Clinical Profiles of Osteoporotic Vertebral Compression Fractures: A Secondary Data Analysis of 358 Patients from a Prospective Clinical Study

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Abstract

Background: For back pain patients with spine dysfunction, clinical profiles are crucial for clinicians to establish the diagnostic and therapeutic decision-making. The objectives of this study were (1) to outline the incident clinical findings and familiarize physicians with the clinical profiles of osteoporotic vertebral fractures (OVFs) and (2) to characterize patients with radiating pain (RP), spinal palpation tenderness (SPT), or axial spinal percussion pain (ASPP).

Methods: This is a secondary data analysis of 358 patients from a prospective clinical study (November 1, 2016, to September 30, 2018) with particular focus on the incident RP, SPT, and ASPP. Predictive analyses for the incident RP, SPT and ASPP were done along the clinical profiles in 358 patients (284 females).

Results: The cohort patients who complained of spinal movement-related pain performed a limited amplitude of movements with the purpose of avoiding the onset of back pain in daily life. Of the patients who had OVFs, 76 (21.2%) patients had RP, 197 (55.0%) patients had SPT, and 83 (23.2%) patients had ASPP. On multiple regression analysis, only patients with VFs located in T1–T9 or those who had a $-2.5 \leq$ T-score < -3.5 showed significantly higher incidences of RP, SPT, and ASPP ($p < 0.05$).

Conclusion: Dynamic back pain and backache avoidance behavior are the typical clinical presentations of patients with OVFs. RP, SPT, and ASPP are nondeterministic incidents, indicating that avoidance is necessary with respect to cognitive bias in clinical practice.

Introduction

Osteoporotic vertebral fractures (OVFs) are among the most prevalent complications of osteoporosis and fragility, with an incidence of 10% for males and 24% for females in populations over 50 years old [1]. A heterogeneity in incidence exists between different nations and races, affecting Caucasians and people of Asian descent more predominantly [2, 3]. Patients with painful OVFs have a poor quality of life due to complications and chronic back pain [4, 5], with an increasing risk of recurrent fracture and mortality [4, 6–8]. With an aging population, OVFs have become an increasingly serious public health problem. Only one-third of patients with OVFs seek medical aid, and up to 40% of patients remain underdiagnosed [4, 9]. However, accurate data about the clinical profiles of OVFs should aid in confident clinical diagnosis and assessment of the severity of disease, guide further imaging, and manage decision-making.

In the outpatient setting, back pain is among the prevalent complaints for patients with OVFs, such pain may result from one single factor (structural factor) or several originators [10, 11], even be in common with other pain-related clinical features, such as radiating pain (RP) and referred pain, among others [11–13]. An extensive review of literature showed that the quoted clinical features were proposed based on clinical impression rather than proper clinical study. Evidence has supported that clinical presentations are affected by the natural course or classifications of OVFs [14], but there is scant literature about the

various clinical profiles of back pain from OVFs and specific information would aid in the recognition and comprehension of OVFs.

Our prior study demonstrated that the Back Pain-Inducing Test (BPIT) is a sensitive approach to screen patients with painful OVFs [12], indicating that back pain from OVFs is specific. The discrepancy between the actual location of the OVF and the location suggested by RP, spinal palpation tenderness (SPT), or axial spinal percussion pain (ASPP) has been confirmed [13]. Our previous study also hinted that RP, SPT, and ASPP were not present in all patients, but approaches to characterize these incident measures in patients are underinvestigated. We hypothesized that the incident RP, SPT, and ASPP were opportunistic events. A secondary data analysis based on the 358 patients with OVFs from a prospective clinical study [13] was performed to outline specific clinical back pain profiles from OVFs and characterize the incident RP, SPT, and ASPP, so that comprehensive recognition regarding OVFs could be established and cognitive biases could be avoided for medical students, family doctors, general practitioners, residents, chiropractors, physiotherapists, and paramedics.

Methods

Study design, setting

This was a secondary data analysis based on information from the clinical records of 358 patients with OVFs from a prospective clinical study (November 1, 2016, to July 30, 2018) [13], which was conducted at the Spine Clinic of Daping Hospital (Third Affiliated Hospital) of Army Medical University.

