Jaundice is a common problem in the neonatal period with wide spectrum of etiology. The radiologist is called upon to differentiate between the neonatal hepatitis (NH) and extrahepatic biliary atresia as also for the evaluation of choledochal cyst. The radiological modalities available to investigate these conditions primarily include ultrasound and magnetic resonance cholangiopancreatography (MRCP).

NH and EHBA clinically present as conjugated hyperbilirubinemia and together, account for 2/3 of cases. They have widely different clinical course. While NH is a benign self-limiting disease, EHBA leads to progressive liver fibrosis leading to liver failure. Thus, early diagnosis of EHBA is of paramount importance. Several signs have been described on sonography for the diagnosis of EHBA but none is infallible. These sonographic signs include absence of gall bladder, triangular cord sign, gall bladder morphology and its contraction after feeding and visualization of CBD. Evaluation of hepatic vasculature may reveal enlargement of hepatic artery and presence of hepatic subcapsular flow. In the presence of conjugated hyperbilirubinemia in an infant, hepato-splenomegaly may provide supportive evidence for the diagnosis of EHBA. MRCP is an alternative modality noninvasive evaluation of the biliary tree which has been utilized for the diagnosis of EHBA.

Choledochal cysts are congenital segmental dilatation of the biliary tree and several subtypes have been described. Both ultrasound and MRCP are used for establishing the preoperative diagnosis. The lecture will detail the various imaging findings and their diagnostic accuracy for evaluation of a neonate with Jaundice.
RESULTS: Of the 60 (42 boys and 18 girls) US C.I.’s measured by ROC, sensitivity and specificity with 95% variables. The diagnostic accuracy of sonography was curve analysis were used for comparison of parametric t test, the Levene test, one-way ANOVA test and ROC and proximal bowel obstruction was noted. The Student invagination. The presence or absence of lead point outer wall thickness, inner fat core and segmental measurements included the diameter of intussusception, intussusception were evaluated using US. US study was IRB approved. 60 children with suspected transient small bowel intussusceptions.

MATERIALS AND METHODS: This prospective study was IRB approved. 60 children with suspected intussusception were evaluated using US. US measurements included the diameter of intussusception, outer wall thickness, inner fat core and segmental invagination. The presence or absence of lead point and proximal bowel obstruction was noted. The Student t test, the Levene test, one-way ANOVA test and ROC curve analysis were used for comparison of parametric variables. The diagnostic accuracy of sonography was measured by ROC, sensitivity and specificity with 95% C.I.’s.

RESULTS: Of the 60 (42 boys and 18 girls) US examinations, 36 cases were diagnosed as obstructive intussusceptions (22 ileocolic and 14 ileoileal); 10 were classified as transient small-bowel intussusceptions and 14 cases negative for intussusception. Mean fat core diameter was 1.45 cm ± 0.32 for ileocolic vs. 0.37 cm ± 0.06 for obstructive small-bowel vs. 0.29 cm ± 0.08 for transient small bowel intussusceptions (P = 0.000000397). Among the 36 operated cases; mean lesion diameter was 3.23 cm ± 0.08 for ileocolic and 2.12 cm ± 0.038 for small-bowel intussusception (P = 0.0000001610); and ratio of inner fat core to outer wall thickness was greater than 1 for ileocolic and less than 1 for small-bowel intussusceptions. There was a statistical significant difference between segmental invagination of transient versus obstructive small bowel intussusceptions with mean values 1.93 ± 0.39 and 3.17 ± 0.25 respectively (P < 0.0001) and “optimal” threshold at 2.5 cm. The overall sensitivity and specificity of sonography is 100% and 91.67% having a significant correlation with final diagnosis including surgical findings (ROC 0.958 (P < 0.001).

CONCLUSION: The US measurements of intussusception fat core, outer wall thickness, the length of segmental invagination, ratio of fat core to outer wall thickness and lesion diameter, allows definite differentiation between ileocolic, obstructive and transient small bowel intussusceptions. The role of US as the preferred diagnostic modality for diagnosing intussusception remains justified.

CLINICAL RELEVANCE/ APPLICATION: A definitive diagnosis of ileocolic, obstructive and transient small-bowel intussusception allows an intrepid choice between conservative management and urgent intervention avoiding unnecessary laparotomies

MC 01 PD-04 14:50
Bedside upper gastrointestinal series for the evaluation of stomach and small bowel passage in neonates of intensive care unit
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BACKGROUND AND PURPOSE: The upper gastrointestinal (UGI) series is performed for assessing passage of gastrointestinal tract and diagnosing malrotation in neonates. Previously, a bedside UGI technique was suggested in 2014 and demonstrated to be useful to exclude malrotation in critically ill neonates who had the risks of transportation from neonatal intensive care unit (NICU). However, to date, no study has evaluated or validated this technique out of that institution. The purpose of this study was to evaluate the utility of bedside UGI technique for assessing the position of the duodenojejunal junction (DJJ), passage of stomach and small bowel loops and clinical impact.

MATERIALS AND METHODS: Institutional review board approved this retrospective study and obtaining informed consent was waived. We reviewed bedside UGI examinations performed in neonates of NICU from 2014 to 2019. The examination consists of scout radiograph and series of frontal supine radiographs obtained at fixed time intervals following administration of 5cc/kg isotonic water-soluble contrast agent via the enteric tube. We reviewed the UGI findings with clinical data including sex, age, birth weight, and indication as well as final diagnosis including surgical findings.

RESULTS: In 17 patients identified (weight range: 520-3620g, age range: 0-4 months), total 20 bedside UGI examinations were performed. Confidence to identify the DJJ was good in seven series and equivocal in eight series among these 20 examinations. The DJJ could not be evaluated in five series, because of inadequate time (n=3), delayed passage (n=1) or status of gastric volvulus (n=1). The DJJ given good confidence was mostly found in immediate after or 1-minute interval radiographs (6/7). Four series showed passage delay including two meconium plug syndrome cases and one gastric volvulus. There was only one case of intestinal malrotation which was detected at the first examination and underwent surgery due to midgut volvulus during
follow-up.

