KU-S01

Data Augmentation based on Generative Adversarial Networks to Improve Chronic Kidney Disease Stage Classification

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It is estimated that prevalence of chronic kidney disease (CKD) is 13.4% worldwide and 15% in the United States. The CKD has been recognized as a leading public health problem all over the world. Unfortunately, as many as 90% CKD patients do not know that they already have CKD. Ultrasonography is usually the first and the most common imaging examination tool used for patients at risk of CKD. In order to provide a consistent assessment for CKD stage classification, this study proposed an auxiliary diagnosis system based on deep learning approaches for renal ultrasound images. The deep learning model applied ACWGAN-GP and MobileNetV2 pre-training models. As long as the ACWGAN-GP model learned the potential probability distribution from the collected samples within the training dataset, it could provide a large amount of newly generated training samples, thereby improving prediction accuracy for the constructed classifier. The images synthesized by the ACWGAN-GP generation model and the original real images were entered into the pre-training model MobileNetV2 simultaneously. The MobileNetV2 classification model could achieve an accuracy of 81.9% for the four stages CKD classification. If the prediction results allowed a higher stage tolerance, the accuracy could be improved up to 90.1%. The proposed deep learning model solves the problems of imbalance and insufficient data samples during training processes for an automatic classification system, and it also improves the prediction accuracy of CKD stage diagnosis. The model can be widely applied to other challenging medical imaging issues.

Keywords: deep learning, generative adversarial network, chronic kidney disease, ultrasonography.

KU-S02

Using Dada Mining and Sonographic Images to Construct a Predictive Model for Renal Disorders Severity in Children with Urinary Tract Infection

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The underlying will be the presenter.

The febrile children without other focus usually had the differential diagnosis of urinary tract infection (UTI). In addition to urinalysis and bacterial culture, renal ultrasonography (US) is required when febrile children are diagnosed UTI. Point-of-care ultrasound (POCUS) is valuable for clinical decision making. However, the accuracy of US was operator dependent. By the data-mining approaches, we retrospectively reviewed the admission records of around 300 febrile infants or toddlers with UTI or control when aged 0-36 months in National Taiwan University Hospital Yunlin Branch (NTUH-YL) between 2016 – 2017. In this study, we used convolution neural network (CNN) algorithm and renal sonographic images for children with UTI to construct a predictive model for renal disorder severity. The sonographic images included 211 images of normal structure, 69 of mild structural anomalies, and 42 of severe anomalies taken from. Those images were classified the renal disorder severity into normal, mild and severe categories. In the results, the model accuracy rate was 86.71%. The area under curve (AUC) of our optimal model (CNN with random forest classifier) to predict normal structures, mildly and severe anomalies were 89.33%, 83.24%, and 88.43% respectively. We concluded that our model could be clinically applicable.

Keywords: Children, urinary tract infection, ultrasonography, convolution neural network, sensitivity, specificity.

KU-S03

The Application of AI in the Detection of Hydronephrosis

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In this talk, I will introduce our recent study on the detection of hydronephrosis. This study aimed to assess the feasibility of three detection models for hydronephrosis through ultrasound images using state-of-the-art deep learning algorithms. The diagnosis of hydronephrosis is challenging because of varying and nonspecific presentations. With ready accessibility, non-radiation, and repeated assessments, point-of-care ultrasound becomes a complementary diagnostic tool for hydronephrosis. However, inter-observer variability still exists following time-consuming training. Artificial intelligence has the potential to overcome human limitations.

A total of 97 patients with hydronephrosis confirmed by the expert nephrologists were included, and 4,288 ultrasound frames. The 831 ultrasound frames were also extracted from the 265 controls with normal renal ultrasonography. We built three deep learning models based on U-Net, Res-UNet, and UNet++, and compared their performance. We applied the preprocessing techniques, including wiping the background to lessen interference by YOLOv4 and standardized image sizes. Also, post-processing techniques such as adding a filter for filtering the small effusion areas were used. The Res-UNet algorithm had the best performance with an accuracy of 94.6% of moderate/severe hydronephrosis with substantial recall rate, specificity, precision, F1 measure, and intersection over the union. The Res-UNet algorithm has the best performance in the detection of moderate/severe hydronephrosis. It would decrease variability among sonographers and improve efficiency in clinical conditions.

KU-S04

Alterations of Renal Function after Unilateral Nephrectomy

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Background: Radical nephrectomy is the standard treatment for patients with kidney neoplasms, living kidney donation, or trauma. Because of reduced renal mass, alterations of renal function after unilateral nephrectomy remain to be concerned. There is paucity of data evaluating long-term monitoring of renal function in post-nephrectomy patients.