Patient selection

Completed information of the clinical records of six hundred and sixty-three back pains patients from the prospective clinical study [13] were reviewed. OVFs were diagnosed on MRI. In total, 358 patients with conclusive OVFs were enrolled. Exclusion criteria were as follows: (1) concurrent limb RP or night/resting pain due to the prior prospective study design; (2) definite recent high-energy trauma; (3) diagnosed with spinal infection, tumor, or fracture before presenting to our clinic; (4) concomitant dysfunction of the central or peripheral nervous system; (5) poor coordination to perform physical examination (including SPT and ASPP) due to a cognitive deficit, mental impairment, or communication dysfunction (e.g., deaf and mute); and (6) failure to complete a magnetic resonance imaging (MRI) scan due to claustrophobia or artificial pacemaker implantation.

Variables assessment and collection

History taking, physical examination and radiographic examination were assessed procedurally, according to standard clinical evaluation in the previous prospective study within three days [13]. Lumbar spine bone mineral density (BMD) T-score in the standard position was measured using dual-energy X-ray

absorptiometry (GE Lunar Prodigy, USA) over L1–L4. Patients were diagnosed with OVFs using 1.5-T whole-spine MRI scanners (Signa EXCITE; GE Healthcare, United Kingdom), and MRI results were independently interpreted by three spine surgeons with extensive experience in reading the spine imaging of spinal disorders. They were blinded to the clinical information and established the presence of a VF according to the following diagnostic criteria: low signal changes on T1-weighted images (T1WI) and high or low signal changes on T2-weighted images (T2WI), particularly high signal changes on short-tau inversion recovery (STIR) images [15–17]. The interrater consistency for interpreting MRI was perfect [12].

Demographics, epidemiological information, clinical manifestations, T-score and MRI results were collected from a case report form (CRF) at the baseline with detailed history-taking and physical examination. The analysis was particularly focused on back pain site; pain intensity (numerical rating scale); time from back pain onset (timing for seeking medical aid); incident RP and corresponding dermatomal area; precipitating event of back pain; and history of glucocorticoid use, vertebral fracture (VF), and vertebral augmentation (VA). Physical examination findings, such as SPT, ASPP and spinal deformity, were collected.

Statistical analysis

We required 166 patients to achieve a rate of SPT of 48% [18], with an allowable error of 10% and a significance level of 0.01. To account for a 15% loss from potential withdrawals, more than 196 subjects were needed.

The timing for seeking medical aid was subdivided into three stages based on the natural course of back pain: < 2 weeks, 2–8 weeks, and ≥ 8 weeks [19, 20]. Patients were subdivided into the positive and negative groups based on RP, SPT, and ASPP, respectively. Differences in clinical parameters between different groups were analyzed using Student's t-test for parametric data and chi-square test for nonparametric data. Multiple logistic regression analysis was performed to assess the association between all clinical parameters and RP, SPT, and ASPP, as well as the timing for seeking medical aid. Statistical analysis was conducted using SPSS software (IBM SPSS Statistics, Version 21.0, New York, United States). Statistical significance was set at $p < 0.05$.

Results

From the information from the clinical records of 358 patients with OVFs collected in the history-taking phase, we found that patients with OVFs complained of spinal movement-related pain, particularly with spine flexion, extension, or rotation. Such pain was elicited by the BPIT (including lying supine, rolling over, and siting up behaviors), and patients performed a limited amplitude of movements with the purpose of avoiding the onset of back pain in daily life. The clinical presentations above could be termed dynamic back pain and pain avoidance behaviors. We also found that the incident RP was refractory while the BPIT and ASPP were performed. The clinical profiles of the 358 patients enrolled in the study are shown in Table 1. The clinical profiles of OVFs are outlined as follows: (i) the most prevalent back

