automatic detection of hand joint region, ankylosis and subluxation in radiographic images using deep learning: development of artificial intelligence-based radiographic evaluation system for bone destruction

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Background: Artificial intelligence (AI) techniques including deep learning have been rapidly evolving and have yielded appreciable benefits in many fields in recent years. In rheumatology field, however, these techniques have not been used often.

Objectives: In an early phase of development of an AI-based automatic radiographic evaluating system for bone destruction, we aimed to develop learning-based models to automatically detect hand joint region, ankylosis and subluxation in radiographic images.

Methods: A total of 130 radiographic image sets of both hands were randomly obtained from rheumatoid arthritis patients who had visited our division at Keio University Hospital in 2015. Well-trained rheumatologists determined the boundaries of regions of MP and PIP/IP joint and evaluated the presence of ankylosis and subluxation of each joint in radiographs. These evaluations of hand joints were performed using our developed annotation software tool [1]. In learning phase, joint images were randomly divided into five sets for 5-fold cross validation. As deep learning models, we utilized Single Shot Multibox Detector (SSD) method [2] with ensemble learning for detecting ankylosis and subluxation of MP and PIP/IP joint regions.

Results: Our model showed 100% detection rate of MP and PIP/IP joint regions. As a performance of detecting hand joint ankylosis and subluxation, our model presented precision values of 0.85 and 0.73, recall values of 0.94 and 0.79, and F-measure values of 0.90 and 0.76, respectively.

Conclusion: Deep learning-based models to automatically detect hand joint region, ankylosis and subluxation in radiographic images were developed with relatively small samples, which suggests that the predictive performance may increase by collecting more training dataset. Next, we are elaborating a plan for a deep learning-based evaluating system for erosion and joint space narrowing.

REFERENCES
[1] Izumi K, Hashimoto M, Suzuki K, Endoh T, Doi K, Iwai Y, Jinzaki M, Ko S, Jun Kuchikuchi, Komei Sakata, Satoshi Takahashi, Chihiro Takahashii, Hiroshi Takeuchi, Hiroya Tamai, Kazuhiro Hiramoto, Yuko Kaneko, Masahiro Jinzaki, Shigeru Ko, Tsutomu Takeuchi. Keio University School of Medicine, Division of Rheumatology, Department of Internal Medicine, Tokyo, Japan; National Hospital Organization Tokyo Medical Center, Division of Connective Tissue Diseases, Tokyo, Japan; Keio University School of Medicine, Medical AI Center, Tokyo, Japan; Fujitsu Laboratories Ltd., Kanagawa, Japan; Keio University School of Medicine, Department of Radiology, Tokyo, Japan; Fujitsu Ltd., Tokyo, Japan; Keio University School of Medicine, Department of Systems Medicine, Tokyo, Japan.
[2] Izumi K, Hashimoto M, Suzuki K, Endoh T, Doi K, Iwai Y, Jinzaki M, Ko S, Jun Kuchikuchi, Komei Sakata, Satoshi Takahashi, Chihiro Takahashii, Hiroshi Takeuchi, Hiroya Tamai, Kazuhiro Hiramoto, Yuko Kaneko, Masahiro Jinzaki, Shigeru Ko, Tsutomu Takeuchi. Keio University School of Medicine, Division of Rheumatology, Department of Internal Medicine, Tokyo, Japan; National Hospital Organization Tokyo Medical Center, Division of Connective Tissue Diseases, Tokyo, Japan; Keio University School of Medicine, Medical AI Center, Tokyo, Japan; Fujitsu Laboratories Ltd., Kanagawa, Japan; Keio University School of Medicine, Department of Radiology, Tokyo, Japan; Fujitsu Ltd., Tokyo, Japan; Keio University School of Medicine, Department of Systems Medicine, Tokyo, Japan.


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REFERENCES

Acknowledgement: Keisuke Izumi and Kanata Suzuki are contributed equally.

