HİTİT MEDICAL JOURNAL
HİTİT ÜNİVERSİTESİ TIP FAKÜLTESİ DERGİSİ

e-ISSN: 2687-4717 Cilt|Volume: 6 • Sayı|Issue: 1 - Şubat|February 2024

The Effect of Albumin to Alkaline Phosphatase Ratio on Survival in Patients with Metastatic Bone Sarcomas

Metastatik Kemik Sarkomlu Hastalarda Albumin-Alkalen Fosfataz Oranının Sağ Kalıma Etkisi

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Makale Bilgisi | Article Information
Makale Türü | Article Type: Araştırma Makalesi | Research Article
Doi: https://doi.org/10.52827/hititmedj.1389249
Geliş Tarihi | Received: 10.11.2023
Kabul Tarihi | Accepted: 21.01.2024
Yayım Tarihi | Published: 26.02.2024

Atıf | Cite As
Mutlu E, Bozkurt O, İnanç M, et al. The Effect of Albumin to Alkaline Phosphatase Ratio on Survival in Patients with Metastatic Bone Sarcomas. Hitit Medical Journal 2024;6(1): 71-78 https://doi.org/10.52827/hititmedj.1389249

Hakem Değerlendirmesi: Alan editörü tarafından atanan en az iki farklı kurumda çalışan bağımsız hakemler tarafından değerlendirilmiştir.
Etik Beyanı: Çalışma Erciyes Üniversitesi Tıp Fakültesi Klinik Araştırmalar Etik Kurulu izni (Tarih:28.09.2022 Karar No:2022/675) ile gerçekleştirilmiştir.
İntihal Kontrolleri: Evet - (iThenticate)
Çıkar Çatışması: Yazarlar arasında çıkar çatışması bildirilmemiştir.
Şikayetler: hmj@hitit.edu.tr
Katkı Beyanı: Fikir/Hipotez: EM, MI Tasarım: EM, STF, RC Veri Toplama/Veri İşleme: IB, MC, ME,EM Veri Analizi: MO, OB Makalenin Hazırlanması: EM, AKD
Hasta Onamı: Gerek yoktur.
Finansal Destek: Finansal destek alınmamıştır.
Telif Hakı & Lisans: Dergi ile yayın yapan yazarlar, CC BY-NC 4.0 kapsamında lisanslanan çalışmalarının telif hakkını elinde tutar.

Peer Review: Evaluated by independent reviewers working in the at least two different institutions appointed by the field editor.
Ethical Statement: The study was carried out with the permission of Erciyes University Medical Faculty Clinical Researches Ethics Committee (Date:28.09.2022 Decision No:2022/675).
Plagiarism Check: Yes - (iThenticate)
Conflict of Interest: The authors have no conflicts of interest to declare.
Complaints: hmj@hitit.edu.tr
Authorship Contribution: Idea/Hypothesis: EM, MI Design: EM, STF, RC Data Collection/Data Processing: IB, MC, ME,EM Data Analysis: MO, OB Article Preparation: EM, AKD
Informed Consent: No need.
Financial Disclosure: The authors declared that this study has received no financial support.
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The Effect of Albumin to Alkaline Phosphatase Ratio on Survival in Patients with Metastatic Bone Sarcomas

Abstract

Objective: To investigate the effect of albumin to alkaline phosphatase ratio (AALPR) on survival in patients with metastatic bone sarcomas.

Patients and Method: 60 patients with metastatic bone sarcomas were included in the study. The relationship between AALPR before chemotherapy and overall survival (OS) and progression free survival (PFS) was evaluated with Cox regression multivariate analysis.

Results: Of the patients in the study, 25 (58.3%) were osteosarcoma, 16 (26.7%) Ewing's sarcoma, 5 (8.3%) chondrosarcoma and 4 (6.7%) giant cell bone tumor. AALPR was 0.039 obtained in ROC analysis. The median PFS and OS at AALPR ≥ 0.039 group were statistically significantly higher than the group with <0.039 (*p=0.006, p=0.003*). AALPR <0.039 was found to be associated with poor OS and PFS (OS, HR=1.778, 95% CI, 1.211-1.912, *p=0.023* - PFS, HR=4.782, 95% CI, 1.963-11,647, *p=0.001*).

