

## Generative Neural Network Inserting or Removing Cancer into Mammograms Fools Radiologists and Deep Learning Alike: Example of an Adversarial Attack

Wednesday 11:10-11:20 AM | SSK02-05 | E451B

### PURPOSE

To investigate whether a cycle-consistent generative adversarial network (CycleGAN) can insert or remove cancer-specific features into mammographic images in a realistic fashion.

### METHOD AND MATERIALS

From two publicly available datasets (BCDR and INbreast) 680 mammographic images from 334 patients were selected, 318 of which exhibited potentially cancerous masses, and 362 were healthy controls. We trained a CycleGAN, using two pairs of generator and discriminator networks to convert cancerous breast images to healthy and back, and vice versa for the controls, without the need for paired images. The network, implemented in TensorFlow, was trained for 40 epochs on an augmented dataset enlarged ten-fold by random rotation, scaling, and contrast perturbations. To investigate how realistic the images appear, we randomly selected 20 image pairs of original and generated images, and 10 single images of each category (60 images in total). The images were presented to three radiologists (5 and 3 years of experience, and PGY-5 resident) who rated them on a 5-point Likert-like scale and had to indicate whether the image was real or generated/modified. The readout was analysed with a receiver-operating-characteristics (ROC) analysis, performance was expressed as area under the ROC curve (AUC).

### RESULTS

For the most experienced radiologist, the modifications introduced by CycleGAN reduced diagnostic performance, with the AUC dropping from 0.85 to 0.63 ( $p=0.06$ ), respectively, while the two less experienced ones seemed unaffected at a lower baseline performance (AUC 0.75 vs. 0.77 and 0.67 vs. 0.69). None of the radiologists could reliably detect which images were real and which were modified by CycleGAN (AUC 0.50-0.66).

### CONCLUSION

CycleGAN can inject or remove malignant features into mammographic images while retaining their realistic appearance. These artificial modifications may lead to false diagnoses.

### CLINICAL RELEVANCE/APPLICATION

Modern adversarial attacks may go undetected by humans as well as deep learning algorithms, and could be used in cyber warfare. It is vital to secure healthcare devices and information systems against such attacks mediated by neural networks.

## Subclinical Changes in Cardiac Functional Parameters as Determined by Cardiovascular Magnetic Resonance (CMR) Imaging in Patients with Sleep Apnea and Snoring: Findings from UK Biobank

Thursday 11:50-12:00 PM | SSQ02-09 | Room: S404AB

### PURPOSE

Obstructive sleep apnea (OSA) is a common disorder that shows an increased risk for left ventricular (LV) and, more rarely, right ventricular (RV) dysfunction. Most studies to date have examined populations with manifest cardiovascular disease and have used echocardiography to analyze ventricular dysfunction, with little or no reference to ventricular volumes or myocardial mass. We hypothesized that there would be stepwise increase in LV mass and RV volumes from the unaffected, to the snoring and the OSA group.

### METHOD AND MATERIALS

We analyzed cardiac MRI data from 4493 UK Biobank participants free from cardiovascular disease. Participants were allocated into three cohorts: (i) with OSA; (ii) with self-reported snoring; and (iii) without OSA or snoring (n=38; 1919; and 2536 respectively). We determined ventricular volumes, ejection fraction and LV mass from balanced cine-SSFP sequences.

### RESULTS

Trend analysis showed a stepwise increase for LV mass in both genders ( $p < 0.001$ ) and for LV and RV ejection fraction (EF) and stroke volume (SV) as well as LV end diastolic volume in males ( $p < 0.02$ ). There was no significant difference when comparing the OSA group to the unaffected group but we found a significant difference when comparing snoring to unaffected in LV mass of females ( $\beta = 1.45 \pm 0.55\text{g}$ ;  $p = 0.009$ ) and in LVEF and RVEF as well as LVSV and RV end systolic volume of males ( $\beta = 0.80 \pm 0.28\%$ ;  $p = 0.005$ ,  $\beta = 1.17 \pm 0.28\%$ ;  $p < 0.001$ ,  $\beta = 1.68 \pm 0.76\text{ml}$ ;  $p = 0.027$  and  $\beta = -2.41 \pm 0.90\text{ml}$ ;  $p = 0.008$ ) respectively.

