Electromagnetic vs. Traction-Based Head Positioning for Cervical Alignment

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INTRODUCTION: Optimal cervical sagittal alignment is essential for deformity correction surgery, yet intraoperative techniques often fail to achieve desired alignment. This study compared an Electromagnetic Head Positioner (EMHP) and Bivector Traction (BVT) in achieving patient-specific cervical lordosis targets under two conditions: (1) flexible cervical spine and (2) rigid cervical deformity requiring osteotomy.

METHODS: Six fresh-frozen cadaveric torsos (mean age 76.1±9.3 years, all female) with intact head and neck anatomy were positioned prone and imaged laterally using both EMHP and BVT systems. C2 slope, T1 slope, and calculated cervical lordosis were measured. Each specimen was evaluated in flexible and rigid (post-osteotomy) conditions. Statistical analyses included Friedman's ANOVA with Wilcoxon signed-rank post hoc tests (Holm correction).

RESULTS: Head positioner condition significantly influenced alignment error ($\chi^2_4 = 23.7$, $p < 0.001$). The EMHP achieved lower error in the flexible spine (8.8° [9.0°]) compared to all other groups ($p < 0.008$). In the rigid condition, EMHP outperformed BVT (13.9° [12.2°] vs 18.8° [16.4°]; $p = 0.018$).

DISCUSSION: EMHP more accurately achieved target cervical alignment than BVT in both flexible and rigid spine conditions. Direct, incremental control offered by EMHP may explain its superiority, particularly after spinal releases. These findings suggest EMHP offers mechanical advantages over BVT during complex deformity correction.

SIGNIFICANCE/CLINICAL RELEVANCE: Accurate intraoperative cervical alignment is vital for optimizing outcomes in deformity surgery. This study supports EMHP as a more precise alternative to traction-based systems and justifies further investigation in clinical settings.

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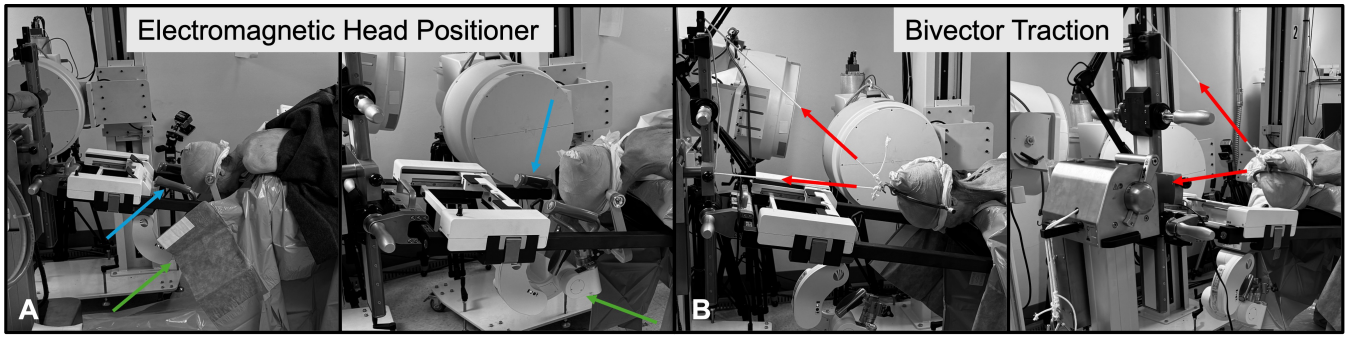

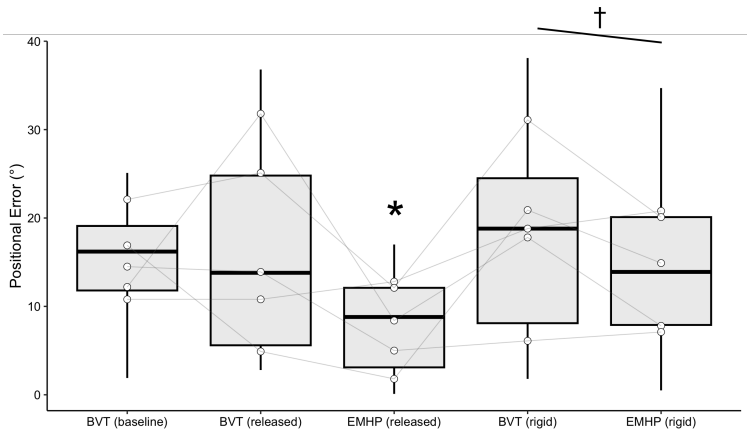

Figure 1 (top). Intraoperative head positioning systems. (A) The Electromagnetic Head Positioner (EMHP) enables precise head manipulation through surgeon-controlled handles (blue arrows) attached to the Mayfield head clamp. The electromagnetic locking mechanism (green arrow) allows the head position to be held rigidly once aligned. (B) The Bivector Traction (BVT) system uses a rope-weight-pulley configuration (red arrows) in conjunction with Gardner-Wells tongs to apply sequential traction vectors for cervical alignment. Both systems are shown with specimens in the prone surgical position.

Figure 2 (left). Positional error (degrees) across head-positioning conditions expressed as box and whisker plots. Individual specimen values are shown as open circles, with connecting lines indicating repeated measures across conditions. * Indicates a statistical difference between EMHP (released) and all other conditions ($p < 0.008$). † Indicates a statistical difference between BVT (rigid) and EMHP (rigid) ($p = 0.018$).