 10.1177/0300060521989468
journals.sagepub.com/home/imr
SAGE

Risk factors for thoracolumbar pain following percutaneous vertebroplasty for osteoporotic vertebral compression fractures

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Abstract

Objective: To explore possible risk factors for poor outcomes following percutaneous vertebroplasty (PV) for painful osteoporotic compression fractures of thoracolumbar vertebra.

Methods: This was a retrospective review of data from patients who underwent PV at our institution over a ten-year period to evaluate the association between possible risk factors and thoracolumbar pain (T11-L2). According to the difference between pre- and post-operative visual analogue scale (VAS) scores for pain, patients were separated into poor relief (PR; <4) and good relief (GR; ≥ 4) of pain.

Results: Of the 750 patients identified, 630 (PR group, $n = 310$; GR group, $n = 320$) fulfilled the eligibility criteria. Multivariate binary logistic analysis showed that bone mineral density (BMD), >2 fractured vertebral bodies, maldistribution of bone cement, <5 ml bone cement injected into a single vertebral body and thoracolumbar fascia injury prior to surgery were independent risk factors associated with thoracolumbar pain following PV.

Conclusion: Although prospective controlled studies are required to confirm our results, this review suggests that the above factors should be taken into account when selecting patients for PV.

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Keywords
Percutaneous vertebroplasty, vertebral compression fracture, thoracolumbar pain

Date received: 12 July 2020; accepted: 10 December 2020

Introduction

Percutaneous vertebroplasty (PV) is a widely accepted treatment for patients with painful vertebral compression fractures (VCFs).[1] However, complications of PV are thought to include cord compression, nerve root damage, new VCFs and bone cement leakage.[2–4] In addition, some patients experience chronic back pain following PV.[5] Therefore, it is important to determine and mitigate potential risk factors for a poor outcome.

Reports have suggested that advanced age, low bone mineral density (BMD), low body mass index (BMI) multiple VCFs, and thoracolumbar fascia injury prior to surgery are potential risk factors for poor outcomes following PV.[2,6–9] Other studies suggest that large cement volumes and its maldistribution are associated with poor relief of thoracolumbar pain following PV.[3,10,11] We conducted a retrospective review of patients who underwent PV at our institution over a ten-year period to evaluate the association between possible risk factors and thoracolumbar pain (T11-L2).

Methods

This retrospective study included patients 18–90 years of age who had undergone PV at our institution from June 2010 to June 2019. Patients were identified from our tertiary medical institutions.

Patients eligible for the study included: T-score of $\leq$-2.5 for BMD (DXA machine, LNR-7605, GE LUNAR, USA); painful osteoporotic VCFs of thoracolumbar vertebra (T11-L2) treated with PV; available visual analogue scale (VAS) pain scores. Patients excluded from the analysis had the following: incomplete baseline information; T-scores of <-4.0 for BMD; multiple fractures (i.e., VCFs with pelvic or limb fractures); vertebral bone non-union, a new fracture on collapsed vertebral bodies; nerve pain related diseases or peripheral or central nervous system (CNS) pain (i.e., neuroma); cancer pain; active infectious diseases; concomitant treatment with nonsteroidal anti-inflammatory drugs or central analgesics.

Patient data were extracted from the hospital's electronic medical records system. Post-operative thoracolumbar pain was assessed one month after VP using VAS scores as previously described.[2] Patients with a difference of <4 in pre- and post-operative VAS scores were categorized as having 'poor relief' (PR) of post-operative thoracolumbar pain. By contrast, patients with VAS scores $\geq$4 were categorized as having 'good relief' (GR) of pain.

Maldistribution of bone cement was based on a 9-score scale as previously described.[11] According to this scale, the scores for spatial distribution of cement were calculated from anterior, posterior and lateral views of a plain radiograph within one week following the PV. Scores were assigned to each of the views based on percentage of bone cement distribution across the width of the vertebra as follows: 3 points (>75%); 2 points (50%–75%); 1 point (25%–50%); 0 (<25%). Maldistribution of bone cement

was defined as scores ≤ 1 for each of the three view total scores.

