**Name of Journal:** *World Journal of Clinical Cases*

**Manuscript NO:** 60941

**Manuscript Type:** CASE REPORT

**Primary bone anaplastic lymphoma kinase positive anaplastic large-cell lymphoma:** **A case report and review of the literature**

Zheng W *et al*. Primary bone ALK+ ALCL

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**Supported by** National Science and Technology Major Subproject of China, No. 2018ZX10302205-002; Chinese Foundation for Hepatitis Prevention and Control-Tianqing Liver Disease Research Fund Subject, No. TQGB2020168.

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**Received:** November 19, 2020

**Revised:** February 22, 2021

**Accepted:** March 5, 2021

**Published online:** May 16, 2021

**Abstract**

BACKGROUND

Primary bone lymphoma (PBL) is an uncommon extranodal disease that represents approximately 1%-3% of lymphomas. Anaplastic lymphoma kinase (ALK) positive anaplastic large-cell lymphoma (ALCL) is an extremely rare type of PBL. The aim of this report is describe the symptoms, diagnosis, and treatment of primary bone ALK-positive ALCL.

CASE SUMMARY

A 66-year-old man presented to our hospital with neck and shoulder pain and intermittent fever that lasted for 1 mo. After extensive evaluation, positron emission tomography-computed tomography (CT) examination showed multiple osteolytic bone lesions without other sites lesions. CT-guided biopsy of the T10 vertebral body was performed, and the pathology results showed that neoplastic cells were positive for ALK-1, CD30, and CD3. A diagnosis of primary bone ALK positive ALCL was ultimately made. The patient was in partial response after four cycle soft cyclophosphamide, doxorubicin, vincristine, and prednisone chemotherapy, and we planned to repeat the biopsy and radiological examination after completion of the fifth cycle of therapy.

CONCLUSION

Primary bone ALK positive ALCL is a rare disease and physicians should keep in mind that ALCL can present with isolated osseous involvement without nodal involvement, and lymphoma should be considered in the differential diagnosis of primary bone lesions.

**Key Words:** Anaplastic large cell lymphoma; Anaplastic lymphoma kinase; Primary bone lymphoma; Bone involvement; Osteolysis; Case report

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**Citation:** Zheng W, Yin QQ, Hui TC, Wu WH, Wu QQ, Huang HJ, Chen MJ, Yan R, Huang YC, Pan HY. Primary bone anaplastic lymphoma kinase positive anaplastic large-cell lymphoma: A case report and review of the literature. *World J Clin Cases* 2021; 9(14): 3403-3410

URL: https://www.wjgnet.com/2307-8960/full/v9/i14/3403.htm

DOI: https://dx.doi.org/10.12998/wjcc.v9.i14.3403

**Core Tip:** Primary bone lymphoma (PBL) is an uncommon extranodal disease that represents approximately 1%-3% of lymphomas. Among PBLs, diffuse large B-cell lymphoma is the most common pathological type, accounting for approximately 70%-80% of all PBLs. The anaplastic large-cell lymphoma (ALCL) subtype of PBL is extremely rare, and it therefore remains unclear whether it is similar to ALCL in general or whether it is a subtype with unique clinical biological characteristics. Furthermore, the prognostic impact of anaplastic lymphoma kinase (ALK) expression in ALCL with primary bone lesions is still under debate. Herein, we report one rare case of primary bone ALK positive ALCL in a 66-year-old man. Our case suggests that physicians should keep in mind that ALCL can present with isolated osseous involvement without nodal involvement, and lymphoma should be considered in the differential diagnosis of primary bone lesions.