**CONCLUSION:** Bedside UGI series can evaluate intestinal malrotation and UGI passage delay in neonates of NICU. Immediate after and 1-minute delay radiographs are important for the evaluation of DJJ location. Caution is needed in patients with delayed passage because of the possibility of meconium plug syndrome or volvulus.

**MC 01 PD-05  15:10**

**Pediatric MRCP**

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Magnetic resonance cholangio-pancreaticography (MRCP) is a noninvasive option for visualizing biliary and pancreatic ductal system. It is often performed after an initial ultrasound examination and offers the advantage of being devoid of ionizing radiation. MRCP can visualize ducts up to 1 mm in caliber. While performing a MRCP in a pediatric patient, attention should be paid to the technique to ensure good image quality. Apart from the protocol parameters, several other factors like sedation, respiratory motion correction, RF coil selection etc. can affect the image quality. Use of negative oral contrast, intravenous contrast, hepatocyte specific contrast agent and secretin have been tried to improve the image quality in pediatric MRCP. The imaging protocol may involve use of both 2D and 3D sequences.

The interpretation of MRCP involves evaluation of hepatic and pancreatic ductal system for the caliber of the lumen and the contents. Common indications for pediatric MRCP include evaluation for the congenital abnormalities of the biliary and pancreatic ductal systems, extra hepatic biliary atresia, sclerosing cholangitis, gall stone disease and acute and chronic pancreatitis. Neoplasms of the biliary system and pancreas are rare in pediatric population and may require MRCP in addition to MRI. MRCP is also needed for evaluation of trauma to the biliary and/or pancreatic ductal system.

The details of technique, indications and imaging finding will be discussed in the lecture.

**MC 01 PD-06  15:30**

**The relationships between liver fat fraction, AST and ALT levels in overweight and obese children using new magnetic resonance imaging technique**

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**BACKGROUND AND PURPOSE:** Proton density fat fraction (PDFF) magnetic resonance (MR) imaging can be useful technique for volumetric measurements of liver fat. The purpose of our study is to evaluate the relationships between liver fat fraction (LFF), aspartate aminotransferase (AST) and alanine aminotransferase (ALT) levels in overweight and obese children.

**MATERIALS AND METHODS:** Twenty-five children aged 9-17 years included. Patients with between 85 - 95th percentile of BMI z-score (12 of 25 patients) were assigned to overweight group and patients with above 95th percentile of BMI-z-score (13 of 25 patients) were assigned to obese group. 12 healthy children with below 85th percentile of BMI-z-score were assigned to control group. Liver fat fraction measurements were performed on 3D volume measurement workstation using PDFF magnetic resonance (MR) images. Spearman’s correlation coefficients between liver fat fraction, AST and ALT levels were evaluated for overweight, obese and control groups, separately. Receiver operator characteristics (ROC) analysis was also performed.

**RESULTS:** Among all overweight and obese groups; liver proton density fat fraction and AST levels had strong correlation \( r=0.716, p<0.001 \). LFF and ALT levels also demonstrated a strong correlation \( r=0.878, p<0.001 \). ROC analysis ascertained an optimal liver fat fraction threshold of 114 for predicting AST level (sensitivity = 75%, specificity = 89%). ROC analysis ascertained an optimal LFF threshold of 114 for predicting ALT level (sensitivity = 80%, specificity = 90%).

**CONCLUSION:** Our results indicate that there is strong correlation between LFF values, AST and ALT levels in overweight and obese children.
Free-breathing 3D GRE T1WI with golden angle stack-of-stars acquisition technique for upper abdominal MRI in children

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BACKGROUND: Respiratory artifacts impair image quality of abdominal MRI in children because of limited breath-hold capability, especially in cases with sedation during MRI examination.

OBJECTIVE: To compare the image quality of contrast-enhanced 3D gradient echo T1-weighted images (GRE T1WI) using Cartesian acquisition (Cartesian eTHRIVE), golden angle stack-of-stars acquisition with spectral fat suppression (3D VANE eTHRIVE) and that with fat suppression using modified Dixon (3D VANE mDixon) of upper abdomen in children with free-breathing state.

MATERIALS AND METHODS: Pediatric patients who underwent whole-body MRI with free-breathing contrast-enhanced GRE T1WI axial scans of upper abdomen using Cartesian eTHRIVE, 3D VANE eTHRIVE and 3D VANE mDixon were enrolled. Qualitative analysis of image quality was performed for overall image quality, hepatic edge sharpness, hepatic vessel clarity, respiratory artifact, radial artifact, lesion conspicuity, and lesion edge sharpness. Quantitative analysis using coefficient of variation of signal intensity of liver, spleen and air was performed.

RESULTS: In 41 pediatric patients, 3D VANE eTHRIVE showed the highest scores, followed by 3D VANE mDixon and Cartesian eTHRIVE (P ≤ 0.001) for all image quality parameters. 3D VANE eTHRIVE (2.42 ± 0.63) also showed significantly higher score in radial artefact than 3D VANE mDixon (2.28 ± 0.81, P = 0.001). The scores for lesion conspicuity and lesion edge sharpness of 3D VANE eTHRIVE were higher than those of Cartesian eTHRIVE and 3D VANE mDixon without statistical significance. 3D VANE eTHRIVE and 3D VANE mDixon showed less variation of signal intensity compared with Cartesian eTHRIVE within liver (P ≤ 0.001) and spleen (P ≤ 0.011), but the difference between 3D VANE eTHRIVE and 3D VANE mDixon was not significant. Acquisition time of 3D VANE eTHRIVE (81.26 ± 16 seconds) was higher than those of Cartesian eTHRIVE(7.87 ± 0.95 seconds) and 3D VANE mDixon (76.66 ± 12.44 seconds, P < 0.001).

CONCLUSIONS: Golden angle stack-of-stars acquisition technique applied in 3D T1WI of abdominal MRI has better image quality and decrease respiratory artifact than Cartesian acquisition technique in children with free-breathing state. In the golden angle stack-of-stars acquisition, fat suppression by spectral fat suppression has better image quality and fewer artifacts than mDixon.

