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Bone biopsy results of patients who underwent percutaneous vertebroplasty: clinical study

Alemiddin Özdemir, Ahmet Melih Erdoğan, Özge Sevimoğlu, Mustafa Öğden Ulaş Yüksel, Bülent Bakar

[1]*Department of Neurosurgery, Faculty of Medicine, Kırıkkale University, Kırıkkale, Turkiye*

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Corresponding Author: Alemiddin Özdemir, alemozdemir@yahoo.com

ABSTRACT

Aims: Vertebral corpus fractures (VCF) can occur after trauma, osteoporosis, benign or malignant tumors, metastases, or infections. In this study, biopsy results of patients undergoing percutaneous vertebroplasty were discussed.

Methods: Digital hospital records were retrospectively reviewed and age, gender, hemoglobin, leukocyte, neutrophil, lymphocyte, basophil, eosinophil, platelet, C-reactive protein, biopsy pathology result, and hospitalization day of patients who underwent vertebroplasty for VCF were recorded. In addition, preoperative and postoperative radiologic images were examined.

Results: Fifty-one patients (17 males, and 34 females) were included in the study. When the patients were grouped as under and over 65 years of age, infection was found in two patients under 65 years of age, and malignant tumor was found in patients over 65 years of age. When the patients were grouped according to gender, 4 male patients had cancer or infection. The diagnoses made in the biopsy materials had already been clinically established in all patients. Although ROC-Curve analysis revealed that gender, leukocyte, and neutrophil counts could be used as predictive markers for diagnosing "pathologic fracture" in patients with VCF, regression analysis showed that none of these parameters could be used as the "best predictive marker".

Conclusion: This study showed that because up to 8% of patients undergoing vertebroplasty might have abnormal biopsy results, it is necessary to obtain a biopsy from these patients, especially male patients, before cementing the fractured vertebra

Keywords: Vertebroplasty, biopsy, pathology, metastasis, infection

INTRODUCTION

Osteoporotic vertebral corpus fracture (VCF) is usually seen in elderly patients with decreased bone mineral density (BMD). Fractures can occur as a result of minor trauma or without any history of trauma. Worldwide, 1.416.000 osteoporotic VCFs occur, and approximately 40% of women experience at least one osteoporotic VCF in their lifetime.[1] On the other hand, 5-30% of cancer patients may develop spinal metastases during their disease. Especially prostate, breast, blood, and lung malignancies may cause vertebral metastasis in addition to primary organ pathology. Metastatic vertebral involvement may cause erosion of the vertebrae, resulting in vertebral corpus fracture and subsequent pain and spinal instability.[2] In addition, pyogenic vertebral osteomyelitis may be confused with osteoporotic vertebral fractures in radiologic imaging studies.[3]

When VCF is encountered, many clinicians may assume that the cause is isolated trauma. However, the clinician should be careful when diagnosing VCF, whether it is spontaneous or secondary to cancer metastasis or osteomyelitis.[4] Computed tomography (CT) may not provide accurate information about whether VCF is acute or chronic and its etiology, and magnetic resonance (MR) imaging is more effective in diagnosing acute VCF. Especially in MR images with the "Short Tau Inversion Recovery" (STIR) sequence, the development of edema-induced hyperintensity in the vertebra supports the diagnosis of acute VCF, and contrast-enhanced MR should be performed if spinal metastasis or osteomyelitis is suspected.[5] However, in some patients, a definitive diagnosis could not be made despite all these tests and MR imaging cannot always differentiate osteoporotic VCFs from metastatic fractures or infection-related fractures.

Percutaneous vertebroplasty (PVP) and kyphoplasty (KP) are the treatment options for these patients preventing macroscopic collapse and providing stability within the fractured vertebral body.[6] On the other hand, the incidence of the incidental detection of spinal metastases in biopsy materials obtained during PVP/ KP has been reported to be between 1% and 3%.[7,8] Therefore, pathologic examination is still advocated as the gold standard method for differential diagnosis of VCF.[4,9] In addition, failure to perform a biopsy during PVP /KP may pose a medical-legal problem and malpractice lawsuits against physicians.[10,11]

This study aimed to examine the biopsy pathological examination results of patients who underwent PVP. Additionally, this study aimed to investigate whether patients' blood biochemistry results could predict pathological VCF. Additionally, it was planned to evaluate the complications of the PVP procedure applied to the study group.

METHODS

The study was carried out with the permission of Ethical Committe of Faculty of the Kırıkkale University Faculty of Medicine (Date: 22.05.2024, Decision No: 2024.05.18).

Patients

In this study, hospital digital patient records were retrospectively reviewed and data of patients who underwent PVP for VCF between January 2021 and January 2024 were recorded.Patients were divided into two groups according to their age as follows and the results were compared:

- <65-year-old group (n: 13)
- >65-year-old (n: 38)

In addition, the patients were divided into two groups according to gender as follows and the results were compared:

- Female group (n: 34)
- Male group (n: 17).

In addition, the patients were divided into groups according to the presence or absence of cement leakage as follows and the results were compared:

- Leakage (-) (Patients without cement leakage, n: 31)
- Leakage (+) (Patients with cement leakage, n: 17).

