Comparison of the quantitative measurement of 18F-FDG PET/CT and histopathological findings in IgG4-related disease

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Abstract

Background

Although there is increasing use of $^{18}$F-FDG PET/CT in the diagnostic procedure for IgG4-related disease (IgG4-RD), little is known about the quantification of $^{18}$F-FDG PET/CT. We aimed to evaluate the utility of the quantification of $^{18}$F-FDG PET/CT in the diagnosis of IgG4-RD by analyzing the relation between $^{18}$F-FDG PET/CT findings and histopathologic findings.

Methods

Twenty-one patients with IgG4-RD, in whom $^{18}$F-FDG PET/CT was performed at the time of diagnosis between November 2011 and July 2018, were enrolled. Tissue biopsy was performed at 24 sites in 21 patients. To perform quantitative analysis of $^{18}$F-FDG PET/CT imaging, the highest standardized uptake value (SUV) of the pixels ($\text{SUV}_{\text{max}}$) and the average SUV ($\text{SUV}_{\text{mean}}$) within the biopsied lesion were measured. The $\text{SUV}_{\text{mean}}$ of the liver was also measured as a reference.

Results

The mean age at diagnosis was 64.6 ± 11.9 years, and the median serum IgG4 level was 650 mg/dl. Histological findings were consistent with IgG4-RD (histopathology-positive) at 19 out of 24 sites. Although there was no significant difference in the values of $\text{SUV}_{\text{max}}$ between histopathology-positive and histopathology-negative tissues, the values of $\text{SUV}_{\text{mean}}$ were significantly higher in the histopathology-positive tissue than those in the histopathology-negative tissue (4.98 and 3.54, respectively $P < 0.05$). The value of $\text{SUV}_{\text{mean}}$/liver were also higher in the histopathology-positive tissue (2.17 and 1.52, respectively $P < 0.05$). To establish a cut-off value of $\text{SUV}_{\text{mean}}$ to determine which of multiple lesions should be biopsied, a receiver operating characteristic (ROC) curve was constructed. ROC curve analysis indicated $\text{SUV}_{\text{mean}}$ = 4.07 or $\text{SUV}_{\text{mean}}$/liver = 1.66 as a cut-off value that could discriminate IgG4-RD-related lesions.

Conclusions

Our present study suggested that quantitative analysis of $^{18}$FDG-PET/CT imaging might be useful for selecting the biopsy site in IgG4-RD. The calculation of $\text{SUV}_{\text{mean}}$, not of $\text{SUV}_{\text{max}}$, is important for evaluating IgG4-RD-related lesions in $^{18}$F-FDG PET/CT imaging.

Introduction

IgG4-related disease (IgG4-RD) is a systemic fibroinflammatory condition characterized by IgG4-positive plasma cell infiltration of the affected organs or tissue resulting in organ enlargement and organ fibrosis$^{1,2}$. The commonly affected organs are the lacrimal glands, salivary glands, periorbital tissue, pancreas, lymph nodes, retroperitoneal tissue, lung, kidney, and skin, and dysfunctions of these organs are sometimes caused as a consequence$^{3,4}$. The diagnosis of IgG4-RD is based on the combination of characteristic histopathologic, clinical, serologic, and radiologic findings$^{5,6}$. IgG4-RD should also be differentiated from multiorgan disorders that may present organ enlargement, lymph node swelling, and tumor-like swelling, such as lymphoproliferative disease and neoplastic disease$^{6,7}$. Thus, it is important to biopsy the organ or tissue that is suspected to be affected by IgG4-RD not only for diagnostic but also differential diagnostic purposes. However, until now, little has been known about the method of selecting the biopsy site from multiple suspected lesions. Also, depending on the organ involved, e.g. the aorta or pituitary gland, a biopsy is sometimes a difficult and invasive procedure. Thus,
a non-invasive method that can provide useful information for selecting a biopsy site that is suspected of being IgG4-RD-associated from among the lesions is needed.

