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Original Article

The relationship between immunohistochemical parameters, bone marrow fibrosis and bone marrow ^{18}F-FDG uptake in multiple myeloma patients undergoing PET/CT examination

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ABSTRACT

Purpose: The aim of this study was to determine the power of the SUVmax value obtained from ^{18}F-FDG PET/CT in multiple myeloma (MM) patients to be able to predict immunophenotype characteristics (CD20, CD44, CD56, CD117, CD138 antigen expressions), bone marrow fibrosis, cyclin D1 oncogene, and M-protein subtypes which play a role in diagnosis-treatment and prognosis of the disease.
Material and method: The study included 54 patients with multiple myeloma who underwent PET/CT for initial staging and bone marrow biopsy. The relationship was examined in these patients between the SUVmax value measured from the iliac bone region and the immunohistochemical and bone marrow fibrosis data of the biopsy taken from the iliac bone. The Mann Whitney *U* test was used in the comparisons of dependent paired groups, and the Kruskal Wallis H test in the comparisons of three or more groups.
Results: The median SUVmax value was 4.5 (1.9–15.6) in patients with CD117 antigen positivity, which was statistically significantly higher than the value in the patients with CD117 negativity ($p = 0.031$). When patient grouping was made according to the reticulin level; we found that the median SUVmax value was 4.9 (3.0–14.8) in the group with increased fibrosis and 3.6 (1.6–15.6) in the group with low fibrosis. The median SUVmax was statistically significantly higher in the group with increased fibrosis compared to the group with low fibrosis ($p = 0.004$). No statistically significant difference was determined in the comparisons of the SUVmax values when the patients were grouped according to the immunoglobulin heavy chain and light chain, CD20, CD44, CD56, and cyclin D1 characteristics ($p > 0.05$).
Conclusion: In MM patients who underwent PET/CT for initial staging, significant relationships were determined between FDG uptake in the bone marrow (SUVmax) and CD117 antigen and bone marrow fibrosis, which is an important prognostic factor. Higher SUVmax values were determined in the bone marrow of patients with increased fibrosis and CD117 positivity.

La relación entre los parámetros inmunohistoquímicos, la fibrosis de la médula ósea y la captación de ^{18}F-FDG en la médula ósea en pacientes con mieloma múltiple sometidos a examen PET/TC

Palabras clave:
Mieloma múltiple
PET/TC
Fibrosis de médula ósea
Parámetros inmunohistoquímicos

RESUMEN

Propósito: El objetivo de este estudio fue determinar el poder del valor de SUVmax obtenido de ^{18}F-FDG PET/TC en pacientes con mieloma múltiple (MM) para poder predecir las características del inmunofenotipo (expresiones de antígenos CD20, CD44, CD56, CD117, CD138), fibrosis de la médula ósea, oncogén ciclina D1 y subtipos de proteína M que juegan un papel en el diagnóstico-tratamiento y pronóstico de la enfermedad.
Material y Método: Se incluyeron en el estudio 54 pacientes con mieloma múltiple a los que se les realizó PET/TC para estadificación inicial y biopsia de médula ósea. En estos pacientes se examinó la relación entre el valor de SUVmax medido en la región del hueso ilíaco y los datos inmunohistoquímicos y de fibrosis de la médula ósea de la biopsia tomada del hueso ilíaco. Se utilizó la prueba U de Mann Whitney en las comparaciones de grupos pareados dependientes y la prueba H de Kruskal Wallis en las comparaciones de tres o más grupos.