Conclusion: In our study, low AALPR value before chemotherapy was associated with poor OS and PFS in patients with metastatic bone sarcoma. Low AALPR has been associated with poor OS and PFS in many cancer types, but the association of AALPR with survival at bone sarcoma patients has not been evaluated previously. Our study is the first in the literature to investigate this issue. AALPR can be used as an inexpensive and simple marker to evaluate the prognosis of patients. However, studies with larger number of patients are needed to give more precise results.

Keywords: Albumin-to-alkaline phosphatase ratio, bone cancer, neutrophil to lymphocyte ratio, osteosarcoma.

Özet

Amaç: Metastatik kemik sarkomu hastalarında albümin-alkalen fosfataz oranının (AALPO) sağ kalıma etkisini araştırmak.

Hastalar ve Yöntem: Çalışmaya metastatik evrede olan 60 kemik sarkomu hastası dahil edildi. Kemoterapi öncesi bakılan AALPO ile genel sağkalım (GS) ve progresyonsuz sağkalım (PS) arasındaki ilişki Cox regresyonu multivariate analizi ile değerlendirildi.

Bulgular: Çalışmaya alınan hastaların 25 (%58,3)'i osteosarkom, 16 (%26,7)'si Ewing sarkomu, 5 (%8,3)'ü kondrosarkom ve 4 (%6,7)'ü dev hücreli kemik tümörüydü. ROC analizi ile elde edilen AALPO değeri 0,039 olarak bulundu. AALPO ≥ 0,039 grubundaki medyan PS ve GS, <0,039 olan gruba göre istatistiksel olarak anlamlı derecede yüksekti (*p=0,006, p=0,003*). AALPO <0,039 (HR=1,778, %95 CI, 1,211-1,912, *p=0,023*) olması düşük genel GS ile ilişkili ve (HR=4,782, %95 CI, 1,963-11,647, *p=0,001*) olması düşük PS ile ilişkili bulundu.

Sonuç: Çalışmamızda metastatik kemik sarkomlu hastalarda kemoterapi öncesi düşük AALPO değeri, kötü GS ve PS ile ilişkili bulunmuştur. Daha önce birçok kanser türünde düşük AALPO kötü GS ve PS ile ilişkili bulunmuştur ancak daha önce kemik kanseri hastalarında AALPO'nun sağ kalım ile ilişkisi değerlendirilmemiştir. Çalışmamız literatürde bu konuyu araştıran ilk çalışmadır. AALPO, hastaların prognozunu değerlendirmede ucuz ve basit bir belirteç olarak kullanılabilir. Ancak daha kesin sonuçlar söylemek için daha fazla hasta sayısı ile yapılacak çalışmalara ihtiyaç vardır.

Anahtar Sözcükler: Albumin alkalen fosfataz oranı, kemik kanseri, nötrofil lenfosit oranı, osteosarkom.

Introduction

Sarcomas are types of cancer that arise from the connective tissue of the body. They are named according to the tissue they originate as bone sarcoma or soft tissue sarcoma. Bone sarcomas have subtypes of osteosarcoma, chondrosarcoma, Ewing's sarcoma, and giant cell bone tumor. The most common of these is osteosarcoma, which originates from osteoclast cells. Ewing's sarcoma originating from bone marrow or primitive neuroectodermal cells is the second most common bone cancer (1). Chondrosarcoma and giant cell bone tumors are much less common types. Osteosarcomas often arise from the long bones such as the tibia, humerus, femur. Ewing's sarcoma and giant cell bone tumors are common in the diaphysis of flat bones, such as the pelvis, scapula, as well as long bones (2). Chondrosarcoma is more common in vertebrae. The most common distant metastase sites of all bone tumors are the lungs. The probability of metastasis of giant cell tumors of the bone is very low compared to other bone tumors, and the most common site of distant metastasis is the lungs (3). Although bone cancers are rarely seen all over the world, mortality and morbidity rates are high. The 5-year overall survival rate for metastatic bone cancers is approximately 30% (4).