### CONCLUSION

Our study suggests that the transition from snoring to OSA is an evolving process which is associated with LV hypertrophy. The different results based on the gender in the pilot data point to a gender specific progression. Separate prospective studies are needed to further explore the direction of causality.

### CLINICAL RELEVANCE/APPLICATION

Sleep apnea and snoring lead to gender specific alterations in cardiac function which may require diversified prevention and treatment strategies.

## Screening Mammography: There is Value in Screening Women Aged 75 and Over

Sunday 11:15-11:25 AM | SSA01-04 | Room: E450A

### PURPOSE

To review outcomes of screening mammography performed in women 75 and over to determine the rate of cancer diagnosed and associated histology and surgical excision performed.

### METHOD AND MATERIALS

Patients 75 years of age and over who presented for screening mammography and underwent biopsy with resultant malignant pathology were retrospectively collected and analyzed to record patient demographics, lesion information, pathology results and treatment. Cases of non-breast malignancy, cases of breast cancer diagnosed by modality other than mammography, and cases with missing or incomplete records were excluded.

### RESULTS

From 2007-2016 there were a total of 679,168 screening appointments, with 3,480 patients diagnosed with screen-detected cancers (5.1/1000). 68,218 (10%) screenings were performed in women aged 75 and over; 530 of these women were diagnosed with 560 breast cancers, for a cancer detection rate of 7.8/1000. Average patient age 80.3 (range 75-98). Lesions most frequently presented as a mass (74%). A large majority (81%) of the malignancies diagnosed were invasive; 55.7% grade 2 or 3. Positive lymph nodes were reported at surgical excision in 7.0% of patients. Tumor stage was largely stage 0 or 1 (64%); 12% were determined to be stage II or III. 98% of cancers were surgically excised; twelve cancers were not due to advanced patient age or overall degraded patient health.

### CONCLUSION

For the relatively small percentage of our screening population that women 75 and over comprise (10%), the patients diagnosed in this population made up 16% of all patients diagnosed with screen-detected cancers, a substantial cancer detection rate (7.8/1000). Most of the cancers diagnosed were low grade, a significant number were invasive (81%), over half were grade 2 or 3, and a majority were lower stage (0 or I). Most (98%) underwent surgical excision, suggesting that most women 75 and over are in good health and want to pursue surgical excision. Screening mammography should be performed in this age group given the incidence of breast cancer that exists.

### CLINICAL RELEVANCE/APPLICATION

Ongoing debate exists regarding the age to cease screening mammography, citing lack of research in the aging population. Our study demonstrates the value of screening women 75 and over.

## Evaluation of Deep-Learning-Based Technology for Reducing Gadolinium Dosage in Contrast-Enhanced MRI Exams

Monday 11:50-12:00 PM | SSC12-09 | Room: N226

### PURPOSE

Gadolinium Deposition is one of the most urgent issues facing radiology community. In this work, we further validated a Deep Learning based contrast-boost method, on 200 patients with mixed indications, and demonstrated the generalization and robustness of the deep learning based solution to reducing gadolinium dosage while maintaining diagnostic quality.

### METHOD AND MATERIALS

Dataset: A cohort of 200 patients were included in this study, with mixed indications and receiving clinically routine contrast-enhanced MRI (CE-MRI) exams. Sequences: Pre-contrast (zero-dose), post-contrast after 10% dosage administration (low-dose) and post-contrast after 100% dosage administration (full-dose) was collected with 3D T1 IR-FSPGR sequences for each patient. Method: Different series from the same patient were coregistered and normalized. A deep convolutional neural network (3D U-Net) was trained to learn the approximation of the full-dose CE-MRI using low-dose and zero-dose images. 5-fold cross-validation was used to generate results for evaluation. Evaluation: Quantitative metrics (PSNR, RMSE, SSIM) were used to evaluate the improvement of the enhanced contrast using deep learning. Qualitative metrics (image quality, contrast enhancement quality) were used to evaluate the result of the DL based enhancement. A non-inferiority test was conducted to demonstrate the performance of the method and validate the capability of reducing dosage without image quality loss.