**INTRODUCTION**

Anaplastic large-cell lymphomas (ALCLs) are a subgroup of peripheral T-cell lymphomas thought to be derived from cytotoxic T cells. Most cases are characterized by the t(2;5)(p23;q35), which results in a fusion between the anaplastic lymphoma kinase *(ALK)* gene at chromosome band 2p23 and nucleophosmin (NPM) at chromosome band 5q35[1]. The 2016 revised World Health Organization (WHO) lymphoma classification recognizes four different entities: Systemic ALK-positive ALCL (ALK+ALCL), systemic ALK-negative ALCL (ALK-ALCL), primary cutaneous ALCL, and breast implant-associated ALCL. ALK expression has been considered an important favorable prognostic factor for ALCL. ALK positive ALCL represents approximately 3% of adult non-Hodgkin’s lymphomas and 10%-15% of childhood lymphomas[2]. ALCL mostly affects lymph nodes, while the involvement of extranodal sites, including the soft tissue, bone, lung, and liver, is uncommon[3].

Primary bone lymphoma (PBL) is a subtype of lymphoma that exclusively affects skeletal tissue. The prevalence of PBL is estimated to be 3%-7% among primary bone tumors and less than 2% among all lymphomas in adults[4,5]. Among PBLs, diffuse large B-cell lymphoma (DLBCL) is the most common pathological type, accounting for approximately70%-80% of all PBLs[6-9]. The ALCL subtype of PBL is extremely rare (3%-5% of all PBLs)[10-13], and it therefore remains unclear whether it is similar to ALCL in general or whether it is a subtype with unique clinical biological characteristics. Furthermore, the prognostic impact of ALK expression in ALCL with primary bone lesions is still under debate. Due to the rarity of this disease, more relevant studies and case reports are needed. Herein, we report one rare case of primary bone ALK positive ALCL in a 66-year-old man.

**CASE PRESENTATION**

***Chief complaints***

A 66-year-old man presented with a 1 mo history of neck and shoulder pain and intermittent fevers.

***History of present illness***

His fevers had no clear pattern in timing or duration. His neck and shoulder pain was not sharp, with no neck and shoulder stiffness or limited movement, and was relieved by nonsteroidal anti-inflammatory drugs. However, intermittent fevers of 37.7-38.9 °C persisted. Therefore, he was given empirical antimicrobial therapy with moxifloxacin for 5 d in his native hospital. However, 2 d after leaving the hospital, the fever (up to 38.8 °C) returned, and his neck and shoulder pain got worse.

***History of past illness***

His past medical history included diabetes and cervical spondylosis.

***Physical examination***

Physical examination showed no palpable lymph nodes, organomegaly, or cutaneous lesions.

***Laboratory examinations***

Blood laboratory results were as follows: Leukocytosis (14.39 × 109/L, 84.4% neutrophils), elevated C-reactive protein (126.3 mg/L), elevated transaminases (alanine aminotransferase: 71 U/L; aspartate aminotransferase: 51 U/L), elevated alkaline phosphatase (208 U/L), elevated lactate dehydrogenase (LDH) (313 U/L), and hypoproteinemia (32.5 g/L). The anti-Epstein-Barr virus capsid antigen immunoglobulin G test was positive, and the tuberculosis antibody tests and tubercle-specific immune responses were negative. Urinalysis indicated 1 + protein, moderate blood (61 red blood cells), and trace leukocyte esterase (10 white blood cells/hibernation-promoting factor). Blood and urine cultures were negative. Electrocardiogram, serum protein electrophoresis, and tumor markers, as well as abdomen and heart ultrasonography were normal. The trephine bone marrow biopsy showed hypocellularity, and the aspirate revealed granulocyte hyperplasia but no cellular atypia. Flow cytometry was negative for any atypical lymphocytes.

