Intrafractional movement of patients with spinal cord compression receiving radiation therapy

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Purpose/Objective
Patients with spinal cord compression (SCC) often experience moderate to severe pain. This pain could potentially increase intrafractional movement, requiring planning treatment volume (PTV) margins to be adjusted. We conducted a prospective study to examine the impact of patient-experienced pain on intrafractional movement and the time needed for treatment delivery.

Material/Methods
This prospective study included 38 consecutive patients receiving radiation therapy for spinal cord compression at our clinic. The patients provided informed consent to participate in the study. The patients who had SCC at Th4 and above (31 fractions) were treated in a 5 point net (fig 1). The remaining patients were positioned with only a head rest. We recorded the patients’ intrafractional shifts, the treatment time, the treatment site and the patients’ self-reported pain score. The patients were asked to assess their pain (‘pain’) prior to radiation therapy fraction, on a scale from 1 to 10 using the NRS (Numerical Ratings Scale) [Pain Pract 3 (4): 310–6]. Cone beam CT images were acquired before and after all daily treatments. The interfractional shift (‘shift’), linac ID number (‘linac’), treatment time (‘time’), fraction number (‘fr number’) and treatment site (‘site’) were recorded. The average and maximum shifts, and the standard deviation (s.d.), were determined.

Spearman correlation coefficients were calculated between: shift and time, fr number, or pain; time and fr number or pain; pain and fr number. Since site was scored by a categorical variable, a Kruskal Wallis test was used to investigate effect of treatment site on shift, time or pain score.

Results and discussion
A total of 123 shifts were recorded. The average shift was 0.96 mm, the maximum 4.11 mm, and the s.d. was 0.89 mm (fig 1). The only significant correlations (see fig 2) were between:
• Shift and pain (patients reporting more pain had greater shifts, $r_s=0.0445$, $p=0.2699$). This may be due to patient discomfort.
• Time and fr number (later fractions were completed more quickly, $r_s=0.001$, $p=0.3300$). The reduced time for later fractions may be due to the patient becoming more familiar with the treatment procedure.
• Pain and fr number (patients reported less pain in later fractions, $r_s=0.0424$, $p=0.1960$). While pain score decreased with fraction number, fewer patients provided pain scores for later fractions.
• Site and time ($p=0.0444$, $C^2=0.87$). Treatment site correlates with treatment time. Shorter treatment time for patients treated for a cervical SCC, may be related to the fact that matching on pre-treatment imaging may be easier due to the anatomy of the cervical area.

Patients with pain scores ≤5 had mean intrafractional shift 0.03 cm (s.d. 0.09), while patients with pain scores >5 had mean shift 0.35 (s.d. 0.07).

Conclusion
A 5 mm PTV margin appears sufficient to account for interfractional patient movement for patients with spinal cord compression imaged daily.

Figure 1. Patient fixation used for treatment of cervical spinal cord compression. The dots indicate taken positions due to a second target in the lumbar region.

Figure 2. Distribution of interfractional patient shifts in this work.

Figure 3. Plots of the four sets of variables which were found to be correlated, and their p-values. The patient shift increased significantly with increasing pain (A); the treatment time decreased significantly with fraction number (B); the pain decreased with increasing fraction number (C) and the time correlated with treatment site (D, site=1 is cervical, site=2 is thoracic, site=3 is lumbar).

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