Original Research Article

A study to compare MinIP findings of lung with the HRCT finding

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Abstract

The obvious low attenuation lesions noted in both HRCT and MinIP, but when the lesions are subtle MinIP appeared to better than HRCT in picking the finding. MinIP images mainly increased the conspicuity of the low attenuation lesions when they are subtle or when not seen in HRCT. Hence helps to increase the confidence of radiologist in picking up such findings. Nodules, linear, reticular opacities and vasculature markings are better seen in HRCT images as compaired to the MinIP images. HRCT and/or CECT Chest were performed on 50 patients. Using same raw data MinIP images were reconstructed. Presence or absence of the above mentioned findings were noted in both the modalities. Among 50 patients, air trapping was seen in 15(30%) in HRCT and 18(36%) in MinIP, bronchial dilatation is seen in 25(50%) patients each in HRCT and MinIP images, cysts was noted in 11 (22%) patients in HRCT and 12(24%) in MinIP, ground-glass opacities in 21(42%) in HRCT and 22(44%) in MinIP, and emphysematous changes was seen in 9(18%) patients each in HRCT and MinIP images.

Key Word: HRCT, CECT, MinIP

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INTRODUCTION

MinIP images are multiplanar slab images produced by displaying only the lowest attenuation value encountered along a ray cast through an object toward the viewer's eye. MinIP is not used commonly but may be used to generate images of the central airways or areas of air trapping within the lung. These images may provide valuable perspective in defining lesions for surgical planning or detecting subtle small airway disease. Compared with 3D shaded surface and VRT, MinIP is relatively simple method. Useful in conditions having features of decreased lung opacity, cysts and airway abnormalities like-honey combing, lung cysts, emphysema, bullae, pneumatocele, cavitatory nodule, bronchectasis and mosaic perfusion.[1,2] Shaded surface display (SSD), also called surface rendering, provides a 3D view of the surface of an object. The surface of an object must first be separated from other structures, a process called segmentation (discussed later). For osseous structures, this may be as simple as selecting a threshold that excludes soft-tissue structures. For other objects, segmentation may require meticulous editing. All data within the volume are included in or excluded from the image on the basis of edge detection and/or thresholding, resulting in a binary data set. A gray-scale shading procedure is then performed by using a formula to compute the observed light intensity in a given 3D scene, simulating surface reflections and shadowing from an artificial light source. The shading procedure assumes the presence of low-level ambient or diffuse light as well as a brighter, direct beam of light. Surfaces perpendicular to the beam of light have the highest levels of illumination whereas other surfaces appear shaded. Combinations of direct and diffuse light result in a range of gray shades. SSD has been used to demonstrate findings such as fractures after they are diagnosed on two dimensional images. However, just as MIPdiscards low-value data, SSD discards all but the surface-defining data, typically

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using less than 10% of the acquired data. Although decreasing the amount of data was often an advantage when computer processing power was a limiting factor, this is no longer necessary and the binary nature of surface rendering limits flexibility of the data and makes it prone to undesirable artifacts. Volume rendering is now preferable to SSD for most if not all applications.[3,4] Volume rendering assigns opacity values on a full spectrum from 0% to 100% (total transparency to total opacity) along an artificial line of sight projection using a variety of computational techniques. Because all acquired data may be used, volume rendering requires significantly greater processing power than MIP or surface rendering, limiting wide availability until relatively recent advances in computer hardware. Rectangular or trapezoidal classification schemes may be applied along the opacity spectrum, calculating the probability that a given voxel contains a specific tissue type, with separate classifications for tissues such as bone soft tissue, contrast-enhanced vessels, air, and fat, depending on the clinical task at hand. As in SSD, gray-scale shading is applied to simulate the surface reflections and shadowing of an artificial light source; however, more sophisticated calculations are possible using neighbouring voxel values, since volumetric data are available. For example, instead of manual segmentation or an attenuation threshold being used to define a surface, abrupt changes in attenuation between adjacent voxels may signal a transition from one type of tissue to another. Some prefer the term "compositing" to describe the lighting effects performed in volume rendering. Although the 3D nature of volume rendering makes it appear similar to SSD, assigning a full spectrum of opacity values and separation of the tissue classification and shading processes provide a much more robust and versatile data set than the binary system offered by SSD . Volume rendering combines the use of opacity values and lighting effects to allow appreciation of spatial relationships between structures. However, there are limitations in perception if both tissue classification and surface shading are restricted to gray scale. One of the many strengths of volume rendering is the ability to select a variety of viewing perspectives. In addition to viewing angle and distance, schemes of perception may be applied to simulate specific types of visualization such as fiberoptic endoscopy. In general terms, volume rendering may be displayed as either orthographic or perspective volume rendering[5,6] High-resolution CT (HRCT) has become a valuable tool for the evaluation of patients with diffuse pulmonary diseases. HRCT is now widely recognized as more sensitive and specific than chest radiography for the assessment of such patients, and it has been integrated into the diagnostic algorithms for the assessment of a number of diffuse lung processes, most notably the idiopathic interstitial pneumonias, eosinophilic lung diseases, and obstructive lung diseases. Furthermore, HRCT has become a front-line test for the evaluation of patients with a number of very common clinical complaints, including patients with chronic cough and progressive shortness of breath or exertionaldyspnea. Because HRCT is a commonly requested imaging technique, familiarity with the basis of interpretation of HRCT images is critical for accurate diagnosis. In essence, HRCT imaging, by use of narrow collimation and high spatial frequency reconstruction algorithms, seeks to maximize spatial resolution and thereby approach a pathologic representation of a disease process[7]

