V20: What is it, and why do we care?

Radiation Oncologists are highly cognizant and careful with regard to the potential side effects of radiation therapy on the normal tissues and organs of the body. In the care of patients with lung cancer, the Radiation Oncologist must carefully examine potential radiation doses (depending on specific clinical situations) to the heart, chest wall (ribs and musculature), spinal cord, esophagus, and to the lung itself.

With regard to the healthy, normal lung tissue surrounding a lung cancer, it has been long known that radiation therapy can cause an inflammatory reaction in the lungs with a potentially significant negative impact on the patient's health and respiratory function. When significant enough volume of the lung is exposed to significant enough radiation doses, the risk for causing a radiation induced lung problem is real. As a result of radiation exposure, a condition known as *radiation pneumonitis* can develop.

Radiation pneumonitis is symptomatically similar to the condition that we all know as pneumonia, but the cause is not infectious – hence the more general term "pneumonitis" referring to an inflammatory process ("-itis") of the lung ("pneumo-"). Patients with radiation pneumonitis experience cough, fever, chills, and shortness of breath. Chest x-ray or cat scan of the chest demonstrates infiltration of the lung with fluid (similar to imaging findings in cases of infectious pneumonia), which tends to be in the area of prior radiation therapy field coverage. The time course of radiation pneumonitis often surprises patients – it typically occurs after a radiotherapy course is completed – on the order of six weeks to six months after radiation therapy. Radiation pneumonitis is typically treated with a course of steroid medication such as prednisone.

Especially in the modern era of radiation oncology, lung dose and volume relationships are carefully examined during radiation therapy treatment planning in order to minimize the risk of radiation pneumonitis. Some of the early understanding of radiation dose tolerance of the lung came from the study of patients that underwent total body (and hence total lung) irradiation. Patients that had full lung exposure to doses in the range of 20 Gray were at very high risk of radiation pneumonitis and lung scarring resulting in life threatening lung illness.

As a reminder, radiation dose is measured in "Gray" – a metric of absorbed radiation dose. One Gray (abbreviated "Gy") is equivalent to one joule per kilogram of absorbed radiation dose. Radiation doses for lung cancer typically are in the range of 45 to 74 Gy, depending on the specific clinical scenario.

Over the last decade, three dimensional radiation therapy planning has enabled a detailed analysis of what now is commonly known as "V20" – which is the percentage of the lung volume (with subtraction of the volume involved by lung cancer) which receives radiation doses of 20 Gy or more. Numerous retrospective studies have examined safe thresholds for V20 and provide an estimation of the risk for radiation pneumonitis depending on V20 values.

In general, when one-third of the total lung volume is exposed to radiation doses of 20 Gy or

more, the risk for symptomatic radiation induced pneumonitis is ten to fifteen percent. When lung V20 is kept below 22% (approximately one-fifth of the total lung volume), the risk for radiation pneumonitis is nearly zero. Above a V20 of 35%, the risk for radiation pneumonitis rises precipitiously, such that when V20 is increased to greater than 40%, the risk for radiation induced pneumonitis increases to nearly 50%.

Since the advent of V20 proportional analysis, many other metrics have also been studied and are frequently employed to assess the risk of radiation pneumonitis. Akin to V20, V5 (proportion of the lung receiving 5 Gy), V10 and V16 all are correlated with radiation pneumonitis risk. Also correlated is mean lung dose.

Altogether, the assessment of radiation pneumonitis risk by the radiation oncologist is a critical aspect of radiation therapy treatment planning. The V20 (the percent of the lung receiving 20 Gy) is an important metric that helps inform optimization of a radiotherapy treatment plan for lung cancer and thereby minimize the risk of lung related radiotherapy side effects.