### RESULTS

Quantitative metrics demonstrated consistent (~4dB in PSNR and 10% in SSIM) and significant ( $p < 0.001$ ) quality improvement of the deep learning based solution, compared with low-dose CE-MRI. Qualitative ratings showed non-significant differences between the proposed method and acquired full-dose CE-MRI images, which was also verified with the non-inferiority testing. Initial results also demonstrated the possibility of synthesizing full-dose CE-MRI images with zero-dose MR images only.

### CONCLUSION

With a large dataset, we demonstrated the DL solution can generalize well, achieving robust and significant quality improvement over the low-dose CE-MRI, using 10% or even less gadolinium dosage. It enables significantly (at least 10x) gadolinium dosage reduction without sacrificing diagnostic quality.

### CLINICAL RELEVANCE/APPLICATION

Deep Learning solution is valuable in clinical radiology for fighting against gadolinium deposition.

## Longitudinal Strain Measures of White Matter Tracts in Youth Football Players

Thursday 10:40-10:50 AM | SSQ19-02 | Room: S402AB

### PURPOSE

We characterized longitudinal strain of the white matter in youth football players compared to non-contact sport control athletes and tested the hypothesis that axial and radial shape changes of fiber bundles would be associated with participation in contact sports and serve as a new neuroimaging biomarker of subconcussive head impact exposure.

### METHOD AND MATERIALS

Twenty-three male youth football players (Age=12.1±1.2 yrs) and 13 male non-contact sports control participants (Age=10.6±1.7 yrs) were recruited for this IRB approved study. Longitudinal brain MRI data, including diffusion tensor imaging (DTI) were acquired before and after a single sports season (approximately 3-months). Longitudinal registration was performed between pre-season and post-season T1-weighted images. DTI processing included geometric distortion correction, eddy-current correction, fitting of diffusion parameters, and co-registration to T1-weighted images. The voxel-wise fiber-specific deformations (axial and radial strains) were estimated by aligning 3D deformation tensor derived from longitudinal T1-weighted images to the co-registered eigenvectors from DWI. Parameter maps for axial and radial strains were registered to the study-specific template. We compared total and voxel-wise white matter volume change rates between football players and control participants using a linear regression and multiple comparison correction.

### RESULTS

There was greater axial strain (contraction) among football players compared to controls in the body and right splenium of the corpus callosum ( $p < 0.01$ , 340 vox) (upper panel of figure). There was greater radial strain (expansion) in the splenium of the corpus callosum among controls compared to football players ( $p < 0.01$ , 219 vox) (lower panel of figure).

### CONCLUSION

Axial and radial strain data demonstrated more directional contraction and less expansion, respectively, in the football group compared to non-contact sports controls. These tract-specific strains in white matter tracts may reflect changes associated with repetitive sub-concussive head impact exposure.

### CLINICAL RELEVANCE/APPLICATION

There is growing concern regarding the long-term consequences of repetitive sports-related subconcussive head impact exposure on the developing brain. We propose a novel white matter tract-specific morphometry method to analyze the effects of repetitive subconcussive impacts on brain developmental trajectory.

## Risk-Based Screening Mammography for Women Age <40: Outcomes from the National Mammography Database

Wednesday 3:10-3:20 PM | SSM02-02 | Room: E350

### PURPOSE

There is insufficient large-scale evidence supporting screening mammography in women <40 years with risk factors. This study compares risk-based screening of women ages 30-39 versus women age 40-49 with no known risk factors, using screening mammography performance metrics from the National Mammography Database (NMD).

### METHOD AND MATERIALS

This HIPAA compliant and IRB approved study analyzed data from 150 mammography facilities in 31 states in the NMD. The NMD collects clinical practice data including self-reported patient demographics, clinical findings, screening mammography interpretation and biopsy results. Patients were stratified by 5-year age intervals and specific risk factors for breast cancer: family history of breast cancer (any first degree relative regardless of age), personal history of breast cancer and breast density of heterogeneously or extremely dense (C or D). Prior mammograms were identified by patient date of birth and facility-assigned identification number. Four performance metrics for screening mammography were calculated for each age and risk group: recall rate, cancer detection rate, and positive predictive values for biopsy recommended (PPV2) and biopsy performed (PPV3).

