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Application of Dual-Energy CT Gemstone Spectral Imaging (DECT GSI) in the Characterization of Ground-glass nodules (GGNs)

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Abstract: *Dual-Energy CT Gemstone Spectral Imaging (DECT GSI) is a new application of a fundamental physics concept that uses rapid kV switching to acquire the dual energy samples almost simultaneously to generate material density data that can be used for the separation of materials and derivation of monochromatic spectral images using a projection based reconstruction algorithm. DECT GSI of lungs allow for detection and Characterization of lung lesions including solid and ground glass nodules (GGNs) [1, 2]. Spectral CT plays a pivotal role in the detection, characterization, and staging of lung cancer. It acquires CT datasets at both low- and high-kVp settings that can improve diagnostic information for clinicians to quantify and separate materials – such as calcium, iodine and water – enhancing image quality, and reducing artifacts from implanted devices [3]. In this review article, we will outline the usefulness of dual-energy CT for the assessment of Ground-glass nodules (GGNs). In addition, we discuss the physical principles of dual- energy CT and potential future applications in patients with GGNs.*

Keywords: *Dual-energy CT, Gemstone Spectral Imaging, Lung Cancer, Ground-glass nodules, Characterization.*

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I. Introduction

Lung cancer is one of the most common malignancies in both developing and developed countries and is also one of the leading causes of mortality worldwide [5]. Early resection and chemoradiotherapy are very important for the prognosis of patients with lung cancer. Ground-glass nodule is one of the most common manifestations of lung cancer. GGOs are defined as having hazy increased attenuation of the lung with preservation of bronchial and vascular margins and need a standardized approach in order to avoid misdiagnosing lung cancer and delaying surgical excision whilst simultaneously avoiding unnecessary invasive procedures if the lesions prove to be benign[6,7]. Recently introduced dual-energy applications of dual-energy CT plays very important role in the detection, characterization, and staging of lung cancer and other thoracic malignancies. The aim of this review is to observe the value of Dual-Energy Computed Tomography Gemstone Spectral Imaging in the diagnosis of ground-glass nodules, during the contrast-enhanced early phase and late phase.

II. Principles Of Dual-Energy CT Gemstone Spectral Imaging

Dual-Energy CT Gemstone Spectral Imaging (DECT GSI) is a new CT technique that allows the quantification of iodinated contrast material by applying different X-ray spectra and analyzing the differences in attenuation which allows differentiation of iodine from other materials due to its stronger photoelectric absorption, it is based on the varying behavior of materials when exposed to differing x-ray photon energies [8, 9]. The basic principle of the DECT is to obtain two datasets with different x-ray energy levels from the same anatomic location and material decomposition on the basis of attenuation differences at different kVp (usually 80 and 140 kVp) [10]. The goal of DECT is to obtain the low and high-energy attenuation characteristics of structures, which is done by analyzing the attenuation spectra at different energies but the same anatomic location. The magnitude of change in attenuation between the low- and high-energy spectra is determined by the effective atomic number of the materials that enables distinguishing materials with higher atomic number (such as iodine), which have a greater change in attenuation, from those with lower atomic number (such as calcium and water), which have a lesser change[11].The main advantages of this new technique include simultaneous visualization of lower voltage tube images with improved iodine conspicuity and the performance of material specific imaging, which attempts to differentiate specific materials in the generated images and the collection of a virtual single image, which makes the image clearer after iodine deposition [12,13]. This technique has higher sensitivity and specificity than conventional multi-slice CT, particularly in the detection, characterization, and staging of lung cancer.