Pediatric patients, patients who underwent kyphoplasty, and patients with vertebral burst fractures were excluded from the study.

Age and gender, biopsy pathology results, and duration of hospitalization were recorded. Hemoglobin (reference range 10-18 g/dl), leukocyte (reference range 4400-11300 /ul), neutrophil (reference range 1,100-9600 /uL), lymphocyte (reference range 500-6000 /ul), basophil (reference range 0-300 /ul), and platelet (reference range 150000-500000 /ul) counts and C-reactive protein (CRP) levels (normal range 0-5 mg/L) were also recorded. In addition, preoperative and postoperative X-ray, CT, and MR images were analyzed to determine the fractured vertebra performed PVP, cement leakage, and the location of cement leakage.

Statistical Analysis

Power analysis was applied to the study results using G-Power 3.1 software and it was concluded that the number of individuals included in the study constituted an adequate sample (effect size d=9.60, power=0.96, critical t=4.303, power=0.95, minimum total sample size=4). Independent Samples t-test was used to evaluate the differences between groups regarding parametric data ($p<0.05$). *Mann-whitney U* test was used to compare nonparametric data between groups ($p<0.05$). *Pearson chi-square* test was used to evaluate the differences between groups regarding categorical data ($p<0.05$). *Sp*earman's rho Correlation test was used to determine the correlations between the parameters ($p<0.05$). ROC-curve test, and linear *regression* test were applied to determine the predictive study parameter(s) for decision-making of the pathological vertebral fracture ($p<0.05$).

RESULTS

Fifty-one patients (17 males, and 34 females) were included in the study. When the patients were grouped according to age, no statistical difference was found between the groups regarding the study parameters (Table 1). However, osteomyelitis in two male patients under 65 years of age (one with "*Brucella melitensis*" in T7 vertebrae (Figure 1) and one with "*Mycobacterium tuberculosis*" in L1 vertebrae (Figure 2) and malignant tumor infiltration in two male patients over 65 years of age (one with "multiple myeloma" in T8 vertebrae (Figure 3) and one with "poorly differentiated upper gastrointestinal tumor" in T10 vertebrae) (Figure 4) were detected in the biopsy materials (X2=1.187, p=0.034). In all patients, these diagnoses had already been made clinically before.

Platelet count values (t=2.141, p=0.037) and biopsy results (X2=7.957, p=0.019) were statistically different between genders (Table 2).

When the patients were grouped according to the presence of cement leakage, information about cement leakage could not be obtained because the postoperative imaging of 3 patients was not available. On the other hand, it was found that 14 patients had 1-level cement leakage and 3 patients had 2-level cement leakage (13 to the disc space and 4 to the spinal canal). However, foraminal cement leakage was not detected in any patient. In addition, CRP values were found to be higher in patients without leakage compared to normal laboratory values (Z=-2.253, p=0.024)(Table 3).

At the end of the correlation analysis, it was hypothesized that males would be more likely to diagnose infection or tumor in biopsy material (r=0.407, p=0.004), and the CRP values would be higher in patients without leakage (r=0.340, p=0.022). *ROC-Curve* analysis revealed that gender (AUC=0.854, p=0.021, male gender, 100% sensitivity, 71%

Table 1. Distribution table of the study parameters of the patients according to age

Variable		<65-year-old Mean±SD/ Median (min-max)/ N (%)	>65-year-old Mean±SD/ Median (min-max)/ N (%)	t/ Z/ X2	p
Gender	Female	9 (17.6%)	25 (49.0%)	0.052‡	0.820
	Male	4 (7.8%)	13 (25.5%)		
Hemoglobin		13.30 (10-14.90)	13 (6.90-16.80)	-0.054†	0.957
Leukocyte		8688±3022.80	7891±3026.80	0.819*	0.416
Neutrophil		5610 (3490-11260)	4475 (1530-14760)	-1.037†	0.300
Lymphocyte		1660±684.12	1720±686.12	-0.276*	0.784
Basophil		30 (10-60)	30 (10-140)	-0.166†	0.868
Eosinophil		160 (10-310)	100 (10-460)	-0.141†	0.888
Platelet		273230±6352.41	246789±8090.07	1.069*	0.291
C-reactive protein		12.80 (0.6-69.20)	4.50 (0.20-106.80)	-0.685	0.494
Segment	1	8 (15.7%)	26 (51.0%)	0.690‡	0.708
	2	5 (9.8%)	11 (21.6%)		
	3	0 (0.0%)	1 (2.0%)		
Area	Thoracic	8 (15.7%)	15 (29.4%)	2.266‡	0.322
	Lumbar	5 (9.8%)	21 (41.2%)		
	Thoracolumbar	0 (0.0%)	2 (3.9%)		
Fractured vertebrae	T4	0 (0.0%)	1 (2.0%)	7.612‡	0.868
	T5	0 (0.0%)	1 (2.0%)		
	T6	1 (2.0%)	3 (5.9%)		
	T7	2 (3.9%)	1 (2.0%)		
	T8	0 (0.0%)	2 (3.9%)		
	T9	1 (2.0%)	1 (2.0%)		
	T10	0 (0.0%)	1 (2.0%)		
	T11	1 (2.0%)	1 (2.0%)		
	T12	1 (2.0%)	6 (11.8%)		
	L1	2 (3.9%)	10 (19.6%)		
	L2	2 (3.9%)	4 (7.8%)		
	L3	1 (2.0%)	4 (7.8%)		
	L4	1 (2.0%)	2 (3.9%)		
	L5	1 (2.0%)	1 (2.0%)		
Biopsy result	Bone material	10 (20.8%)	34 (70.8%)	6.788‡	0.034
	Tumor	0 (0.0%)	2 (4.2%)		
	Infection	2 (4.2%)	0 (0.0%)		
Cement leakage	No	10 (20.8%)	21 (43.8%)	1.187‡	0.276
	Yes	3 (6.2%)	14 (29.2%)		
Leakage segment	No	10 (20.8%)	21 (43.8%)	1.641‡	0.440
	1 level	2 (4.2%)	12 (25.0%)		
	2 level	1 (2.1%)	2 (4.2%)		
Leakage to intervertebral disk area	No	11 (22.9%)	24 (50.0%)	1.236‡	0.266
	yes	2 (4.2%)	11 (22.9%)		
Leakage to spinal canal	No	12 (25.0%)	32 (66.7%)	0.010‡	0.922
	Yes	1 (2.1%)	3 (6.2%)		
Leakage to other side	No	12 (25.0%)	34 (70.8%)	0.555‡	0.456
	Yes	1 (2.1%)	1 (2.1%)		
Hospitalization time (day)		2 (1-14)	1 (1-9)	-1.430†	0.153