Independent predictors entered as continuous variables included age, time-averaged c-reactive protein (CRP), cumulative prednisone dose, bDMARD exposure (years), and statin exposure (years). Gender, hypertension, dyslipidemia, diabetes, and presence of IgA anti-beta2-glycoprotein1 antibodies (a-b2GPI-IgA) constituted dichotomous independent variables. Cox proportional hazards models assessed the role of SIS, SSS, TPS and CAC progression on incident CVE risk 14±2.7 months later, after adjustment for cardiac risk scores, or baseline plaque load.

**Results:** Total plaque burden increased in 42% of patients; progression was predicted by older age, higher cumulative inflammation (TA-CRP) and higher total prednisone dose (table 1). Longer exposure to bDMARDs and statins was linked to lower risk of NCP progression (all p<0.05). MP change was predicted by a-b2GPI-IgA presence, whereas CP progressors were older, more obese, hypertensive and with higher microvascular inflammation compared to non-progressors (p<0.05). CAC increase correlated with older age, hypertension, obesity, higher inflammation and a-b2GPI-IgA presence (Table 1). Both total plaques and CAC progression predicted CVE independently of baseline burden and cardiac risk scores (all p<0.01).

**Conclusion:** Change in coronary atherosclerosis burden and complexity was differentially impacted by Inflammation, cardiac risk factors, a-b2GPI-IgA presence and medications such as prednisone, biologics and statins and independently predicted cardiovascular events in RA.

<p>| Table 1. Coronary plaque progression in RA: Role of Inflammation, risk factors and medications |</p>
<table>
<thead>
<tr>
<th>Model</th>
<th>Predictors</th>
<th>OR (95% CI)</th>
</tr>
</thead>
<tbody>
<tr>
<td>SIS Total</td>
<td>Age</td>
<td>1.09 (1.04-1.15)**</td>
</tr>
<tr>
<td></td>
<td>time-averaged CRP</td>
<td>2.04 (1.33-3.10)**</td>
</tr>
<tr>
<td>SSS Total</td>
<td>Age</td>
<td>1.07 (1.02-1.12)**</td>
</tr>
<tr>
<td></td>
<td>time-averaged CRP</td>
<td>1.83 (1.20-2.77)**</td>
</tr>
<tr>
<td>TPS Total</td>
<td>Age</td>
<td>1.08 (1.03-1.14)**</td>
</tr>
<tr>
<td></td>
<td>Cumulative prednisone dose</td>
<td>1.01 (1.00-1.02)**</td>
</tr>
<tr>
<td></td>
<td>Time-averaged CRP</td>
<td>1.66 (1.22-2.71)**</td>
</tr>
<tr>
<td>CAC</td>
<td>Age</td>
<td>1.14 (1.05-1.23)**</td>
</tr>
<tr>
<td></td>
<td>Hypertension</td>
<td>4.98 (1.46-16.94)**</td>
</tr>
<tr>
<td></td>
<td>Waist-to-height ratio</td>
<td>1.10 (1.02-1.17)**</td>
</tr>
<tr>
<td></td>
<td>a-b2GPI-IgA (g)</td>
<td>4.67 (1.22-17.94)**</td>
</tr>
<tr>
<td></td>
<td>Time-averaged CRP</td>
<td>1.68 (1.00-2.84)**</td>
</tr>
</tbody>
</table>

Table 1. Coronary plaque progression in RA: Role of Inflammation, risk factors and medications

**Disclosure of Interests:** None declared, Matthew Budoff: None declared

**References:**


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**A COMPARATIVE STUDY OF NAILFOLD CAPILLAROSCOPY CHANGES IN IDIOPATHIC INTERSTITIAL PNEUMONIA WITH IDIOPATHIC INTERSTITIAL PNEUMONIA AUTOIMMUNE FEATURES**

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**Background:** Lung involvement especially interstitial lung disease (ILD), can be the first manifestation of an underlying connective tissue disease (CTD). About 25% of ILD occurs in the context of an ‘undifferentiated’ CTDs, characterized by signs and symptoms that are not specific for any of the described CTD entities, now known as IPAF. Nailfold capillaroscopy (NFC) is an important tool, which helps us in early recognition of microvascular changes in patients with ILD.

**Objectives:** To study the various patterns on Nailfold Capillaroscopy in patients of Interstitial Pneumonia with autoimmune features (IPAF) and compare them with those having idiopathic Interstitial Pneumonia (IIP).

