Purpose: To assess the trigger delay in respiratory triggered real-time imaging and its impact on image guided radiotherapy (IGRT) with Varian TrueBeam System.

Methods: A sinusoidal motion phantom with 2cm motion amplitude was used. The trigger delay was determined directly with video image, and indirectly by the distance between expected and actual triggering phantom positions. For the direct method, a fluorescent screen was placed on the phantom to visualize the x-ray. The motion of the screen was recorded at 60 frames/second. The number of frames between the time when the phantom reached expected triggering position and the time when the screen was illuminated by the x-ray was used to determine the trigger delay. In the indirect method, triggered kV x-ray images were acquired in real-time during 'treatment' with triggers set at 25% and 75% respiratory phases where the phantom moved at the maximum speed. 39-40 triggered images were acquired continuously in each series. The distance between the expected and actual triggering points, d, was measured on the images to determine the delay time t by d=Asin(ωt), where ω=2π/T, T=period and A=amplitude. Motion periods of 2s and 4s were used in the measurement.

Results: The trigger delay time determined with direct video imaging was 125ms (7.5 video frames). The average distance between the expected and actual triggering positions determined by the indirect method was 3.93±0.74mm for T=4s and 7.02±1.25mm for T=2s, yielding mean trigger delay times of 126±24ms and 120±22ms, respectively. Although the mean over-travel distance is significant at 25% and 75% phases, clinically, the target over-travel resulted from the trigger delay at the end of expiration (50% phase) is negligibly small(< 0.5mm).

Conclusions: The trigger delay in respiration-triggered imaging is in the range of 120-126ms. This delay has negligible clinical effect on gated IGRT.