$^{18}$F-fluoro-deoxy-glucose positron emission tomography/computed tomography ($^{18}$F-FDG PET/CT) is a functional imaging procedure that is widely used in the diagnosis, staging, treatment response, and relapse monitoring of various types of malignancies, including malignant lymphomas. It may be considered a valuable tool in the workup of patients with newly diagnosed IgG4-RD, in particular for the detection of multiple organ involvement. Additionally, there is growing evidence that $^{18}$F-FDG uptake is correlated with the treatment response.

Quantitative analysis of PET parameters is a more accurate, objective, and reproducible means of assessing PET images. The utility of the quantification of $^{18}$F-FDG PET/CT for the differential diagnosis of patients clinically suspected of having IgG4-RD had been reported. In those studies, $^{18}$F-FDG uptake was lower in IgG4-RD than in malignancies. However, the appropriate method of quantifying $^{18}$F-FDG PET/CT may differ by disease, and a suitable method for use in Ig4-RD patients remains unknown. To identify or suspect the IgG4-RD-associated lesions among multiple lesions with $^{18}$F-FDG uptake using a semiquantitative method, an appropriate method for quantification is needed. Such a method would contribute to the selection of a biopsy site for diagnosis. Here, we evaluated the utility of quantifying $^{18}$F-FDG PET/CT in the diagnosis of IgG4-RD by analyzing the relation between $^{18}$F-FDG PET/CT findings and histopathologic findings. In addition, we determined the optimal method for the quantification of $^{18}$F-FDG-PET/CT in IgG4-RD.

### Patients And Methods

**Patients**

Patients were recruited from the Department of Immunology and Rheumatology, Nagasaki University Graduate School of Biomedical Sciences, Isahaya General Hospital, and Nagasaki Medical Center. A total of 21 consecutive patients, in whom $^{18}$F-FDG PET/CT was undertaken at the time of diagnosis between November 2011 and July 2018, were enrolled. All patients fulfilled the comprehensive diagnostic criteria for IgG4-RD and 2019 American College of Rheumatology (ACR) /European League Against Rheumatism (EULAR) classification criteria for IgG4-RD. The decision as to whether to undergo $^{18}$F-FDG PET/CT in order to exclude other diseases or to evaluate the organ involvement of IgG4-RD were made by each physician with the agreement of each patient. Tissue biopsies for at least one lesion with abnormal $^{18}$F-FDG uptake were performed in all patients during the diagnostic procedure. The patients gave their informed consent to be subjected to the protocol, which was approved by the Institutional Review Board (IRB) of Nagasaki University (IRB approval no.: 17091109).

We retrospectively reviewed the clinical, laboratory, and histopathological features and findings of $^{18}$F-FDG PET/CT and evaluated the clinical course for 1 year.

**Histopathological findings**

Tissue biopsy was performed at the time of diagnosis. According to pathologic criteria for diagnosis of IgG4-RD proposed by the comprehensive diagnostic criteria for IgG4-RD and 2019 ACR/EULAR classification criteria for IgG4-RD, we defined tissue that exhibited the following histopathological characteristics as histopathology-positive tissue. These histopathological characteristics include marked lymphocyte and plasmacytic infiltration with fibrosis, infiltration of IgG4-positive plasma cells with the ratio of IgG4+/IgG + cell > 40%, and an elevated number of IgG4 + plasma cells per high power field (> 10).

**$^{18}$F-FDG PET/CT imaging**
All patients underwent a $^{18}$F-FDG PET/CT scan on a dedicated PET/CT system (Siemens Biograph mCT, Germany, or Siemens Biograph 16true point, Germany, or GE Discovery ST, Wisconsin, USA) consisting of a PET scanner and a 64-row multidetector CT scanner. The patients fasted for more than 5 hours before the intravenous injection of $^{18}$F-FDG. $^{18}$F-FDG was injected intravenously at 180–325 MBq. One hour after the $^{18}$F-FDG injection, the scanning was performed from the middle of the thigh to the top of the skull. The CT data were used for calibration (attenuation correction). $^{18}$F-FDG uptake was assessed at the site of major organ involvement of IgG4-RD, which could be differentiated from the normal uptake of background tissue with $^{18}$F-FDG PET/CT.

