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Meeting Abstracts

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Keynote Session

Small-data AI and Its Applications to Diagnostic Aid and Virtual AI Imaging

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Abstract

Deep leaning has become one of the most active areas of research in medical imaging. My group has been actively studying on deep learning in medical imaging in the past 25 years, including ones of the earliest deep-learning models for medical image processing, semantic segmentation of lesions and organs, lesion/organ enhancement, and classification of lesions in medical imaging. In this talk, small-data AI that can be trained with a small number of cases is introduced. Our small-data AI was applied to develop AI-aided diagnostic systems ("AI doctor") and deep-learning-based imaging for diagnosis ("virtual AI imaging"), including 1) AI systems for cancer detection and diagnosis with medical images, and 2) virtual AI imaging systems for separation of bones from soft tissue in chest radiographs and those for radiation dose reduction in CT and mammography. Some of them have been commercialized via FDA approval in the U.S., including the first FDA-approved deep-learning product.

Artificial Intelligence and Machine Learning

The ReIMAGINE Multimodal Warehouse: Connecting Prostate Cancer Data with Artificial Intelligence Tools

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Abstract

Prostate cancer (PCa) is the most frequent cancer diagnosis in men worldwide. Our ability to identify those men whose cancer will decrease their lifespan and/or quality of life remains poor. MRI will likely become the future cornerstone of the risk-stratification process for men at risk of early PCa. The ReIMAGINE Consortium has been established to improve PCa diagnosis by combining MRI with other data. ReIMAGINE Screening invites men for MRI and PSA evaluation. ReIMAGINE Risk includes men at risk of PCa based on MRI and includes biomarker testing. Baseline clinical information, genomics, blood, urine, fresh prostate tissue samples, digital pathology and radiomics data were analysed. Data are de-identified, stored with correlated mp MRI disease endotypes and linked with long term follow-up outcomes in an instance of the Philips Clinical Data Lake, consisting of cloud-based software. This platform includes application programming interfaces and a user interface that allows users to browse data, select cohorts, manage users, and access rights, query data, and more. Connection to analytics tools such as Python allows statistical and stratification method pipelines to run profiling regression analyses. The ReIMAGINE Multimodal Warehouse comprises a unique data source for PCa research, to improve risk stratification for PCa and inform clinical practice. In this presentation we introduce big data projects in healthcare, we show how the ReIMAGINE platform is organized and connected to AI tools, and we give an example of how the ReIMAGINE dataset can be analyzed using AI algorithms to predict the aggressiveness of PCa.

AI for Preventative Healthcare: Filling the Gaps in Radiology Practice

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Abstract

Clinicians have limited time so today they are primarily focused on the diagnosis and treatment of disease, and less on personalized preventative healthcare. Using AI, information can be unlocked from medical scans to provide risk prediction and personalized health recommendation. Deep learning systems have been demonstrated that predict cardiovascular disease risk, lung cancer risk, diabetes risk, and other disease risks from medical imagines. I discussed a suite of deep learning models that can automatically run in the background on any abdominal CT. These tools segment the liver, visceral and subcutaneous fat, aortic plaque, and a region of interest within the L1 vertebrae. We have shown that aortic plaque measurement between the aortic bifurcation and aortic hiatus can provide a better risk prediction for cardiovascular disease and all-cause mortality than the widely used Framingham risk score. By adding additional biomarkers from fat and liver the risk measurement can be further improved. Measurement of the liver can be used to flag mild steatosis, and measurement of bone mineral density can detect mile osteoporosis/osteopenia. Both conditions are often missed by radiologists. An overview of these can be found in our article in Radiographics: "Opportunistic Screening at Abdominal CT: Use of Automated Body Composition Biomarkers for Added Cardiometabolic Value". One of the general arguments against doing more opportunistic CT screening is that false positives can lead to unnecessary and expensive workups. However, if the AI results are properly calibrated, risk prediction information is always useful to know in principle. The problems people run into with false positives are not caused by AI itself but rather how we understand, communicate, and respond to uncertainty.