### RESULTS

5,772,730 screening mammograms were performed between January 2008 and December 2015 in 2,647,315 women. Overall, mean cancer detection rate was 3.7 per 1000 (95% CI: 3.65-3.75), recall rate was 9.8% (9.8-9.8%), PPV2 was 20.1% (19.9-20.4%), and PPV3 was 28.2% (27.0-28.5%). Overall, women age 30-34 and 35-39 had similar cancer detection rates, recall rates and PPVs, with the presence of the three evaluated risk factors associated with significantly higher cancer detection rates. Moreover, compared to a population currently recommended for screening mammography in the USA (age 40-44 with no known risk factors), incidence screening (at least one prior screening examination) of women ages 30-39 with the three evaluated risk factors has similar cancer detection rates and recall rates.

### CONCLUSION

Women ages 30-39 with 3 specific risk factors should benefit by starting screening at age 30 instead of the age 40 start recommended for average-risk women.

### CLINICAL RELEVANCE/APPLICATION

Women

CTrl-Alt-Radiate?

Tuesday 3:40-3:50 PM | SSJ13-05 | Room: N230B

## PURPOSE

Computed Tomography (CT) is an essential and commonly used X-ray generator modality that uses ionizing X-ray radiation to produce images. The CT modality consists of an ecosystem of components, which communicate with each other within the CT's ecosystem. As technology advances, the CT's ecosystem is becoming more connected to the hospital's network and the Internet, exposing it to a variety of security vulnerabilities and threats to potential cyber-attacks. The combination of ionizing radiation, potentially harmful to patients, and security vulnerabilities to cyber-attacks results in possible dangerous scenarios that compromise patients' safety. To illustrate the importance of the topic, we demonstrate how we hacked a CT.

## METHOD AND MATERIALS

We present a step-by-step implementation of how we bypass current security protection mechanisms of a CT in order to manipulate its behavior, making it potentially dangerous to patients. This attack demonstrates how additional cyber-attacks on medical imaging devices (MIDs) can be similarly implemented. To accurately measure the potential damage to patients' health, we use a phantom device (i.e., a CT radiation measuring device), and analyze the risks that such attack can cause. Furthermore, we demonstrate how to exploit our cyber-attack covertly, so that it is difficult to detect it using current security solutions; thus, such attack may have long-term effects on a large-scale of the population.

## RESULTS

A live demonstration of how we hacked a CT device and how we manipulated its behavior to create various dangerous scenarios for patients' health. Moreover, we analyze this attack in depth, to better understand the potential impacts of such attacks.

## CONCLUSION

CT and MIDs are vulnerable to cyber-attacks; we demonstrate forcefully that hacking CT and MIDs is no longer theoretical. By analyzing the potential impacts to patients, we can conclude that such impacts are critical and must be dealt with urgently.

## CLINICAL RELEVANCE/APPLICATION

This calls for an immediate improvement of CTs and MIDs security and further mitigation of risks to patients.



## Subconcussive Head Impacts May Alter Metrics Associated with Normal Pruning in Youth and High School Football Players

Monday 10:50-11:00 AM | SSC11-03 | Room: S402AB

### PURPOSE

To determine whether exposure to repetitive subconcussive impacts affects fMRI metrics associated with normal pruning in youth and high school football players over a single season.

### METHOD AND MATERIALS

Youth and high school football players are exposed to high numbers of head impacts over the course of a season [1]. The spectral power of resting state networks typically decreases as a function of age and has been interpreted as a sign of normal Gray Matter (GM) pruning [2]. We hypothesized that a season of contact sports will alter this relationship. Specifically, there will be an increase in power of the DMN and consequent change in GM volume (GMV) associated with normal pruning. Sixty age matched players without history of developmental, neurological, or psychiatric abnormalities and no history of concussion during or prior to the season were split into high impact (HI) (24) and low impact (LI) (36) groups, respectively based on each player's risk-weighted cumulative exposure (RWEcp)[3,4]. The RWEcp represents the summed risk of concussion for each impact over the season as derived by the Head Impact Telemetry System (HITS) data [1]. High order ICA (n=60) was performed to extract independent components using the GIFT toolbox [5]. Subject specific time courses for each subject were converted into a power spectrum through power spectral decomposition. Five components of the DMN were identified and changes in the power of the network were computed as post-season minus pre-season values ( $\Delta$ PSD). Following bonferroni correction, only the anterior cingulate network demonstrated a significant difference in  $\Delta$ PSD and was used as a mask to determine GMV using VBM8. A two-sample t-test was performed to determine significant changes in  $\Delta$ PSD and  $\Delta$ GMV between the groups.