**Image analysis**

For quantitative analysis, PET/CT images were extracted. We measured the highest standardized uptake value (SUV) of the pixels ($SUV_{\text{max}}$) and the average SUV ($SUV_{\text{mean}}$) within the biopsied tissue using Metavol, which is a dedicated open-source software (Fig. 1)\textsuperscript{18}. We also measured the $SUV_{\text{mean}}$ of the liver as a reference. Then, we calculated the ratio between the $SUV_{\text{mean}}$ of the biopsied tissue and the $SUV_{\text{mean}}$ of the liver ($SUV_{\text{mean}}$/liver).

**Statistical analysis**

GraphPad prism software (GraphPad Software, San Diego, CA) and JMP Statistical Software (SAS Institute, Cary, NC) were used for the statistical analysis. We used the Kolmogorov-Smirnov test to check the normal distribution, and an unpaired student’s T test was used to detect statistically significant differences in the value of SUV. Receiver operating characteristic (ROC) curves were constructed to establish the cut-off values of $SUV_{\text{mean}}$ and $SUV_{\text{mean}}$/liver on which to base biopsy decisions. P-values less than 0.05 were considered to indicate statistical significance.

**Results**

**Baseline characteristics of the patients and disease course**

The subjects’ characteristics are listed in Table 1. There were 21 patients (11 males, 10 females).

The salivary gland and lymph node were the most commonly affected organs (71.4%), followed by the lacrimal gland (28.6%), pancreas (23.8%), retroperitoneum/abdominal aorta (19.0%), prostate (14.3%), and bile duct (4.8%). The median levels of eosinophils, C-reactive protein(CRP), IgE, and IgG4 were 250/µl (interquartile range, 183–392), 0.15 mg/dl (range, 0.05–0.3), 196.3 IU/mL (125.6-1254.6), and 650 mg/dL (223.5–1075), respectively. The disease course of 11 patients could be analyzed in this study. After the diagnosis of IgG4-RD, prednisolone treatment was initiated in all of these patients, and there was no relapse for one year.

Table 1. Clinical characteristics of the study population.
| Parameters                      | 64.6 ± 11.9 |
|--------------------------------|-------------|
| Age at onset (years)            |             |
| Female, n (%)                   | 10 (47.6)   |
| **Organ involvement, n (%)**    |             |
| Lacrimal gland                  | 6 (28.6)    |
| Salivary gland                  | 15 (71.4)   |
| Lymph node                      | 15 (71.4)   |
| Pancreas                        | 5 (23.8)    |
| Bile duct                       | 1 (4.8)     |
| Prostate                        | 3 (14.3)    |
| Retroperitoneum/Abdominal aorta | 4 (19.0)    |
| Number of affected organs       | 3.6 ± 1.9   |

| Serological features            |             |
| Eosinophils, (median [IQR])     | 250 [183-392]|
| CRP (mg/dL), (median [IQR])     | 0.15 [0.05-0.3]|
| IgE (IU/mL), (median [IQR])     | 196.3 [125.6-1254.6]|
| IgG4 (mg/dL), (median [IQR])    | 650 [223.5-1075]|
| IgG4/IgG ratio, (median [IQR])  | 0.24 [0.13-0.42]|
| sIL2R (U/ml), (median [IQR])    | 801 [465.3-1427.5]|

Data are mean ± standard deviation (SD) unless otherwise indicated.