2.1 Characterization of GGNs Using DECT GSI

Lung cancer is the main cause of cancer-related death in china as well as all over the world [4]. Pulmonary nodule s are the most common cause of the lung cancer. Ground-glass nodules (GGN) remain a diagnostic challenge and can be observed in both benign and malignant conditions; therefore, a more systematic approach is necessary to ensure correct diagnosis and optimal management [14, 15]. GGNs are caused by a variety of disorders including neoplasms, infections, inflammation, and vascular and congenital abnormalities. The natural history of GGNs are generally reported to grow slowly. Approximately 20% of pure GGNs and 40% of part-solid GGNs gradually grow their solid component, whereas others remain unchanged for years. Therefore, it remains unclear whether all pulmonary GGNs should be surgically resected or not [16]. However; Persistent pulmonary ground-glass nodules are worth a closer look, as they are have been well known to have a substantially high probability to be malignancy or benignity.The evaluation of Ground-glass nodules (GGNs) as benign or malignant remains a diagnostic challenge for thoracic imaging. GGNs have many pathological types: the malignant one is mainly lung cancer, and the benign one is mainly inflammatory nodule [23]. For the patients with suspected lung cancer, a standard contrast-enhanced computed tomographic (CT) scan is often the first examination, followed by a number of other examinations [24]. However; using the advent of Dual-Energy CT Gemstone Spectral Imaging (DECT GSI) we can now simultaneously obtain datasets for two different photon spectra with acceptable image quality in a single CT acquisition. DECT GSI has appeared as a potential tool for quantifying iodine concentration; studies have shown its utility in differentiating benign from malignant lesions in lung [25]. It enables to differentiate an iodine substance from other materials by the material decomposition principle detecting all types of lung nodules, including solid, part-solid, and ground glass objects. It helps doctors and physicians to diagnose their patients more efficiently and accurately. Distinguishing benign from malignant ground glass nodules (GGNs) requires careful analysis of nodule size, morphology, and CT attenuation in the challenging medical imaging [17]. With dual-energy CT, the attenuation of iodine is exceedingly greater at 80 kVp than at 140 kVp; thus, dual-energy CT may improve detection of GGN in comparison with conventional CT [18]. Previous studies reported that iodine content (contrast enhancement) can successfully differentiate benign from malignant nodules and they also encouraged DECT for its applications in differentiation of benign and malignant thoracic lesions and in assessment of treatment response in patients with lung cancers [19].

III. Future Applications

DECT GSI has multiple opportunities to be implemented in radiotherapy that could improve the accuracy of various parts of the workflow in the future. The development of imaging technologies that have specificity and sensitivity to enable early accurate detection of cancer and differentiating malignant GGNs from benign ones has long been a goal in medical imaging. Starting at the stage of diagnosis, the dual energy CT imaging equipment is playing a prominent role in the radiological department and will be utilized much more in the future because of the added information that is acquired compared to single energy CT imaging in a dose-neutral way[26,27]. Radiologists believe that DECT will have further potential applications in the detection, evaluation and staging of lung cancer and thoracic lesions.

IV. Conclusion

DECT GSI provides promising quantitative approach for distinguishing malignant GGNs from benign ones by quantitatively measuring iodine enhancement on iodine maps or monochromatic imaging. And the iodine content and slope of HU curve obtained in dual energy spectral CT could be valuable parameters for the differentiation of GGNs [20, 21]. The dual-phase DE-CT examination with a quantification of post-contrast iodine uptake is a promising method for the functional evaluation of thoracic lesions with lower radiation dose in comparison to volume perfusion CT [22]

References

[1]. www.gehealthcare.com/aw/applications/gsi-viewer .(1)

[2]. Benjamin L Odry, Jing Huo, Li Zhang , Carol L. Novak, David P. Naidich. Solid Component Evaluation in Mixed Ground Glass Nodules Proc of SPIE Vol. 6512, 65120R, (2007) .(2)

[3]. Leesha Lentz, A Different Energy — CT Manufacturers Develop Different Approaches to Spectral Scanning, Radiology Today Vol. 15 No. 3 P. 14. 14.March 2014.(3)

[4]. Pareesha Aggarwal, Rishi Kumar,Detection of Ground Glass Nodules in Human Lungs Using Lungs CT scan iimages, International journal of current engineering and technology.ISSN 2277-4106.Vol.3,No.2.June 2013. (4)