Pretreatment prognostic factors for children with hepatoblastoma based on radiological and clinical criteria

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The purpose of this study was to identify predictors of outcome in pediatric patients with hepatoblastoma. Eligible criteria for this retrospective study were patients who (1) diagnosed with hepatoblastoma, (2)
were younger than 18 years old, and (3) had initial cross-sectional imaging (CT or MRI) at the time of diagnosis. A total 84 patients (mean age, 2.9 ± 3.5 years) were identified between 1998 and 2017 in our tertiary referring center. Clinical variables including age and serum alpha fetoprotein (AFP) level at the initial diagnosis and imaging variables of PRETEXT (PRE-Treatment EXtent of tumor) staging system including groups (I-IV) and annotation factors (V, P, E, F, R, C, N, M) were evaluated. Event-free survival (EFS) (i.e., time from diagnosis to first relapse, progression, second malignancy, or death for any reason), which was the primary outcome of this study, was analyzed. Univariable Cox proportional hazards analysis revealed that age group, and PRETEXT annotation factor of P, F, and M were significant predictors of EFS. On multivariable Cox proportional hazard analysis, the PRETEXT annotation factor of F (multifocality of tumor) was the strongest predictor (HR 2.908, 95% CI of 1.061-7.972, p=0.038) in predicting EFS. The PRETEXT annotation factor of M (distant metastasis) showed borderline significance in predicting EFS (HR 2.416, 95% CI of 0.918-6.354, p=0.074). The prediction model based on F and M (F+M model) showed good performance to predict EFS (C statistics, 0.734; 95% CI of 0.612-0.854). In conclusion, the PRETEXT annotation factor of F was the strongest predictor of EFS and the F+M model showed good performance to predict EFS in pediatric hepatoblastoma patients.

The usefulness of configuration and size of residual mass for diagnosing truly failed pneumatic reduction in children with intussusceptions

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PURPOSE: To determine fluoroscopic criteria enabling reliable diagnosis of truly failed pneumatic reduction in children with intussusceptions

METHODS: Between January 2003 and May 2018, we reviewed 373 procedures of fluoroscopic pneumatic reduction for ileocolic intussusceptions (324 patients under 18 years of age; mean age, 2.3 years). Two pediatric radiologists classified all procedures according to original radiologic criteria (ORC): procedures with successful results (PSR) vs. those with failed results (PFR). PFR, which include a residual intussusception mass and no air reflux into the terminal ileum, were divided into true failure group and false failure group based on the clinical outcome or surgical records. Clinical and radiologic data were analyzed, focusing on the configuration and size of the residual mass at post-reduction fluoroscopic images. Statistical analyses included student t-test, Mann-Whitney U test, Chi-square test, and multivariable logistic regression.

RESULTS: Of 373 procedures, 264 (71%) were PSR and 109 (29%) were PFR. All 264 PSR were truly successful pneumatic reduction. Of 109 PFR, 40 (37%) were true failure group and 69 (63%) were false failure group. The symptom of bloody stool, presence of pathologic lead points (PLP), US findings including entrapped fluid, free peritoneal fluid, and decreased blood flow at color Doppler US were more common in true failure group than in false failure group (P<.05). At post-reduction fluoroscopic images, all PFR showed residual masses around the ileocecal valve. All except one (98%) of true failure group had residual masses with protruded configuration, whereas 88% (61/69) of false failure group showed indented configuration of the mass (P<.001). The size of the mass was larger in true failure group than in false failure group (P<.001). In a multivariable logistic regression model, the configuration and size of the residual mass were significant parameters to differentiate true failure group from false failure group with age, gender, and presence of PLP controlled for (P<.001).

CONCLUSION: Only 37% of PFR were proved to be truly failed pneumatic reduction. Recognition of a residual mass configuration in combination with measurement of its size may be useful for the diagnosis of truly failed pneumatic reduction in children with intussusceptions.
Primary intracranial tumors (ICTs) are the most common solid tumor in pediatric population and the incidence is about 2.1-3.4/100,000. The differential diagnosis of pediatric brain tumors begins with an accurate assessment of lesion location, which is often the most important diagnostic feature provided by conventional MRI. Most of the pediatric brain tumors involve the posterior fossa, pineal or suprasellar, supratentorial regions... Furthermore, some image tools like diffusion-weighted image, diffusion kurtosis image, texture analysis... may help to narrow down a list of differentials.

About 40-55% of all pediatric ICT involve the posterior fossa. Embryonal medulloblastomas, brain stem gliomas, juvenile pilocytic astrocytomas, ependymomas... are the most common tumors found within the posterior fossa. Among these, medulloblastoma is the most common malignant brain tumor during childhood accounting for the majority of cancer-related mortality in children. Four distinct clinical and molecular subgroups, namely wingless (WNT), sonic hedgehog (SHH), group 3, and group 4 with characteristic anatomic, enhancement, and clinical characteristics were identified and incorporated as individualized treatment regimens. Supratentorial ependymoma is mostly an intraparenchymal tumor; but infratentorial ependymoma is usually found adjacent to the fourth ventricle. After using contrast medium, ependymomas usually show moderate to strong enhancement. Solid portions of juvenile pilocytic astrocytomas were similarly well enhanced after using contrast medium. Tumor cysts are common in juvenile pilocytic astrocytoma.

Among intracranial germ cell tumors (GCTs), germinomas are the most frequent histological subtype. Mixtures of these tumors are also common, i.e. about 1/3 of intracranial germ cell tumors are of mixed types. Most pineal tumors in the true sense are GCTs or parenchymal tumors but the former is more common in children. However, intra-tumoral calcifications ("engulfed") are frequently evident in germinoma. In comparison, non-germinomatous germ cell tumors tend to be heterogeneously enhanced with contrast enhancement. The tumor ADCs were significantly smaller in germinoma than non-germinomatous groups. The neuroimaging features of GCTs at the basal ganglia differ to some extent from other locations. Most CNS GCTs affecting the basal ganglia are invasive germinomas, showing no mass effect or enhancement, initially. Slightly high signal intensity on FLAIR or T2-weighted images is sometimes the only prominent finding. Thus, diagnosis at this stage can be difficult. In addition, the ipsilateral brain parenchyma adjacent to the germ cell tumor can be atrophic. Radiologists become better at making a preoperative diagnosis of that tumor type, detecting recurrence, and guiding surgical management to avoid injury to vital brain structures.

