Purpose:
To reduce radiation exposure, internal/external correlation has been applied to derive tumor position based on radiation free external motion tracking. However, the reliability and stability of the correlation is a big concern. This study will characterize the temporal correlation patterns and provide a dynamic approach to build reliable correlation with minimum internal imaging.

Methods:
Retrospective analysis has been performed on simultaneously collected 3D internal and 1D external motion of eight patients with 51 treatment days and 165 beams. Both static and dynamic correlations are built through linear and quadratic functions. Static approach compares and summarized the correlation patterns of different granularities (different patients, treatment fractions, beams, and breathing cycles). Dynamic approach studies the temporal correlation patterns and derives tumor positions by adjusting three parameters: internal imaging frequency, previous acquired tumor positions, and future tumor positions. The correlation coefficient and the difference between derived and truly observed tumor positions are used to evaluate the accuracy.

Results: The statistical analysis showed that the internal/external correlation is patient specific. Overall, the quadratic correlation outperforms the linear correlation. For the 8 patients, three patients have steady internal/external correlation (1 SD <0.35%), three with medium variation (<0.65%), and two with significant changes (<2.50%). The temporal changes of the last two patients showed that considerable correlation variations exist from day to day, beam to beam, and breathing cycle to cycle during the same beam delivery. Different combinations of the three parameters for the dynamic approach showed the most recent breathing patterns are of more importance in building a reliable correlation and internal imaging frequency of 1 Hz is sufficient for most patients.

Conclusions:
This study addressed several major concerns for establishing reliable internal/ external correlations. Dynamic correlation with proper settings will yield improved tumor tracking precision with minimal internal imaging.

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