(*) t value, Independent Samples t-test; (†) Z value, Mann-Whitney U test; (‡) X2value, Pearson Chi-square test, p<0.05
(min: minimum, max: maximum, SD: standard deviation, N: patient number)

specificity), leukocyte counts (AUC=0.134, p=0.017, cut-off value <5445 uL, 75% sensitivity, 95% specificity), and neutrophil counts (AUC=0.186, p=0.040, cut-off value <3710 uL, 75% sensitivity, 74% specificity) could be used as predictive markers for the diagnosis of "pathologic fracture" in vertebral fractures. (Table 4, Figure 5). However, *linear logistic regression* analysis revealed that none of these parameters could be used as the "best predictive marker".

Table 2. Distribution table of the study parameters of the patients according to gender

Variable		Female Mean±SD/ Median (min-max)/ N (%)	Male Mean±SD/ Median (min-max)/ N (%)	t/ Z/ X2	p
Age (year)		71.65±11.92	70.88±10.79	0.223*	0.825
Hemoglobin		12.80 (9-16.80)	14 (6.90-15.40)	-0.054†	0.957
Leukocyte		8353±2750.10	7578±3520.13	0.863*	0.392
Neutrophil		5355 (2450-11260)	4130 (1530-14760)	-1.037†	0.300
Lymphocyte		1745±684.12	1622±683.91	0.602*	0.550
Basophil		30 (10-140)	30 (10-60)	-0.166†	0.868
Eosinophil		105 (10-360)	110 (10-460)	-0.141†	0.888
Platelet		269323±72584.63	221941±78296.29	2.141*	0.037
C-reactive protein		3.95 (0.3-106.80)	11.60 (0.20-61.80)	-0.685†	0.494
Segment	1	24 (47.1%)	10 (19.6%)	2.360‡	0.307
	2	10 (19.6%)	6 (11.8%)		
	3	0 (0.0%)	1 (2.0%)		
Area	Thoracic	15 (29.4%)	8 (15.7%)	0.349‡	0.840
	Lumbar	18 (35.3%)	8 (15.7%)		
	Thoracolumbar	1 (2.0%)	1 (2.0%)		
Fractured vertebrae	T4	1 (2.0%)	0 (0.0%)	10.971‡	0.613
	T5	0 (0.0%)	1 (2.0%)		
	T6	3 (5.9%)	1 (2.0%)		
	T7	1 (2.0%)	2 (3.9%)		
	T8	1 (2.0%)	1 (2.0%)		
	T9	1 (2.0%)	1 (2.0%)		
	T10	0 (0.0%)	1 (2.0%)		
	T11	1 (2.0%)	1 (2.0%)		
	T12	5 (9.8%)	2 (3.9%)		
	L1	9 (17.6%)	3 (5.9%)		
	L2	5 (9.8%)	1 (2.0%)		
	L3	4 (7.8%)	1 (2.0%)		
	L4	1 (2.0%)	2 (3.9%)		
	L5	2 (3.9%)	0 (0.0%)		
Biopsy result	Bone material	31 (64.6%)	13 (27.1%)	7.957‡	0.019
	Tumor	0 (0.0%)	2 (4.2%)		
	Infection	0 (0.0%)	2 (4.2%)		
Cement leakage	No	20 (41.7%)	11 (22.9%)	0.000‡	0.990
	Yes	11 (22.9%)	6 (12.5%)		
Leakage segment	No	20 (41.7%)	11 (22.9%)	0.006‡	0.997
	1 level	9 (18.8%)	5 (10.4%)		
	2 level	2 (4.2%)	1 (2.1%)		
Leakage to intervertebral disk area	No	22 (45.8%)	13 (27.1%)	0.168‡	0.682
	yes	9 (18.8%)	4 (8.3%)		
Leakage to spinal canal	No	29 (60.4%)	15 (31.2%)	0.406‡	0.524
	Yes	2 (4.2%)	2 (4.2%)		
Leakage to other side	No	29 (60.4%)	17 (35.4%)	1.144‡	0.285
	Yes	2 (4.2%)	0 (0.0%)		
Hospitalization time (day)		1.5 (1-14)	2 (1-9)	-1.430†	0.153