We aimed to evaluate the frequency, radiological-clinical findings of brain herniation into arachnoid granulation (BHAG) in pediatric age group using 3 T magnetic resonance imaging. Patients were under 18 years of age and underwent brain MRI examination which consists of 3D T1, 3D T2 FLAIR and 3D T2 sequences. A total of 2320 patients were enrolled in the study. All cases of AG into transverse sinus were included. The location of the AG, the deep, transverse, vertical and neck diameters and volume of AG were recorded. Clinical findings and imaging findings of patients were also recorded. The patients were categorized as BHAG and AG without brain herniation (AGWBH). The mean diameters (deep, transverse, vertical and neck) and volume of AGWBH were 5.23 ± 1.91, 4.07 ± 1.58, 4.99 ± 1.68, 3.64 ± 1.84 mm and 85.05 ± 89.10 mm$^3$, respectively. The mean diameters (deep, transverse, vertical and neck) and volume of BHAG were 7.46 ± 2.6, 6.85 ± 2.34, 8.32 ± 2.35, 5.41 ± 1.79
mm and 331 ± 361.26 mm$^3$, respectively. The mean diameters and volume of BHAG were significantly larger than AGWBH (p < 0.001 for all parameters). There was no significant difference related to clinical and imaging findings between groups (p > 0.05). Brain herniation into arachnoid granulation is seen in pediatric age group as frequently as adults. Its frequency is not related to age. It is not significantly associated with neurological symptoms. As the AG size increases, the risk of BHAG increases.

**MC 01 PD-12  17:10**

**Association between maternal iron deficiency anemia and fetal hippocampal volume**

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**PURPOSE:** Although there are causes of anemia during pregnancy but the most significant contributor being iron deficiency. Anemia in pregnancy can have negative implications both for mother as well as her fetus such as prematurity, low birth rate, fetal impairment etc and can also have deleterious effect on fetal neurodevelopment.

With the dearth of literature regarding the co-relation between maternal iron deficiency anemia and fetal hippocampus volume, we hypothesized that maternal iron deficiency anemia may alter the hippocampal volume and for the same, we conducted a study which compared hippocampal volumes between two groups of neonates (3-5 days of life) - one born to mother with iron deficiency anemia and another who were born to mother without iron deficiency anemia.

**OBJECTIVE:** To determine the correlation between maternal iron deficiency anemia and fetal hippocampal volume.

**MATERIALS & METHODS:** This prospective observational study, with the study period extending from January 2017 to July 2018, was conducted in tertiary care university based teaching institution after taking consent from all parents before inclusion in the study - 75 term singleton neonates born to mother with iron deficiency anemia were compared with 25 healthy singleton, gestational age matched neonates born to mother without IDA. Cranial MRI of sedated infants were performed in supine position using 1.5 tesla MRI machine and a quadrature head coil was used to acquire predesigned protocol. Contiguous 1 mm thick sections were obtained using 3D-FSPGR (three dimensional-magnetization prepared rapid gradient echo) imaging. Manual tracing of hippocampus was done on postprocessing work station. For a statistical analysis, Paired sample T Test was done for comparing right and left hippocampal volume.

**RESULTS:** Right, left and combined hippocampal volumes, corrected for total intracranial volumes, were compared between cases and controls. Significant reduction in hippocampal volumes of cases was noted as compared to that of controls.

**CONCLUSION:** Hippocampal volumes were found to be significantly low in neonates born to anemic mothers with reduction in hippocampal volume being proportional to severity of maternal anemia.

**MC 01 PD-13  17:20**

**Texture Analysis of susceptibility-weighted imaging in neonatal brain**

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**BACKGROUND AND PURPOSE:** Susceptibility-weighted imaging (SWI) allows visualization of the deep medullary vein (DMV) in neonates. It is important to assess the prominence of DMV in neonates since it is related to pathologic conditions. We hypothesized that quantitative comparison of DMV in neonates could be possible using SWI texture analysis. Therefore, the purpose of this study was to compare the SWI texture parameters by age group and showing their relationship with gestational age. We also compared SWI texture parameters between normal neonates and neonates with ischemic injury.

**MATERIALS AND METHODS:** Total 38 neonates with normal brain (MRI scan at preterm [n = 12], term-
equivalent age [TEA] \( n = 18 \), and term \( n = 8 \)) and 7 neonates with ischemic injury (MRI scan at preterm \( n = 2 \), term-equivalent age [TEA] \( n = 1 \), and term \( n = 4 \)) underwent MRI with SWI. Regions of interests were drawn at the centrum semiovale including deep medullary veins. Texture parameters of entropy, skewness, and kurtosis were derived from the SWI. Texture parameters were compared between the groups according to the age at MRI scan (preterm vs. TEA vs. term) and the presence of ischemic injury (normal vs. ischemic injury). A correlation and nonlinear regression analysis were performed between postmenstrual age (PMA) and texture parameters in normal neonates.

**RESULTS:** In normal neonates, there was a significant difference in entropy according to age groups (preterm vs. TEA vs. term: \( 4.883 \) vs. \( 4.885 \) vs. \( 5.395 \), \( p < 0.001 \)). There was no significant difference in skewness (\( p = 0.712 \)) and kurtosis (\( p = 0.946 \)) values among the age groups. There was a significant positive relationship between entropy and PMA (R square = \( 0.402 \), \( p < 0.001 \)) and a significant negative relationship between skewness and PMA (R square = \( 0.248 \), \( p = 0.001 \)). There was no significant correlation between kurtosis and PMA (\( r = 0.469 \), \( p = 0.469 \)). The skewness of the ischemic group was significantly higher than that of the normal group (1.37 vs. 0.70, \( p = 0.001 \)).