The Role of AI in Diagnosing Respiratory Diseases

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Abstract

The field of artificial intelligence (AI) involves teaching machines to simulate human intelligence and perform specific tasks. AI can analyze large amounts of data that would be impossible to process using traditional statistical methods and produce reliable results. In the medical field, AI has been used for nearly two decades to diagnose and predict outcomes for pulmonary diseases. By analyzing clinical data, chest imaging, lung pathology, and pulmonary function testing, AI-based applications enable physicians to utilize vast amounts of data and improve their precision in treating pulmonary diseases. Given the increasing importance of AI in pulmonary medicine, it is crucial for healthcare providers to understand how AI works and integrate it into clinical practices to enhance patient care. This presentation delves into how AI can be applied in pulmonary medicine. I also highlight various ways this cutting-edge technology can be utilized in imaging.

Computed Tomography

Single Phase Dual Energy CT Urography in Evaluation of Hematuria

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Abstract

Aims & Objectives: To assess the value of single-phase DECT urography protocol with synchronous nephrographic-excretory phase enhancement in patients with hematuria & to calculate the potential dose reduction by omitting the unenhanced scan.

Materials and Methods: Forty patients referred for hematuria underwent CT urography using a protocol that included single-energy unenhanced and dual-energy contrast enhanced with synchronous nephrographic excretory phase scans. DECT-based images [virtual unenhanced (VUE), weighted average, and color-coded iodine overlay] were reconstructed. Opacification degree by contrast media of the upper urinary tract, and image quality of virtual unenhanced images were independently evaluated using a four-point scale. The diagnostic accuracy in detecting urothelial tumors on DECT-based images was determined. The dose of a theoretical dual-phase single-energy protocol was obtained by multiplying the effective dose of the unenhanced single-energy acquisition by two. Radiation dose saving by omitting the unenhanced scan was calculated.

Results: The degree of opacification was scored as optimal or good in 87.5% of cases (k = 0.79); VUE image quality was excellent or good in 80% of cases (k =0.88). Sensitivity, specificity, positive predictive value, and negative predictive value for urothelial tumors detection were 83.3%, 97.1%, 83.3%, and 97.1%, omission of the unenhanced scan led to a mean dose reduction of 38% ± 3.3% (range 31.8% - 44.88%)

Conclusion: Single-phase DECT urography with synchronous nephrographic-excretory phase enhancement represents an "all-in-one" approach, which enables detection of urinary stones, accurate distinction of enhancing from non-enhancing renal masses, and identification of urothelial neoplasms, with a radiation dose saving up to 45%.

Neuroimaging

Central Nervous System Tuberculosis: What's New?

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Abstract

Background: The timely and accurate diagnosis of meningitis caused by Mycobacterium tuberculosis (TBM) is essential to institute the correct treatment and avoid comorbidity and mortality. However, no studies evaluated the diagnostic performance of neuroimaging findings.

Methods: In a single-center, observational, randomized and blind study, neuroimaging exams of a cohort of 601 patients with or without TBM, were reviewed to find five features that suggests TBM: Hydrocephalus (HID), Basal Meningeal Enhancement (BME), Lesions without restriction in diffusion (LN), Infarction and Basal Meningeal pre-contrast Hyperdensity (BMH). Receiver Operating Characteristic curves with Area Under the Curve (AUC), nomograms and diagnostic performance indexes were calculated. Thirty-one possible combinations of these findings were also evaluated.

Results: With a prevalence of TBM estimated in 4-9%. Infarct, HID, BMH, BME and LN have AUCs of 0.86 (95% IC of 0.06, 0.82 (95% IC of 0.05), 0.81 (95% IC of 0.06), 0.80 (95% IC of 0.05) 0.73 (95% IC of 0.06) respectively. The best combination of findings was HID+Infarct (AUC of 0.86 and 95% IC of 0.07), HID+BME+Infarct, BME+Infarct (AUC of 0.82 and 95% IC of 0.07) and HID+BME (AUC of 0.81 and 95% IC of 0.07)

Conclusions: Infarct proved be useful to consider TBM in a suspicious clinical scenario. Although with optimal AUC, the remaining findings and combination of them are mostly useful for excluding TBM when absent probably due to several differential diagnosis that this population are susceptible.