***Imaging examinations***

A chest computed tomography (CT) scan revealed local bronchiectasis in the upper left and right middle lobes, furthermore, an obviously osteolytic lesion in T10 vertebral body was also noted (Figure 1). Because of neck and shoulder pain, a thoracic enhanced magnetic resonance imaging (MRI) scan was performed. It indicated T2 and T10 vertebrae bone destruction, suggesting evident malignancy (Figure 2A and B). Based on these findings, the patient underwent a positron emission tomography (PET)-CT examination for further evaluation. On PET-CT, increased 18F-fluorodeoxyglucose (FDG) avidity involved the left sphenoid wing, the C4-5, T2, T10, L5, S1, and S5 vertebrae, the right humeral head, both sides of the humerus, and the right proximal femur. These lesions were identified as hypermetabolic lesions with a maximum standard uptake value of 18.64. Different degrees of bone destruction could be observed in corresponding sites, indicating lymphoma or multiple myeloma involvement (Figure 2C-F). No lymph node or extranodal site (such as the lung, liver, spleen, *etc.*) lesion was identified. CT-guided biopsy of the T10 vertebral body was performed and the pathological diagnosis was ALCL. Microscopic examination showed that the lesions of the vertebral body were infiltrated by pleomorphic tumor cells that have scanty cytoplasm and hyperchromatic nuclei. The neoplastic cells exhibited small- to medium-sized, irregular nuclei and abundant clear cytoplasm. Hallmark cells (horseshoe-shaped or doughnut cells) were present and Reed-Sternberg cell-like cell were also noted (Figure 3A and B). Immunohistochemistry showed that the large atypical cells were positive for ALK (Figure 3C), CD3 (Figure 3D), and CD30 (Figure 3E), but negative for CD2, CD5, CD7, CD4, CD8, CD10, CD19, CD79a, B-cell lymphoma-2, multiple myeloma-1, epithelial membrane antigen, and pan-cytokeratin. The proliferative index (Ki-67) was approximately 60% (Figure 3F). Moreover, we indagated the specific fusion partner using a two color, two fusion translocation probe, designed to detect the translocation between the *ALK* gene located at 2p23 and the *NPM* gene located at 5q35, and real-time reverse transcription polymerase chain reaction analysis demonstrated that the *NPM/ALK* fusion product was positive in the bone marrow.

**FINAL DIAGNOSIS**

Based on the above findings, a final diagnosis of primary bone ALCL, ALK-positive, stage IVB was made.

**TREATMENT**

The patient was given chemotherapy with the cyclophosphamide, doxorubicin, vincristine, and prednisone (CHOP) regimen.

**OUTCOME AND FOLLOW-UP**

The patient was in partial response (PR) after four cycles of CHOP chemotherapy, and we planned to repeat the biopsy and radiological examination after completion of the fifth cycle of therapy.

**DISCUSSION**

PBL is an uncommon extranodal disease that represents approximately 1%-3% of lymphoma cases and is more common in males than in females (8:1). In 1928, Oberling[14] first described it as reticulum cell sarcoma. Based on their series in 1939, Parker and Jackson[15] established PBL as a distinct clinical entity. According to the last version of the WHO classification of tumors of soft tissue and bone, PBL is defined as a neoplasm composed of malignant lymphoid cells, producing one or more masses within the bone, without regional lymph node or distant extranodal involvement[16].

It is difficult to diagnose PBL by clinical manifestations and common laboratory examination. Pain (82%-92%) and swelling (34%-45%) of the involved site are two of the most common clinical manifestations of PBL. Other less common presentations include pathological fractures and systemic “B-type” symptoms such as fevers, weight loss, and night sweats. It can involve any skeletal site, and the axial skeleton is the most commonly involved site. PBL most commonly presents as osteolytic or osteoblastic lesions with disease involvement of the cortex and reactive periosteal changes[17]. Plain X-ray films are the initial diagnostic test of choice, but they often underestimate the extent of the lesion. CT scans are useful for disease staging and delineating spinal lesions. MRI is helpful in demonstrating bone marrow and soft tissue involvement. In addition, the functional assessment of bone lesions using FDG-PET imaging plays an important role. Studies have shown that FDG-PET displays a higher specificity and sensitivity than conventional bone scintigraphy in identifying lymphomatous infiltration of skeletal tissue[18].