**CONCLUSION:** Quantification of the deep medullary vein at centrum semiovale was possible using texture analysis of SWI in neonates. As the brain maturity and pathologic changes affected the SWI texture parameters, the parameters can be useful for neonatal brain evaluation.

**MC 01 PD-14  17:30**

**Gender- and age-related T1 and T2 values of the pituitary gland in infants**

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**BACKGROUND AND PURPOSE:** The anterior pituitary gland shows lower T1 signal intensity with aging during infancy. The signal intensity change of this infundibular structure is explained by the effect of estrogen during pregnancy. Although there were studies showing the signal intensities of the anterior pituitary, a quantitative study with the T1 or T2 values has not been done. Therefore, the objective of our study was to investigate gender- and age-related changes of T1 and T2 values of the anterior pituitary gland in infants using synthetic MRI.

**MATERIALS AND METHODS:** We reviewed infants who underwent synthetic brain MRI and showed no pathologic finding. Using synthetic MRI, T1 and T2 maps of the infants were generated. By drawing a region of interest at the anterior pituitary gland, the T1 and T2 values of the structure were examined. The Mann-Whitney U test was used to compare the values between genders. A correlation and nonlinear regression analysis were performed between “postnatal age and the values” and between “postmenstrual age and the values.”

**RESULTS:** A total of 64 infants (36 males and 28 females; mean ± standard deviation of gestational age, 222 ± 26.2 days) were included. The mean anterior pituitary gland T1 and T2 values were 1122.1 milliseconds and 92.6 milliseconds, respectively. At term-equivalent age, the anterior pituitary T2 values of females were significantly higher than that of males (105 milliseconds vs. 85 milliseconds, \( p = 0.012 \)). The anterior pituitary T1 values showed no significant difference between males and females (1133 milliseconds vs. 1098 milliseconds, \( p = 0.720 \)). There was a significant positive relationship between postnatal age and the anterior pituitary T1 values (R square = \( 0.307 \), \( p < 0.001 \)). There was no significant correlation between postnatal age and the anterior pituitary T2 values (\( r = -0.169 \), \( p = 0.181 \)). The T1 and T2 values of the anterior pituitary gland showed no significant correlation with postmenstrual age (\( p = 0.997 \) and 0.369, respectively).

**CONCLUSION:** At term-equivalent age, females showed significantly higher T2 values of the anterior pituitary gland than males. The T1 values of the anterior pituitary gland increased with postnatal age, but not with postmenstrual age.

**MC 01 PD-15  17:40**

Abnormal cortical neurodevelopment in children with moyamoya disease after indirect surgery

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**PURPOSE:** Children with postoperative moyamoya disease (pMMD) often accompanied with neurodevelopment impairments. Our study aimed to characterize the cortical neurodevelopment in pMMD using imaging analysis, and to explore the neurodevelopmental mechanism of this disease.

**METHODS:** 13 pMMD children and 14 healthy controls were recruited in our hospital. We investigated cortical surface indicators including cortical fractal dimension and thickness in all subjects using high-resolution T1-weighted image and surface-based data analysis techniques. Cortical fractal dimension (FD) and cortical thickness were calculated by using the Computational Anatomy Toolbox (CAT12). Analyses were performed for
the entire cortical surface followed by a complementary regions-of-interest approach.

**RESULTS:** pMMD children showed significantly decreased cortical FD in right superior temporal cortex and superior parietal cortex, and increased cortical thickness in right medial orbitofrontal cortex compared with controls (FDR p<0.05). In addition, there was a positive correlation between cortical FD in right superior parietal cortex and performance intelligence quotient scores (p=0.047, r=0.559).

**CONCLUSIONS:** This study showed cortical surface abnormalities in pMMD and correlated with intelligence quotient scores, which suggested that abnormal cortical development may serve as a vulnerability marker of MMD and provide new insight into the neuropathological of pMMD.

**MC 01 PD-16  17:50**

Arterial spin-labeling MR imaging can identify the collateral perfusion changes in moyamoya disease patients after indirect revascularization

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**PURPOSE:** To determine whether arterial spin-labeling (ASL) magnetic resonance (MR) imaging could be used to identify changes in collateral blood flow after indirect revascularization in children patients with moyamoya disease (MMD).

**MATERIALS AND METHODS:** From January 2016 to December 2018, 38 children with moyamoya disease (15 boys and 23 girls; mean age 6.6 ± 2.9 years) underwent indirect revascularization surgery. Both preoperative and postoperative ASL and dynamic-susceptibility contrast-enhanced (DSC) perfusion MR images were analyzed. Collateral grading in the encephalo-duro-arterio-synangiosis (EDAS) area was assessed using arterial transit artifact (ATA) scoring with a 3-grade scale. And according to the results of collateral grading and additional parenchymal perfusion scoring, perfusion status of EDAS area was qualitatively assessed with 4 grade scale. The value of cerebral blood flow (CBF) and time-to-peak (TTP) in the EDAS area normalized by that of the cerebellum was also compared between the end-systole and the end-diastole. Volumetric parameters were compared among three left ventricular hypertrophy groups (definite, borderline, none). The reproducibility was assessed. The t-test, one-way analysis of variance and Pearson correlation were used.

**RESULTS:** The collateral grading with ATA in the EDAS area decreased from the grade of 1.5 to 1 (p < 0.001), which means the normalized perfusion of the EDAS area. The perfusion status grading in the EDAS area improved from the grade of 2 to 3 (p < 0.001). There was no significant difference between the preoperative and postoperative CBF values in the EDAS area (1.594 vs. 1.649, p = 0.483). The value of TTP delay at the postoperative MR was improved compared to that of preoperative MR (0.858 vs. 0.926, p = 0.003). There was significant correlation between the perfusion status grading and TTP values (p = 0.003, rho = 0.476).

**CONCLUSION:** ASL MR imaging can provide perfusion status with collateral and parenchymal perfusion and the results were quite correlative with CBF values in children with moyamoya disease after indirect revascularization.

