

O-38

Application of a three-dimensional spatial parameter-based evaluation system for assessing reduction difficulty in posterior atlantoaxial surgery

Cheng Zhang¹, Shanshan Liu¹, Yinglun Tian¹, Junhe Wang², Xiyao Yang², Shenglin Wang¹, Nanfang Xu¹

¹*Peking University Third Hospital, Department of Orthopedic Surgery, Beijing, China*

²*Peking University Health Science Center, Beijing, China*

Background: The assessment of atlantoaxial dislocation (AAD) plays a pivotal role in guiding treatment decisions. Objective morphometric methods may mitigate subjective biases in evaluation outcomes. Two-dimensional (2D) images are prone to variability stemming from differences in imaging equipment and patient positioning. 3D morphological evaluation offers a more objective and comprehensive characterization of the atlantoaxial relationship.

Research question: How to evaluate the AAD based on 3D parameters

Design: A retrospective study

Methods: This study collected CT from 66 patients of AAD with sandwich deformity. Based on reducibility under traction in general anesthesia, patients who failed to achieve reduction, or who achieved reduction with intraoperative traction but had unsatisfactory reduction after posterior surgery, were classified as the "Posterior Irreducible"(PI) group. Patients who achieved and maintained satisfactory reduction following posterior surgery were classified as the "Posterior Reducible"(PR) group. The atlas and axis were manually segmented and reconstructed in 3D, with 18 key points annotated on the 3D models. Spatial positional features were calculated from these key points and statistical analysis was performed.

Results: Of the 66 patients, 51 were classified as PI group and 15 as PR group. 25 spatial features were calculated from 18 key points. Multivariate binary logistic regression revealed that the atlanto-dental interval, odontoid tip-anterior arch distance, the atlanto-dental angle, the lateral mass deflection angle, and the incline angle of lateral mass joint were independent predictors of reduction difficulty ($p < 0.05$). The evaluation of the model yielded an AUROC of 0.95.

Discussion: Three-dimensional spatial parameters enable the development of an evaluation system for the AAD patients. Spatial morphology is strongly associated with the difficulty of reduction, offering potential value in evaluation and decision-making.