Clinical Case Review | Complex Airway Injury

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3D printing in a complex airway injury secondary to erosion of spinal hardware.

Introduction

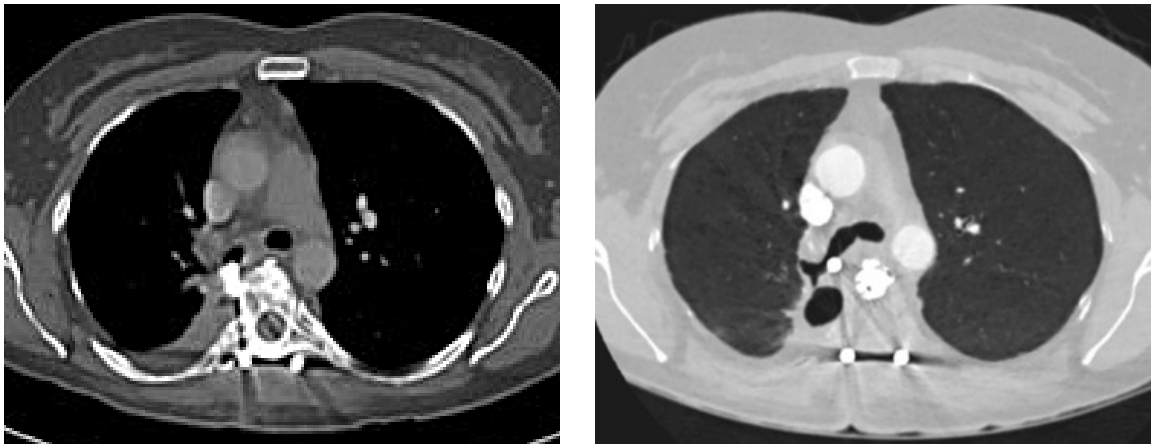
The patient is a 45-year-old female with history of recurrent pheochromocytoma metastatic to the spine who has undergone radiation therapy and multiple spinal reconstructive surgeries with hardware replacement. The patient now presents with progressive migration of the spinal hardware resulting in erosion into the right bronchus intermedius causing complete atelectasis of the right lower lobe bronchus. A bronchial stent was placed to restore patency and a definitive treatment was proposed, which would involve removal of the hardware, reconstruction of the airway, and placement of a soft tissue flap. Due to the complexity of the anatomy and surrounding vital structures, and need for a multidisciplinary approach, a 3D volume rendering of the CT scan was performed using Vitrea® Advanced Visualization software to better evaluate the extent of spinal hardware migration. Due to complexity of the approach, a 3D model was created using the Vitrea segmentation tools and .stl export functionality.

Method

The patient underwent the Computed Tomography (CT) of the chest with contrast to evaluate for extent of migration of the spinal hardware.

Findings

The contrast enhanced CT of the chest-demonstrated spinal hardware with vertebral body screws and spinal fusion rods in the mid thoracic spine which have migrated laterally causing compression of the right main stem bronchus and obscuration of the medial wall of the bronchus intermedius airway. (Figure 1)