Radiation Oncology

Harnessing DW-MRI to Identify Direction of the Microscopic Tumor Spread of Soft-Tissue Sarcoma

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Abstract

We have developed a microscopic tumor spread model for soft tissue sarcoma (STS) and glioma. The model is based on pre-treatment imaging data and is therefore patient specific. Recent microscopic studies have confirmed that cancer cells invade soft tissue by adopting the encountered tissue structure, which acts as a barrier or determines the direction of spread. Diffusion-weighted MR imaging (DW-MRI) provides information about tissue microstructure based on the anisotropic diffusion of water molecules and can be used to define the directionality of muscle fibers. Clinical applications of DW-MRI are limited to the identification of muscle pathology in the musculoskeletal system. We aim to unlock the potential of DW-MRI for managing soft tissue sarcomas. Our method is based on the solution of the anisotropic Eikonal equation with diffusion tensor data as geometry encoding input.

We recruited 10 healthy volunteers and acquired DW-MR images of the left and right thigh in a pilot imaging study. The aim of the study was to investigate the parameters of the acquisition protocol to ensure the best balance between image quality and acquisition time. We quantified the variability of tissue anisotropy in the human femur derived from diffusion tensor and investigated the impact of this variability on the modeled extent of microscopic tumor spread.

For brain tumors, although there is evidence that glioma spreads preferentially along white matter tracts, current clinical practice defines the microscopic tumor spread limit under the assumption of isotropic spread in brain tissue. We calculated the tumor spread limit from retrospectively acquired DW-MRI data of glioma patients.

Magnetic Resonance and Ultrasound

Role of Trans Cerebellar Diameter (TCD) in Estimation of Gestational Age

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Abstract

Background: In routine, gestational age is estimated by using various fetal biometric parameters such as the biparietal diameter (BPD), femur length (FL), abdominal circumference (AC) and head circumference (HC) with the help of ultrasound, but these parameters are more reliable only in 1st trimester and becomes less reliable with discrepancy up to 3 weeks in 3rd trimester.

Aims and Objectives: To study role of trans cerebellar diameter (TCD) in estimation of gestational age in 3rd trimester of singleton pregnancies.

Materiels and Methods: It was studied in department of obstetrics and gynecology at NDMC medical college and Hindu Rao hospital from October 2017 to May 2019 in prospective manner. 100 women with age between 18-35 years with singleton pregnancy and gestational age > 28 weeks were included in study after informed consent and filling F form to rule out any sex determination. it has included only those women with regular menses for last 6 month, who were sure of their last menstrual period (LMP), dating scan was done in 1st trimester and level 2 scan was done in 2nd trimester. Estimation of gestational age was done using BPD, FL, HC, AC and TCD and results were compared using paired T test.

Results: Reliability of BPD after 32 weeks, HC and FL after 32 weeks and AC after 28 weeks is less for estimation of gestational age, while reliability of TCD is highest compared to these parameters.

Conclusion: TCD has discrepancy of ±1 day at 28-32 weeks, ±1-2 days at 32-36 weeks and ±6 days after 36 weeks for estimation of gestational age. It makes TCD a reliable parameter for estimation of gestational age within 6 days in near term pregnancies with unknown LMP.

Evaluation of Carotid Artery Plaques Measured by Carotid Ultrasound in Patients with Rheumatoid Arthritis

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Abstract

Background: Carotid Ultrasound is an established tool to evaluate carotid atherosclerotic disease in clinical practice and cardiovascular research. It's suggested that the higher number of plaques seen within the carotid circulation, location and laterality of plaques may be associated with differential risk of stroke and cardiovascular disease. This study aimed to investigate the prevalence of carotid atherosclerosis and lesions in rheumatoid arthritis (RA) patients compared with healthy controls.