(*) t value, Independent Samples t-test; (†) Z value, Mann-Whitney U test; (‡) X2value, Pearson Chi-square test, p<0.05
(min: minimum, max: maximum, SD: standard deviation, N: patient number)

Table 3. Distribution table of the study parameters of the patients according to the presence or absence of cement leakage

Variable		LEAKAGE (-) Mean ± SD/ Median (min-max)/ N (%)	LEAKAGE (+) Mean ± SD/ Median (min-max)/ N (%)	t/ Z/ X2	p
Age (year)		69.91±11.01	73.41±12.98	-0.973*	0.336
Gender	Female	20 (%41.7)	11 (%22.9)	0.000‡	0.990
	Male	11 (%22.9)	6 (%12.5)		
Hemoglobin		13.50 (6.90-16.80)	13 (9-15.40)	-0.561†	0.575
Leukocyte		8158±2822.77	8124±3479.99	0.037*	0.971
Neutrophil		4520 (2760-11260)	4820 (1530-14760)	-0.313†	0.755
Lymphocyte		1724±680.51	1734±720.33	-0.046*	0.964
Basophil		30 (10-140)	30 (10-80)	-0.166†	0.868
Eosinophil		120 (10-460)	90 (10-270)	-0.518†	0.604
Platelet		265451±80130.24	226352±68567.43	1.698*	0.096
C-reactive protein		11.80 (0.30-106.80)	2.15 (0.20-69.20)	-2.253†	0.024
Segment	1	21 (43.8%)	11 (22.9%)	1.867‡	0.393
	2	10 (20.8%)	5 (10.4%)		
	3	0 (0.0%)	1 (2.1%)		
Area	Thoracic	17 (35.4%)	6 (12.5%)	1.715‡	0.424
	Lumbar	13 (27.1%)	10 (20.8%)		
	Thoracolumbar	1 (2.1%)	1 (2.1%)		
Fractured vertebrae	T4	1 (2.1%)	0 (0.0%)	11.335‡	0.583
	T5	1 (2.1%)	0 (0.0%)		
	T6	3 (6.2%)	1 (2.1%)		
	T7	3 (6.2%)	0 (0.0%)		
	T8	0 (0.0%)	2 (4.2%)		
	T9	1 (2.1%)	1 (2.1%)		
	T10	1 (2.1%)	0 (0.0%)		
	T11	2 (4.2%)	0 (0.0%)		
	T12	4 (8.3%)	3 (6.2%)		
	L1	7 (14.6%)	2 (4.2%)		
	L2	3 (6.2%)	3 (6.2%)		
	L3	3 (6.2%)	2 (4.2%)		
	L4	1 (2.1%)	2 (4.2%)		
	L5	1 (2.1%)	1 (2.1%)		
Biopsy result	Bone material	26 (57.8%)	15 (33.3%)	1.305‡	0.521
	Tumor	1 (2.2%)	1 (2.2%)		
	Infection	2 (4.4%)	0 (0.0%)		
Cement leakage	No	31 (64.6%)	0 (0.0%)	48.000‡	<0.001
	Yes	0 (0.0%)	14 (29.2%)		
Leakage segment	1 level	31 (64.6%)	4 (8.3%)	32.511‡	<0.001
	2 level	0 (0.0%)	13 (27.1%)		
Leakage to intervertebral disk area	No	31 (64.6%)	13 (27.1%)	7.957‡	0.005
	Yes	0 (0.0%)	4 (8.3%)		
Leakage to spinal canal	No	31 (64.6%)	15 (31.2%)	3.806‡	0.051
	Yes	0 (0.0%)	2 (4.2%)		
Leakage to other side	No	31 (64.6%)	15 (31.2%)	3.806‡	0.051
	Yes	0 (0.0%)	2 (4.2%)		
Hospitalization time (day)		2 (1-9)	1 (1-14)	-0.535†	0.593

(*) t value, Independent Samples t-test; (†) Z value, Mann-Whitney U test; (‡) X2value, Pearson Chi-square test, p<0.05
(min: minimum, max: maximum, SD: standard deviation, N: patient number)

Table 4. Results of ROC-Curve analysis for parameters that can predict pathological fracture

Variable	AUC	p	Cut-off value	Sensitivity	Specificity	95% Confidence Interval Lower	Upper
Gender	0.854	0.021	Male	%100	%71	0.731	0.976
Leukocyte	0.134	0.017	<5445 ul	%75	%95	0.000	0.299
Neutrophil	0.186	0.040	<3710 ul	%75	%74	0.039	0.333