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Resultados: El valor medio de SUVmax fue de 4,5 (1,9–15,6) en pacientes con antígeno CD117 positivo, que fue estadísticamente significativamente superior al valor de los pacientes con CD117 negativo (p = 0.031). Cuando la agrupación de pacientes se hizo según el nivel de reticulina; Encontramos que la mediana del valor de SUVmax fue de 4,9 (3,0−14,8) en el grupo con mayor fibrosis y de 3,6 (1,6–15,6) en el grupo con poca fibrosis. La mediana de SUVmax fue significativamente mayor desde el punto de vista estadístico en el grupo con mayor fibrosis en comparación con el grupo con baja fibrosis (p = 0.004). No se determinó diferencia estadísticamente significativa en las comparaciones de los valores de SUVmax cuando los pacientes se agruparon según las características de cadena pesada y cadena ligera de inmunoglobulina, CD20, CD44, CD56 y ciclina D1 (p > 0.05).
Conclusión: En pacientes con MM a los que se les realizó PET/TC para la estadificación inicial, se determinaron relaciones significativas entre la captación de FDG en la médula ósea (SUVmax) y el antígeno CD117 y la fibrosis de la médula ósea, que es un factor pronóstico importante. Se determinaron valores de SUVmax más altos en la médula ósea de pacientes con fibrosis aumentada y positividad para CD117.

Introduction

Multiple myeloma (MM) is a neoplastic plasma cell dyscrasia, in which clinical conditions are observed such as anemia, monoclonal protein in the serum and/or urine, osteolytic bone lesions, hypercalcemia, and renal failure, and which progresses with multiple systemic symptoms. MM comprises 1% of all cancers and 10% of hematological cancers. The prognosis in newly diagnosed patients is related to the disease stage. To determine the treatment, it is necessary to know the prognostic factors. As the biology of myeloma has become better understood, different prognostic factors have come into play. Serum beta 2 microglobulin, CRP, LDH, bone marrow plasma cell count and morphology, immunophenotype of myeloma cells, and bone marrow fibrosis are factors affecting prognosis[1,2].

The presence of M-protein is a typical characteristic of the disease. Monoclonal protein can be determined in the serum of 97% of myeloma patients. Non-secretory myeloma cases with no detectable monoclonal protein constitute 1–3% of all myeloma cases. Serum and urine M-protein concentration is used in myeloma staging and the evaluation of response to treatment. Most MM cases carry M-protein in the Ig structure, followed by IgA and IgM structures. It is very rare in IgD and IgE structures. This grouping is made according to heavy chains in the immunoglobulin structure. In addition there are two sub groups of kappa (κ) and lambda (λ) according to light chain characteristics[3–5].

There are studies in literature reporting that relationships have been observed between disease prognosis in MM patients and immunophenotype characteristics such as CD19, CD20, CD38, CD44, CD56, CD117, CD138 antigen expression[6–9].

Many studies have been conducted related to the relationship between the determination and degree of bone marrow fibrosis in bone marrow biopsy samples of MM cases and patient survival. The presence of bone marrow fibrosis is known to have a negative effect on prognosis[10,11].

Epidemiological evidence has shown a relationship between genes controlled by the metabolism of carcinogens and the risk of cancer. Studies have examined irregularity in passing to the G1-S phase in the cell cycle. Passage from G1 to the S phase in the cell cycle is a checkpoint controlled by cyclin proteins. Many oncogenes and tumour suppressor genes that play a role in the cycle have been associated with errors in the G1 checkpoint. Cyclin D1 (CCND1), which is an important protein for the regulation of the cell cycle from the G1 phase to the S phase, is accepted as an oncogene. Over-expression of protein accelerates the G1 phase and thus with cell proliferation causes an increase in the risk of carcinogenesis. Cyclin D1 positivity is observed in 15–20% of MM patients[12–14].

Bones and the bone marrow are the most frequently involved regions in MM patients. Bone and bone marrow involvement is not homogenous in approximately 60% of patients, and the accumulation of bone marrow plasma cells and bone destruction is focal and patchy. Therefore, bone marrow samples taken blind from the iliac bone and sternum may not always provide correct information about the disease status. When not all the bone marrow is involved, positron emission tomography/computed tomography (PET/CT) and whole body magnetic resonance imaging (MRI) allow the determination of disease spread and activity. PET/CT is superior to MRI in showing focal lesion viability, and MRI has been shown to be superior in showing diffuse bone marrow involvement[15,16].

The aim of this study was to determine the power of the maximum standardised uptake value (SUVmax) obtained from Fluorine-18-fluorodeoxyglucose positron emission tomography/computed tomography (^{18}F-FDG PET/CT) in multiple myeloma patients to be able to predict immunophenotype characteristics (CD20, CD44, CD56, CD117, CD138 antigen expressions), bone marrow fibrosis, cyclin D1 oncogene and M-protein subtypes which play a role in diagnosis-treatment and prognosis of disease.