### RESULTS

The frontal DMN (FDMN) demonstrated a significant increase in power in the HI group (p-value: 0.00018). A significant increase in GM volume was found in the same frontal regions of the DMN (p-value: 0.005) (Fig.1) for HI group.

### CONCLUSION

Our results suggests that normal GM pruning is affected in the HI group, over a single season of contact sport. Longitudinal studies are needed to understand the long-term changes in resting state networks and effects on functional brain health.

### CLINICAL RELEVANCE/APPLICATION

This work demonstrates that playing a season of contact sports may affect normal GM pruning in high school and youth football players.



## CT Guided Pulsed Radiofrequency in Patients with Acute Low Back Pain and Sciatica: 1 Year Follow-Up versus Image-Guided Injection Only as Control Group

Tuesday 3:00-3:10 PM | SSJ26-01 | Room: S502AB

### PURPOSE

To determine the clinical impact of CT-guided Pulsed Radiofrequency in the management of patients with acute or sub-acute neuro-radicular pain from lumbar disc herniation, refractory to prolonged conservative treatment.

### METHOD AND MATERIALS

We conducted a single center, prospective, randomized trial (1:1) in patients with acute or sub-acute neuro-radicular low back pain (EMG confirmed), refractory to usual care (conservative). Pulsed radiofrequency (pRF) treatment was performed using a 22-20 G needle-electrode with probe tip directed to the symptomatic dorsal root ganglion under CT guidance; E-pulsed radiofrequency (Cosman G4) was administered for 10 min at 45V with constant local temperature of 42°C. Masking group received 1 to 3 sessions of CT-guided steroid injection on the same anatomical target. Primary outcome was clinical efficacy measured with Visual Analogue Scale (VAS), Oswestry Disability Index (ODI) and Roland-Morris (RM) score for quality of life assessment; all questionnaires were obtained at baseline and at 1-week, 1-3-6 and 12-month follow-up. Analyses were performed on a per-protocol basis.

### RESULTS

Of 260 patients enrolled, 128 patients received Pulsed Radiofrequency, 120 were treated with injection only strategy treatment. Median VAS scores decreased linearly in both groups; patients that received radiofrequency obtained greater significant overall improvement in pain and disability scores during the first year ( $P < 0.001$ ). Relief of leg pain was faster for patients assigned to pRF ( $P < 0.001$ ). Patients assigned to pRF also reported a faster rate of perceived recovery (hazard ratio, 1.97; 95% confidence interval, 1.72 to 2.22;  $P < 0.001$ ). The probability of perceived recovery after 1 year of follow-up was 95% in the pRF group and 61% in the injection only group. There were 6 patients considered partial responders that required a second PRF session. Eight patients required further surgical management.

### CONCLUSION

The 1-year outcomes demonstrated CT-guided Pulsed Radiofrequency superior to injection only strategy. pRF is an effective and repeatable percutaneous treatment option for patients with acute or sub-acute neuro-radicular low back pain.

### CLINICAL RELEVANCE/APPLICATION

The results of this study are superior to those reported from literature for usual care strategies and injections and may avoid surgery for a substantial number of patients with sciatic disc compression.

## Tract Based Spatial Statistics in Persons who Will Develop Alzheimer's Dementia: A Study from the Alzheimer's Disease Neuroimaging Initiative (ADNI)

Sunday 11:45-11:55 AM | SSA19-07 | Room: E351

### PURPOSE

To quantify differences in diffusion tensor imaging of persons who decline from normal cognition to Alzheimer's dementia compared to controls who do not develop dementia.