*IQR* interquartile range, *CRP* C-reactive protein, *IgE* immunoglobulin E, *IgG4* immunoglobulin G4, *IgG* immunoglobulin G, *sIL2R* soluble interleukin-2 receptor

### Quantitative 18 F-FDG PET/CT findings and histopathological findings

Tissue biopsy was performed at 24 sites (lymph node 4, submandibular gland 10, prostate gland 4, pancreas 2, thyroid gland 1, lung 1, retroperitoneum 1, and kidney 1) in 21 patients. Among these 24 sites, 19 tissues were histopathology-positive, whereas the histopathological findings for the other 5 tissues were not consistent with the pathologic criteria for the diagnosis of IgG4-RD (Table 2). These 5 histopathology-negative tissues were also
not consistent with other diseases such as malignant lymphoma. Almost all of these histopathological findings showed lymphocyte and plasmacytic infiltration with few/no IgG4-positive cells.

Table 2. Biopsy site and histopathological findings

| Biopsy site          | Histopathology-positive | Histopathology-negative |
|----------------------|--------------------------|-------------------------|
| Lymph node           | 4                        | 0                       |
| Submandibular gland  | 9                        | 1                       |
| Prostate             | 2                        | 2                       |
| Pancreas             | 1                        | 1                       |
| Thyroid              | 0                        | 1                       |
| Lung                 | 1                        | 0                       |
| Retroperitoneum      | 1                        | 0                       |
| Kidney               | 1                        | 0                       |

The values of $SUV_{\text{max}}$ and $SUV_{\text{mean}}$ for each organ and $SUV_{\text{mean}}/\text{liver}$ are summarized in Table 3. The IgG4-RD-involved organ with the highest $SUV_{\text{max}}$ was the lung, and the lowest was the retroperitoneum (7.61 and 3.37, respectively), and the same tendency was seen in the analysis of $SUV_{\text{mean}}$ (6.04 and 3.06, respectively). However, in the analysis of the ratio between $SUV_{\text{mean}}$ and $SUV_{\text{mean}}/\text{liver}$ of the liver, the organ that showed the highest value was the lymph node, while the prostate showed the lowest (2.48 and 1.43, respectively). There were no significant differences in the values of $SUV_{\text{max}}$, $SUV_{\text{mean}}$ and $SUV_{\text{mean}}/\text{liver}$ among the organs. The mean values of $SUV_{\text{max}}$, $SUV_{\text{mean}}$, $SUV_{\text{mean}}/\text{liver}$ in all sites were 5.26, 4.68 and 2.04, respectively.

Table 3. Biopsy site and the value of standardized uptake value (SUV).
| Tissue                  | $SUV_{\text{max}}$ | $SUV_{\text{mean}}$ | $SUV_{\text{mean}}/\text{liver}$ |
|------------------------|--------------------|----------------------|----------------------------------|
| Lymph node             | 5.68 ± 2.39        | 5.17 ± 2.07          | 2.48 ± 1.17                      |
| Submandibular gland    | 5.94 ± 1.45        | 5.32 ± 0.90          | 2.27 ± 0.41                      |
| Prostate               | 3.69 ± 1.21        | 3.26 ± 0.93          | 1.43 ± 0.44                      |
| Pancreas               | 4.83 ± 0.23        | 4.25 ± 0.61          | 1.71 ± 0.27                      |
| Thyroid                | 4.39               | 3.88                 | 1.64                             |
| Lung                   | 7.61               | 6.04                 | 2.05                             |
| Retroperitoneum        | 3.37               | 3.06                 | 1.47                             |
| Kidney                 | 4.27               | 3.87                 | 1.92                             |
| Total                  | 5.26 ± 1.71        | 4.68 ± 1.36          | 2.04 ± 0.65                      |

Data are mean ± standard deviation (SD). $SUV_{\text{mean}}/\text{liver}$ was the ratio between the $SUV_{\text{mean}}$ of the biopsied tissue and the $SUV_{\text{mean}}$ of the liver.