Material and methods

Patients

Approval for the study was granted by the Ethics Committee of Afyonkarahisar Health Sciences University Medical Faculty. This retrospective study included 54 multiple myeloma patients who underwent PET/CT imaging for initial staging in the Nuclear Medicine Department of Afyonkarahısar Health Sciences University Medical Faculty Hospital and bone marrow biopsy between February 2016 and September 2021, had a histopathologically confirmed diagnosis, and had not received any treatment. The patients included in the study had no additional malignancy.

PET/CT imaging

After a fasting period of 6 h, each patient was injected intravenously with 0.10 mCi/kg F18-FDG while the blood glucose level was <200 mg/dl. After waiting 60 min, PET/CT imaging was performed between the vertex-upper thigh with a PET/CT unit (Siemens Biograph 6 PET/CT; CT 3 mm slice thickness, 110 mAs, 120 kV; bedside 3 min. PET). The images obtained were examined simultaneously as PET on attenuation corrected images and CT and fusion PET/CT images; visual and semiquantative evaluations were made. SUVmax was used as the semiquantative parameter in the FDG PET examination. The SUVmax value was calculated by draw-

Table 1
The characteristics of the antibodies used in the immunohistochemical study.

	Clone	Dilution rate	Incubation time	Antigen revealing	Company
CD20	L26	1:200	40 min	ER2	Leica
CD10	56C6	1:100	40 min	ER2	Leica
CD79A	HM47/A9	1:150	40 min	ER2	Thermo
CD19	ZR212	1:100	30 min	ER2	Zeta
CD138	MI15	1;20	40 min	ER2	Thermo
IgA	Polyclonal	1;1000	30 min	ER1	Thermo
IgG	Polyclonal	1;500	–	–	Thermo
IgM	Polyclonal	1;1000	20 min	ER1	Thermo
IgD	Polyclonal	1;1000	30 min	ER1	Thermo
CYCLİN-D1	P2D11F11	1:30	40 min	ER2	Leica
CD117	EP10	1:200	20 min	ER2	Leica
CD44	MRQ-13	1:100	30 min	ER1	Cell Marque
KAPPA	L1C1	1:900	30 min	ER1	Thermo
LAMBDA	SHL53	1:200	10 min	ER1	Leica

ER1: Citrat Buffer, pH:6; ER2 : EDTA Buffer, pH:9.

ing a 3-dimensional region of interest (ROI) from the posterior iliac wing.

Pathological analyses

The study included myeloma patients who met the International Myeloma Working Group (IMWG) criteria. The bone marrow biopsies were fixed in 10% formaldehyde, then after decalcification and routine tissue processing, the samples were embedded in paraffin blocks. Slices 4 microns in thickness were cut and stained with hematoxylin and eosin (HE). For the immunohistochemical studies, slices 2–3 microns in thickness were cut and placed on polylysinised slides. An immunohistochemical panel, formed of IgG, IgA, IgD, IgM,CD20, CD56, CD117, CD138, CD44, cyclin D1, kappa and lambda antibodies, was applied to all the bone marrow biopsy samples (Table 1).

The antigen retrieval technique was used in the immunohistochemical studies and the avidin-biotin-peroxidase complex method was applied. The antibodies were examined using a Leica Bandmax automatic immunohistochemistry device. A Bond Polymer Refine Detection (Leica marka, DS9800) kit was used for each antibody, and the staining procedure written on the data sheet was followed. Appropriate positive and negative controls were used for each antibody. The percentage of plasma cells infiltrating the bone marrow was evaluated with HE slices and CD138 immunohistochemical staining. In order to calculate the amount of plasma cells in CD138 immunohistochemically stained preparations, the distribution of dark-stained plasma cells was examined first at low (×100) and then at intermediate (×200) magnification. An area within the section was then selected that was judged to have approximately the same concentration of plasma cells as the section as a whole. Then, at high (×400) magnification, 200 cells with nuclei were counted and the percentage of plasma cells was calculated. Accordingly, group 1 was classified as <20%, group 2 as 20–50%, group 3 as >50%, all of our cases were group 3[17].