The increase in cancer cases and the variety of treatments have brought about the search for more easily applicable, inexpensive and practical biomarkers. The development of practical markers to predict the prognosis of patients before treatment is necessary for better treatment responses. As an indicator of liver function tests, albumin is the most abundant protein in plasma and its plasma level reflects the function of organs. Albumin is a biomarker used in cancer and non-cancer (liver diseases, nutritional status, diabetes mellitus, etc.) diseases (5). Elevated alkaline phosphatase (ALP) is a marker used primarily in skeletal system, hepatobiliary system, and cardiovascular system diseases. As in albumin, elevated ALP can be observed in benign (cholestasis, bone fracture, etc.) and malignant (bone cancers, pancreatic cancer, etc.) conditions. Elevated ALP in malignant conditions is associated with poor prognosis (6). Albumin to ALP ratio (AALPR) was first investigated in patients with hepatocellular cancer (HCC). Later, it was also investigated in breast cancer, nasopharyngeal cancer, non-small cell lung cancer, genitourinary system cancers and low AALPR was associated with shorter survival (7).

In our study, we aimed to investigate the survival effect of AALPR, which was performed before metastatic first-line chemotherapy, in bone sarcomas patients with distant metastases.

Material and Method

The study was carried out with the permission of the Erciyes University Scientific Research Evaluation and Ethics Committee (Date: 22.09.2022 Decision No: 2022/675). We obtained an informed consent form from all patients for procedure. All procedures were carried out in accordance with the ethical rules and the principles of the Declaration of Helsinki. In the study, the clinical, laboratory, radiological and demographic characteristics of cancer patients who were diagnosed with metastatic bone sarcoma by pathological and radiological tests and followed up in the medical oncology clinic of Erciyes University between January 2008 and April 2022 were evaluated retrospectively. 60 patients were included in the study. Inclusion criteria for the study; to be between the ages of 18-85, to have osteosarcoma, Ewing's sarcoma, chondrosarcoma or giant cell bone cancer diagnoses, to be in the metastatic stage at the time of diagnosis or during follow-up, to have received chemotherapy treatment for at least 3 months in the metastatic stage. The exclusion criteria are; being younger than 18 years old, having the current stage of the disease as a local disease or locally advanced stage, having received chemotherapy for less than 3 months and having hepato-biliary disease. The information of the patients was scanned retrospectively from the files of the oncology clinic and the hospital database. Clinicopathological features, whole blood and plasma biochemistry parameters of the patients were recorded.

Statistical Analysis

AALPR; with the formula albumin (g/dL) / ALP (u/L), neutrophil to lymphocyte ratio (NLR); with neutrophil (10^3/µL) / lymphocyte (10^3/µL) formula, platelet to lymphocyte ratio (PLR); calculated with the platelet (10^3/µL) / lymphocyte (10^3/µL) formula. ROC analysis was performed for optimal AALPR, NLR, and PLR cut-off values with high sensitivity and specificity and patients were categorized according to this value. The normality distribution for continuous variables was evaluated with the Kolmogorov test. The Mann-Whitney U test was used for comparative analysis between two independent groups in data that did not fit the normal distribution. Numerical and categorical variables were compared with the independent sample T test in data with normal distribution. Significance between the categorized groups was evaluated with the chi-square test. Differences in overall survival (OS) and progression-free survival (PFS) between categorized groups were evaluated using log rank curves and Kaplan-Meier test. Multivariate analysis was performed on the statistically significant data with Cox regression analysis. Analysis results were

presented as median (minimum-maximum), mean, standard deviation, and hazard ratio (HR). *p<0.05* was considered statistically significant in all statistical tests performed at the 95% confidence interval (CI). For data that could be clinically significant, *p<0.200* was also included in the multivariate analysis.

Results

Median age was 24 (18-70) years in the whole group. 58.3% of the patients had osteosarcoma. 43.3% of the patients were initially at the metastatic stage. The most common localization site was the upper extremity with a rate of 40%. 36.7% of the patients received adjuvant/neoadjuvant chemotherapy and 15% adjuvant/neoadjuvant radiotherapy. Partial response (PR) and complete response (CR) were 40% and 6.7% respectively in patients with metastatic first-line chemotherapy. ROC analysis was performed for AALPR, NLR, and PLR values."Area under the ROC Curve (AUC)" value obtained for AALPR, NLR, and PLR was statistically significant(AUC=0.795, AUC=0.657, AUC=0.648).