$SUV$ standardized uptake value

**Comparison between $^{18}$F-FDG uptake and histopathological findings**

We next examined whether $^{18}$F-FDG uptake was correlated with histopathological findings. Although there was no significant difference in the value of $SUV_{\text{max}}$ between histopathology-positive and histopathology-negative tissues, the values of $SUV_{\text{mean}}$ were significantly higher in the histopathology-positive tissues (Fig. 2). The values of $SUV_{\text{mean}}/\text{liver}$ were also higher in those of the histopathology-positive group as compared to in the histopathology-negative tissue.

To calculate the cut-off value of $SUV_{\text{mean}}$ to determine which among multiple lesions is to be biopsied, a ROC curve was constructed (Fig. 3A). Curves were drawn for $SUV_{\text{mean}}$ and $SUV_{\text{mean}}/\text{liver}$, and the areas under the curves (AUCs) were 0.81 and 0.82, respectively. According to ROC curve analysis, at the best discriminative $SUV_{\text{mean}}$ cut-off of 4.07, the sensitivity and specificity were 79.0% and 80.0%, respectively. Moreover, ROC curve analysis found $SUV_{\text{mean}}/\text{liver} = 1.66$ to be the cut-off value with a sensitivity and specificity of 84.2% and 80.0%, respectively (Fig. 3B).

**Discussion**

We investigated the relation between the value of $SUV$ on $^{18}$F-FDG PET/CT imaging and the histopathological findings of suspected IgG4-RD-involved lesions. To avoid unnecessary biopsies and to select suitable lesions for biopsy in diseases with multi-organ involvement such as IgG4-RD, determining which lesion is suspected to be disease-involved using a non-invasive test is important. The results of this study indicated that the value of
**SUV\textsubscript{mean}, not SUV\textsubscript{max}, has good diagnostic performance in IgG4-RD.**

In IgG4-RD, \(^{18}\text{F}-\text{FDG}\) PET/CT has been reported to be more accurate and more sensitive for detecting the lesions associated with IgG4-RD as compared to other imaging techniques. Zhang et al. reported \(^{18}\text{F}-\text{FDG}\) uptake in multiple organs in 34 of 35 IgG4-RD patients, and \(^{18}\text{F}-\text{FDG}\) PET/CT imaging was able to detect more organ involvements in 25 of 35 patients as compared to conventional evaluations including ultrasonography and conventional CT\(^{12}\).

Another report revealed that all 21 IgG4-RD patients who underwent \(^{18}\text{F}-\text{FDG}\) PET/CT presented \(^{18}\text{F}-\text{FDG}\) uptake in typical IgG4-RD localizations, and some of these lesions were not detected by conventional CT, magnetic resonance imaging, or ultrasound\(^{10}\). Moreover, the correlation of disease activity and \(^{18}\text{F}-\text{FDG}\) PET/CT has also been reported \(^{10,13,14}\). \(^{18}\text{F}-\text{FDG}\) uptake was seen in all patients enrolled in our present study, and several lesions with \(^{18}\text{F}-\text{FDG}\) uptake were not detected by other imaging modalities (data not shown). Based on these previous studies, we further analyzed whether the characteristics of the region of interest (ROI) of \(^{18}\text{F}-\text{FDG}\) PET/CT imaging correlated with true lesions of IgG4-RD by comparing them with histopathology.