pain site was localized in the thoracic-lumbar junction and lower (70.7%); unilateral back pain (49/358, 13.7%) and lumbosacral or buttock pain remote from the site of the lesion (14/358, 3.9%) was possible; (ii) the prevalence of the incident RP, SPT, and ASPP was 21.2%, 55.0%, and 23.2%, respectively; (iii) half of patients (51.1%) sought medical attention within two weeks of the onset of back pain, 16.5% of patients had delayed medical attention, and patients with a history of VF or VA did not seek medical aid at the first point of the onset of back pain; (iv) 53.6% of patients had a spontaneous VF, and the precipitating events included falling from a standing height or less, coughing, sneezing, and routine everyday activity (lifting, bending, walking, and position changes); (v) the patient presented for care with a complaint, usually acute pain resulting in disability or difficulty lying supine or sitting up from a supine position, such pain is elicited and refractory once the stress or loading on the axial spine changes and will subsides (even disappears) while the trunk is static; and (vi) the most frequent areas for VFs were the first and second lumbar vertebrae (L1 and L2) and twelfth thoracic vertebra (T12) [12].

Table 1
Clinical parameters of 358 patients with OVFs

Total, n	**358**
Female, n (%)	284 (79.3)
Age, years (mean ± SD)	72.3 ± 9.4
BMI, kg/m^2 (mean ± SD)	22.1 ± 3.5
Timing for seeking medical aid, weeks, n (%)	12 (days, median)
< 2	183 (51.1)
2 to 8	116 (32.4)
≥ 8	59 (16.5)
Back pain region, n (%)	
Thoracic spine	71 (19.8)
Thoracic-lumbar junction	104 (29.1)
Waist and lower	149 (41.6)
Multiple regions	34 (9.6)
Glucocorticosteroid use for 3 months or more, n (%)	17 (4.7)
Precipitating event*, n (%)	
Low-energy injury	93 (26.0)
Daily activities	57 (15.9)
Cough and sneeze	16 (4.5)
Spontaneous	192 (53.6)
Radiating pain, n (%)	
Yes	76 (21.2)
No	282 (78.8)
NRS (mean ± SD)	6.9 ± 1.8

* Precipitating event was defined as any behavior before back pain onset, including falling from standing height or less, coughing, sneezing, and daily activities (lifting, bending, walking, and position changes) in this study

n, number; BMI, body mass index; SD, standard deviation; NRS, numerical rating scale; BMD, bone mineral density

Total, n	358
Pain grades, n (%)	
Mild	17 (2.7)
Moderate	121 (33.8)
Severe	220 (61.5)
History of vertebral augmentation, n (%)	
Yes	64 (17.9)
No	294 (82.1)
Deformity, n (%)	
Yes	148 (41.3)
No	210 (58.7)
Spinal palpation tenderness, n (%)	
Yes	197 (55.0)
No	161 (45.0)
Axial spinal percussion pain, n (%)	
Yes	83 (23.2)
No	275 (76.8)
Lumber spine BMD T-score, SD, n (%)	
> -2.5	34 (9.5)
-2.5 to -3.5	126 (35.2)
≤ -3.5	198 (55.3)
* Precipitating event was defined as any behavior before back pain onset, including falling from standing height or less, coughing, sneezing, and daily activities (lifting, bending, walking, and position changes) in this study	
n, number; BMI, body mass index; SD, standard deviation; NRS, numerical rating scale; BMD, bone mineral density	

Characteristics of the incident RP

In this patient group, 21.2% (76/358) of patients with OVFs complained of back pain radiating bilaterally or unilaterally to the chest (51), hypochondria (12), abdomen (8) and inguinal region (5). Of these, 19

patients with radiating chest pain complained that the RP was more severe than the back pain. Notably, such pain was elicited or refractory for 61 patients with chest or hypochondria RP when the ASPP was performed. There was no significant correlation between RP and several clinical parameters, with the exception of history of VA, spinal deformity, SPT, and VF region ($p < 0.05$) (Table 2). Only the VFs located in T1–T9 (odds ratio [OR] = 4.9, $p < 0.05$) were significantly associated with the incident RP in multivariate analysis.