**Methods:** The study population consisted of 50 patients each of IIP and IPAF who fulfilled ERS/JSRS/ALAT 2011 revised diagnostic criteria for IIP and ERS/ATS classification criteria for Interstitial pneumonia with autoimmune features respectively. The study also included 50 age and sex matched controls, having normal respiratory examination clinically, normal CXR and normal PFTs. All patients underwent NFC at room temperature and the following parameters were recorded: capillary density, presence of megacapillaries, tortuosity, avascular areas, disarrangement and neoangiogenesis.

**Results:** Our study consisted of 23 (46%) female patients and 27 (54%) male patients for IPAF group and 19 (38%) female patients and 31 (62%) male patients for IIP. The mean capillary density was significantly reduced in IPAF group and also had presence of abnormal capillary morphologic patterns (microhemorrhages, neangiogenesis and megacapillaries).

**Conclusion:** This single centre study found that Nailfold Capillaroscopy (NFC) is an important adjunct to differentiate between patients of IPAF and IIP demonstrating a higher frequencies of abnormalities (microhemorrhages, megacapillaries and reduced capillary density) among patients with IPAF.

**Disclosure of Interests:** None declared


**SAT0545**

IL-17A IS UPREGULATED IN SYSTEMIC SCLEROSIS PATIENTS WITH MIXED ANA IMMUNOFLUORESCENT PATTERN AND MORE THAN ONE POSITIVE ANTI NUCLEAR ANTIBODY IN THE SERUM

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**Background:** Systemic sclerosis (SSc, sclerodema) is a rare systemic connective tissue disease characterized by deposition of connective tissue in the skin and internal organs, microvascular impairment and shift in cellular and humoral immune response. More than 95% of the patients produce antinuclear autoantibodies (ANA) years before the first clinical manifestations of SSc. The majority of SSc patients have positive ANA at a high-titre of dilution and nuclear immunofluorescent staining pattern. The indirect immunofluorescent assay (IFA) on HEp-2 cells is the reference method for ANA screening. According to the International consensus on antinuclear antibody patterns (ICAP the most relevant and usual patterns ANA patterns have been assigned an alphanumeric code from anti-cell (AC)-1 to AC-28 and are organized into a classification tree.

**Objectives:** The aim of the present study is to investigate whether there is a significant correlation between the AC-pattern and the specific auto-antibodies in the serum of SSc patients on the one hand, and the percentage of Tregs, Th17 cells and the serum levels of their corresponding antibodies in the skin and internal organs, microvascular impairment and shift in cellular and humoral immune response.

**Methods:** We enrolled 31 patients who fulfilled the 2013 ACR/EULAR Classification Criteria for SSc at age mean of 47±3 were recruited in the study; 17 with diffuse SSc and 14 patients with localized SSc, respectively. IFA on HEp-2 cells was performed to screen the patients sera for ANA and to determine the AC staining pattern. Immunoblot method was used to evaluate the specific ANA in patients’ sera. We performed flow cytometric analysis of Th17 and Treg’s percentage in the peripheral blood of the patients. The serum levels of IL-6, IL-10, TGF-β, IL-17A on the other hand.

**Results:** All patients sera were ANA positive at high titer of dilution (above 1:1280). We detected increased IL-17A levels in the sera of patients with AC-3 IFA pattern versus patients positive for AC-29 (18.7 [3.95-99.67] vs 2.5 [0.35-8.45], p=0.045). Moreover, IL-17A levels were elevated in the sera with AC-4 IFA pattern when compared to AC-29 (15.6 [4.4-28.9] vs 2.5 [0.35-8.45], p=0.033). When opposing patients sera, positive for only one ANA, with “simple” AC-IFA pattern, to sera with mixed AC pattern (positive for more than one ANA on immunoblot) we found: increased levels of IL-17A (13.7 [10.2–67.2] vs 3.9 [0.4–11.6], p = 0.01) and IL-10 (4.4 [2.2 – 5.8] vs 1.5 [0.3 – 3.2], p = 0.043) in the...