(AUC: area under the curve)

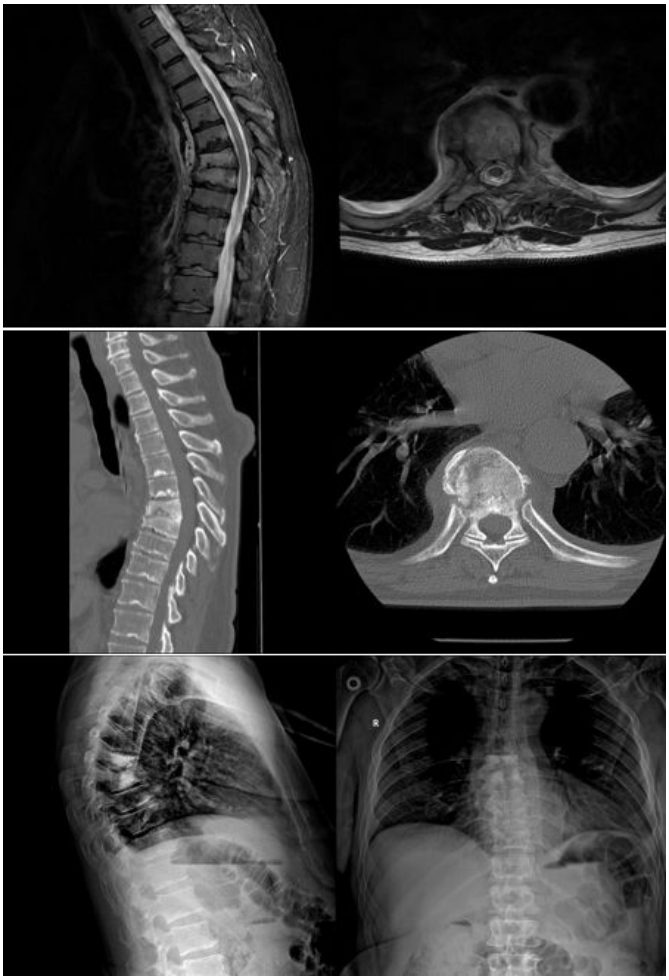

Figure 1. Preoperative and postoperative radiologic images of the patient whose bone biopsy was reported as "Brucella osteomyelitis" on pathologic examination.

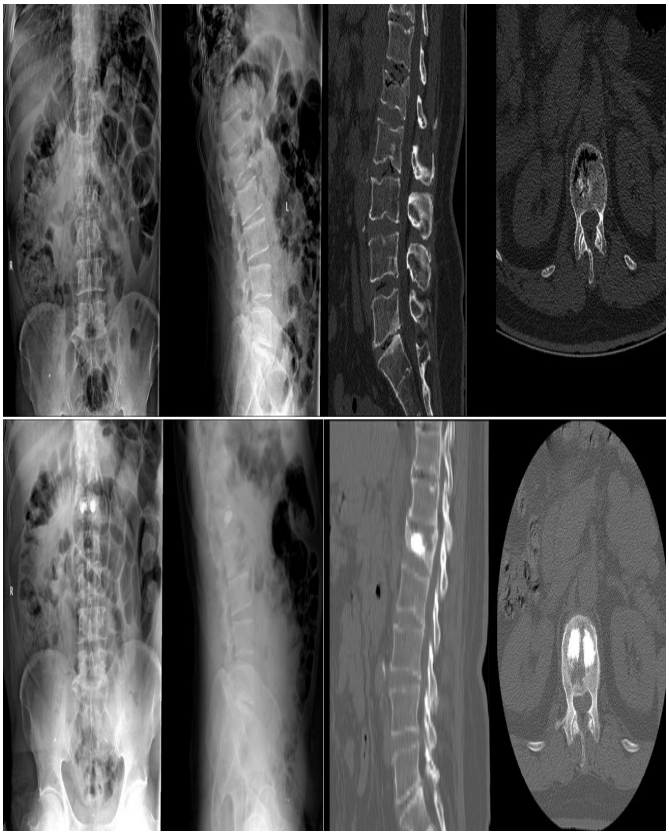

Figure 2. The pictures show the preoperative and postoperative radiologic images of the patient whose bone biopsy was reported as "tuberculosis osteomyelitis" on pathologic examination.