Methods: This retrospective and descriptive study identified 232 subjects who underwent radical nephrectomy from January 2011 to December 2020. Their demographic data, co-morbidities and results of renal sonography were reviewed and collected. Serum creatinine level was measured annually over a 5-year period. Glomerular filtration rate (GFR) was estimated by Modification of Diet in Renal Disease Study equation. Patients were divided into different groups according to postoperative 1-year estimate GFR (eGFR) and the percentage of eGFR recovery at the 5th year following nephrectomy.

Results: Mean age was 76.5 years; 44% of patients were male, and 29% had diabetes mellitus. The leading cause of radical nephrectomy was kidney cancer (59.1%). Postoperative 1-year eGFR levels of greater than 60 mL/min/1.73 m^2 were found in 63 patients (27%); 30-59 mL/min/1.73 m^2, in 105 patients (45%); 15-30 mL/min/1.73 m^2, in 44 patients (17%) and less than 15 mL/min/1.73 m^2, in 24 patients (10%). There was more eGFR recovery at the 5th year following radical nephrectomy (35.5% vs.16.7% in non-decline group, p= 0.047) when compared patients between postoperative1-year eGFR greater and less than 15 mL/min/1.73 m^2. Overall, their average annual eGFR decline was -2.2 ± 4.1 mL/min/1.73 m^2. The decline was significantly greater among diabetic than non-diabetic patients (-3.12 ± 5.76vs.-1.78 ± 3.12mL/min/1.73 m^2/year, p=0.022). Multivariate logistic regression analysis revealed that diabetes mellitus (β= -1.474, p=0.02) was the only significant predictor for eGFR

decrease.

Conclusion: Patients with postoperative1-year eGFR greater than 15 mL/min/1.73 m^2 were associated with higher percentage of eGFR recovery at the 5^{th} year following unilateral nephrectomy. Diabetes mellitus was an independent predictor for postoperative renal function decline.

Keywords: after unilateral nephrectomy; renal function alteration; eGFR recovery.

KU-S05

Current Trends in Prostate Cancer Ablation Therapy Using High Intensive Focal Ultrasound

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The number of prostate cancer cases is increasing in Taiwan, and it currently ranks fifth in male cancer, with nearly 7,000 new patients every year. Radical prostatectomy and radiation therapy are the two main methods for localized prostate cancer treatment. However, prostate cancer is considered a rather slow growing cancer if the patient has a low risk cancer feature such as Gleason's score <= 6, or PSA <10. Patient can be monitored by active surveillance(AS) despite it posed the risk of cancer progression and causing anxiety. Curative treatment by surgery or radiation therapy may cause adverse effects in urination and sexual function, therefore, prostate cancer ablation therapy using high intensive focal ultrasound (HIFU) can be consider an alternative therapy for this group of patient. This treatment mode requires the use of high-precision magnetic resonance and ultrasound fusion images to precisely treat the prostate cancer lesions, and avoid the damage of normal tissues and neurovascular bundles that can cause urinary incontinence and sexual dysfunction. Therefore, it is expected that HIFU will have a lot of room for development in the future, and will gradually become one of the standard treatment modes of prostate cancer with minimally invasive (non-invasive) and extremely low side effects.

KU-S06

Role of Ultrasound-based Exam in Urologic Emergency

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Urologic emergencies are critical in urology since they require prompt treatment to minimize organ structure, function, or even life loss. Generally, traditional ultrasound is essential in the early assessment of these emergencies, especially in blunt trauma of the kidney, bladder, external genitalia, and scrotum. Also, sonographic evaluation with color Doppler plays a crucial role in diagnosing testicular torsion and priapism. However, there were still some limitations of traditional ultrasound, including detection of parenchyma injuries of the genitourinary organ or acute presentation in trauma event, and could have false positive/negative diagnosis due to equivocal sonographic sign. Contrast-enhanced CT might be needed in these circumstances but are relative contraindication in hemodynamically unstable patients, fertile females, and pediatrics.

Recently a new ultrasound technique using second-generation contrast agents, named contrast-enhanced ultrasound (CEUS), has been developed. This technique allows all the vascular phases to be performed in real-time, increasing ultrasound capability to detect parenchymal injuries and enhancing qualitative findings, such as lesion extension, margins, and its relationship with capsule and vessels. The levels of sensitivity and specificity of CEUS could be up to 95%, almost as sensitive as contrast-enhanced CT. Also, compared with conventional Doppler techniques in scrotal trauma, priapism, and testicular torsion, CEUS has been shown to offer improved flow visualization and tissue perfusion.

The advantage of CEUS includes portability, real-time, lack of nephrotoxicity, the absence of

ionizing radiation and therefore its repeatability. Due to these characteristics, the CEUS technique is worth promotion in Taiwan's urology and nephrology field.