**Recent issues in pediatric imaging**

Chairperson(s)

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**SS 14 PD-01  09:40**

Technical feasibility of semiautomatic 3D threshold-based CT quantification of left ventricular mass

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**BACKGROUND:** Semiautomatic three-dimensional (3-D) threshold-based cardiac computed tomography (CT) quantification has not been attempted for left ventricular mass.

**PURPOSE:** To evaluate the technical feasibility of semiautomatic 3-D threshold-based cardiac CT quantification of left ventricular mass in patients with various degrees of left ventricular hypertrophy.

**MATERIALS AND METHODS:** In 99 patients, cardiac CT was utilized to quantify ventricular volume and mass by using a semiautomatic 3-D threshold-based method. Left ventricular mass values were compared between the end-systole and the end-diastole. Volumetric parameters were compared among three left ventricular hypertrophy groups (definite, borderline, none). The reproducibility was assessed. The t-test, one-way analysis of variance and Pearson correlation were used.

**RESULTS:** There were no technical failures. The left ventricular mass between the two sessions exhibited a
small mean difference of 2.3 ± 1.1% (mean ± standard deviation). The indexed mass values were significantly higher at the end-systole than at the end-diastole (71.4 ± 42.9 g/m^2 vs. 65.9 ± 43.3 g/m^2, p < 0.001), with significant correlation (r = 0.99, p < 0.001). The definite group (83.5 ± 41.3 g/m^2) showed statistically significantly higher indexed mass values than the borderline and none groups (64.7 ± 26.9 and 55.6 ± 23.9 g/m^2, respectively; p < 0.03), while demonstrating no statistically significant difference between the latter two groups (p > 0.05). Left ventricular volume-mass and mass-volume ratios could be calculated in all three groups.

CONCLUSION: CT quantification of left ventricular mass using semiautomatic 3-D threshold-based segmentation is feasible with high reproducibility and the mass values and its ratios with ventricular volumes may be used in patients with various degrees of left ventricular hypertrophy.

SS 14 PD-02 09:50
Volumetric severity assessment of Ebstein anomaly using three-dimensional cardiac CT: a feasibility study
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PURPOSE: In Ebstein anomaly, volumetric severity assessment may be better than area-based one for predicting clinical outcome. The purpose was to demonstrate the feasibility of volumetric severity assessment of Ebstein anomaly using cardiac CT.

MATERIALS AND METHODS: In six children with Ebstein anomaly, delineated tricuspid valve, streak artifacts, and contrast enhancement heterogeneity on cardiac CT were graded. Volumes of all cardiac chambers including atrial and functional RV were quantified using cardiac CT data. Functional RV fraction, functional RV/left ventricle volume ratio, and total right/left-volume index were calculated. Volume-based CT severity index was compared with area-based echocardiographic and CT severity indices.

RESULTS: Regarding the extent of delineation of the malformed tricuspid valve and streak artifacts, all cases showed grade 3 or 4. In only one case, the right atrium showed image noise (126.7HU) greater than 50HU and all others demonstrated image noise lower than 50HU. With the given image quality, all the volumetric measurements could be successfully obtained. RV volumes were increased in 83.3% (5/6) of the cases. Functional RV fraction was approximately 60.8-61.5%. Functional RV/left ventricle volume ratio and total right/left-volume index were 2.0 ± 1.4 and 3.5 ± 1.5, respectively. Smaller difference (0.2 ± 0.1) was found between the area-based and volume-based CT severity indices than other comparisons. They also showed a higher concordance rate (83.3%, 5/6) in the severity grades.

CONCLUSION: Volumetric severity assessment using cardiac CT is feasible in Ebstein anomaly and may be useful to characterize diverse phenotypes of Ebstein anomaly.

SS 14 PD-03 10:00
Role of split-bolus dual energy CT angiography in evaluation of pediatric hemoptysis: a tertiary care center experience
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BACKGROUND: MDCT is the modality of choice for imaging evaluation of a child with significant hemoptysis. PURPOSE: To study the etiologies causing hemoptysis in pediatric population using single phase split-bolus DECT angiography (DECTA) and compare presence of abnormal bronchial and non-bronchial systemic arteries with various etiological groups.

MATERIALS AND METHODS: Using dual-source (80 kV & 140 kV), 2 × 128-slice equipment, DECT angiography was performed in a split bolus protocol using 1.5-2 ml/kg iodinated contrast in 86 children less than 18 years (M:F = 45:41; age range, 3 months-18 years) presenting with hemoptysis. Systemic and pulmonary arterial abnormalities were evaluated from these single phase acquisitions.

RESULTS: Split bolus protocol led to overall optimal opacification of both systemic and pulmonary arteries in all patients. Causes of hemoptysis were categorized into various groups such as active tuberculosis (TB) (21), other active pulmonary infections (pyogenic/fungal) (9), post infective sequelae (17), bronchiectasis (situs inversus with ciliary dyskinesia, immunodeficiency) (11), cystic fibrosis (CF) (7), congenital lung malformations (CPAM/Sequestration/Scimitar) (6), congenital heart diseases (CHD) (7), miscellaneous (Idiopathic pulmonary hemorrhage, diffuse alveolar hemorrhage, pulmonary thromboembolism, Swyer-James syndrome) (11). No cause could be identified in 9 patients. Some patients had two etiologies on CT; these were counted in both the respective groups. Most of the children (83%) were more than 10 years of age; amongst which active TB, post infectious sequelae and bronchiectasis...
(including CF) were the most common etiologies. Total 165 abnormal arteries were identified; out of which 108 were abnormal bronchial arteries (BA) (99 eutopic and 9 ectopic) and 57 non-bronchial systemic arteries (NBSA), majority arising from subclavian artery branches. Most of the primary bronchiectasis cases had abnormal BA only, in comparison to other etiologies which had both BA and NBSA.