In the immunohistochemical study made with CD56, expression of >50% neoplastic plasma cells was accepted as positive[18].

In the evaluation of the immunohistochemical studies made with CD117 and cyclin D1, scoring was applied according to the expression in neoplastic plasma cells as 0: no staining, 1: ≥1% positive cells, 2: ≥10% positive cells, 3: ≥33% positive cells, 4: ≥66% positive cells, 5: 100% positive cells. A score of 0 was accepted as negative and a score of ≥1 point as positive[19].

In the evaluation of CD44 immunohistochemical uptake, the membranous staining of neoplastic plasma cells was considered. Membranous staining of ≥10% was accepted as positive, cytoplasmic, and <10% membranous staining as negative[20].

For the evaluation of bone marrow biopsy fibrosis, reticulin and Masson trichrome staining was applied. Sections 4 microns in thickness were placed on polylysinised slides and staining was applied with a prepared kit according to the written rules in the staining guide. Reticular fibre grading in the bone marrow was applied according to the European Consensus Report of Bone Marrow Fibrosis grading[21]. Accordingly, bone marrow fibrosis was evaluated as grades 0–3.

Statistical analysis

Data obtained in the study were analyzed statistically using Statistical Package for the Social Sciences (SPSS) version 23 software. Descriptive statistics were stated as median, minimum and maximum values for continuous variables and number (n) and percentage (%) for categorical variables. According to the Shapiro Wilk test, continuous variables did not show normal distribution ($p > 0.05$). The Mann Whitney *U* test was applied in the comparisons of two independent groups and the Kruskal Wallis H test was applied to 3 or more groups. A value of $p < 0.05$ was accepted as the level of statistical significance.

Results

Evaluation was made of 54 patients, comprising 31.5% females and 68.5% males with a median age of 67 years (range, 44–87 years).

All patients in our study were patients with a confirmed diagnosis of multiple myeloma and bone marrow involvement. In addition, none of them had infection or drug use that could cause reactive bone marrow involvement in PET/CT examination. Therefore, we did not detect any false positive cases in PET/CT. We had 48 true positive cases with iliac bone involvement (Fig. 1). However, in our 6 patients, we did not observe pathological FDG uptake in the bone marrow in PET/CT images, consistent with false negativity in the iliac bone (Fig. 2). There was also no involvement in the extra-iliac bones in these 6 patients.

As a result of the pathology examinations, IgG type was observed in 64.8% of the patients and IgA type in 24.1%. In respect of light chain type, 64.8% Kappa clonality was seen. When examined according to immunophenotype characteristics, the patients were observed to be 11.3% CD20 positive, 66.7% CD44 positive, 66.0% CD56 positive, 46.3% CD117 positive, 100% CD138 positive, and 19.2% cyclin D positive. When evaluated according to reticulin characteristics, 8 (14.8%) patients were grade 0, 28 (51.9%) patients were grade 1, 7 (13.0%) patients were grade 2, and 11 (20.3%) patients were grade 3. The majority (66.7%) of patients were seen to be grade 0–1 (Table 2).

