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PET/CT IN ASSESSING THE LYMPHOMA RESPONSE TO TREATMENT

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ABSTRACT

Relevance: *PET/CT has become an integral part of the diagnostic algorithm in lymphoma patients since lymphomas actively accumulate ^{18}F-FDG. The high accuracy of PET/CT in patients with certain lymphoma types allows effective use of this method in clinical practice for diagnosis, staging, re-staging, evaluating the effectiveness of treatment, and determining further patient management tactics.*

The study aimed to *evaluate the PET/CT capacity in assessing lymphoma treatment effectiveness.*

Methods: *We conducted a retrospective analysis of PET/CT ^{18}F-FDG results in 109 patients with a verified lymphoma diagnosis. The patients underwent PET/CT examinations at "Orhun Medical" PET/CT center based in the JSC "Kazakh Institute of Oncology and Radiology" (Almaty, Kazakhstan).*

Results: *According to PET/CT results in assessing the lymphoma treatment effectiveness, the stabilization of the process was achieved in 38.5% of cases, progression – in 33.03%, a partial metabolic response – in 18.35%, and a complete response – in 10.09% of cases.*

Conclusion: *PET/CT is the method of choice for evaluating the effectiveness of lymphoma treatment compared to other radiological techniques. PET/CT is based on determining metabolic treatment response, not only on size indicators. It plays an essential role in different stages of lymphoma treatment, providing new opportunities for personalized treatment.*

Keywords: *positron emission computed tomography (PET/CT), ^{18}F-FDG, lymphoma, treatment response.*

Introduction: Lymphomas are a heterogeneous group of malignant tumors that can be divided into two main subgroups: Hodgkin lymphomas and non-Hodgkin lymphomas [1]. After histological verification of the lymphoma diagnosis, the next step is staging, which is essential for monitoring and assessing the treatment effectiveness and predicting the outcome [2].

Despite the significant progress in lymphoma treatment, many patients still fail to respond positively to the therapy and later relapse [3, 4].

Current imaging techniques (ultrasound investigation, positron emission tomography (PET), computed tomography (CT), magnetic resonance imaging) have some restrictions since they mainly rely on dimensional-anatomical criteria. At that, positron emission computed tomography (PET/CT) offers high diagnostic accuracy. PET/CT is gaining popularity in diagnosis, staging, and assessment of treatment effectiveness [5].

^{18}F-FDG PET/CT is a recognized imaging technique for FDG-avid lymphomas [6, 7]. Currently, there are several offers on the response assessment techniques using ^{18}F-FDG PET/CT from the point of view of the target lesions and quantitative indicators. One technique recommends measuring a single representative lesion's standardized uptake value (SUV), while the other recommends measuring the tumor diameters [8-10]. Thus, the techniques of assessing the treatment response using quantitative indicators provided by ^{18}F-FDG PET/CT need further clarification and validation [11-13].

The study aimed to evaluate the PET/CT capacity in assessing lymphoma treatment effectiveness.

Materials and Methods: We conducted a retrospective analysis of ^{18}F-FDG PET/CT findings in 109 patients, including 45 with verified Hodgkin lymphoma and 64 with non-Hodgkin lymphoma. The study involved 49 men and 60 women aged from18 to 87; the average age was 51.5 years. The patients underwent PET/CT examinations at "Orhun Medical" PET/CT center based in the JSC "Kazakh Institute of Oncology and Radiology" (Almaty, Kazakhstan).

Treatment effectiveness was assessed using the quantitative assessment of the metabolic response by measuring the standardized uptake level 18F-FDG – SUVmax before and after treatment. The assessment results were distributed among the following categories: complete metabolic response, partial metabolic response, stabilization, and advance. The criteria for quantitative assessment of lymphoma treatment effectiveness according to 18F-FDG PET/CT findings are provided in Table 1.

Table 1 – Quantitative assessment of 18F-FDG PET/CT findings

Full metabolic response	No 18F-FDG uptake
Partial metabolic response	Decrease in 18F-FDG uptake by more than 30%
Stabilization	Decrease in 8F-FDG uptake by less than 30%
Advance	Increase of 18F-FDG uptake by more than 30% and/or occurrence of the new nidus.

Results: Frequent localizations of the nidus were analyzed during the study. Table 2 shows the most frequent system lesions of lymph nodes of different groups and coexisting lesions of the organ and lymph nodes typical for both Hodgkin and non-Hodgkin lymphomas. At that, isolated bone, mammary glands, and spleen thyroid gland, spleen lesions were less frequent and found only in patients with non-Hodgkin lymphoma.