[5]. Eun Jin Chae, MD, PhD, Jae-Woo Song, MD, PhD, Bernhard Krauss, PhD, w Koun-Sik Song, MD, PhD,Choong Wook Lee, MD, Hyun Joo Lee, MD, and Joon Beom Seo, MD, PhD. Dual-energy Computed Tomography Characterization of Solitary Pulmonary Nodules. Journal of Thoracic Imaging.2010 Nov;25(4):301-10. (5)

[6]. Hiroshi Mizuuchi, Kenichi Suda, Hirokazu Kitahara, Shinichiro Shimamatsu, Mikihiro Kohno, Tatsuro Okamoto, Yoshihiko Maehara,Solitary pulmonary metastasis from malignant melanoma of the bulbar conjunctiva presenting as a pulmonary ground glass nodule: Report of a case, thoracic cancer journal.2015 Jan; 6(1): 97–100. (6)

[7]. M.Lederlin, M.-P.Revel,A.Khalil,G.Ferretti,B.Milleron,F.Laurenta,Management strategy of pulmonary nodule in 2013, journal of diagnostic and interventional imaging.2013 Nov;94(11):1081-94. (7)

[8]. Thomas Henzler, Jingyun Shi, Hashim Jafarov, Stefan O. Schoenberg, Christian Manegold, Christian Fink, Gerald Schmid-Bindert .Functional CT imaging techniques for the assessment of angiogenesis in lung cancer. translational lung cancer research journal.2012 Mar; 1(1): 78–83. (8)

[9]. Jane P. Ko, MD, Scott Brandman, MD, Joseph Stember, PhD, and David P. Naidich, MD, Dual-energy Computed Tomography Concepts, Performance, and Thoracic Applications, Journal of Thoracic Imaging.2012 Jan;27(1):7-22. (9)

[10]. Shima Aran , Laleh Daftari Besheli , Musturay Karcaaltincaba , Rajiv Gupta , Efren J. Flores , Hani H. Abujudeh,Applications of Dual-Energy CT in Emergency Radiology. American Journal of Roentgenology AJR:202, April 2014. (10)

[11]. Ravi K. Kaza, Lakshmi Ananthakrishnan, Avinash Kambadakone, Joel F. Platt,Update of Dual-Energy CT Applications in the Genitourinary Tract, American Journal of Roentgenology AJR:208, June 2017. (11)

[12]. Myrna C. B. Godoy, MD,* David P. Naidich, MD,* Edson Marchiori, MD, PhD, w Bernard Assadourian, BSc,* Christianne Leidecker, PhD, z Bernhard Schmidt, PhD, z and Ioannis Vlahos, MRCP, FRCR.Basic Principles and Postprocessing Techniques of Dual-Energy CT: Illustrated by Selected Congenital Abnormalities of the Thorax. Journal of Thoracic Imaging.2009 May;24(2):152-9 . (12)

[13]. Jing-Jian Wang, Shu-Jie Fan, Long-Long Wang, Yan-Zhong Gao, and Xiao-Juan Liu.Clinical relevance of gemstone spectral CT in the diagnosis of carotid atherosclerosis. Journal of experimental and therapeutic medicine. 2017 Jun; 13(6): 2629–2636. (13)

[14]. Pedersen JH, Saghir Z, Wille MM, Thomsen LH, Skov BG, Ashraf H.Ground-Glass Opacity Lung Nodules in the Era of Lung Cancer CT Screening: Radiology, Pathology, and Clinical Management. journal of oncology (williston park).2016 Mar;30(3):266-74. (14)

[15]. Yoshihisa Kobayashi, Tetsuya Mitsudomi, Management of ground-glass opacities: should all pulmonary lesions with ground-glass opacity be surgically resected? translational lung cancer research journal.2013 Oct; 2(5): 354–363. (15)

[16]. XIAO-DAN YE, JIAN-DING YE, ZHENG YUAN, SHENG DONG,XIANG-SHENG XIAO. Characterization of solitary pulmonary nodules: Use of washout characteristics at contrast-enhanced computed tomography. Journal of oncology letters.2012 Mar; 3(3): 672–676.