Table 2
Correlations between clinical parameters and the incident radiating pain (n = 358)

Clinical parameters		Radiating pain		X^2	P
		Negative	Positive		
Sex	Female	220	64	1.402	0.236
	Male	62	12		
Age (years)	< 70	108	30	0.035	0.852
	≥ 70	174	46		
BMI categories (kg/m^2)	< 18.5	42	6	2.567	0.277
	18.5 to 24	214	63		
	≥ 24	26	7		
Time from back pain onset (weeks)	< 2	151	32	4.364	0.113
	2 to 8	84	32		
	≥ 8	47	12		
Precipitating event	Yes	136	30	1.844	0.174
	No	146	46		
History of VF	Yes	103	22	1.513	0.219
	No	179	54		
History of VA	Yes	57	7	4.936	0.026
	No	225	69		
Deformity	Yes	104	44	10.903	0.001
	No	178	32		
Pain severity	Mild	16	1	2.661	0.264
	Moderate	93	28		
	Severe	173	47		
SPT	Yes	163	34	4.129	0.042
	No	119	42		
ASPP	Yes	63	20	0.531	0.466

BMI, body mass index; VF, vertebral fracture; VA, vertebral augmentation; SPT, spinal palpation tenderness; ASPP, axial spinal percussion pain; SD, standard deviation

	No	219	56		
T-score (SD)	> -2.5	29	5	2.607	0.272
	-2.5 to -3.5	103	23		
	≤ -3.5	150	48		
Number of VFs	1	192	46	1.743	0.418
	2	53	19		
	≥ 3	57	11		
VF region	T1–T9	38	32	34.128	< 0.001
	T10–L2	154	23		
	L3 or below	30	4		
	Multiple regions	60	17		

BMI, body mass index; VF, vertebral fracture; VA, vertebral augmentation; SPT, spinal palpation tenderness; ASPP, axial spinal percussion pain; SD, standard deviation

Characteristics of the incident SPT and ASPP

In this cohort, 55.0% (197/358) and 23.2% (83/358) of patients presented with SPT and ASPP, respectively. No statistically significant differences between the positive and negative SPT subgroups were found in several clinical parameters, with the exception of age and RP variables ($p < 0.05$) (Table 3). In multivariate analysis, incident RP (OR = 1.8, $p < 0.05$) and BMD T-score ranging from − 2.5 to -3.5 (OR = 1.9, $p < 0.05$) were significantly associated with SPT. We also found that no statistical correlation existed between the incident ASPP and clinical parameters (Table 4). The only risk factor related to the incident ASPP was VF located in T1–T9 (OR = 3.3, $p < 0.05$) in multiple regression analysis.

Table 3
Correlations between clinical parameters and the incident SPT (n = 358)

Clinical parameters		SPT		X^2	P
		Negative	Positive		
Sex	Female	133	151	1.919	0.166
	Male	28	46		
Age (years)	< 70	78	60	12.105	0.001
	≥ 70	83	137		
BMI categories (kg/m^2)	< 18.5	18	30	1.684	0.431
	18.5–24	126	151		
	≥ 24	17	16		
Time from back pain onset (weeks)	< 2	76	107	1.979	0.372
	2–8	55	61		
	≥ 8	30	29		
Precipitating event	Yes	80	86	1.297	0.255
	No	81	111		
History of VF	Yes	55	70	0.073	0.787
	No	106	127		
History of VA	Yes	27	37	0.244	0.621
	No	134	160		
Deformity	Yes	66	82	0.015	0.904
	No	95	115		
Pain severity	Mild	8	9	3.108	0.211
	Moderate	62	59		
	Severe	91	129		
Radiating pain	Yes	42	34	4.129	0.042
	No	119	163		
ASPP	Yes	34	49	0.701	0.402

SPT, spinal palpation tenderness; BMI, body mass index; VF, vertebral fracture; VA, vertebral augmentation; ASPP, axial spinal percussion pain; SD, standard deviation

	No	127	148		
T-score (SD)	> -2.5	14	20	2.214	0.330
	-2.5 to -3.5	51	75		
	≤ -3.5	96	102		
Number of VFs	1	112	126	1.574	0.467
	2	28	44		
	≥ 3	21	27		
VF region	T1–T9	32	38	5.461	0.141
	T10–L2	85	92		
	L3 or below	18	16		
	Multiple regions	26	51		

SPT, spinal palpation tenderness; BMI, body mass index; VF, vertebral fracture; VA, vertebral augmentation; ASPP, axial spinal percussion pain; SD, standard deviation

Table 4
Correlations between clinical parameters and the incident ASPP (n = 358)