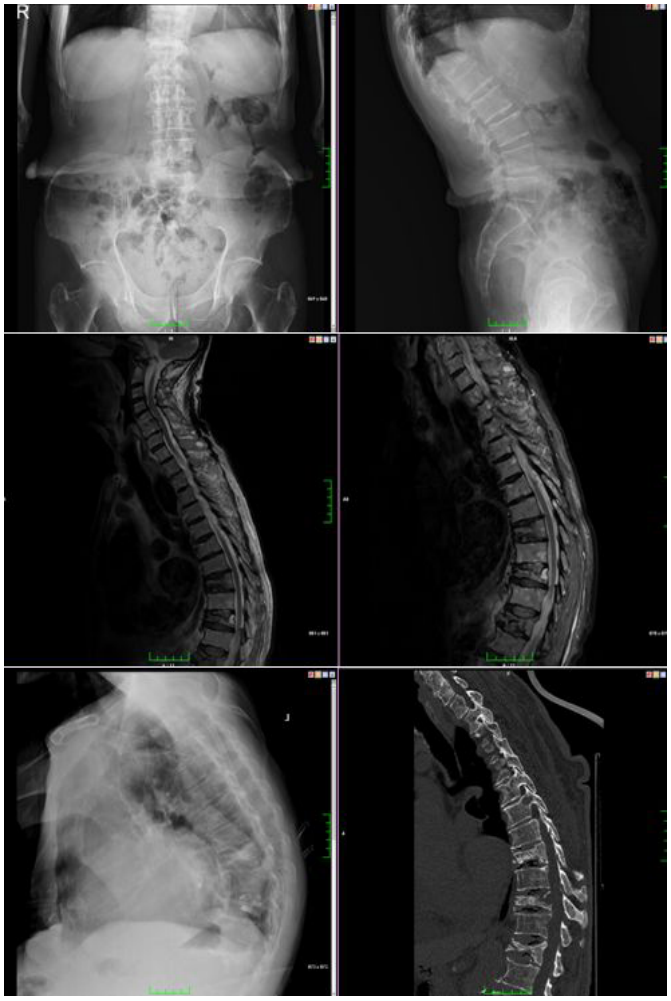

Figure 3. The pictures show the preoperative and postoperative radiologic images of the patient whose bone biopsy was reported as "multiple myeloma" on pathologic examination.

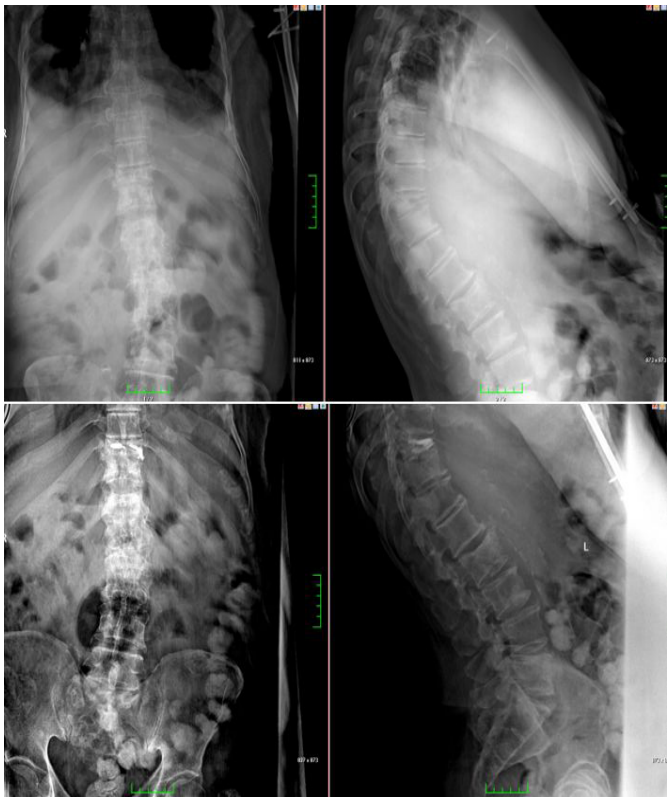

Figure 4. The pictures show the preoperative and postoperative radiological images of the patient whose bone biopsy was reported as a "malignant tumor of the gastrointestinal system" on pathological examination.

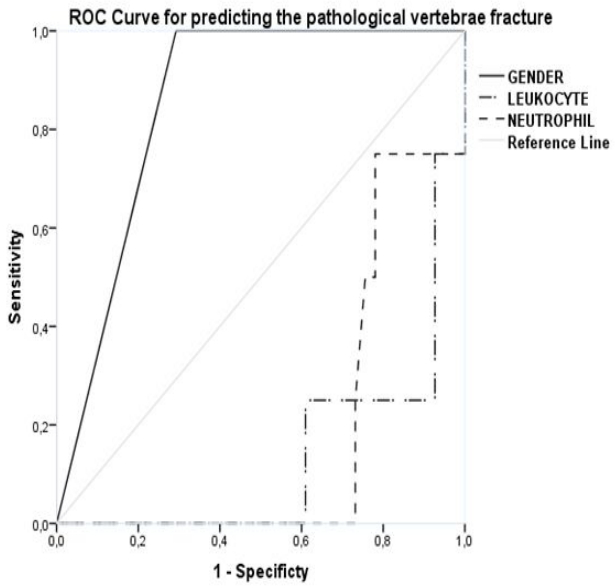

Figure 5. ROC-Curve graph for parameters that can predict pathologic fracture

DISCUSSION

Although imaging modalities such as MR, CT, and positron emission tomography are frequently used to diagnose benign and malignant spinal diseases, sometimes they cannot distinguish osteoporotic fractures from pathological fractures.[12,13] In this context, Zhihong et al.[15] showed that malignant processes can be successfully diagnosed with preoperative MR in almost 98% of patients with malignancy and several MR protocols (such as diffusion-weighted imaging, contrast-enhanced, and STIR sequences) can help differentiate benign and malignant VCF. Acute vertebral fractures show hypo intensity on T1-weighted MR images and hyperintensity on STIR-weighted MR images. Similarly, vertebral fractures due to osteomyelitis show hypo intensity on T1-weighted MR images and hyperintensity on T2-weighted MR and enhanced T1-weighted MR images. Therefore, tissue diagnosis is suggested for pathologic confirmation in such cases.[3,16,17]