[17]. Eric Barne,Dual-energy CT helps distinguish malignant lung nodules, the journal of continuing medical education in radiology October 8, 2008. (17)

[18]. Mi-Jin Kang, MD1, Chang Min Park, MD, Chang-Hyun Lee, MD, Jin Mo Goo, MD, and Hyun Ju Lee, MD, Dual-Energy CT: Clinical Applications in Various Pulmonary Diseases, American Journal of Roentgenology.2010 May;30(3):685-98. (18)

[19]. Canellas R, Digumarthy SR, Otrakji A and Kalra MK,Applications of DECT in Thoracic Oncology: Evidence So Far，Clinics in Oncology Journal (ISSN 2474-1663).2016; 1: 1148. (19)

[20]. Long Jiang Zhang , Gui Fen Yang , Sheng Yong Wu , Jian Xu , Guang Ming Lu , U. Joseph Schoepf，Dual-energy CT imaging of thoracic malignancies，journal of the International Cancer Imaging Society. 2013 Mar 6; 13:81-91. (20)

[21]. Ying Zhang , Jiejun Cheng , Xiaolan Hua, Mingji Yu, Chengdong Xu, Feng Zhang, Jianrong Xu, Huawei Wu. Can Spectral CT Imaging Improve the Differentiation between Malignant and Benign Solitary Pulmonary Nodules?, journal of plos one February 3, 2016. (21)

[22]. Jan Baxa , Alena Vondráková , Táňa Matoušková , Olga Růžičková , Bernhard Schmidt , Thomas Flohr , Martin Sedlmair , Jiří Ferda，Dual-phase dual-energy CT in patients with lung cancer: assessment of the additional value of iodine quantification in lymph node therapy response : European Journal of Radiology.2014 Aug;24(8):1981-8. (22)

[23]. Ji-zheng Lin, MD, Liang Zhang, MD, Chuan-yu Zhang, MD, Lei Yang, MD, He-nan Lou, MD, and Ze-guo Wang, MD, Application of Gemstone Spectral Computed Tomography Imaging in the Characterization of Solitary Pulmonary Nodules: Preliminary Result. Journal of Computer Assisted Tomography 2016 Nov/Dec; 40(6):907-911. (23)

[24]. S W Harders, MD, PhD,corresponding author, H H Madsen, MD, H M Nellemann, MD, T R Rasmussen, MD, PhD, J Thygesen, MS, H Hager, MD, PhD, N T Andersen, MS, PhD, F Rasmussen, MD, DMSc. Dynamic contrast-enhanced CT in suspected lung cancer: quantitative results. The British Journal of Radiology.2013 Nov; 86(1031): 20130257. (24)

[25]. Víctor González-Pérez ，Estanislao Arana ，María Barrios，Albert Bartrés ，Julia Cruz，Rafael Montero，Manuel González，Carlos Deltoro， Encarnación Martínez-Péreze，karol De Aguiar-Quevedo，Miguel Arrarás.Differentiation of benign and malignant lung lesions: Dual-Energy Computed Tomography findings. European Journal of Radiology 2016 Oct;85(10):1765-1772. (25)

[26]. Wouter van Elmpt, Guillaume Landry, Marco Das, Frank Verhaegen . Dual energy CT in radiotherapy: Current applications and future outlook. Journal of radiotherapy and oncology. April 2016Volume 119, Issue 1, Pages 137–144. (26)

[27]. Daniele Marin, MD Daniel T. Boll, MD Achille Mileto, MD Rendon C. Nelson, MD State of the Art: Dual-Energy CT of Abdomen the the journal of continuing medical education in radiology,.Volume 271, Issue 2.May 2014. (27)

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