The "cut-off" values obtained for all three parameters as a result of the analyses were examined. AALPR ≥ 0.039 was better predictive for survival than the other two parameters. (sensitivity =72.1%, specificity =79.4%). Patients were grouped to AALPR <0.039 (A) and ≥ 0.039 (B). Groups A and B were compared with the X^2 test. Significant differences were observed between the two groups in terms of histology, progression status under chemotherapy, ALP, and albumin values. Median ALP values were

Table I. Comparison of clinical characteristic sand laboratory parameters according to the AALPR cut-off value

Variables	Categories	AALPR<0.039 (n=30) (A)	AALPR ≥ 0.039 (n=30) (B)	Total (n=60)	*p- value*
Age (median/ min-max)		22 (18-60)	23 (18-70)	24 (18-70)	*0.059* [1]
Gender, n (%)	Male	14 (46.7%)	20 (66.7%)	34 (56.7%)	*0.118* [2]
	Female	16 (53.3%)	10 (33.3%)	26 (43.3%)	
Histology, n (%)	Osteosarcoma	22 (73.3%)	13 (43.3%)	35 (58.3%)	***0.022***
	Chondrosarcoma	1 (3.3%)	4 (13.3%)	5 (8.3%)	
	Ewing sarcoma	4 (13.3%)	12 (40%)	16 (26.7%)	
	Giant cell bone tumor	3 (10%)	1 (3.3%)	4 (6.7%)	
Adjuvant/ neoadjuvant chemotherapy, n (%)	Yes	10 (333%)	12 (40%)	22 (36.7%)	*0.592*
	No	20 (66.7%)	18 (63.3%)	38 (63.3%)	
Adjuvant/ neoadjuvant radiotherapy, n (%)	Yes	5 (16.7%)	4 (13.3%)	9 (15%)	*0.717*[3]
	No	25 (83.3%)	26 (86.7%)	51 (85%)	
Progression status under chemotherapy, n (%)	Yes	23 (76.7%)	15 (50%)	38 (63.3%)	***0.032***
	No	7 (23.3%)	15 (50%)	22 (36.7%)	
Exitus status, n (%)	Yes	22 (73.3%)	16 (53.3%)	38 (63.3%)	*0.108*
	No	8 (26.7%)	14 (46.7%)	22 (36.7%)	
PLR (mean)		0.218±0.110	0.201±0.079	0.209±0.095	*0.494* [4]
NLR (median/ min-max)		3.875 (1.772-11.912)	2.972 (0.942-13.393)	3.426 (0.942-13.393)	*0.169* [3]
ALP (U/L) (median/ min-max)		150 (82-4429)	83 (48-163)	110 (48-4429)	***<0.001*** [3]
Albumin (g/dL) (median/ min-max)		4 (2.140-5.100)	4.285 (3-5.310)	4.075 (2.140-5.310)	***0.007*** [3]
LDH (U/L) (median/ min-max)		268 (153-937)	229 (123-1051)	259 (123-1051)	*0.067* [3]
NLR, n (%)	<3.154	11 (36.7%)	17 (56.7%)	28 (46.7%)	*0.121*
	≥ 3.154	19 (63.3%)	13 (43.3%)	32 (53.3%)	
PLR, n (%)	<0.191	13 (43.3%)	16 (53.3%)	29 (48.3%)	*0.438*
	≥ 0.191	17 (56.7%)	14 (46.7%)	31 (51.7%)	

[1]Mann-Whitney U test, [2]Chi-squared test, [3]Fisher exact test, [4]Independent sample T test AALPR: Albumin alkaline phosphatase ratio, NLR:Neutrophil lymphocyte ratio, PLR:Platelet lymphocyte ratio, LDH:Lactatede hydrogenase, PR:Partial response, CR: Complete response, SD:Stable disease, PD:Progressive disease

significantly higher in group A and median albumin values was significantly higher in group B (*p<0.001, p=0.007* respectively) (Table I).