Clinical parameters		ASPP		X^2	P
		Negative	Positive		
Sex	Female	216	68	0.445	0.505
	Male	59	15		
Age (years)	< 70	105	33		
	≥ 70	170	50		
BMI categories (kg/m^2)	< 18.5	35	13	0.512	0.774
	18.5–24	214	63		
	≥ 24	26	7		
Time from back pain onset (weeks)	< 2	134	49	3.582	0.167
	2–8	91	25		
	≥ 8	50	9		
Precipitating event	Yes	120	46	3.561	0.059
	No	155	37		
History of VF	Yes	96	29	0.000	0.996
	No	179	54		
History of VA	Yes	48	16	0.144	0.704
	No	227	67		
Deformity	Yes	113	35	0.031	0.861
	No	162	48		
Pain severity	Mild	14	3	1.132	0.568
	Moderate	96	25		
	Severe	165	55		
Radiating pain	Yes	56	20	0.531	0.466
	No	219	63		
SPT	Yes	148	49	0.701	0.402

ASPP, axial spinal percussion pain; SPT, spinal palpation tenderness; BMI, body mass index; VF, vertebral fracture; VA, vertebral augmentation; SD, standard deviation

	No	127	34		
T-score (SD)	> -2.5	26	8	0.102	0.950
	-2.5 to -3.5	98	28		
	≤ -3.5	151	47		
Number of VFs	1	185	53	0.529	0.768
	2	55	17		
	≥ 3	35	13		
VF region	T1–T9	50	20	1.976	0.577
	T10–L2	136	41		
	L3 or below	28	6		
	Multiple regions	61	16		

ASPP, axial spinal percussion pain; SPT, spinal palpation tenderness; BMI, body mass index; VF, vertebral fracture; VA, vertebral augmentation; SD, standard deviation

Correlations between clinical parameters and the timing for seeking medical aid

A significant difference existed between the timing for seeking medical aid and several clinical parameters, including BMI, number of VFs, and VF region ($p < 0.05$), and no statistically significant difference was found in the other parameters (Table 5). On multiple regression analysis, comparing < 2 weeks to ≥ 8 weeks, a false spinal deformity (OR = 2.6, $p < 0.05$) and one single VF (OR = 8.5, $p < 0.05$) were significantly associated with the timing for seeking medical aid; comparing 2–8 weeks to ≥ 8 weeks, a spinal deformity (OR = 2.1, $p < 0.05$), one single VF (OR = 5.4, $p < 0.05$), and two VFs (OR = 4.2, $p < 0.05$) were statistically significant.

Table 5
Correlations between clinical parameters and time from back pain onset (n = 358)

Clinical parameters		Time from back pain onset (weeks)			χ^2	P
		< 2	2–8	≥ 8		
Sex	Female	145	91	48	0.204	0.903
	Male	38	25	11		
Age (years)	< 70	72	41	25	0.916	0.633
	≥ 70	111	75	34		
BMI (kg/m^2)	< 18.5	27	18	3	10.000	0.040
	18.5–24	133	91	53		
	≥ 24	23	7	3		
Precipitating event	Yes	93	44	29	4.963	0.084
	No	90	72	30		
History of VF	Yes	63	44	18	0.988	0.610
	No	120	72	41		
History of VA	Yes	37	22	5	4.330	0.115
	No	146	94	54		
Deformity	Yes	66	51	31	5.482	0.064
	No	117	65	28		
Pain severity	Mild	7	4	6	8.639	0.071
	Moderate	56	40	25		
	Severe	120	72	28		
Radiating pain	Yes	32	32	12	4.364	0.113
	No	151	84	47		
SPT	Yes	107	61	29	1.979	0.372
	No	76	55	30		
ASPP	Yes	49	25	9	3.582	0.167
	No	134	91	50		

BMI, body mass index; VF, vertebral fracture; VA, vertebral augmentation; SPT, spinal palpation tenderness; ASPP, axial spinal percussion pain; SD, standard deviation

T-score (SD)	> -2.5	18	9	7	0.933	0.920
	-2.5 to -3.5	63	43	20		
	≤ -3.5	102	64	32		
Number of VFs	1	134	73	31	16.303	0.003
	2	30	30	12		
	≥ 3	19	13	16		
VF region	T1–T9	35	28	7	13.224	0.039
	T10–L2	98	48	31		
	L3 or below	17	15	2		
	Multiple regions	33	25	19		

