Sagittal motion in the thoracic spine: the effect of three different surgical releases

Chaiwat Kraiwattanaponng[1, 2], William C Horton[1], William C Hutton[1]

[1]The Emory Spine Center, Department of Orthopaedics, Emory University School of Medicine, Atlanta, Georgia, U.S.A., [2]Department of Orthopaedic Surgery and Physical Medicine, Faculty of Medicine, Prince of Songkla University

Introduction: The thoracic spine is different from the cervical and lumbar spine; besides the intervertebral disc, facet joints, related capsules and ligaments, the ribs and sternum are important structures that contribute to stability and controlling motion. The role of the sternum and costosternal articulation in the biomechanics of thoracic fracture or deformity correction has not been well studied. The effects of releasing each of these structures, whether alone or in combination, is potentially relevant in the surgical correction of thoracic deformities such as severe hyphosis. The purpose of this study was to investigate the relative effects of releasing the intervertebral disc, the costosternal joint, the sternum, and the facet joints on sagittal thoracic motion and the consequences of altering the sequence of the releases.

Methods: Eighteen torsos were used in three experiments (A, B, and C) to determine the effect on sagittal motion due to three different sequences of three surgical releases, Before any of the surgical releases were carried out, each specimen was first tested intact. A force of 25 N was applied perpendicular to the long axis of spine by manually pulling on the spring balance, to produce extension then flexion. The extent of angular flexion and the extent of angular extension were measured using a digital goniometer. The length of sternum was measured using a digital electronic caliper. Then Experiment A was performed and the sequence of surgical release as follows: total facetectomy, then radical discectomy, the sternal osteotomy plus costosternal release. Experiment B: Sternal osteotomy plus costosternal release, then radical discectomy, then total facetectomy. Experiment C: Radical discectomy, then sternal osteotomy plus costosternal release, then total facetectomy. In each of three experiments the extent of angular flexion, the extent of angular extension and the length of sternum were measured same as intact.

Results: When first single release was considered, radical discectomy provided the greatest increase ($p < 0.05$) in extension and in range of motion (ROM) as compared to the other two single releases. When the first two releases are considered, the combination of radical discectomy and sternal plus costosternal release (as in Experiments B and C) provided the significant ($p < 0.05$) increase in extension and ROM as compared to the radical

discectomy and total facetectomy (Experiment A). There are no significant differences ($p > 0.05$) in the percentage increase (when compared to intact) in extension and in total ROM between each experiment when all three releases were completely performed. This is suggesting internal consistency in the experiment method. The average increase in length of sternum after releasing of all the structures from zero position to full extension was 1.55 cm (1-1.75 cm).

Conclusion: Radical discectomy provided the greatest in crease of extension as compared to the orher two releases, no matter what the sequence. Sternal osteotomy and costosternal release provided greater increase in range of extension than total facetectomy. In general, all of the releases allowed more extension than flexion. In Single release, radical discectomy provided the greatest increase in range of motion whereas in two releases, combination of radical discectomy and sternal osteobomy plus costosternal release did. Sternum and ribs should be considered as another column of structural thoracic thoracic spine support. Sternal osteotomy plus costosternal release also can significant increase sternal length that may improve pulmonary function which often impaired in severe thoracic deformity patients.