

# Analytical Static Stress Analysis of First Cervical Vertebra (Atlas)

E C Teo,\**BSc, MSc, PhD*, H W Ng,\*\**BEng*

## Abstract

**Introduction:** Fracture of the atlas was first described by Jefferson (1920). He theorised a bursting mechanism of fracture as the occipital condyles were driven into the atlas. Experimental studies by Hays and Alker (1988) and Panjabi et al (1991) were also conducted to explain the injury mechanisms. Injury mechanisms and fracture patterns are important in the clinical evaluation of spinal injuries. Recognition and interpretation of the fracture patterns help to determine the spinal instability and consequently the choice of treatment. Although the fracture mechanics of the atlas have received much attention, it has not been investigated using theoretical modelling. **Materials and Methods:** A high-definition digitiser was used to obtain the geometrical data for the finite element mesh generation. Contrary to the widely used method, such as computed tomography scan for geometric extraction, the direct digitising process of the dried specimen reliably preserves the accurate topography of up to 0.1-mm interval of the original structure. The finite element model was exercised under an axial compressive mode of pressure loading to investigate the sites of failure reported in vivo and in vitro. **Results:** Using material properties from literature, the predicted results from the 7808-finite element model demonstrate high concentration of localised stress at the anterior and posterior arch of the atlas, which agrees well with those reported in the literature. Furthermore, our results are also in good agreement with the findings reported by Panjabi et al (1991), which show that the groove of the posterior arch is subjected to enormous bending moment under simulated hyperextension conditions. **Conclusions:** The close agreement of the failure location provided confidence to perform further analysis and in vitro experiments. The predicted results from finite element analysis may be potentially used to supplement experimental research in understanding the clinical biomechanics of the C1.

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**Key words:** Atlantooccipital, Burst fracture, Cadaver

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\* Associate Professor

\*\* Research Scholar

School of Mechanical and Production Engineering

Nanyang Technological University

Address for Reprints: Dr E C Teo, School of Mechanical and Production Engineering, Nanyang Technological University, Nanyang Ave, Singapore 639798.

E-mail: mecteo@ntu.edu.sg