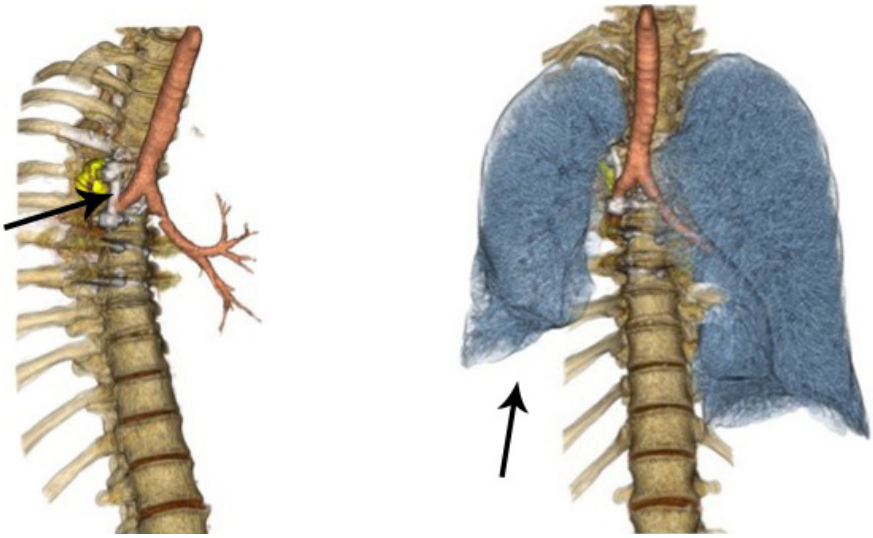


(a) (b)

Images courtesy of Ritu Gill MD

Figure 1: Contrast enhanced CT of the chest in (a) soft tissue window and (b) lung window demonstrating lateral migration of the spinal fusion rod, which is impinging upon the right bronchus intermedius.

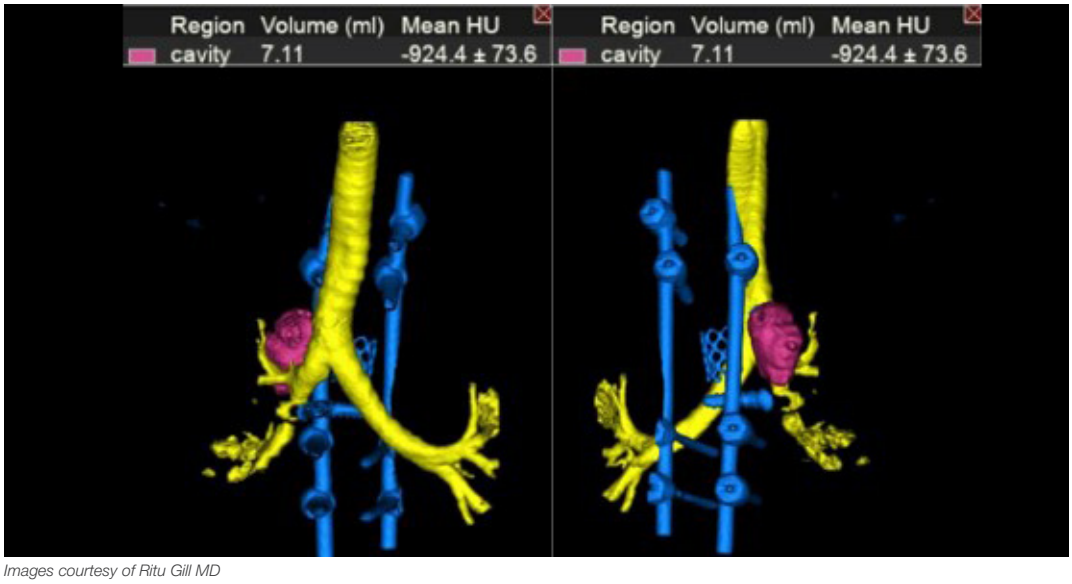
To better evaluate the extent of migration and 3-dimensional relationship between the spinal hardware, airways and adjacent vessels, volume rendering of the CT scan was performed using Vitrea Advanced Visualization software. (Figure 2 and 3)



(a) (b)