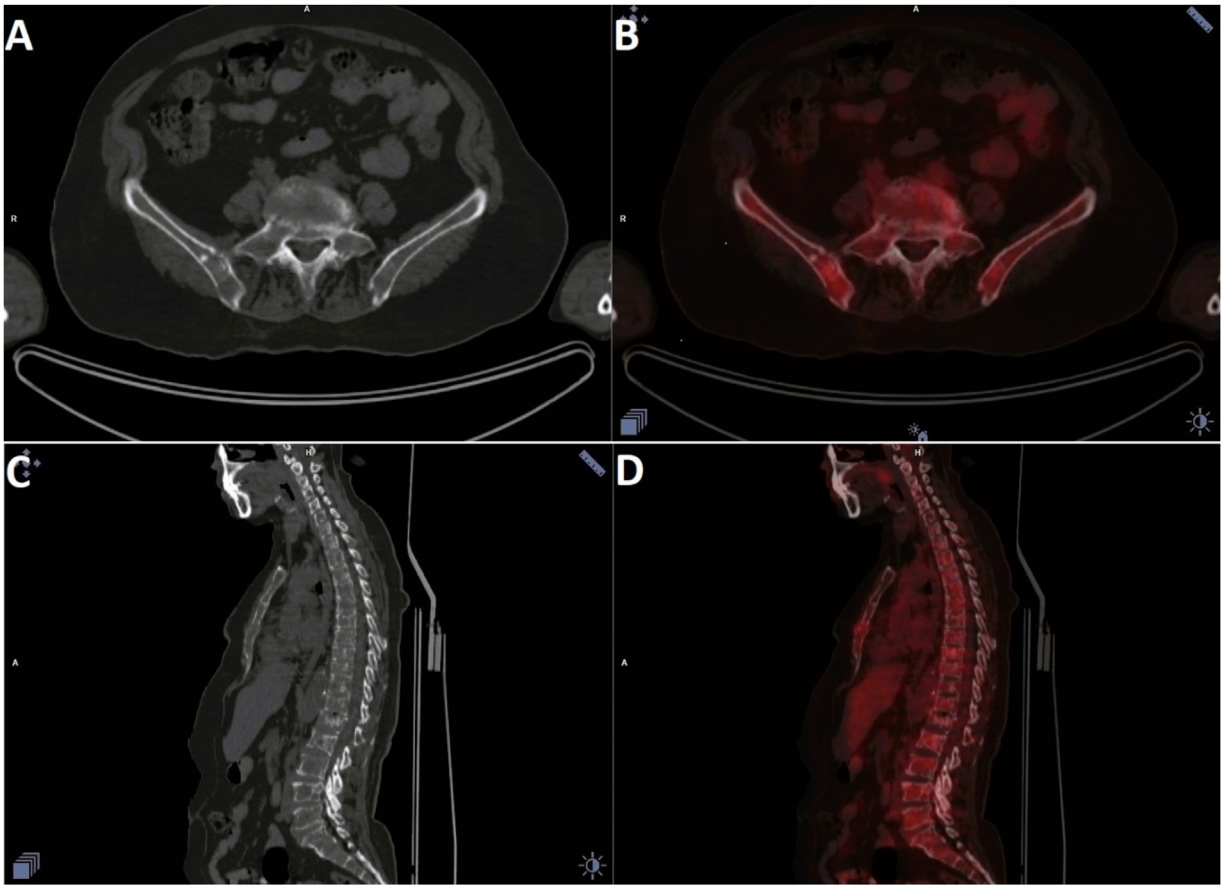

Figure 1. Axial CT (A), PET/CT fused images (B); Sagittal CT (C), PET/CT fused images (D) in a patient with diffuse bone marrow tracer uptake pattern. PET/CT fused images (B, D) showed diffuse increased FDG uptake in bones.

Table 2
Relationships between bone marrow FDG uptake (SUVmax) and bone marrow biopsy data.

	N (%)	SUVmaxMedian (min–max)	P Value
Monoclonal protein types			
IgG	35(64.8)	4.1(1.6–15.6)	0.335
IgA	13(24.1)	3.7(2.8–4.4)	
Others	6(11.1)	4.4(1.6–11.2)	
Light-chain types			
Lambda (λ)	19(35.2)	3.8(2.0–11.2)	0.885
Kappa (κ)	35(64.8)	4.0(1.6–15.6)	
CD20			
Positive	6(11.3)	4.4(3.7–10.3)	0.182
Negative	47(88.7)	3.8(1.6–15.6)	
CD56			
Positive	35(66.0)	3.7(1.6–15.6)	0.135
Negative	18(34.0)	4.3(1.6–14.8)	
CD117			
Positive	25(46.3)	4.5(1.9–15.6)	**0.031**
Negative	29(53.7)	3.8(1.6–14.8)	
CD138			
Positive	54(100.0)	3.95(1.6–15.6)	
CD44			
Positive	18(66.7)	4.0(1.6–10.1)	0.940
Negative	9(33.3)	3.8(2.4–7.2)	
Reticulin			
Grade 0–1	36(66.7)	3.6(1.6–15.6)	**0.004**
Grade 2–3	18(33.3)	4.9(3.0–14.8)	
Cyclin D1			
Positive	10(19.2)	4.1(1.9–8.2)	0.963
Negative	42(80.8)	3.9(1.6–15.6)	