The review was approved by the Institutional Review Board (IRB) of the Yantaishan Hospital and because of the study's retrospective design, there was no requirement for patients' informed consent.

Statistical analyses

Data were analysed using the Statistical Package for Social Sciences (SPSS®) for Windows® release 25.0 (IBM Corp., Armonk, NY, USA). All tests were two-sided and a P-value <0.05 was considered to indicate statistical significance. Differences between groups were compared using the χ^2 test for categorical variables. Continuous data were compared using Student t-test for normally distributed variables and Mann– Whitney U test was used for non-normally distributed variables. Multivariate binary logistic analysis was used to examine influential factors on PV related thoracolumbar pain.

Results

From June 2010 to June 2019, 745 consecutive subjects were identified from our tertiary medical institutions. Of these, 630 cases (PR group, $n = 310$; GR group, $n = 320$) fulfilled the eligibility criteria and had undergone PV for osteoporotic VCF of thoracolumbar vertebra (T11-L2).

Patient demographic details and outcomes are shown in Table 1. Mean age for both groups was approximately 46 years and overall, there were approximately the same number of male and female patients. There were no statistically significant differences between groups in age, sex, length of education, concomitant diseases (i.e., hypertension, diabetes chronic obstructive pulmonary disease), duration or location of the fracture and surgical approach.

However, patients in the PR group had statistically significant greater BMI and lower BMD. There were also statistically significant more patients in the PR group with >2 VCF, maldistribution of cement, <5 ml bone cement injected into a single vertebral body and thoracolumbar fascia injury prior to surgery.

Multivariate binary logistic regression analysis showed that, low BMD, >2 VCFs, maldistribution of bone cement, <5 ml bone cement injected into a single vertebral body and thoracolumbar fascia injury prior to surgery were statistically significantly associated with occurrence of thoracolumbar pain following PV (Table 2). However, analysis showed that BMI was not statistically significantly associated with occurrence of thoracolumbar pain following PV.

Discussion

There are several possible causes of postoperative pain, including number, type and severity of VCFs at baseline, number of vertebral bodies treated, inadequate relief of pain by the procedure, gender and psychosocial factors.[5] To avoid the possibility of differences in pain-related risk factors occurring at different follow-up times, we only included patients with poor pain relief in the early post-operative period (i.e., one month following PV).

Similar to other studies we found that low BMD, thoracolumbar fascia injury prior to surgery, >2 fractured vertebral bodies and maldistribution of bone cement and were associated with a poor outcome (i.e., back pain) following PV.[2,6–8] In addition, we found that that <5 ml bone cement injected into a single vertebral body was also an independent risk factor for thoracolumbar pain following PV. This finding is consistent with a previous report that showed low volumes of injected cement

Table 1. Patient demographics and outcomes according to relief of postoperative thoracolumbar pain.

	Poor relief of pain* ($n = 310$)	Good relief of pain* ($n = 320$)	Statistical significance
Age, years	45.8 ± 17.5	45.4 ± 16.7	ns
Sex, F/M	163/147	156/164	ns
Education, years	10.0 ± 7.0	10.2 ± 7.3	ns
Concomitant diseases	52 (17)	50 (16)	ns
Hypertension	52 (17)	50 (16)	ns
Diabetes	26 (8)	19 (6)	ns
Chronic obstructive pulmonary disease	14 (5)	12 (4)	ns
Body mass index, kg/m^2	27.1 ± 5.6	25.3 ± 6.0	$P = 0.001$
Bone mineral density	-3.6 ± 0.6	-3.3 ± 0.7	$P = 0.014$
Duration of the fracture, months	4.1 ± 2.2	4.2 ± 2.2	ns
Location of fracture			ns
T11	24 (8)	26 (8)	
T12	43 (14)	44 (14)	
T11-12	64 (21)	58 (18)	
T12-L1	55 (18)	66 (21)	
L1	36 (12)	45 (14)	
L2	22 (7)	25 (8)	
L1-2	25 (8)	31 (10)	
Surgical approach			ns
Unilateral	154 (50)	165 (52)	
Bilateral	156 (50)	155 (48)	
Maldistribution of bone cement	75 (24)	47 (15)	$P = 0.003$
<5 ml bone cement injected into a single vertebral body	56 (18)	32 (10)	$P = 0.002$
Thoracolumbar fascia injury prior to surgery	46 (15)	22 (7)	$P = 0.001$
>2 fractured vertebral bodies	41 (13)	25 (8)	$P = 0.027$

Values are shown as mean ± SD, *n* or *n* (%).