Among the multiple testing modalities, bone biopsy and immunohistochemical studies remain essential for confirmation of PBL and for differential diagnosis. CT-guided percutaneous biopsy has proven to be a safe and reliable way to obtain sufficient samples[19,20]. Microscopically, DLBCL is the most common histological subtype of lymphoma with primary or secondary skeletal involvement. It accounts for 70%-80% of all bone lymphomas[6-9], with rare to anecdotal occurrences of follicular, marginal zone, lymphoplasmacytic, anaplastic large-cell, natural killer/T-cell, Burkitt, and Hodgkin lymphomas[21,22]. Available data on primary bone ALCLs are currently rare. ALCLs with primary bone involvement fulfill the previously mentioned PBL definition and show the typical immunohistochemical and molecular findings noted in a few case reports in the literature. The main differential considerations of PBL include secondary osseous lymphoma, other subtypes of lymphoma (DLBCL, NK/T-cell lymphoma, Burkitt’s, follicular, and lymphoplasmacytic)[23], osteosarcoma, metastases, Ewing sarcoma[24], chronic osteomyelitis, and granulomatous infection such as tuberculosis[25].

The prognosis of patients with primary bone DLBCL is directly correlated with the stage of disease. The 5-year overall survival (OS) varies from 82% for patients with stage IE disease to 38% for patients with disseminated DLBCL with skeletal involvement. However, the prognosis of ALCL-type PBLs is controversial. Noh *et al*[26] collected 22 cases of ALCL with primary bone involvement and found that the ALCL type of PBL showed poor biological behavior compared with PBL (5-year OS was 43.1% and 62%-76%, respectively). In addition, the expression of ALK-1 protein has been reported to be a favorable prognostic factor in conventional nodal ALCL, but Nagasaka *et al*[27] showed that ALK-1 positivity is not a favorable prognostic feature for patients with primary bone ALCL. Therefore, further studies investigating the clinical behavior and pathogenesis of primary bone ALCL are warranted.

Strategies such as chemotherapy, immunotherapy, surgery, and radiotherapy have been used to treat primary bone ALCL, yet CHOP remains the most commonly used initial therapy. The addition of etoposide to CHOP (also known as CHOEP) improved outcomes for younger patients with ALK+ ALCL (especially those with normal LDH levels at diagnosis) in a large retrospective meta-analysis (*P* < 0.04); however, the regimen was too toxic for older patients[28]. The infusional dose-adjusted etoposide, cyclophosphamide, doxorubicin, vincristine, and prednisone (EPOCH) protocol produced very encouraging outcomes in a single institution long-term prospective study that enrolled ALCL patients with high-risk features. After a median follow-up of more than 12 years, median survival for both ALK+ and ALK- patients was not reached, with a 10-year OS rate of 75%[29]. On the basis of these results, CHOEP should be considered in younger patients with ALK+ ALCL for initial therapy, while CHOP and da-EPOCH should be reserved for older or less fit patients.

Recently, novel agents have emerged in the treatment of ALCL. Brentuximab vedotin (BV) is an anti-CD30 antibody-drug conjugate that selectively delivers an antimicrotubule agent, monomethyl auristatin E, into CD30-expressing cells. The initial phase 1 study conducted in patients with CD30-positive lymphomas, including ALCL, showed that BV treatment led to a response rate of 38%, including 11 cases of complete remission. The two patients with ALCL in the study achieved complete remission[30]. Subsequently, a phase 2 study in relapsed/refractory ALCL demonstrated an overall response rate of 86% and complete response (CR) rate of 57%. The median progression-free survival was 13.3 mo[31]. On the basis of these results, BV has been Food and Drug Administration-approved for relapsed/refractory ALCL following first-line therapy. ALK inhibitors are also very promising because ALK tyrosine kinase activity is essential to the survival of ALK+ ALCL cells. The oral ALK inhibitor crizotinib has demonstrated activity[32,33]. Crizotinib, an orally available dual ALK/MET inhibitor currently approved for advanced ALK+ non-small-cell lung cancer in adults, has been shown to induce high response rates: In a case series of nine patients with relapsed/refractory ALK+ ALCL, all nine attained a CR following treatment with crizotinib[33]. The duration of response exceeded 30 mo in some patients. With the constant development of novel agents, there may be profound modifications in the therapeutic strategies for ALCL in the near future.