### METHOD AND MATERIALS

All subjects were from ADNI2 (n = 20). Average age was  $73.4 \pm 3.9$  years with age range 68.2-83.7 years. All subjects were age and gender-matched for comparison. The sample was 60% women and 40% men. Each subject received 3T MR imaging on either a Siemens or GE scanner for T1 volumetric imaging, MP-RAGE for Siemens or SPGR for GE. All DTI scans were obtained on a 3T GE scanner. Raw T1 and DTI DiCOM images were converted to NIFTI file format. Each scan was visually inspected for gross artifacts. Images were corrected for motion, eddy currents and skull-stripped using the fMRI software library (FSL). Fractional anisotropy (FA), mean diffusivity (MD), axial diffusivity and radial diffusivity (RD) maps were also obtained via FSL's dtifit and FSLmaths tools and visualized for errors. Data were then processed through FSL's tract-based spatial statistics (TBSS) with default parameters. FA, MD, RD, and axial diffusivity values were extracted.

### RESULTS

Of the 20 subjects, 10 experienced longitudinal cognitive decline and 10 remained cognitively normal. Of the 10 converters, 80% were MCI at baseline and converted to AD and of these 50% declined after 6 months and another 50% declined after 12 months. Of the remaining two converters, one declined from normal to mild cognitive impairment (MCI) to AD after 24 months and another subject experienced a similar trajectory after 48 months. Comparing global DTI metrics, there was a trend towards statistical significance with respect to lower global mean FA in converters compared to non-converters ( $t = -.43$ ,  $p = .07$ ). However, voxel wise analyses with TBSS showed statistically significant reductions in frontal white matter tracts in converters compared to non-converters as shown in Figure 1 (red arrows). There were no statistically significant differences in other global DTI metrics including RD, MD, and axial diffusivity.

### CONCLUSION

Diffusion weighted MR imaging identifies quantifiable differences between AD converters compared to non-converters.

### CLINICAL RELEVANCE/APPLICATION

Identification of non-invasive quantitative neuroimaging biomarkers that predict cognitive decline to Alzheimer's dementia is important for determining persons who may benefit from drug trials or modification of risk factors.

The Echogenic Appearance of the Diabetic Deltoid Muscle on Shoulder Ultrasound: Is This Simply from Adipose Tissue Infiltration, Can This Appearance Predict Type 2 Diabetes and be Used to Detect Pre-Diabetes?

All Day | MK346-SD-SUA1-ALL | MK Community, Learning Center Station #1

## PURPOSE

To evaluate the association of an echogenic deltoid muscle seen in type 2 diabetics during shoulder ultrasound versus the deltoid muscle appearance in non-diabetic obese patients and for any corresponding associations.

## METHOD AND MATERIALS

The study Included 137 shoulder ultrasounds from type 2 diabetics, Including 13 pre-diabetics, confirmed by hemoglobin A 1 c levels and medications. It also included 49 ultrasounds from non-diabetic obese patients based on body mass index (BMI). Images of the deltoid muscle were blindly reviewed by 3 musculoskeletal radiologists as to whether the appearance was normal, suspected diabetic or definite diabetic. These results along with the patient's age, sex, race, hemoglobin A 1 c level, BMI, and the use of insulin were analyzed.

## RESULTS

A consensus diagnosis of 'definite diabetic' by 3 musculoskeletal radiologists based on an echogenic appearing deltoid muscle on ultrasound was a powerful predictor of diabetic status. The positive predictive value for the accurate designation of 'definite diabetic' was 89% (70 of 79 diabetic patients). An echogenic deltoid muscle was also a powerful predictor of pre-diabetes. Of 13 pre-diabetic ultrasounds reviewed, 13 were assigned either 'suspected diabetic' (3 of 13, 23%) or 'definite diabetic' (10 of 13, 77%) ( $P = 0.062$ ). Obesity alone cannot solely explain the appearance of an echogenic deltoid muscle in diabetics. Nonobese diabetics were diagnosed 'definite diabetic' with 30% sensitivity (11 of 37 non-obese diabetics). Diabetic patients with a higher BMI, were more often diagnosed 'definite diabetic'. Of 137 diabetic ultrasounds reviewed, 31(22.6%) were designated 'normal' (BMI  $30.9 \pm 7.3$ ), 36 (26.2%) designated 'suspected diabetic' (BMI  $32.6 \pm 6.9$ ), and 70 (51.2%) designated 'definite diabetic' (BMI  $37.5 \pm 8$ ).