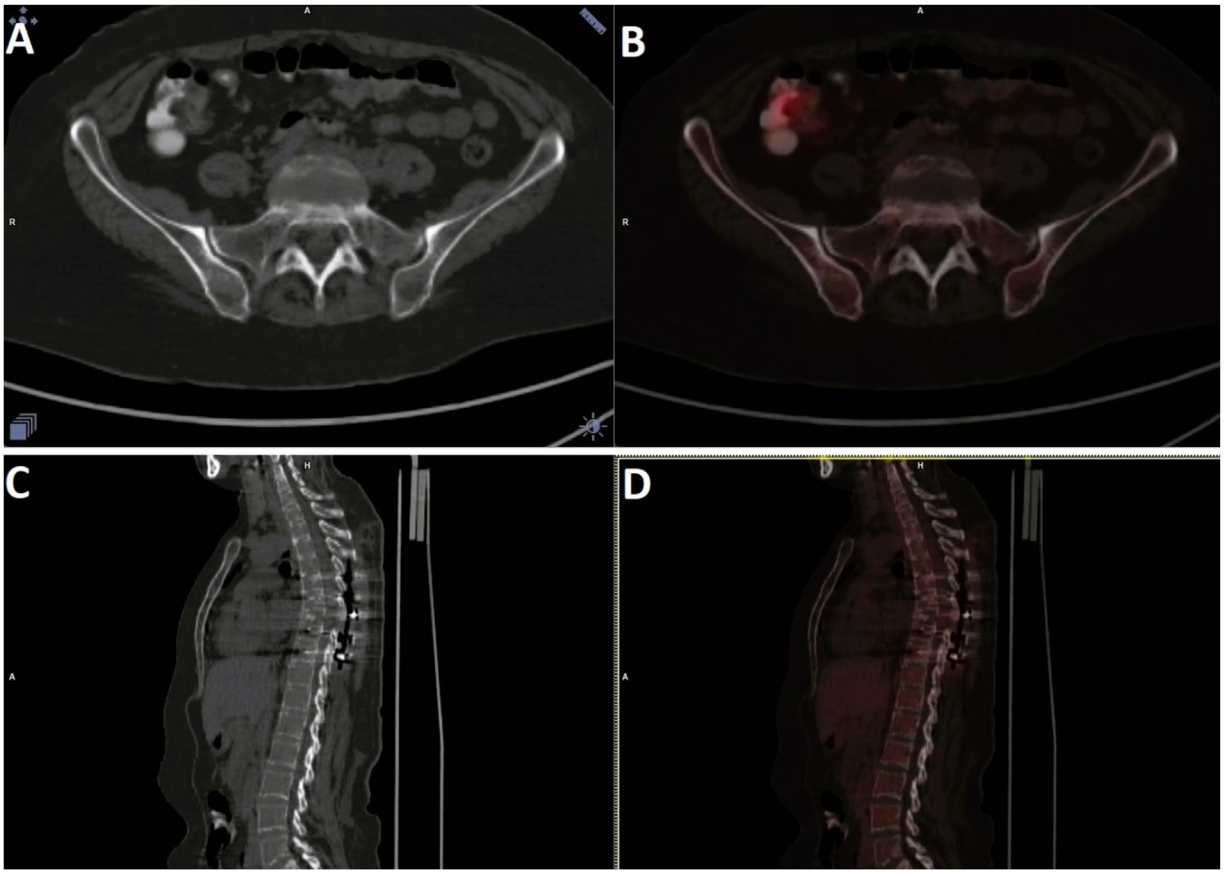

Figure 2. Axial CT (A), PET/CT fused images (B); Sagittal CT (C), PET/CT fused images (D) in a patient without bone marrow involvement. No pathological FDG uptake in the bone marrow in the PET/CT fused images (B, D).