The median OS was 47 months. There was no statistically significant OS difference in terms of age, gender, tumor localization, adjuvant/neoadjuvant chemotherapy-radiotherapy status, NLR groups, and PLR groups. Median OS was 153 months in the chondrosarcoma group and it was statistically significantly higher than in other histologies (*p=0.005*). Median OS was 47 months with AALPR ≥ 0.039 and it was statistically significantly higher than with <0.039 (*p=0.003*).

The median PFS was 15 months. There was no difference in PFS in terms of age, gender, surgery status, tumor localization, adjuvant/neoadjuvant

Table II. Comparison of the OS and PFS times according to the characteristics of the patients.

Variables	Categories	Median OS (Month) 95% CI (Min-Max)	*p-value**	Median PFS (Month) 95% CI (Min-Max)	*p- value* *
Survival	General population	47 (35.703-58.297)		15 (10.688-19.312)	
Age	<45	46 (36.583-55.417)	*0.963*	14 (9.460-18.540)	*0.71*
	≥45	49 (36.124-62.353)		20 (13.099-26.901)	
Gender	Male	46 (33.48-55.519)	*0.680*	14 (10.958-17.015)	*0.86*
	Female	49 (39.544-68.456)		17 (11.578-22.422)	
Histology	Osteosarcoma	47 (34.586-59.414)	***0.005***	14 (4.489-23.511)	***0.048***
	Chondrosarcoma	153 (152.040-155.960)		37 (13.119-82.061)	
	Ewing sarcoma	25 (16.629-33.371)		13 (8.497-17.503)	
	Giant cell bone tumor	121 (119-121)		120 (110.235-121)	
Initialstage	Local/resectable	102 (72.965-131.570)	***<0.001***	81 (56.968-105.698)	***0.02***
	Local advanced/unresectable	58 (59.094-111.550)		35 (12.061-58.302)	
	Metastatic	22 (14.658-29.342)		20 (10.220-30.099)	
Surgery	Yes	90 (69.863-11.968)	***<0.001***	17 (11.365-39.860)	*0.077*
	No	29 (18.586-40.537)		13 (9.951-16.049)	
Localization	Lower extremity	35 (25.168-44.832)	*0.601*	12 (7.845-16.155)	*0.235*
	Upper extremity	47 (26.513-67.487)		18 (6.586-29.414)	
	Trunk-pelvis	63 (22.587-103.413)		42 (12.124-88.192)	
	Head and neck	49 (45.799-52.201)		17 (8.998-25.002)	
Adjuvant/neoadjuvant chemotherapy	Yes	66 (10.254-144.873)	*0.342*	17 (5.558-21.569)	*0.296*
	No	38 (10.536-47.464)		13 (7.546-18.454)	
Adjuvant/neoadjuvant radiotherapy	Yes	58 (48.770-217.230)	*0.420*	37 (3.773-70.227)	*0.702*
	No	38 (22.712-53.288)		15 (10.334-19.666)	
First line chemotherapy response	CR	143 (123.400-162.600)	***<0.001***	37 (1.793-72.207)	***<0.001***
	PR	99 (73.425-124.844)		30 (8.941-39.156)	
	SD	47 (33.938-61.462)		18 (10.531-25.469)	
	PD	14 (6.524-21.476)		6 (4.889-7.111)	
NLR	<3.154	49 (12.719-85.281)	*0.138*	17 (10.100-23.900)	*0.491*
	≥ 3.154	46 (25.667-66.333)		14 (10.291-17.709)	
PLR	<0.191	39 (16.035-61.965)	*0.900*	14 (4.988-23.012)	*0.787*
	≥ 0.191	47 (45.418-48.582)		15 (10.356-19.644)	
AALPR	<0.039	39 (26.046-51.954)	***0.003***	9 (2.982-15.018)	***0.006***
	≥ 0.039	47 (42.126-69.547)		24 (16.979-31.021)	

OS: Overall survival, PFS: Progression free survival, Min: Minimum, Max: Maximum, AALPR: Albumin alkaline phosphatase ratio, NLR: Neutrophil lymphocyte ratio, PLR: Platelet lymphocyte ratio, LDH: Lactate dehydrogenase , PR: Partial response, CR: Complete response, SD: Stable disease, PD: Progressive disease

chemotherapy-radiotherapy status, NLR groups, and PLR groups. The median PFS in the chondrosarcoma group was 37 months and it was statistically significantly higher than other histologies (*p=0.048*). Median PFS was 24 months with AALPR ≥ 0.039 and it was statistically significantly higher than with <0.039 (*p=0.006*) (Table II).