## CONCLUSION

The ultrasound appearance of an echogenic deltoid muscle is a strong predictor of type 2 diabetes and seems to be due to more than just adipose Infiltration. It could be related to impaired Insulin-stimulated intramuscular glycogen synthesis or Issues with collagen synthesis. We also conclude that this appearance may be used to detect pre-diabetes.

## CLINICAL RELEVANCE/APPLICATION

Ultrasound of the type 2 diabetic deltoid muscle demonstrates increased echogenicity which is likely secondary to insulin resistance and may be used as a noninvasive means to detect pre-diabetes.

## Sex Differences in Resting-State Cerebral Activity Alterations in Internet Gaming Disorder

Wednesday 11:40-11:50 AM | SSK16-08 | Room: E351

### PURPOSE

Although evidence has shown that the prevalence rates of Internet gaming disorder (IGD) differ between males and females, no study has examined whether such sex differences extend to brain function. This study aimed to explore the sex differences in resting-state cerebral activity alterations in IGD.

### METHOD AND MATERIALS

Thirty male participants with IGD (IGDm), 23 female participants with IGD (IGDf), and 30 male and 22 female age-matched healthy controls (HC) underwent resting-state functional MRI. Maps of the amplitude of low-frequency fluctuation (ALFF) and functional connectivity (FC) were constructed. A two-factor ANCOVA model was constructed using SPM8, with sex (Male, Female) and diagnosis (IGD, HC) as the between-subject factors. When interaction effects occurred, post hoc pair-wise comparisons were performed using two-sample t-tests within the interaction masks. We used the Barratt Impulsiveness Scale-11 (BIS-11) to assess the behavioural inhibition function of the IGD participants. The correlations of the psychological scores with the ALFF and FC values were assessed using partial correlation analyses.

### RESULTS

The ALFF values in the orbital part of left superior frontal gyrus (SFG) significantly decreased specifically in IGDm, which were negatively correlated with BIS-11 scores. IGDm also demonstrated lower connectivity between the orbital part of the left SFG and the posterior cingulate cortex, the right angular gyrus, and the right dorsolateral prefrontal cortex than HCDm. Furthermore, IGDm had lower seed connectivity between the orbital part of the left SFG and the PCC than ICDf.

### CONCLUSION

Our findings suggest that sex-specific regional- and network-level alterations exist in IGD, and the altered ALFF values in the SFG represent a clinically relevant biomarker for the behavioural inhibition function of IGDm.

### CLINICAL RELEVANCE/APPLICATION

These neuroimaging findings can provide a comprehensive understanding of the neural basis of the sex-specific alterations in IGD.

## Body Composition Changes at Computed Tomography after Left Gastric Artery Embolization in Overweight and Obese Individuals

Monday 11:35-11:45 AM | RC214-14 | Room: E350

### PURPOSE

Left gastric artery embolization (LGAE) is currently under investigation as a potential bariatric therapy. This study aimed to characterize body composition changes in overweight and obese individuals who underwent LGAE.

### METHOD AND MATERIALS

Institutional review board approval was obtained for this study. Eighty-nine patients who underwent LGAE for gastric bleeding between 1/2006 and 3/2018 were retrospectively reviewed. Of these, 61 patients were excluded for unavailable imaging or follow-up and 12 more patients were excluded for body mass index (BMI) below 25 kg/m<sup>2</sup>. Computed tomography body composition parameters were analyzed at the L1, L3 and L5 lumbar levels in the remaining 16 overweight or obese patients with semiautomated imaging processing algorithms (MATLAB 13.0, Math Works, MA). Adipose tissue and skeletal muscle area were measured using threshold attenuation values between -190 to -30 Hounsfield Units (HU) and -29 to +150 HU, respectively. Total body fat index (BFI), subcutaneous fat index (SFI), visceral fat index (VFI) and skeletal muscle index (SMI) were determined  $[(\text{tissue area (cm)}^2)/(\text{height (m)})^2]$  at each lumbar level and summed. Excess body weight (EBW) was determined based on the Lorentz formula for ideal body weight. Changes in weight and body composition were analyzed with either Wilcoxon signed-rank test or paired Student's t tests based on the normality of the distributions.