Table 2 – Distribution as per nidus localization

Nidus localization	Hodgkin lymphoma	Non-Hodgkin lymphoma
	abs. (%)	abs. (%)
Isolated lungs lesion	0	2 (3.1%)
System lesion of intramammary lymph nodes	5 (11.11%)	6 (9.4%)
Isolated palatine tonsil lesion	0	2 (3.1%)
Coexistent lesion of the organ + lymph nodes	14 (31.11%)	23 (35.9%)
System lesion of different groups lymph nodes	18 (40%)	22 (34.4%)
Isolated lesion of inguinal nodes	1 (2.22%)	0
Isolated lesion of cervical lymph nodes	6 (13.33%)	1 (1.6%)
Isolated lesion of suprailiac lymph nodes	1 (2.22%)	0
Mammary glands lesion	0	1 (1.6%)
Spleen lesion	0	1 (1.6%)
Bone lesion	0	5 (7.8%)
Thyroid gland lesion	0	1 (1.6%)
Total	45 (100%)	64 (100%)

Table 3 shows the average size of lesions and average SUVmax by lymphoma type and lesion localization.

Table 3 – Distribution of lesions according to average size and average SUVmax

Nidus localization	Hodgkin Lymphoma n=45 (100%)		Non-Hodgkin Lymphoma n=64 (100%)	
	Max average size	SUV average	Max average size	SUV average
Isolated lymph node involvement	-	-	>2.5 cm (1.6%)	38.74
Coexistent lesions in lymph nodes	-	-	>1.3 cm (3.1%)	5.74
Isolated lungs lesion	-	-	>7.7 cm (1.6%)	16.5
Isolated palatine tonsil lesion	-	-	>1.1 cm (1.6%)	6.01
System lesion of intramammary lymph nodes	>4.45 cm (11.11%)	8.01	>1.42 cm (10.2%)	2.68
Coexistent lesion of the organ + lymph nodes	>2.35 cm (31.11%)	7.63	>1.29 cm (34.5%)	4.43
System lesion of different groups lymph nodes	>2.7 cm (40.12%)	6.18	>1.78 cm (34.5%)	7.58
Isolated lesion of inguinal nodes	>1.0 cm (2.22%)	9.06	-	-
Isolated lesion of cervical lymph nodes	>1.76 cm (13.22%)	6.29	>1 cm (1.6%)	2.77
Isolated lesion of suprailiac lymph nodes	>1,1 cm (2,22%)	2,19	-	-
Bone lesions	-	-	>8.8 cm (8.1%)	7.7
Mammary gland lesions	-	-	>1.7 cm (1.6%)	5.25
Spleen lesions	-	-	>1.1 cm (1.6%)	7.94

Table 4 offers the assessment details of lymphoma treatment effectiveness by quantitative criteria.

Table 4 – Assessment of lymphoma treatment effectiveness by quantitative criteria

Treatment effectiveness	Hodgkin lymphoma, abs. (%)	Non-Hodgkin lymphoma, abs. (%)	Total, abs. (%)
Process stabilization	15 (33.33%)	27 (42.18%)	42 (38.5%)
Process advancement	19 (42.22%)	17 (26.56%)	36 (33.03%)
Partial metabolic response	8 (17.78%)	12 (18.75%)	20 (18.35%)
Full metabolic response	3 (6.67%)	8 (12.51%)	11 (10.09%)
Total	45 (100%)	64 (100%)	109 (100%)

During the analysis of treatment effectiveness based on the metabolic response, 42 patients showed process stabilization, 36 – process advancement, 20 – partial regression, and 11 – complete regression (Table 4).

Discussion: CT was viewed as the technique of choice in the ongoing monitoring of oncology patients for the treatment response assessment. However, the results were based on the changes in tumor size that different observers may identify differently. The CT does not make it possible to detect the changes that occurred in treatment response [14]. It is challenging to differentiate necrotic tissue or a fibrous scar from the residual tumor [15]. Changes in the tumor sizes are not actual markers of therapeutic efficiency since tumor tissue comprises different components, not all of which fully regress over time [16]. Thus, more satisfactory assessment techniques for accurate quantitative measuring of the tumor response are necessary. PET with 18G-FDG overcomes these restrictions and has become an essential part of managing lymphoma patients to identify the stage and assess the treatment response [17-20]. The 18F-FDG PET/CT technique, which is the integrated anatomic and metabolic imaging, gave origin to using PET to assess the treatment response with solid tumors and hematological malignant tumors [21].

This study aimed to identify the PET/CT capacity in assessing the lymphoma treatment effectiveness. We made a quantitative analysis of treatment effectiveness assessment in 109 patients with Hodgkin and non-Hodgkin lymphomas. Quantitative analysis was held based on changes in the SUV indicators before and after treatment to assess metabolic treatment response.

Following the study results, process stabilization was achieved in most of the patients studied (46/109); the advance occurred in 36 patients; the partial metabolic response was achieved in 20 patients, and the complete metabolic response – in 11 patients.