Table III. Cox regression analysis results of the OS and PFS

		Multivariate OS *		Multivariate PFS *	
Variables	**Categories**	**HR (95% CI) (Min-Max)**	***p-value***	**HR (95% CI) (Min-Max)**	***p- value***
Histology	Giant cell bone tumor (ref)		*0.073*		*0.778*
	Osteosarcoma	20.443 (2.162-193.288)	*0.008*	17.012 (0.257-35.265)	*0.891*
	Chondrosarcoma	12.312 (3.568-125.147)	*0.957*	13.568 (0.895-57.865)	*0.898*
	Ewing sarcoma	19.112 (1.810-201.832)	*0.014*	15.745 (0.658-95.145)	*0.895*
Initial stage	Local/resectable (ref)		***0.036***		*0.223*
	Local advanced/unresectable	2.222 (0.589-8.386)	*0.239*	1.256 (0.176-9.388)	*0.086*
	Metastatic	17.492 (1.981-154.428)	*0.010*	2.865 (0.054-3.283)	*0.804*
Surgery	Yes (ref)	0.667 (0.095-4.673)	*0.684*		
First line chemotherapy response	CR (ref)		*0.115*		*0.526*
	PR	0.189 (0.024-1.484)	*0.113*	0.254 (0.029-2.260)	*0.219*
	SD	1.158 (0.144-9.277)	*0.890*	1.480 (0.178-12.332)	*0.452*
	PD	4.107 (0.557-30.303)	*0.166*	3.149 (0.034-2.580)	*0.717*
NLR	<3.154 (ref)	1.320 (1.012-2.803)	***0.032***		
AALPR	≥ 0.039 (ref)	1.778 (1.211-1.912)	***0.023***	4.782 (1.963-11.647)	***0.001***

*Risk factors affecting OS and PFS were analysed by Cox regression analysis as multivariate models. OS: Overall survival, PFS:Progression free survival, Min:Minimum, Max: Maximum, HR:Hazard ratio, AALPR:Albumin alkaline phosphatase ratio, NLR:Neutrophil lymphocyte ratio, PR:Partial response, CR: Complete response, SD:Stable disease, PD:Progressive disease

Cox regression multivariate analysis was performed using log rank curves and the Kaplan Meier test variables with significant differences between the groups in terms of OS and PFS, and the NLR variable that was considered clinically significant. Being metastatic at diagnosis (HR=17.492, 95% CI, 1.981-154.428, *p=0.010*), NLR≥3.154 (HR= 1.320, 95%CI, 1.012-2.803, *p=0.032*) and AALPR <0.039 (HR=1.778, 95% CI, 1.211-1.912, *p=0.023*) was found to be associated with poor OS. AALPR <0.039 (HR=4.782, 95% CI, 1.963-11.647, *p=0.001*) was associated with poor PFS (Table III).

Discussion

Bone sarcomas are a rare type of cancer and therefore there are still deficiencies in prognostic markers. NLR has previously been investigated to determine prognosis in bone sarcomas patients and similar results were found in this study as well as in other studies. The association of higher NLR with worse survival was previously demonstrated in solid tumors. The correlation between higher NLR values and worse survival in osteosarcoma patients in the literature was found to be statistically significant (OS, HR= 2.097, 95% CI, 1.202–3.658, *p=0.009*) (8). In another study, high NLR before treatment was associated with poor survival in nonmetastatic osteosarcoma patients (OS, HR= 1.810, 95% CI, 1.23–2.67, *p=0.003*) (9). In another study involving patients with chondrosarcoma, osteosarcoma, and Ewing's sarcoma, high NLR levels were found to be associated with worse survival (OS, HR= 2.200, 95% CI, 1.000-5.200, *p=0.003*) (10. In our study, high NLR was associated with poor survival, consistent with the literature (HR= 1.320, 95% CI, 1.012-2.803, *p=0.032*). PLR has also been previously investigated for prognosis in bone sarcoma patients, and high PLR values have been associated with poor survival. However, no statistically significant relationship was found in our study, possibly due to the small number of patients.