The transpedicular biopsy in VCF is much more sensitive and specific (32.4%-89%) compared to most cancer screening methods. It can significantly reduce the likelihood of misdiagnosis and treatment costs and positively impact patients and their families by allowing for shorter treatment and earlier return to work.[18,19] In addition, the prevalence of pathologic findings on biopsy varies between 0.4% and 7.4% in the literature.14 In one study, a high incidence of malignancy of 4.9% was reported in the biopsy results of patients who underwent preoperative MR for VCF and were reported as osteoporotic VCF.[20] For this reason, taking bone biopsy during vertebral body augmentation procedures has become a routine practice in many centers.

In the present study, pathologic examination of biopsy material obtained during PVP was abnormal in 4 (8%) patients. All of these patients were male gender and in two middle-aged patients the pathological examination result was reported in favor of osteomyelitis and in the remaining two elderly patients the pathological examination result was reported in favor of malignant metastasis. In light of these findings, it was argued that in patients with vertebral

fractures who were planned to undergo PVP or KP, it would be appropriate to take a biopsy of bone tissue during the procedure.

In addition, when the patients were grouped according to age and gender, there was a statistical difference between the groups regarding bone biopsy pathologic examination results. With these results, it was thought that infection-related VCF may occur especially in male patients under 65 years of age and VCF secondary to tumor metastasis may occur in male patients over 65 years of age. As a result of the correlation analysis, it was concluded that a biopsy of the fractured bone tissue is necessary, especially in male patients. Furthermore, *ROC-curve* analysis revealed that male gender and decreased leukocyte and neutrophil counts may predict the possibility of pathologic vertebral corpus fracture. It is well known that in patients with osteomyelitis or malignant tumors, the inflammatory response may be reduced due to the existing chronic disease, and these patients may be immunocompromised. Therefore, these findings suggested that vertebral fractures occurring in men should be evaluated carefully, especially inflammatory cell counts should be taken into consideration. In conclusion, although *linear logistic regression* analysis suggested that these parameters could not be used as the "best predictive markers", it was argued that the results of these parameters should be evaluated more carefully in the decision-making of pathological vertebra fractures, especially in male patients.

Although cement leakage was common (27.4-41.7%), symptomatic complications only occurred in approximately 1% of cases. In the literature, the data indicate a significantly lower rate of cement leakage when performing KP compared to PVP. However, given the low incidence of symptomatic complications, this finding may not be clinically relevant. Studies involving osteoporotic fractures have found similar leakage rates between PVP and KP.[21] Cement leakage was detected in 17 (33.3%) patients in our study. Of these patients, 14 had 1-level and 3 had 2-level cement leakage (13 to the disc space and 4 to the spinal canal). However, foraminal cement leakage was not detected in any patient. In addition, none of the patients had any symptoms due to this cement leakage. All these findings were consistent with the literature.

In addition, there was no statistical difference between patients with osteoporotic VCF and pathologic VCF regarding cement leakage. With these findings, it was concluded that PVP application can be used safely in both patient groups. On the other hand, CRP values were higher than the normal laboratory values in patients without cement leakage. In contrast, when the blood count results were analyzed, the leukocyte, neutrophil, lymphocyte, basophil, and eosinophil counts were not different between the two groups. Therefore, it was thought that the elevated CRP was not secondary to infection or an allergic reaction (such as a foreign body reaction).

Limitations

This study had some limitations. *First*, the study was retrospective and the study population was small. *Second*, the "Visual Analog Scale", "Oswestry Disability Index" and "Karnofsky Performance Scale" values were not included in this study because it was far from the purpose of the study. Finally, the study did not include the "body mass index", bone mineral densitometry values, and serum parathormone, calcium, and phosphorus level values of the patients. Therefore, we could not provide information about the osteoporosis levels of patients with vertebral fractures.

CONCLUSION

The results of this study showed that it is necessary to take a biopsy from patients who will undergo PVP for VCF, especially from male patients, before cementing the fractured vertebra because abnormal biopsy results could be reported in up to 8%. There is no "conflict of interest" among the authors. Furthermore, through any of the products used in this research, no financial engagement has been established with any company that makes and/ or markets these products or with any corporation that produces and/or markets a competing product.

ETHICS COMMITTEE APPROVAL

Ethics Committee Approval

The study was carried out with the permission of Ethics Committe of the Kırıkkale University Faculty of Medicine (Date: 22.05.2024, Decision No: 2024.05.18).

Informed Consent

Because the study was designed retrospectively, no written informed consent form was obtained from patients.

Referee Evaluation Process

Externally peer-reviewed.