To analyze the characteristics of suspected IgG4-RD-involved lesions, quantitative analysis was performed. Additionally, to identify the optimal quantitative method for IgG4-RD, we also performed three methods of quantitative analysis. The optimal method for the quantification of PET/CT imaging might be different depending on the disease. For the differentiation of metastatic lesions of non-small-cell lung carcinoma from benign lymph nodes, the SUV\textsubscript{max} lymph node/ SUV\textsubscript{max} primary tumor ratio showed better diagnostic performance as compared to SUV\textsubscript{max} lymph node\(^{19,20}\). Another study showed that the median SUV was correlated with local recurrence of a squamous cell carcinoma of the anal canal but that SUV\textsubscript{mean} was not correlated with local recurrence\(^{21}\). In patients with head-and-neck cancer, SUV\textsubscript{mean}, not SUV\textsubscript{max}, was correlated with disease-free survival, and so SUV\textsubscript{mean} seemed to have the potential to become a prognostic factor in head-and-neck cancer\(^{22}\). Our present study showed that SUV\textsubscript{mean} and SUV\textsubscript{mean}/liver were significantly correlated with biopsy-proven IgG4-RD involvement, but that SUV\textsubscript{max} was not correlated. This is consistent with the results of other studies. Zhan et al. reported that diffusely elevated \(^{18}\text{F}-\text{FDG}\) uptake in organs should be considered to be more likely to indicate IgG4-RD lesions as compared to a patchy/nodule uptake pattern\(^{12}\). Diffused and enlarged tissues/organisms are clinicopathologic characteristics of IgG4-RD \(^{23,24}\), such as in the following examples: 1) diffuse infiltration of sinonasal mucosa with an IgG4-positive plasmacytic infiltrate in IgG4-reralted chronic rhinosinusitis; 2) diffusely thickened gastric mucosa on endoscopy in IgG4-related gastritis; 3) diffusely enlarged sausage-shaped pancreas in autoimmune pancreatitis (considered to be on the IgG4-RD spectrum); 4) homogenous thyroid grand enlargement in IgG4-related thyroiditis; and 5) diffuse kidney enlargement and diffuse immune complex deposition in the tubular basement membrane in IgG4-related kidney disease. These characteristics are also consistent with our study; namely, the comparison of SUV\textsubscript{mean} between tissues with abundant IgG4-positive plasmacytes and tissues with few/no IgG4-positive plasmacytes in our study showed more significant differences as compared to the analysis of SUV\textsubscript{max}. SUV\textsubscript{max} is the most commonly used \(^{18}\text{F}-\text{FDG}\) PET/CT parameter in daily clinical practice, and it is often included in imaging reports. It is simple and quick to measure, but SUV\textsubscript{max} may not represent the status of ROI in IgG4-RD because its value is taken from a single voxel. SUV\textsubscript{mean} within an ROI is supposed to represent disease status in IgG4-RD more precisely, as we found in this study; therefore, we should calculate SUV\textsubscript{mean} to identify IgG4-RD lesions. Furthermore, according to ROC curve analysis, the AUC using the value of SUV\textsubscript{mean}/liver was higher as compared to that using the value of SUV\textsubscript{mean}. This suggested that SUV\textsubscript{mean} was influenced by the individual hepatic metabolism, and SUV\textsubscript{mean}/liver might be more preferable.

ROC curve analysis also indicated SUV\textsubscript{mean}=4.07 or SUV\textsubscript{mean}/liver = 1.66 as the cut-off value that discriminated...
IgG4-RD-associated lesions. This value might be useful for selecting appropriate tissue for biopsy among multiple lesions that are suspected to be associated with IgG4-RD by $^{18}$F-FDG uptake or to determine if an $^{18}$F-FDG uptake lesion on which a biopsy cannot be performed is an IgG4-RD-associated lesion. However, this cut-off value should be interpreted with caution because the appropriate cut-off value might be different in each organ. For example, the SUVs in the prostate and pancreas were relatively low in our study, although the SUV values of those organs have been reported to be almost the same in normal subjects as compared to other organs\textsuperscript{25,26}. The appropriate cut-off value for each organ should be identified by analyzing a larger number of patients in the future.