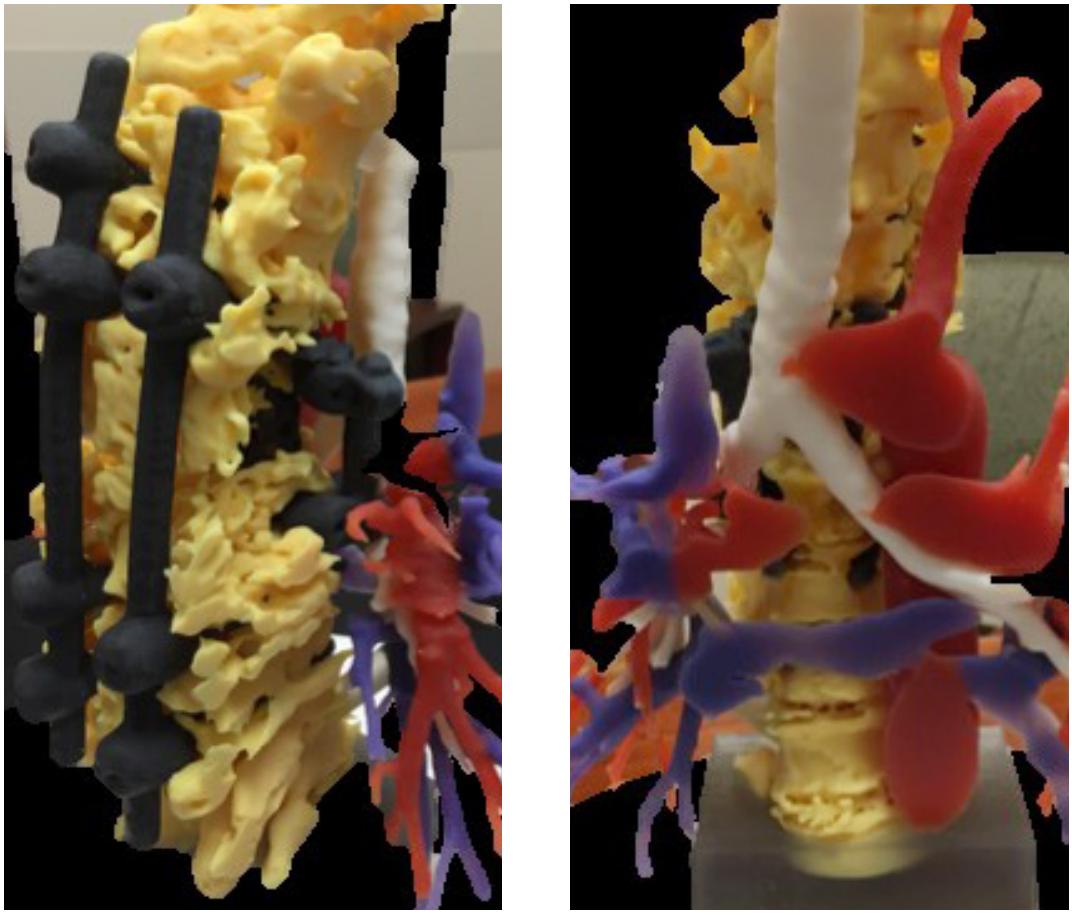
Images courtesy of Ritu Gill MD

Figure 2: 3D volume rendering of the thoracic spine and adjacent structures demonstrating (a) lateral migration of the spinal hardware and resulting obstruction of the right bronchus intermedius (arrow) and (b) associated collapse of the right lower lobe which is evidenced by lower volume of the right lung as compared to the left (arrow).



Images courtesy of Ritu Gill MD

Figure 3: 3D volume rendering of the spinal hardware and thoracic airway demonstrating impingement of the right bronchus intermedius.



Images courtesy of Ritu Gill MD

Figure 4: Subsequently, a 3D printed model was created from the CT scan using Vitrea Advanced Visualization segmentation tools such as thresholding and region growing. The 3D print model was printed on a Polyjet J750 printer at Stratasys Direct Manufacturing.

Conclusion

The multidisciplinary team used the 3D printed model and found the model immensely useful, as the spatial relationship of the hardware migration in relation to adjacent vital structures was better demonstrated than would have been possible by using 2D images alone. The 3D model was used to explain the complex problem and the different aspects of the surgical repair. The patient underwent a successful repair of the bronchus intermedius with a muscle flap and readjustment of the spinal hardware.

Stratasys Direct Manufacturing is a manufacturer of 3D printed models.

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