Conflict of Interest Statement

The authors have no conflicts of interest to declare.

Financial Disclosure

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Author Contributions

All of the authors declare that they have all participated in the design, execution, and analysis of the paper, and that they have approved the final version.

REFERENCES

1. Lee BG, Choi JH, Kim DY, Choi WR, Lee SG, Kang CN. Risk factors for newly developed osteoporotic vertebral compression fractures following treatment for osteoporotic vertebral compression fractures. *Spine J.* 2019;19(2):301-305.
2. Sciubba DM, Gökaslan ZL. Diagnosis and management of metastatic spine disease. *Surg Oncol.* 2006;15(3):141-151.
3. Allen RT, Kum JB, Weidner N, Hulst JB, Garfin SR. Biopsy of osteoporotic vertebral compression fractures during kyphoplasty: unsuspected histologic findings of chronic osteitis without clinical evidence of osteomyelitis. *Spine.* 2009;34(14):1486-1491.
4. Ozger O, Kaplan N. Clinical results of percutaneous vertebroplasty in thoracolumbar (T6-L5) vertebral compression fractures: Retrospective study of 111 patients with 140 fractured segments. *J Turk Spinal Surg.* 2019;(30):199-205.
5. Meyers SP, Wiener SN. Magnetic resonance imaging features of fractures using the short tau inversion recovery (STIR) sequence: correlation with radiographic findings. *Skeletal Radiol.* 1991;20(7):499-507.
6. Sorensen ST, Kirkegaard AO, Carreon L, Rousing R, Andersen MØ. Vertebroplasty or kyphoplasty as palliative treatment for cancer-related vertebral compression fractures: a systematic review. *Spine J.* 2019;19(6):1067-1075.

7. Jung HS, Jee WH, McCauley TR, Ha KY, Choi KH. Discrimination of metastatic from acute osteoporotic compression spinal fractures with MR imaging. *Radiographics*. 2003;23(1):179-187.
8. Spinnato P, Bazzocchi A, Facchini G, et al. Vertebral fractures of unknown origin: role of computed tomography-guided biopsy. *Int J Spine Surg*. 2018;12(6):673-679.
9. Uzunoglu I, Kaya I, Sucu HK, et al. Evaluation of incidentally detected pathology results of patients with vertebral fracture treated by vertebroplasty and kyphoplasty: a retrospective study. *World Neurosurg* 2019;122:e639-e646.
10. Mukherjee S, Thakur B, Bhagawati D, et al. Utility of routine biopsy at vertebroplasty in the management of vertebral compression fractures: a tertiary center experience. *J Neurosurg Spine*. 2014;21(5):687-697.
11. Nowak S, Müller J, Schroeder HW, Müller JU. Incidence of unexpected positive histology in kyphoplasty. *Eur Spine J*. 2018;27(4):847-850.
12. Akyuva Y, Baysoy B, Savrunlu EC, et al. Kyphoplasty in the early oncologic diagnosis and treatment of vertebral fractures: a clinical study. *Turk Neurosurg*. 2020;30(4):588-594.
13. Yoda T, Maki S, Furuya T, et al. Automated differentiation between osteoporotic vertebral fracture and malignant vertebral fracture on MRI using a deep convolutional neural network. *Spine* (Phila Pa 1976). 2022;47(8):E347-E352.
14. Mukherjee S, Pringle C, Crocker M. A nine-year review of medicolegal claims in neurosurgery. *Ann R Coll Surg Engl*. 2014;96(4):266-270.
15. Zhihong C, Jowell CSD, Aftab S, et al. The diagnostic value of magnetic resonance imaging in identifying unsuspected malignancy in patients undergoing percutaneous vertebral augmentation for vertebral compression fractures. *Int J Spine Surg*. 2019;13(5):464-469.
16. Mazzie JP, Brooks MK, Gnerre J. Imaging and management of postoperative spine infection. *Neuroimaging Clin N Am*. 2014;24(2):365-374.
17. Wang B, Fintelmann FJ, Kamath RS, Kattapuram SV, Rosenthal DI. Limited magnetic resonance imaging of the lumbar spine has high sensitivity for detection of acute fractures, infection, and malignancy. *Skeletal Radiol*. 2016;45(12):1687-1693.
18. Brill JV. Screening for cancer: the economic, medical, and psychosocial issues. *Am J Manag Care*. 2020;26(14):300-306.
19. Clarke CA, Hubbell E, Kurian AW, Colditz GA, Hartman AR, Gomez SL. Projected reductions in absolute cancer-related deaths from diagnosing cancers before metastasis, 2006-2015. *Cancer Epidemiol Biomarkers Prev*. 2020;29(5):895-902.
20. Hansen EJ, Simony A, Carreon L, Andersen MO. Rate of unsuspected malignancy in patients with vertebral compression fracture undergoing percutaneous vertebroplasty. *Spine*. 2016;41(6):549-552.
21. Mireles-Cano JN, Gonzalez AM, García-González OG, Pérez RM. Effectiveness of fluoroscopy-guided percutaneous vertebral biopsy. *Rev Bras Ortop*. 2021;56(4):453-458.