**CONCLUSION:** Post infective sequelae, which is the most common cause of hemoptysis in adults, is less common in children. Active pulmonary infection, including TB is the most common cause in children followed by bronchiectasis. In bronchiectasis, mostly only BA are abnormally hypertrophied. Whereas, NBSA are mostly found in post infective sequelae, CHDs and sequestration.

**SS 14 PD-04**

**10:10**

**Enlarged subarachnoid space on cranial ultrasound in preterm infants: neurodevelopmental implication**

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**BACKGROUND:** The role of enlarged subarachnoid space (ESS) in preterm infants has not been described in concrete.

**PURPOSE:** To evaluate whether ESS should be considered a risk factor potentially associated with adverse neurodevelopmental outcomes in prematurity.

**MATERIALS AND METHODS:** Electronic medical records of 197 preterm infants (median 32.1 weeks gestation) including cranial ultrasound (cUS) images, head circumferences, and Korean Developmental Screening Tests for Infants and Children (K-DST) results at 18-24 months corrected age were reviewed. The clinical characteristics and K-DST results were compared in infants with and without ESS (sinocortical width > 3.5 mm). A multivariable logistic regression analysis was performed to identify potential risk factors associated with positive K-DST results.

**RESULTS:** At a median corrected age of 39.0 weeks, 81/197 (41.1%) infants presented ESS. A significantly greater percent of infants in the ESS group screened positive on the K-DST than in the no ESS group (27.2% vs. 12.1%, p = 0.007). Within the ESS group, micro-/macrocephaly at term-equivalent age was not different with regard to the K-DST results. From the multivariable logistic regression analysis, gestational age (p = 0.016, OR = 0.855, 95% CI = 0.753-0.971) and sinocortical width (p = 0.019, OR = 1.310, 95% CI = 1.046-1.641) were two significant risk factors associated with positive K-DST results.

**CONCLUSION:** ESS identified on cUS at term-equivalent age in preterm infants is associated with possible developmental delays. Macrocephaly at term-equivalent age does not guarantee a benign prognosis. Future studies are required to verify sinocortical width as a potential marker for neurodevelopmental delay in preterm infants.

**SS 14 PD-05**

**10:20**

**Optimal timing for the spinal cord ultrasonography to detect filum terminale lipoma in infants**

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**PURPOSE:** To know the optimal timing for the spinal cord ultrasonography (US) to detect filum terminale lipoma in infants.

**MATERIALS AND METHODS:** Infants under 12 months old who underwent repeated spinal cord US from 2011 to 2019 were retrospectively included. The US examinations were excluded when it was performed after the operation or when there were other lesions except for filum terminale lipoma. Among the infants who had spinal MRI, patients who had filum terminale lipoma on MRI were grouped as lipoma group, while infants who did not have lipoma were grouped as control group. To assess the correlation between age (month) and the thickness of filum terminale (mm) measured on US, linear mixed model was used for the repeated measurement. The thickness of filum terminale was compared between lipoma and control group according to the age.

**RESULTS:** Total 241 infants (M:F = 121:120; mean, 2.6 ± 2.8 months old) had repeated spinal cord US and 496 US examinations were included. Among them, 51 infants underwent MRI and 27 infants had filum terminale lipoma. In all infants with or without MRI, there were significant positive correlation with age and thickness of filum terminale (p < 0.001). The thickness was significantly higher in lipoma compared to control groups (mean 1.8 mm vs. 0.9 mm, p < 0.001), but there was no significant differences in the slope of thickness according to the age between two groups (p = 0.167). In post-hoc analysis, the optimal cutoff value of thickness for the detection of lipoma was constant (1.1 mm) in each month. The thickness was significantly different between two groups in 2, 3 months old (p = 0.031, < 0.001, respectively), while it was not different in 0, 1 month old (p = 0.105, 0.386, respectively).

**CONCLUSION:** The thickness of filum terminale was increased with increasing age, but the cutoff value for detecting filum terminale lipoma was constant as 1.1
mm in infants under 12 months old. The 2, 3 months old was optimal for detection of filum terminale lipoma using US compared to the neonatal period.

SS 14 PD-06 10:30
Quantitative ultrasonographic evaluation of the flexor pollicis longus tendon in pediatric trigger thumb: correlation with clinical outcome
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PURPOSE: To quantitatively assess the initial and follow-up ultrasonographic features of the flexor pollicis longus (FPL) tendons in pediatric trigger thumbs and to evaluate the correlation with clinical outcomes.

MATERIALS AND METHODS: A retrospective study on 19 children (mean age, 32 months; M:F = 10:9) with unilateral trigger thumb who undergone conservative treatment was performed. Quantitative finger ultrasonography focused on FPL tendon was performed at the point of diagnosis and follow-up after conservative treatment, including the greatest anteroposterior diameter (APD), transverse radioulnar diameter (RUD), and cross sectional area at the level of A1 pulley (A1) and proximal to A1 pulley (A0) each. The measurements of the FPL tendon in the trigger thumb and the contralateral normal thumb in each patient were compared and correlated with clinical progress.

RESULTS: At the point of diagnosis, the mean APD, RUD, and area of the FPL tendon in the trigger thumb were 1.5, 1.36, 2.05 times larger than the normal thumb at A0, and 1.28, 0.97, 1.25 at A1. The APD, RUD, and area ratios of A0 to A1 level were 1.18, 1.41, 1.68 times larger in the trigger thumb. After an average of 2.02 years of follow-up with conservative treatment, 11 patients showed clinically significant improvement while the other 8 showed mild improvement with residual flexion deformities. At the point of follow-up, the area ratio of A0 to A1 level of the FPL tendon was decreased by an average of 11%, while decreased by 18% in clinically significant improvement group and by 1% in mild improvement group.

CONCLUSION: In quantitative ultrasonographic evaluation, developmental mismatch of the FPL tendon (the enlarged FPL tendon at the proximal level of A1 pulley [A0] compared with the FPL tendon under the A1 pulley [A1]) was improved after conservative treatment and these quantitative ultrasonographic features were in correlation with clinical outcomes.