In the evaluation of the PET/CT results, the median SUVmax value of the patients was determined to be 3.95 (range, 1.6–15.6). The median SUVmax value was 4.5 (1.9–15.6) in patients with CD117 positivity, which was statistically significantly higher than that of the patients with CD117 negativity ($p = 0.031$). The patients were separated into two groups according to the reticulin level, as the low fibrosis group (grade 0–1) and the increased fibrosis group (grade 2–3). The median SUVmax was statistically significantly higher at 4.9 (3.0–14.8) in the group with increased fibrosis compared to 3.6 (1.6–15.6) in the group with low fibrosis ($p = 0.004$). No statistically significant difference was determined in the comparisons of the SUVmax values when the patients were grouped according to the immunoglobulin heavy chain and light chain, CD20, CD44, CD56, and cyclin D1 characteristics ($p > 0.05$) (Table 2).

Discussion

As they are of guidance in planning the treatment for multiple myeloma, prognostic factors should be determined before starting treatment. In addition to other clinical and laboratory findings, the evaluation of bone marrow involvement is important. However, bone marrow involvement can show variations in multiple myeloma patients. In approximately 60% of patients, bone and bone marrow involvement is not homogenous and the accumulation of plasma cells in bone marrow and bone destruction is focal and patchy[16]. In routine clinical practice, biopsy is generally taken from the iliac bone as it can be performed more comfortably. To be able to make the optimal comparisons with the biopsy results, the SUVmax measurements in this study were taken from the iliac bone. The SUVmax was evaluated in respect of the power to be able to predict the histopathological data obtained from the bone marrow biopsy.

Consistent with other findings in literature[3], the greatest number of patients were found to be carrying IgG type M-protein, and approximately 65% (n:35) of the patients were in this group. Patients with IgA type M-protein were determined at the rate of 24%, and others at 11%. In addition, lambda (λ) light chain types were observed in 35% and kappa (κ) in 65%. When the patients were separated into heavy chain and light chain types, no significant difference was determined between the groups in respect of the bone marrow SUVmax values ($p > 0.05$). No other study could be found in literature which has made such a comparison.

Immunophenotype characteristics are known to affect disease prognosis in multiple myeloma patients[6–9]. In the current study, the relationship was investigated between SUVmax and the immunophenotype characteristics of CD20, CD44, CD56, and CD117 antigen expression. The study results demonstrated that the bone marrow SUV max values of patients with CD117 positivity were significantly higher than those of patients with CD117 negativity ($p = 0.031$). No statistically significant differences were observed in the other antigen expressions ($p > 0.05$). There are several studies on this point in literature. Cengiz et al.[22] evaluated the relationship between bone marrow FDG uptake and CD38, and CD138 expression in plasma cells, and found a statistically significant positive correlation between bone marrow FDG uptake and CD38 and CD138 expression ($r = 0.339$, $r = 0.409$). In this study, the percentage of staining of CD38 and CD138 antigens was examined with immunohistochemistry. Antigen expressions in our study were evaluated as positive and negative, and the positive cases were not classified according to the staining percentage. Although not a PET/CT study, Ceran et al.[23] examined the relationship between CD56 and CD117 expressions and clinical and laboratory findings. The levels of CD56 and CD117 expressions were

observed to be lower at advanced stages compared to early stages ($p = 0.026$, $p = 0.017$). However, in the current study, the bone marrow SUVmax values were determined to be significantly higher in patients with CD117 positivity compared to those who were negative.

Myelofibrosis is an event prepared with cytokines in the bone marrow stroma. In myelofibrosis, stromal stricture is increased in bone marrow biopsies. Reticulin staining (reticulin fibrosis) is seen in several benign and malignant conditions. Scoring of the degree of myelofibrosis is based on the subjective evaluation of the pathologist, as 4 categories according to the European Consensus Method; Grade 0: bone marrow with no increased fibre, Grade 1: bone marrow with slight fibre increase, Grade 2: bone marrow with moderate fibre increase, Grade 3: bone marrow with dense fibre increase. In the current study, Grade 0 and Grade 1 were classified as the low fibrosis group, and Grade 2 and Grade 3 as the increased fibrosis group[21,24].