Methods: This prospective study was conducted at King Abdulaziz University Hospital. Carotid ultrasound examination was performed. Prevalence and distribution of carotid plaques were recorded. Comparing findings on carotid ultrasound in the cohort and control was done. The scanning was performed by a certified sonographer using Philips EPIC7 ultrasound systems (Philips Ultrasound; Bothel, WA, USA).

Results: A total of 44 RA patients and 40 healthy controls with median age of 52 and 62 respectively, were involved. The majority of patients (82%) were female. Patients were more likely to be diabetic (30%), non-smokers (92%) and waist circumference tend to be high (46%). The intima media thickness (IMT) was significantly different between patients and controls (0.13 ± 0.12 mm vs 0.09 ± 0.03mm, p= 0.045). Patients have more plaques than controls (21 vs 13) and distribution of plaques between patients and controls pointed to most of them located in internal carotid artery (ICA).

Conclusion: Patients with RA exhibit increased IMT and carotid plaques. Most plaques were found in ICA, which may increase risk factor of CVD events. Further studies investigating RA inflammatory markers are recommended.

Pneumatosis Cystoides Intestinalis: A Benign Cause of Pneumoperitoneum

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Abstract

Objective: To describe the imaging features of pneumatosis cystoides intestinalis with the aim to increase the understanding of this uncommon condition.

Introduction: Pneumatosis cystoides intestinalis (PCI) is an uncommon condition where cyst-like locules of gas are seen in the submucosa or subserosa of GIT tract. Majority of the cases are benign and associated with drugs (like chemotherapy agents) or connective tissue disorders (like scleroderma)

Case Illustrations: May mimic true abdominal visceral perforation; so correct diagnosis is imperative as Rx of PCI is generally conservative. A 56 year old male presented with gradual distension of abdomen for 4 months No h/o pain abdomen, loose stools, vomiting , fever ,trauma , surgery , constipation , obstipation , malignancy or endoscopy.

Imaging Findings: Abdominal radiograph revealed air under right hemi- diaphragm (arrow) with multiple small round lucencies in LHC region (Block arrow). Axial CT images with enteric contrast demonstrate pneumoperitoneum in right upper quadrant of the abdomen, anterior to the liver (arrow). Multiple large cysts are seen within small bowel wall and mesentery (Block arrows), consistent with "Pneumotosis cystoides.

The patient was completely asymptomatic, treated conservatively with bowel rest and maintenance of fluids and subsequently discharged home without surgical intervention.

Pneumatosis cystoides intestinalis (PCI) is characterized by multilocular, gas-filled cysts localized in the intestinal submucosa and subserosa. The condition can occur anywhere along the gastrointestinal tract, but the most common site is colon. Pneumatosis has also been found in unusual regions such as the mesentery, omentum, and hepatogastric ligament.

Pneumatosis cystoides intestinalis can be divided into primary and secondary types. Causes of secondary PCI include pulmonary disease, inflammatory bowel disease, connective tissue disorders, iatrogenic procedures, certain medications, and organ transplantation.

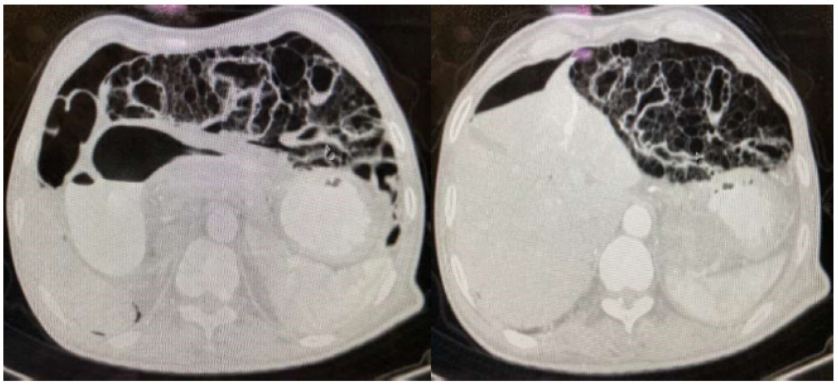
Patients may be asymptomatic, or they may demonstrate a broad spectrum of nonspecific gastrointestinal symptoms such as abdominal pain, distention and/or obstruction, as well as diarrhea, nausea, and vomiting.