SS 14 PD-07 10:40
Bone marrow fat change and sarcopenia in pediatric patients
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PURPOSE: To investigate the change of bone marrow (BM) and para-spinal muscles (PSM) fat content and psoas muscle area (PMA) associated with age and body mass index (BMI) in pediatric patients including non-alcoholic fatty liver disease (NAFLD) patients.

MATERIALS AND METHODS: Institutional Review Board approval was obtained for this retrospective study. Consecutive fat quantification liver MRI examinations including proton density fat fraction between June 2015 and April 2019 to evaluate NAFLD in children were reviewed. Not only hepatic fat, but also BM and PSM fat were quantitatively evaluated on axial images of the fat map at the mid-levels of T11-L2 vertebral bodies for BM fat and at the mid-level of L2 for PSM fat. Furthermore, PMA was evaluated on axial images of the T2 at the mid-level of L3. Age, height and weight at the time of MRI were recorded and BMI was calculated. And Pearson correlation and partial correlation analyses were performed.

RESULTS: Total 235 patients (164 male) were included with the mean age 14.5 ± 3.8 years (range, 6-24 years). The mean fat fractions were 19.5 ± 13.8% (1.5-53%) in liver, 43.4 ± 14.3% (17.3-95.9%) in spinal BM, and 2.9 ± 1.3% (0.7-9.0%) in PSM. The mean PMA was 655.4 ± 273.8 cm² (210.3-1467.5 cm²). Age showed positive correlations with BM fat (ρ = 0.385, p < 0.001) and PMA (ρ = 0.285, p = 0.001). After correction of age and height, PMA showed positive correlations with BMI (ρ = 0.404, p < 0.001) and liver fat (ρ = 0.252, p < 0.004) and negative correlations with BM fat (ρ = -0.392, p < 0.001) and PSM fat (ρ = -0.229, p = 0.009).

CONCLUSION: BM fat and PMA increases with age of pediatric patients. BM fat and PSM fat were associated with sarcopenia, even though obesity and the degree of fatty liver showed positive correlation with PMA after correction of age.
SS 14 PD-08 10:50
Detection of pediatric humerus supracondylar elbow fractures using deep convolutional neural network
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PURPOSE: To determine the feasibility of using deep convolutional neural network (DCNN) in detecting pediatric humerus supracondylar elbow fractures on AP and lateral radiographs.

MATERIALS AND METHODS: A total of 430 AP and lateral elbow radiographs from 215 pediatric patients who presented to the hospital with upper extremity trauma from January 2014 through October 2018 were retrospectively reviewed. The studies were binomially classified as either positive or negative for fracture based on the reports. The studies were randomly divided into a training set (150 patients), a validation set (15 patients), and an independent test set (50 patients). The region-of-interests were set to encompass elbow region and cropped from whole radiograph images. The data oversampling was done by image augmentation (flip and rotation) to overcome small amount of data and class imbalance. The training set was used to train DCNN, specifically ResNet50 model which is a state-of-the-art architecture in image classification purpose. Hyperparameters were optimized using the validation set, and the DCNN with the highest ROC AUC on the validation set was selected for further performance testing on the test set. Sensitivity, specificity, positive predictive value, negative predictive value, area under the receiver operating characteristic curve (AUROC) were calculated.

RESULTS: The final trained DCNN model had an AUROC of 0.75 on the test set. On the test set, sensitivity was 0.91, specificity was 0.59, and accuracy was 0.75.

CONCLUSION: Deep convolutional neural network can effectively detect pediatric humerus supracondylar fractures in the setting of acute trauma.

SS 14 PD-09 11:00
Cervical lymphadenopathy in children: a diagnostic tree analysis model based on US and clinical findings
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PURPOSE: To establish a diagnostic tree analysis (DTA) model based on ultrasonography (US) imaging findings and clinical characteristics for differential diagnosis of cervical lymphadenopathy in children.

MATERIALS AND METHODS: Total 242 patients (131 boys and 111 girls; mean age, 11.2 ± 0.3 years; range, 1 month-18 years) with pathologically confirmed Kikuchi disease (KD) (n = 127), Reactive hyperplasia (RH) (n = 64), lymphoma (n = 24), and suppurative lymphadenitis (SL) (n = 27) who underwent neck US were included. US images of lymph nodes were retrospectively reviewed with regards to location, number, distribution, size, echogenicity, margin, presence of necrosis, calcification, perinodal fat hyperechogenicity, and loss of fatty hilum. Clinical information including age, sex, cervical tenderness, erythema, heat sense, fever, hepatomegaly, splenomegaly, history of antibiotics, and laboratory results were collected. The patients were randomly divided into training (70%, 167/242) and validation (30%, 75/242) datasets to assess diagnostic performance of the DTA model. The DTA model was created using a classification and regression tree algorithm on the basis of US imaging findings and clinical findings.

RESULTS: In the DTA model, perinodal fat hyperechogenicity, loss of fatty hilum, and echogenicity of the lymph nodes (homogeneous or heterogeneous) were found to be significant predictors in the diagnostic algorithm for differential diagnosis of cervical lymphadenopathy while any clinical findings were not. The overall accuracies were 86.2% and 82.7% in training and validation datasets. The accuracy of KD, RH, lymphoma and SL was 92.2%, 80.4%, 62.5%, and 86.2% in the training dataset, and 91.9%, 61.1%, 75.0%, and 91.7% in the validation dataset, respectively.

CONCLUSION: The presence of perinodal fat hyperechogenicity, heterogeneity of echotexture and loss of fatty hilum were significant ultrasonographic findings in the DTA for differential diagnosis of cervical lymphadenopathy in children.

CLINICAL RELEVANCE/APPLICATION: The DTA model based on US imaging findings may be useful for differential diagnosis of cervical lymphadenopathy in children.
Pediatric Fat Hyperchogenicity

Pediatric Fat

Loss of Fatty Hilar

Echogenicity of LN

Positive

Negative

Lymphoma

Reactive Hyperplasia

Suppurative Lymphadenitis

Kitruchi Disease

White arrow: Normal fatty hilum
Yellow arrow: Perinodal fat hyperchogenicity
Asterisk: Internal necrosis