* According to the difference between pre- and post-operative pain visual analogue scale (VAS) scores patients were separated into groups of poor relief (<4) and good relief (≥4) of pain.

Abbreviations: ns, not statistically significant.

significantly boosted the potential risk of refracture.[12]

Our findings that low BMD was a risk factor for pain is not surprising since previous studies have confirmed that osteoporosis is a risk factor for recurrent vertebral fractures after PV.[2,10,13] In addition, due to the collapse of multiple vertebral bodies, patients with osteoporosis are prone to kyphosis and secondary sagittal imbalances.[2,12] In these patients, non-physiological compensation can easily lead to back muscle strain and intermittent lower back pain. The resultant spinal sagittal decompensation, will lead to persistent lower back pain.[13]

Consistent with our findings, a previous study also suggested an association between thoracolumbar fascia injury and post-operative residual lower back pain after PV.[8] However, unlike the previous study which found that patients with thoracolumbar fascia injury benefitted from PV in terms of pain VAS scores,[8] this present study found thoracolumbar fascia injury was a high-risk factor for poor pain relief

Table 2. Odds Ratio for independent risk factors associated with postoperative thoracolumbar pain following percutaneous vertebroplasty.

Risk factors	Regression coefficient (β)	Odds ratio	95% CI	Statistical significance
Bone mineral density	2.11	1.18	2.59, 3.36	$P < 0.001$
>2 fractured vertebral bodies	1.15	1.79	1.82, 2.40	$P < 0.001$
Maldistribution of bone cement	0.56	2.15	1.47, 2.81	$P < 0.001$
<5 ml bone cement	1.14	3.77	2.65, 3.12	$P < 0.001$
Thoracolumbar fascia injury	0.55	4.06	2.10, 3.72	$P < 0.001$
Body mass index	0.12	0.88	0.27, 2.39	ns
Location of fracture	0.36	0.95	0.62, 4.57	ns
Surgical approach	1.34	0.73	0.14, 2.79	ns
Chronic obstructive pulmonary disease	4.32	0.97	0.36, 2.74	ns
Diabetes	2.49	0.85	0.37, 2.74	ns

Abbreviations: ns, not statistically significant; CI: confidence interval.

after PV. A possible explanation for the difference in results is the selection of cases. In the previous study, patients with a VAS score of 10 were included, whereas in our study patients with severe pain triggered by osteoporotic fractures were rare.

The study had several limitations. For example, it was an uncontrolled, retrospective review of patient data that so lacks generalizability. In addition, we took a VAS score difference of 4 as the difference between 'poor' and 'good' relief and this criterion needs further validation. Furthermore, we selected one month as our post-operation study period. This follow-up period may have been too short to capture other pain related events because post-operative vertebral body infections and/or new vertebral body fractures are thought to occur within three months following surgery. [11] Finally, the objectivity of the analysis is weak because some of our data were qualitative assessments.

While, the causes of thoracolumbar pain following PV are multi-factorial, our analysis suggests that low BMD, >2 fractured vertebral bodies, maldistribution of bone cement, <5 ml bone cement injected into a single vertebral body and thoracolumbar fascia injury prior to surgery are associated with significant risk of post-operative pain. Therefore, although prospective controlled studies are required to confirm our results, this review suggests that these factors should be taken into account when selecting patients for PV.

Declaration of conflicting interests

The authors declare that there are no conflicts of interest.

Funding

This research received no specific grant from any funding agency in the public, commercial, or not-for-profit sectors.

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