However, imaging parameters are chosen so as to maximize spatial resolution:

- A narrow slice width is used (usually 1-2 mm).
- A high spatial resolution image reconstruction algorithm is used
- Field of view is minimized, so as to minimize the size of each pixel
- Other scan factors (e.g. focal spot) may be optimized for resolution at the expense of scan speed

Maximizing spatial resolution allows HRCT findings frequently to correlate closely with pathologic findings. It is clear that detailed knowledge of normal pulmonary anatomy and an understanding of how normal anatomy is altered in disease states are required to appreciate fully HRCT findings in patients with pulmonary disease. With such a foundation, a pattern approach to HRCT interpretation may be used successfully.[8]

METHODOLOGY

Patient selection was based on previous inclusion-exclusion criteria. Informed consent was taken from all the subjects.

On HRCT and MinIP images of chest, presence of following findings was noted:

- Air trapping.
- Bronchial dilatation.
- Cysts.
- Emphysematous changes.
- Ground-glass opacity.

Machine Used: CECT and HRCT chest was done on 64-slice SIEMENS SOMATOM scanner.

Technique: All scans was obtained with the patient in the supine position, from apex of lung to dome of diaphragm in both maximum end inspiratory phase and expiratory phase, with their arms held over their head. The patients who had contrast study were on fasting. About 60-70cc of non-ionic contrast was given through power injector into antecubital or hand veins. The injection rate was 2.0-2.5ml/min, the amount was calculated on the basis of weight of patient. The number of CT slices obtained varied between patients based on their body habitus. Scanning time ranged between 30-45s with a peak voltage of 120kVp and effective tube current of 140mAs. Images were saved. Soft tissue reconstructions were done at kernel B40f, at slice thickness of 3mm and 3mm interval. HRCT Images were reconstructed using a high spatial frequency algorithm, through a 512 X 512 matrix, with a small field of view targeted to image only pulmonary areas. Reconstruction done at kernel B70f, 1mm slice thickness and 3mm interval done. A reconstruction at B30f kernel, 1mm slice thickness and 0.5mm interval was done and these reconstructed images were taken as a raw data for reconstruction of dedicated minimum intensity projection images. This raw data is taken into multiple planes than MinIP software applied to it. So we got the reconstructed MinIP images in all the 3 planes. HRCT and reconstructed MinIP images were analyzed at window settings of (window width, 500 to 1500 HU; window level, -600 to -850 HU) and compared with each other.

Data Collection And Analysis: HRCT and/or CECT Chest were performed on 50 patients. Using same raw data MinIP images were reconstructed. Presence or absence of the above mentioned findings were noted in both the modalities.

Master sheet components:

- Age and sex of patients
- Presence or absence of following 5 findings (i.e. air trapping, cysts, bronchial dilatation, emphysematous changes and ground-glass haze) is assessed in all patients in both HRCT and MinIP images.

Analysis: Initially HRCT and MinIP images were evaluated separately for the above mentioned features independently and later comparison was done between both the images.

RESULTS

Among 50 patients, air trapping was seen in 15(30%) in HRCT and 18(36%) in MinIP, bronchial dilatation is seen in 25(50%) patients each in HRCT and MinIP images, cysts was noted in 11 (22%)patients in HRCT and 12(24%) in MinIP, ground-glass opacities in 21(42%) in HRCT and 22(44%) in MinIP, and emphysematous changes was seen in 9(18%) patients each in HRCT and MinIP images.