BMI, body mass index; VF, vertebral fracture; VA, vertebral augmentation; SPT, spinal palpation tenderness; ASPP, axial spinal percussion pain; SD, standard deviation

Discussion

A huge increase in the older population brings an anticipated increase in the prevalence of acute and chronic back pain and a challenge in the assessment of back pain in outpatient settings. In textbooks or guidelines, the location of back pain indicates the spinal disorder level, and palpation or percussion at the level of the spinal disorder yields pain, such conception is deeply embedded in minds of physicians, gradually forming a cognitive bias. In our prior study about back pain from OVFs, the patient-reported back pain location did not match the VF level, and the location from physical examination findings was not colocalized with the VF segment [13]. This study also showed that the incident RP, SPT, or ASPP was not clinically correlated with clinical parameters, and a false correlation existed between the clinical parameters and timing for seeking medical aid.

In the present study, we observed that back pain from OVFs results in disability or difficulty to lie supine or sit up from a supine position, such pain is elicited and refractory once the stress or loading on the axial spine changes and will improve (even disappear) while the trunk is static. Controlling the scope of activities and the amplitude of movements are approaches to escape back pain onset or refractory, which actually are pain behaviors. Marc Chmielnicki et al. [21] also reported typical symptoms from OVFs as spinal loading-dependent pain and a general restriction of physical mobility. Thus, OVFs may be defined as secondary osteoporosis vertebral lesions characterized by dynamic back pain and backache avoidance behaviors, leading to disability, limited lifespan, poor quality of life, and increased morbidity and mortality. In the study by Tae-Hoon Doo et al. [22], back pain from OVFs were classified into three patterns with elucidating the three discrepant pain mechanisms. Such mechanisms also supported our rationale of dynamic back pain and backache avoidance behaviors.

In this cohort, 53.6% of VFs were spontaneous, which was in accordance with that (46%) in a previous study by Patel et al. [11]. They also pointed out that the RP to the flanks and anteriorly was common (66%), and lying flat or the sitting position can improve the pain intensity, which is consistent with those observed in our study. However, they analyzed a small sample size of 30 patients and did not reveal the common clinical appearance. A heterogeneous proportion of different fracture types existed from that reported by Tae-Hoon Doo et al. [22]. The discrepancy in the sample size can be responsible for this. Additionally, regardless of the pain patterns and time courses, we outlined the common clinical presentation of OVFs. Paul F. Heini [14] subdivided OVFs into 4 classifications and underlined their clinical presentation: (a) acute and subacute single-level fractures with sharp localized mechanical back pain; (b) fractures with persistent instability appear with a characteristic symptomatology—an intense local pain sufficiently relieved once upright or lying supine; (c) (multiple) fractures with progressive/creeping vertebral collapse and loss of sagittal balance and posture have a diffuse backache and strain over the whole back; and (d) vertebral fractures with subsequent spinal stenosis/neural compression are concurrent with severe local mechanical back pain together with an RP that usually subsides in the supine position. They pointed out that an individual therapeutic option could be proposed based on this classified system. We supported the opinions that an establishment of the therapeutic decision-making of OVFs must be based on their heterogeneous clinical appearance, but the clinical presentations reported by Paul F. Heini cannot sufficiently guide the classification of this cohort of OVFs. Thus, the clinical application of the classification system is in question.

Back pain from OVFs has a heterogeneous clinical presentation that is commonly correlated with pain generators, such as VF, nerve tension, facet, postural muscle, and ligaments [10]. In the present study, patients with a BMD T-score ranging from − 2.5 to -3.5 or VF region located in T1–T9 had a statistically high possibility of incident RP, SPT, or ASPP, but these clinical parameters could not be clinically applicable to characterize patients with incident RP, SPT, or ASPP. The mechanism of RP may be one or more combinations of compression, inflammation, or microinstability to a spinal nerve root and/or dorsal root ganglion [10]. Such pain will improve while the patient lays supine. Likewise, the possible mechanism of ASPP is local stimulation of a spinal nerve root and/or dorsal root ganglion due to an instantaneous increased loading of the axial spine. Patel et al. [11], Heini [14], and Kendler et al. [23] elucidated a similar possible pain generation mechanism. Notably, the performance of the SPT and ASPP mechanical responses are warranted to explain the SPT- and ASPP-elicited pain.