Several limitations of this study must be mentioned. The number of patients was small, and the longitudinal analysis was not fully performed. We could evaluate the clinical course for one year in 11 out of 21 patients, but there were no relapses or progression of disease. We therefore could not compare the value of $^{18}$F-FDG PET/CT at baseline with respect to the treatment response or disease progression. To make PET/CT imaging more useful for the management of treatment for IgG4-RD, analysis of the relation of the SUV value with the treatment course such as an inadequate response to steroid treatment, the rate of relapse and concomitant use of immunosuppressant desistance is needed in a larger longitudinal study. The values of SUV\textsubscript{mean} of lymph node were relatively higher as compared to other tissues, and all histopathologic findings of lymph nodes were histopathology-positive in our present study. These results influenced the cut-off value in this study. The value of SUV\textsubscript{mean} of histopathology-negative lymph node should be compared with that of histopathology-positive lymph node, and mentioned above in the discussion section, further analysis is needed of the cut-off value of SUV\textsubscript{mean} focused on each organ using larger samples. Also, comparison of the SUV\textsubscript{mean} of IgG4-RD with those of other diseases such as malignant lymphoma was not done in this study. The utility of the quantification of PET/CT for differentiating IgG4-RD from other diseases should be assessed in a future study.

Conclusions

In conclusion, our present study suggested that quantitative analysis of $^{18}$F-FDG PET/CT imaging is useful for selecting the biopsy site in IgG4-related disease. The calculation of SUV\textsubscript{mean}, not of SUV\textsubscript{max}, is important for evaluating IgG4-RD lesions in $^{18}$F-FDG PET/CT imaging.

Abbreviations

IgG4-RD: IgG4-related disease, $^{18}$F-FDG PET/CT: $^{18}$F-fluoro-2-deoxy-D-glucose positron emission tomography/computed tomography, ACR: American College of Rheumatology, EULAR: European League Against Rheumatism, IRB: Institutional Review Board, SUV: standardized uptake value, ROC: Receiver operating characteristic, CRP: C-reactive protein, IgE immunoglobulin E, IgG4: immunoglobulin G4, IgG: immunoglobulin G, sIL2R: soluble interleukin-2 receptor, AUC: areas under the curve, ROI: region of interest

Declarations

Ethical Approval and Consent to participate: This study was performed in accordance with the Declaration of Helsinki and was approved by the Investigation and Ethics Committee at Nagasaki University. Patients gave their informed consent to be subjected to the protocol.

Consent for publication: Not applicable.

Availability of supporting data: Not applicable.
Competing interests: The authors declare that there are no conflicts of interest.

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Authors’ contributions: ST, NI: Conception and design of the study, analysis and interpretation of data and drafting the article. ST, YH, KF, YF, SF: Collection and assembly of data. ST, NI, RI, TK: Analysis and interpretation of data of $^{18}$F-FDG PET/CT findings. SF, MT, SN, MO, YT, YE, TS, ToK, SK, TI, KI, MaT, HN, TO, AK: Analysis and interpretation of data, critical revision the manuscript. NI, AK: supervised the project. All authors have given their final approval of the manuscript to be published as presented.

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Figures

SUVmax = 6.158
SUVmean = 4.337
SUVmax = 6.158
SUVmean = 4.337
Figure 1

18F-FDG-PET imaging results in patients with IgG4-RD using Metavol software. The upper panel shows a fusion image of FDG and CT. Circle (white arrow) indicates the standardized uptake value (SUV)-measurement region. Color indicates the level of FDG activity (red areas indicate high FDG activity). Prostate is showing strong uptake. The lower panel shows a CT image of the same area. 18F-FDG-PET 18F-fluoro-2-deoxy-D-glucose positron emission tomography/computed tomography
The difference of the value of standardized uptake value (SUV) within the biopsied tissue. (A) The values of SUVmax were no significant difference between histopathology-positive tissues and histopathology-negative tissues. (B) The value of SUVmean were significantly higher in histopathology-positive tissues. (C) The value of SUVmean/liver were also significantly higher in histopathology-positive tissues. Values are presented as means ± SD. * = p<0.05 versus histopathology-negative tissues.
Figure 3

Receiver operating characteristic (ROC) curve for determining which among multiple lesions is to be biopsied (A) ROC analysis for SUVmean of biopsy lesions. (B) ROC analysis for SUVmean/liver of biopsy lesions. SUV standardized uptake value, AUC areas under the curve.