The imaging modalities most frequently used to diagnose pneumatosis intestinalis are radiography and CT, the latter of which is the most sensitive and specific for this condition.

Pneumatosis cystoides intestinalis is often benign and only requires conservative treatment with antibiotics (especially metronidazole) and/or normobaric or hyperbaric oxygen therapy with follow-up. Surgical treatment should be considered for patients who remain symptomatic despite medical therapy or who develop PCI-related complications such as bowel obstruction, perforation, peritonitis, and necrosis.

Conclusion: PCI is an uncommon radiological finding and often follows a benign course. PCI remains an important differential of pneumoperitoneum in patients with CTD or those undergoing chemotherapy particularly in the setting of a clinically well patient. Correctly identifying PCI may allow patients to be managed non-operatively thus avoiding the morbidity involved with surgical intervention.





Medical Imaging and Analysis

The Effect of Quality of Life and Depression on the Compliance of Patient with Type 2 Diabetes

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Abstract

Introduction: Therapeutic interventions for Diabetes Mellitus are almost lifelong and do not often lead to the achievement of therapeutic goals. Moreover, they present side effects, which makes the achievement of therapeutic goals even more difficult. People with DM show a large rate of depression and reduced quality of life. Depression has adverse effects not only on the health of the diabetic person but also in his/her efforts to comply with the treatment instructions and to achieve glycemic control.

Aim: Aim of study is to examine the association between quality of life with depression and compliance with antidiabetic treatment. Furthermore, to identify possible relationship between depression and compliance with antidiabetic treatment. The effect of demographic profile in levels of depression, quality of life and compliance with antidiabetic treatment is examined as well.

Methodology: Current search is quantitative research, original, descriptive and correlational with non-experimental design. Sample was consisted by 185 Greek patients with diabetes type 2 in Greek public hospital of Athens, with mean age 56 years, height 170 cm, weight 82 Kg and 7 years patients. The majority of participants are married people, with secondary level of education, who live in urban areas, currently working and ex or present smokers. Question of ADDQoL19 (Impact QoL a=0,936, Importance QoL a=0,913, AWI a=0,942) was used to measure quality of life, CES-D (a=0,876) for depression and MARS-5 (a=0,872) for compliance. Parametric independent samples t-test, One Way ANOVA and non-parametric Kruskal Wallis was used in significance 5%. The ethical issues involved in the research fully meet the requirements of the BPS Code of Conduct.

Results: Diabetes 2 patients represented low levels of compliance to treatment, symptoms of depression and medium quality of life. Quality of life was associated with the appearance of depressive symptoms ($p<0,01$) while AWI and depression with compliance to treatment ($p<0,01$). Quality of life was affected by gender ($p=0,036$), weight ($p<0,01$), diabetes duration ($p<0,05$), marital status ($p=0,011$), education ($p<0,05$), place of residence ($p=0,038$) and working status ($p=0,039$). AWI was affected by age ($p<0,01$), height ($p<0,05$), weight ($p<0,01$), diabetes duration ($p<0,01$), education ($p<0,001$), place of residence ($p=0,004$), alcohol ($p=0,002$). Compliance to treatment was affected by gender ($p<0,001$), age ($p<0,05$), education ($p<0,001$), place of residence ($p=0,001$), working status ($p=0,002$), smoking ($p=0,007$) and alcohol ($p<0,001$). Depression was affected by diabetes duration ($p<0,01$), marital status ($p=0,005$), education ($p<0,001$), smoking ($p=0,003$) and alcohol ($p=0,049$).

Conclusions: Diabetes 2 patients represented low levels of compliance with treatment, high depression and medium quality of life. Low quality of life was associated with higher appearance of depressive symptoms. Patients that feel higher the negative impact of diabetes, indicate higher levels of compliance with antidiabetic treatment, while patients with higher levels of depression, presented lower compliance with antidiabetic treatment. Quality of life, depression and compliance with antidiabetic treatment were significantly affected by the demographic profile.