In the study, we demonstrated for the first time the prognostic value of AALPR in bone sarcoma patients. AALPR was first investigated in HCC patients, and the effect of AALPR on prognosis and survival in various cancers has continued to be investigated thereafter. Chan AW. et al. found low AALPR to be an independent prognostic factor for poor survival in HCC patients (OS, HR= 2.357, 95% CI, 1.354–4.102, *p=0.002*- PFS, HR=1.852, 95% CI, 1.158–2.964, *p=0.010*) (11). Later, Nie M. et al. found that low AALPR is an independent prognostic factor for worse survival in patients with metastatic nasopharyngeal

cancer (HR=2.295, 95% CI, 1.217-4.331, *p=0.042*) (12). On the other hand, in the studies of Zeng X. et al. (OS, HR= 1.570, 95% CI, 0.670-3.720, *p=0.300*- PFS, HR=1.980, 95% CI, 0.940-4.140, *p=0.070*) and Kim JS. et al. (OS, HR= 0.566, 95% CI, 0.236-1.356, *p=0.202*- PFS, HR=0.715, 95% CI, 0.322-1.587, *p=0.410*) at locally advanced nasopharyngeal cancer patients, no statistically significant relationship was found between AALPR and survival. However, it was significant in the analysis in which all stages were included (13,14). In a study by Li D. et al. at patients with metastatic non-small cell lung cancer, higher AALPR was associated with good survival (OS, HR= 0.657, 95% CI, 0.504–0.856, *p=0.002*) (15). Xiong JP et al. at operable cholangiocellular cancer patients (OS, HR=2.880, 95% CI, 1.190-5.780, *p=0.002*- PFS, HR=2.310, 95% CI, 1.40–3.29, *p<0.001*) and Pu N et al. at operable pancreatic cancer patients (OS, HR=2.086, 95% CI, 1.272-3.423, *p=0.004*) demonstrated that lower preoperative AALPR was associated with worse survival (16,17). Higher preoperative AALPR was associated with better survival in patients who subsequently underwent surgery for cervical cancer (OS, HR= 0.331, 95% CI, 0.135-0.809, *p=0.015*- PFS, HR=0.387, 95% CI, 0.176-0.853, *p=0.019*) (18). As seen in the literature, AALPR has been previously investigated in different cancer types and generally low AALPR is associated with poor survival. However, the effect of AALPR on prognosis in bone sarcoma has not been investigated before. We investigated the effect of AALPR on bone sarcoma prognosis for the first time. Similar to other cancer types, we found low AALPR to be associated with worse survival in bone sarcomas (OS, HR=1.778, 95% CI, 1.211-1.912, *p=0.023*-PFS, HR=4.782, 95% CI, 1.963-11.647, *p=0.001*).

Our study is the first in the literature to show the association of low AALPR with poor survival in patients with bone sarcomas. However, this study has several limitations. Firstly, this study is retrospective. Second, despite their advantage in this cohort, the markers were a nonspecific predictor for bone sarcomas and thus inevitably had inherent weaknesses and limitations. However, there is no specific serum marker for bone sarcomas. The most important limitation of our study was that it was a single-center, retrospective study, and the number of patients was limited.

Conclusion

In our study, low AALPR value before chemotherapy was associated with poor OS and PFS in patients with metastatic bone sarcoma. Low AALPR has been associated with poor OS and PFS in many cancer types, but the association of AALPR with survival at bone sarcoma patients has not been evaluated previously. Our study is the first in the literature to investigate this issue. AALPR evaluation before chemotherapy can be used as a cheap and simple marker that can give an idea about the prognosis and survival of patients with metastatic bone sarcomas diagnosis. However, larger studies with larger number of patients are needed for this.

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