### RESULTS

Mean follow-up was  $1.5 \pm 0.8$  months. Mean weight and body composition parameters pre-LGAE vs. post-LGAE as well as per cent change were calculated for body weight ( $87.9 \pm 12.5$  vs.  $82.3 \pm 13.9$  kg, -6.4%,  $p=0.03$ ), BMI ( $30.0 \pm 4.3$  vs.  $28.3 \pm 4.9$  kg/m<sup>2</sup>, -6.3%,  $p=0.005$ ), EBW ( $23.3 \pm 10.6$  vs.  $17.7 \pm 12.6$  kg, -24.1%,  $p=0.003$ ), BFI ( $128.6 \pm 54.7$  vs.  $123.9 \pm 59.5$  cm<sup>2</sup>/m<sup>2</sup>, -3.7%,  $p=0.03$ ), SFI ( $81.7 \pm 44.5$  vs.  $78.4 \pm 43.7$  cm<sup>2</sup>/m<sup>2</sup>, -4.1%,  $p=0.03$ ), VFI ( $35.8 \pm 17.8$  vs.  $34.3 \pm 21.6$  cm<sup>2</sup>/m<sup>2</sup>, -4.1%,  $P=0.13$ ) and SMI ( $44.5 \pm 7.2$  vs.  $41.5 \pm 6.9$  cm<sup>2</sup>/m<sup>2</sup>, -6.8%,  $p<0.001$ ).

### CONCLUSION

Overweight and obese individuals who underwent LGAE had significant weight loss as a result of decreased body fat and skeletal muscle. However, visceral fat did not significantly decrease over the course of follow-up.

### CLINICAL RELEVANCE/APPLICATION

This study quantitatively characterized changes in body composition as they pertain to weight loss after LGAE and highlights how this procedure may affect body fat and muscle mass.

## Cryoablation as a Primary Treatment of Low-Risk Breast Cancers: An Interim Update of the Ice 3 Trial

Wednesday 3:00-3:10 PM | SSM01-01 | Room: E351

### PURPOSE

The Ice 3 Trial is the first of its kind large scale multi center trial in the world to assess image guided cryoablation as a primary treatment for breast cancer without surgical lumpectomy. We report updated interim results and important imaging findings.

### METHOD AND MATERIALS

This HIPPA compliant and IRB approved trial seeks enrollment of between 150 and 200 patients for cryoablation of low risk carcinoma of the breast. The study is limited to female patients ages 60 and over with biopsy proven primary, unifocal cancer. Cancers must measure 1.5cm or less with tumor prognostic panels that are ER+/PR+ or ER+/PR-and HER 2-. All patients underwent ultrasound guided cryoablation using the IceSense 3 system (IceCure Medical). Following local anesthesia, patients underwent a freeze, thaw, freeze cycle of cryoablation with the goal of a visible ice ball producing at least a 10mm margin of ice around the tumor. Patients will be followed for recurrence with mammography at 6 and 12 months and then annually for 5 years. Additional imaging with MRI or Ultrasound may be utilized as needed but is not a requirement. All patients have the option of post cryoablation chemotherapy, hormone therapy and or radiation therapy as clinically indicated. Patients will not undergo surgical lumpectomy following cryoablation.

### RESULTS

A total of 157 patients have been treated with since enrollment began in October 2014 at 17 participating centers across the United States. Patients ranged from 60-90 years of age. Tumor sizes ranged from 3 to 15mm. No serious adverse events were reported. There has been 100% procedural success. All patients have had at least 6 months follow up. 78 patients have had at least 24 months follow up. 24 patients have had at least 36 months follow up. There has been no recurrence in 156/157 patients with at least 6 months follow up (99.4% success rate). Common imaging findings include fat necrosis, scarring and a mammographic "halo" effect.

### CONCLUSION

Cryoablation of the breast is safe and well tolerated with a 100% initial procedural success rate. The overall clinical success rate for 157 patients with at least 6 months follow up is 99.4%. Long term results are also promising.

### CLINICAL RELEVANCE/APPLICATION

Interim results suggest that cryoablation is a safe and effective primary treatment for women with small low risk breast cancers as an alternative to surgical lumpectomy.