Myelofibrosis can develop in several conditions. Leukemia, lymphoma, multiple myeloma, granulomatous diseases of the bone marrow, exposure to some chemical substances and non-hematological tumours metastasizing to the bone marrow can lead to the development of fibrosis in the bone marrow. The first histological classification in multiple myeloma was defined by Barth et al. in 1987 based on bone marrow biopsy findings and the importance of morphological findings was determined[25]. The presence of fibrosis in the bone marrow is known to be a parameter of prognostic importance in patients with multiple myeloma. However, bone marrow fibrosis is a rarely reported condition. It was first reported in 1985 by Vandermolen et al., as increased connective tissue in some myeloma patients, which was not associated with idiopathic myelofibrosis and the relationship with myeloma fibrosis was stated to be of clinical and prognostic importance[26].

The presence of bone marrow fibrosis during diagnosis of multiple myeloma has been reported at rates of 8.8%–20.5%[10]. Singhal et al. reported this rate to be higher at 30%[27]. When the current study patients were classified as two groups of low and increased fibrosis, there was seen to be increased fibrosis in 33.3% of the patients. This is a higher rate than that of several studies in literature. Despite many older and more recent studies in literature related to bone marrow fibrosis in MM patients[10,25,28,29], no study could be found that has examined whether or not there is a relationship between PET/CT data and bone marrow fibrosis. Therefore, the current study can be considered to make a valuable contribution to the literature. The results of this study demonstrated that the bone marrow SUVmax values were significantly higher in the increased fibrosis group than in the low fibrosis group ($p = 0.004$). This finding suggests that the plasma cell infiltration in the bone marrow of the increased fibrosis group was greater than in the other group.

Other than the plasma cell percentage and the presence of bone marrow fibrosis in the bone marrow biopsies, the infiltration pattern should also be evaluated in multiple myeloma. In approximately 60% of patients, bone and bone marrow involvement is not homogenous and the accumulation of plasma cells in bone marrow and bone destruction is focal and patchy[16]. Moreover, as the rate of plasma cell infiltration increases, so the rate of a diffuse pattern increases. In >50% of patients plasma cell infiltration is seen to be mostly diffuse or close to diffuse. Barth et al. showed a diffuse infiltration pattern together with increased fibrosis[25]. In the current study, the patients were not separated according to the bone marrow infiltration pattern. Although this could be considered a limitation of the study, the aim of this research was to compare the SUVmax value obtained from the iliac bone as the most frequently used routine biopsy site with the results of the biopsy taken from the same area. More accurate results are obtained with bone marrow biopsies when there is diffuse homogenous bone marrow involvement, but in patients with patchy form involvement, the ideal biopsy area is evaluated as the place where the highest metabolic activity is measured on PET/CT. However, this is not easy in routine clinical application. In the light of all this information, it was aimed in this study to evaluate whether or not the bone marrow biopsy data in the region where SUVmax was measured could be predicted by the SUVmax value.

Cyclins are an important protein family among cell cycle regulators. The passage from G1 to S phase in the cell cycle is controlled by cyclin proteins. Several oncogenes and tumour suppressor genes with a role in the cell cycle have been associated with errors at the G1 checkpoint. Cyclin D1 is an important protein for the regulation of the cell cycle from G1 phase to S phase. Over-expression of cyclin D1 protein accelerates the G1/S passage, and this over-expression has been associated with short survival and the risk of metastasis[30–32]. In literature, cyclin D1 positivity has been shown in approximately 15–20% of multiple myeloma patients[14,33]. Consistent with the literature, cyclin D1 positivity was determined in 19.2% of the current study patients. However, no significant relationship was determined between SUVmax and cyclin D1 ($p = 0.963$).

Conclusion

In this study, bone marrow FDG uptake and bone marrow biopsy data were compared in MM patients who underwent initial staging with PET/CT. A statistically significant relationship was found between the SUVmax value and bone marrow fibrosis, which is an important prognostic factor, and with CD117 antigen. In patients with increased fibrosis and CD117 positivity, the SUVmax value was determined to be higher. This was a single-centre study and retrospective in design. Therefore, it can be considered that further prospective studies with greater numbers of patients could provide more significant results.

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