**CONCLUSION**

In summary, a rare case of primary bone ALK-positive ALCL is reported in this study. Physicians should keep in mind that ALCL can present with isolated osseous involvement without nodal involvement, and lymphoma should be considered in the differential diagnosis of primary bone lesions. For an accurate and prompt diagnosis, clinical features, PET-CT images, pathological histology, and immunophenotype should all be considered.

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**Footnotes**

**Informed consent statement:** Informed written consent was obtained from the patient for publication of this report and any accompanying images.

**Conflict-of-interest statement:** The authors declare that they have no conflict of interest to report.

**CARE Checklist (2016) statement:** The authors have read the CARE Checklist (2016), and the manuscript was prepared and revised according to the CARE Checklist (2016).

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**Manuscript source:** Unsolicited manuscript

**Peer-review started:** November 19, 2020

**First decision:** February 12, 2021

**Article in press:** March 5, 2021

**Specialty type:** Medicine, research and experimental

**Country/Territory of origin:** China

**Peer-review report’s scientific quality classification**

Grade A (Excellent): 0

Grade B (Very good): B, B

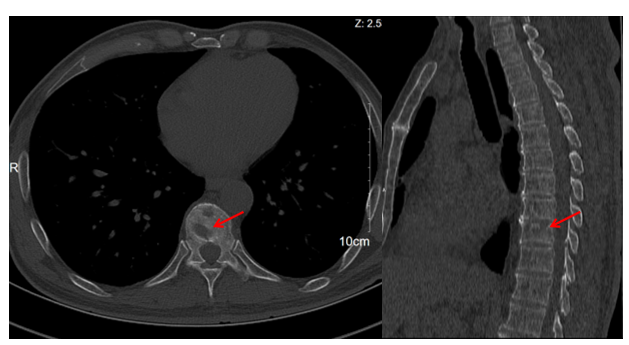
Grade C (Good): 0

Grade D (Fair): 0

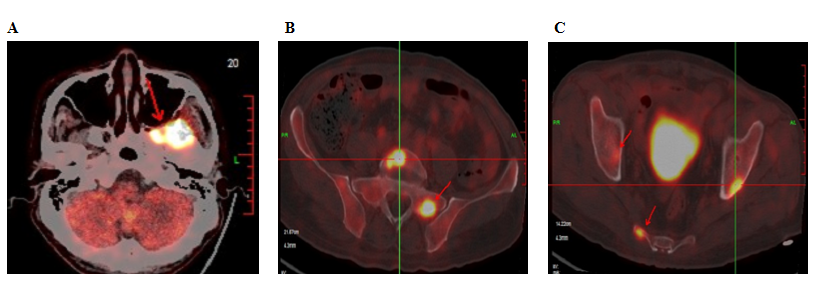
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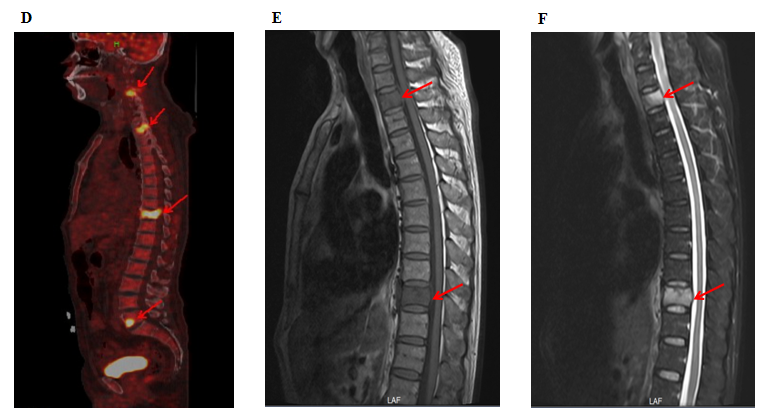
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**Figure Legends**