Our study had some restrictions: analysis was held retrospectively; there was no follow-up of the patients to correlate our results with patients' survival. A multi-center study and the cooperation of research groups may be needed to recruit more lymphoma patients in the study and achieve more accurate results.

Conclusion: According to the PET/CT data, in lymphoma treatment, process stabilization was achieved in 38.5% of cases; the advance has occurred in 33.03%; the partial metabolic response was achieved in 18.35%, and complete response – in 10.09% of cases.

PET/CT is the method of choice for evaluating the effectiveness of lymphoma treatment compared to other radiological techniques. PET/CT is based on determining metabolic treatment response, not only on size indicators. It plays an essential role in different stages of lymphoma treatment, providing new opportunities for personalized treatment.

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ТҰЖЫРЫМ

ЛИМФОМАЛАРДЫ ЕМДЕУ ТИІМДІЛІГІН БАҒАЛАУДАҒЫ ПЭТ/КТ

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Өзектілігі: *ПЭТ/КТ 18F-FDG белсенді жинақталуымен сипатталатын лимфомасы бар науқастарда диагностикалық алгоритмнің құрамдас бөлігіне айналды. Лимфомалардың белгілі бір түрлерімен ауыратын науқастарда ПЭТ/КТ жоғары дәрежедегі диагностика, сатысын анықтау, сатысын қайта анықтау, емдеу тиімділігін бағалау және пациентті одан әрі басқару тактикасын анықтау үшін әдісті клиникалық тәжірибеде тиімді пайдалануға мүмкіндік береді.*

Мақсаты: *Лимфомаларды емдеудің тиімділігін бағалауда ПЭТ/КТ мүмкіндіктерін бағалау.*

Материалдар мен тәсілдер: *лимфома диагнозы расталған 109 пациентке 18F-FDG ПЭТ/КТ зерттеулерінің деректеріне ретроспективті талдау жүргізілді. ПЭТ/КТ зерттеулері «Қазақ онкология және радиология институты» АҚ (Алматы, Қазақстан) базасында «Орхун Медикал» ПЭТ/КТ орталығында жүргізілді.*

Нәтижелер: *Лимфомаларды емдеудің тиімділігін бағалауда ПЭТ/КТ деректері бойынша 38,5% жағдайда процестің тұрақталуына қол жеткізілді, 33,03% жағдайда прогрессия, 18,35% жағдайда ішінара метаболикалық жауап, толық жауап 10,09% жағдайда қол жеткізілді.*

Қорытынды: *ПЭТ/КТ басқа радиологиялық әдістермен салыстырғанда лимфоманы емдеудің тиімділігін бағалаудың таңдау әдісі болып табылады, өйткені ол тек өлшемдік көрсеткіштер бойынша ғана емес, емдеуге метаболикалық жауапты анықтауға негізделген және лимфоманы емдеудің әртүрлі кезеңдерінде маңызды рөл атқарады және жеке емдеуге бағытталған қадамды білдіреді.*

Түйінді сөздер: *позитронды-эмиссиялық компьютерлік томография, ^{18}F-ФДГ, лимфома, емдеу тиімділігі.*

АННОТАЦИЯ

ПЭТ/КТ В ОЦЕНКЕ ЭФФЕКТИВНОСТИ ЛЕЧЕНИЯ ЛИМФОМ

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Актуальность: *ПЭТ/КТ стала неотъемлемой частью диагностического алгоритма у пациентов лимфомами, которые характеризуются активным накоплением 18F-ФДГ. Высокая точность ПЭТ/КТ у пациентов с некоторыми типами лимфом позволяет эффективно использовать метод в клинической практике для диагностики, стадирования, рестадирования, оценки эффективности лечения и определения дальнейшей тактики ведения пациента.*

Цель исследования *– оценить возможности ПЭТ/КТ в оценке эффективности лечения лимфом.*

Материалы и методы: *проведен ретроспективный анализ данных ПЭТ/КТ исследований с 18F-ФДГ, 109 пациентов с верифицированным диагнозом лимфома. ПЭТ/КТ исследования проведены в центре ПЭТ/КТ «Орхун Медикал» на базе АО «Казахский институт онкологии и радиологии» (Алматы, Казахстан).*

Результаты: *По данным ПЭТ/КТ, при лечении лимфом стабилизация процесса была достигнута в 38,5% случаев, прогрессирование – в 33,03%, частичный метаболический ответ– в 18,35%, полный ответ – в 10,09% случаев.*

Заключение: *ПЭТ/КТ является методом выбора для оценки эффективности лечения лимфом в сравнении с другими радиологическими методами, так как основывается на определении метаболического ответа на лечение, а не только на размерных показателях, и играет важную роль на различных этапах лечения лимфом представляя собой новые возможности на пути к персонализированному лечению.*

Ключевые слова: *позитронно-эмиссионная компьютерная томография, ^{18}F-ФДГ, лимфома, эффективность лечения.*

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