Megale and colleagues [24] reported that the most common reason for driving medical care seeking behavior is surprisingly not back pain (48%) but an experience of trauma or injury (6%), a past diagnosis of fracture (6%), or a complaint of not being able to sleep. Emotionally, patients with a history of VF or VA may seek medical care once back pain is recurrent, but no correlation was found between the timing for seeking medical aid and history of VF or VA in this cohort of patients. We also found that patients with OVFs with a negative spinal deformity or one single VF seem to seek medical attention within 8 weeks of the onset of back pain. However, a reasonable explanation between the timing for seeking medical aid and clinical parameters cannot be elucidated clinically. The number of VFs cannot be predicted based on the timing for medical aid, because one single VF is prevalent. Moreover, a false correlation existed

between the timing for seeking medical aid and the precipitating event. We speculated that education level, emotion, awareness of OVF, and socioeconomic factors may be considered to analyze the discrepancy of the timing for seeking medical aid. For this cohort of patients, although patients with one or two VFs had a higher statistical possibility to seek medical care within 8 weeks, no clinical significance existed because such a significant difference may result from a different prevalence of number of VFs [16, 25].

Study limitations

Our study had some limitations. First, our study has limitations in interpreting all results of the incident RP, SPT, and ASPP, because their mechanisms are not fully explained. However, we believed that a mechanical response focused on spinal palpation and percussion might be useful as an initial guide to hypothesize the possible mechanism of palpation and percussion-elicited pain and even expound the incident SPT or ASPP. Secondary, possible additional discrimination variables are lacking due to concomitant symptoms not being evaluated in the present study. Third, we did not collect data on educational level, acknowledgement of back pain or OVFs, or awareness of seeking medical aid, so the reason why patients with OVFs did not seek medical attention at the point of back pain onset was not fully interpreted. Fourth, a few patients with OVFs with RP to the leg were not enrolled due to the prior prospective study design [13].

Conclusions

Many confounding factors affect the appearance of back pain from OVFs. Dynamic back pain and backache avoidance behavior, which can help clinicians to characterize patients with OVFs, is the typical clinical presentation of OVFs. The incident RP, SPT or ASPP are opportunistic findings on clinical assessment. A clinically explainable correlation was not found between the clinical parameters and incident RP, SPT or ASPP; patients with a positive finding were not characterized. The results of this study may improve cognition about OVFs from professional and nonprofessional clinicians, even medical students.

Abbreviations

OVFs, osteoporotic vertebral fractures; MRI, magnetic resonance imaging; BPIT, Back Pain-Inducing Test; BMI, body mass index; SD, standard deviation; NRS, numerical rating scale; BMD, bone mineral density; VF, vertebral fracture; VA, vertebral augmentation; RP, radiating pain; SPT, spinal palpation tenderness; ASPP, axial spinal percussion pain; CRF, case report form; T1WI, T1-weighted images; T2W I, T2-weighted images; STIR, short-tau inversion recovery.

Declarations

Competing interests

Huaijian Jin, Xiaoyuan Ma, Mingyong Liu, Zhong Wang, Jianhua Zhao, and Peng Liu declare that they have no conflict of interest.

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Availability of data and materials

Not applicable.

Ethics approval and consent to participate

Each participant in the study signed a written informed consent. The prospective study was approved by the Human Ethics Committee of the Third Affiliated Hospital of Army Medical University (approval number 2016-16) and registered in the Chinese Clinical Trial Registry (No. ChiCTR1800016834).

Authors' contributions

Huaijian Jin, Xiaoyuan Ma and Peng Liu were responsible for the initial plan, study design, data interpretation, and manuscript draft. Huaijian Jin, Xiaoyuan Ma, and Zhong Wang were responsible for all data summary and statistical analysis. Minyong Liu was responsible for the critical revision of the paper. Jianhua Zhao proofread all of the references.

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