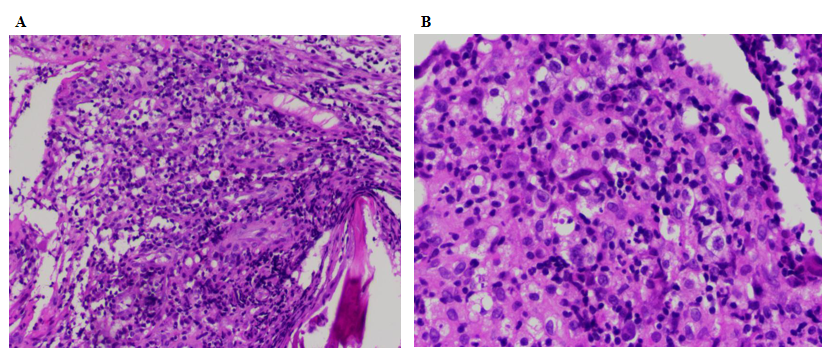


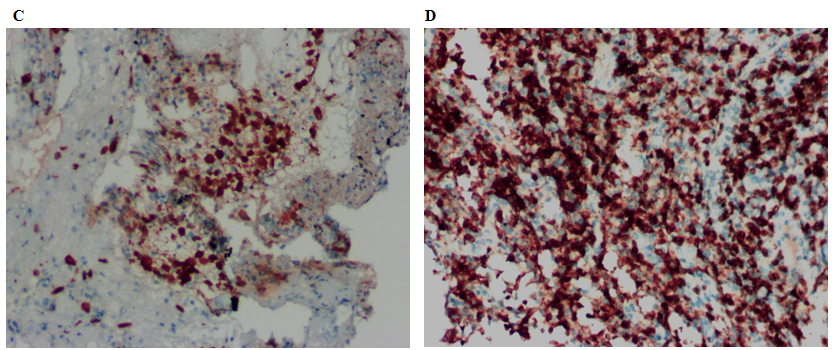
**Figure 1 Computed tomography scan of the chest showing an osteolytic lesion in T10 vertebral body (orange arrow).**

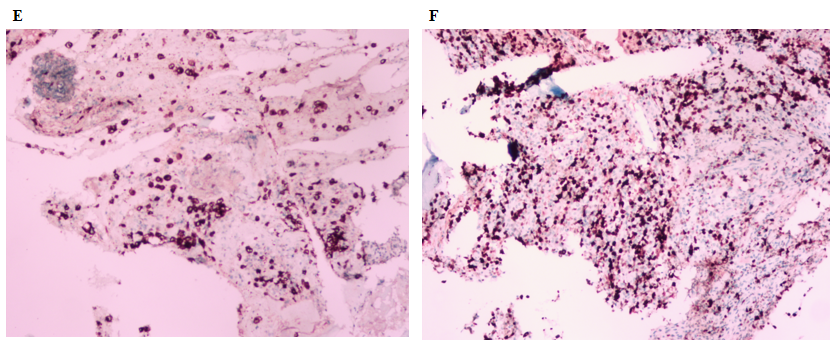




**Figure 2** **Thoracic magnetic resonance imaging.** A and B: Thoracic enhanced magnetic resonance imaging showed obvious T2 and T10 vertebral bone destruction (orange arrows); C-F: Positron emission tomography-computed tomography showed increased 18F-fluorodeoxyglucose avidity involving the left sphenoid wing, the C4-5, T2, T10, L5, S1, and S5 vertebrae; the right humeral head, both sides of the humerus, and the right proximal femur. Multiple osteolytic lesions were identified as hypermetabolic lesions with a maximum standard uptake value of 18.64; different degrees of bone destruction can be observed in corresponding sites (orange arrows).







**Figure 3 Histopathological microphotograph of primary bone anaplastic large-cell lymphoma**. A:The lesions of the vertebral body were infiltrated by pleomorphic tumor cells which have scanty cytoplasm and hyperchromatic nuclei (magnification × 100); B:The neoplastic cells exhibited small- to medium-sized, irregular nuclei and abundant clear cytoplasm. Hallmark cells (horseshoe-shaped or doughnut cells) were present and Reed-Sternberg cell-like cell were also noted (magnification × 400); C-F: On immunohistochemistry, the large atypical cells showed positive expression of anaplastic lymphoma kinase (C), CD3 (D), and CD30 (E), and the Ki67 index was almost 60% (F).



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