Innovation in Virtual Cardiac Care of Heart Failure with VPExam

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Abstract

Telehealth is a growing field of importance, but the loss of comprehensive physical exam data creates barriers to managing complex heart failure patients. Innovative digital tools such as VPExam Virtual Care combine augmented reality guidance of video acquisitions with Bluetooth stethoscopes and single lead ECG to improve diagnostic accuracy by assessing volume status, cardiopulmonary auscultation, detection of arrythmias, and providing structured data including vitals, medication reconciliation, and labs. VPExam intervention has been shown to significantly improve the outcomes of high-risk heart failure patients discharged to Skilled Nursing Facilities and Home Care. VPExam QI revealed timely reliable cardiology consultation for follow up of heart failure hospitalization and urgent consultations created moderate significance modification in clinical management in 84% of encounters, while being associated with a 40% relative risk reduction in 30-day hospital readmission rate and a 56% relative risk reduction in 30-day mortality rate. This abstract summarizes challenges to cardiac transitions of care as well as the evolution of cardiac virtual care with actionable physical exam data to reduce readmissions and mortality.

SPECT Ioflupane123I (DaTscan), 99mTc (TRODAT) and Ioflupane with Myocardial Scintigraphy 123I (MIBG) for Diagnosis of Parkinson's Disease

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Abstract

Parkinson's disease (PD) is one of the most common neurological disorder diseases which takes place when brain cells gradually die. PD is considered a challengeable disease because of the similarities between PD and other brain disorders. For this reason, there are several ways to diagnose PD. Nuclear medicine can be a solution to distinguish the similarities between some brain disorders and PD. The aim of this review is to understand the differences between three radiopharmaceuticals used to diagnose PD and to list the advantages and disadvantages of using each radiopharmaceutical. This review includes studies from 2014 to 2019. Every study published before 2014 was excluded. The database used for this search was found in PubMed. English filters and best matches were used to minimize the outcomes. The comparison between PD nuclear medicine agents was established according to three main points: availability and the length of the scan, sensitivity and specificity, and visual evolution. It would appear that using TRODAT 99mTc can be helpful for some departments that other agents cannot offer, especially 123I. However, using MIBG as a biomarker increases the specificity in some studies. MIBG 123I can be used with TRODAT 99mTc as a biomarker. Moreover, applying PET/CT agents can be studied and researched along with nuclear medicine agents. More research studies are needed to understand the relation between cardiac uptake and PD.

Role of CCTA in Diagnosis of SCAD

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Abstract

Spontaneous coronary artery dissection (SCAD) is defined as a non-atherosclerotic, non-traumatic, or iatrogenic separation of the coronary arterial tunics secondary to vasa vasorum haemorrhage or intimal tear. Although initially considered very rare, the use of higher sensitive troponin assays and early angiogram in ACS, coupled with greater awareness of the condition has led to increased diagnosis of the condition.

A 35-year-old caucasian lady presented with central chest pain with radiation to left arm. High sensitivity Troponin-I was positive at 76 ng/L with a repeat level of 96 ng/L. Serial ECGs showed normal sinus rhythm with no ischemic changes. She underwent a Coronary Computed Tomography Angiogram (CCTA) which raised the suspicion of left circumflex (LCx) artery dissection and occlusion of left dominant system that was subsequently confirmed by traditional coronary angiogram. A long segment of dissection distal to OM1 to origin of OM2 with evidence of thrombi along the vessel was visualized. Cardiac MRI confirmed early myocardial infarction of the infero-lateral wall supplied by the left circumflex artery.

While invasive coronary angiogram and intra-coronary imaging like IVUS and OCT remain the gold standard, newer multi-slice CT scanners with image reconstruction and lesion characterization can aid diagnosis, management and long term follow up, thus preventing unnecessary, invasive treatment in presence of a diagnostic uncertainty. Shortcomings of CCTA for SCAD include lower spatial and temporal resolution than coronary angiography, different appearance of coronaries as compared to typical atherosclerosis and limited value in distal coronary arteries or side branches.

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