Table 1: Comparison between HRCT and MinIP Findings in Patients with Air Trapping

Abnormal Findings (Air Trapping)	Number of patients
HRCT	15
MinIP	18

Table 2: Comparison between HRCT and MinIP Findings in Patients with Airway Dilatation

Abnormal finding (Air way dilatation)	Number of patients
HRCT	25
MinIP	25

Table 3: Comparison between HRCT and MinIP Findings in Patients with Cysts

Abnormal finding (Cysts)	Number of patients
HRCT	11
MinIP	12

Table 4: Comparison between HRCT and MinIP Findings in Patients with Ground-glass Opacity

Abnormal Finding (Ground-glass opacity)	Number of patients
HRCT	11
MinIP	12

Table 5: Comparison between HRCT and MinIP Findings in Patients with Emphysematous changes

Abnormal Finding (Emphysematous changes)	Number of patients
HRCT	09
MinIP	09

Table 6: Comparison between HRCT and MinIP Findings

Imaging Features	HRCT	MinIP
Air Trapping	15	18
Airway Dilatation	25	25
Cysts	11	12
Ground glass opacity	21	22
Emphysematous changes	09	09

DISCUSSION

In our study when the low attenuation lesions are obvious they are noted in both HRCT and MinIP images. whereas when the lesions are subtle than it is better delineated or seen in MinIP images . So MinIP mainly increases the conspicuity of low attenuation lesions as compared to the HRCT images hence increases the confidence of reporting radiologist in interpreting it. Here are few of the other studies on MinIP which are in consonance with our study. Martine Remdy-Jardin*et al*[9].In his study of 29 patient's 13 patients where having emphysematous findings in both HRCT and MinIP images. In all cases, sliding thin slab, minimum intensity projection images improved conspicuity of small areas of hypoattenuation. When thin-section CT scans were negative (n=16), sliding thin slab, minimum intensity projection images enabled identification of focal zones of hypoattenuation in four cases with histological confirmation of emphysema. Sensitivity of thin-section CT (62%) and sliding thin slab, minimum intensity projection technique (81%) were significantly different (P<.01); specificity for both was 100%. U. Joseph Schoepf[10]. In his book Multidetector-row CT of the thorax. Says that althoughminimum intensity projections are not widely used, they improve the assesement of lung disease associated with a decrease in attenuation. Single HRCT slices are not well suited for this type of post processing however, it could be demonstrated that MinIP enhances the changes of small airway disease resulting in increased observer confidence and agreement as compared with HRCT alone. Volumetric high resolution MDCT provides a much better database than HRCT for the application of MinIP in low attenuation lung disease or ground glass opacities. When using spiral CT for volumetric high resolution acquisitions MinIP revealed additional findings in 8% of patients with emphysema and in 25% of cases with ground glass opacities. MinIP improved the detection of pulmonary cysts and their differentiation from honeycomb cysts as well as the detection of ground glass opacities not visible on HRCT. It has to be noted that MinIP was particularly prone to motion artifacts thus; the image quality of MinIP derived from MDCT will be far superior to that obtained from traditional spiral CT as the source data set. Meenakshi Bhalla *et al*.[11] In their study says (Diffuse lung disease:-assessment with helical CT, role of minimum intensity projection images). Says that Minimum intensity projection images proved consistently superior to thin-section scans for depicting low attenuation structures, including the lumens of normal central airways and of abnormally dilated central airways. Minimum intensity projection images were also superior to thin-section scans to help identify foci of emphysema (n = 7), cysts (n = 1 patient with tuberous sclerosis), or focal air trapping (n = 3), including two patients with bronchiectasis and one with hypersensitivity pneumonitis. In addition, minimum intensity projection images proved superior to thin-section scans for depicting focal areas of abnormally increased lung attenuation or ground-glass attenuation. Shinichi Ohdama*et al*[34]. InHis study showed that, the ratio of the low attenuation area in the lung measured by STS-MinIP was significantly higher than that found by thin-section CT (*P* <0.01). The difference between STS-MinIP and thin-section CT was statistically evident even for mild emphysema and increased depending on whether the low attenuation in the lung increased. Moreover, STS-MinIP showed a stronger regression relation with pulmonary function results than did thin-section CT (*P* <0.01). Sandy Napel *et al*[12]in his article STS-MIP: A New Reconstruction Technique for CT of the chest says that minimum intensity projection that retains low density structures at the expense of blood vessels and thereby results in the improved airway visibility along greater portions of their lengths compared with HRCT and MIP images. STS-MinIP is rapid and efficient technique for the visualization of airways. Its computational simplicity and operator-independence is such that it could be easily implemented directly on commercial CT scanner and used in clinical settings without delays in throughput. J L Richenberg*et al*[13] in his study of 29 patients without radiological evidence of emphysema (21 of whom demonstrated histological emphysema) underwent volumetric analysis prior to the lung resection. MinIP sliding slabs did not generate any false positives, but there were four false negatives. HRCT similarly had no false positives, but there were eight false negatives. This type of post processing is likely to improve the accuracy of the diagnosis of small airway disease by similarly emphasizing subtle low density contrast differences.

CONCLUSION

Our study of 50 cases comparing MinIP with HRCT shows that MinIP is more sensitive than HRCT in picking up abnormalities on account of its ability to show lucent areas better than HRCT. Our result is in consonance with the international literature and justifies the value of MinIP in the evaluation of ILD including the patients of asthma.

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