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Corresponding author:
Yang Kondric

yangsong@polyu.edu.hk

Author Affiliation:
Faculty of Sports Science, Ningbo University, Ningbo, Zhejiang, China.

Mechanical behavior of posterior longitudinal ligament ossification in degenerative cervical myelopathy by finite element analysis: a systematic review

Cheng, Z; Zhang, C; Cen, X; Zhang, Q; Teo, E; Sun, D; Song, Y.

ADMINISTRATIVE INFORMATION

Support - This study was sponsored by the Zhejiang Provincial Natural Science Foundation of China for Distinguished Young Scholars (LR22A020002), Zhejiang Provincial Natural Science Foundation (LTGY23H040003), Ningbo key R&D Program (2022Z196), Research Academy of Medicine Com-bining Sports, Ningbo (No.2023001), the Project of NINGBO Leading Medical &Health Discipline (No.2022-F15, No.2022-F22), Ningbo Natural Science Foundation (2022J065, 20221JCGY010607), Public Welfare Science & Technology Project of Ningbo, China (2021S134), and Zhejiang Reha-bilitation Medical Association Scientific Research Special Fund (ZKKY2023001).

Review Stage at time of this submission - Completed but not published.

Conflicts of interest - None declared.

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Amendments - This protocol was registered with the International Platform of Registered Systematic Review and Meta-Analysis Protocols (INPLASY) on 04 August 2024 and was last updated on 04 August 2024.

INTRODUCTION

Review question / Objective This study aimed to review the current finite element modeling practices studying the mechanical behavior of C-OPLL and to provide insights for future research on the impact of C-OPLL on spinal cord mechanics using finite element methods.

Rationale Approximately 25% of degenerative cervical myelopathy (DCM) cases are characterized by ossification of the posterior longitudinal ligament (OPLL), which affects the normal mechanical behavior of the spinal cord. Finite element analysis (FEA) has been widely used to study the abnormal mechanical behavior of the spinal cord caused by cervical OPLL (C-OPLL). However, a comprehensive review of these finite element modeling practices has not yet been conducted.

Condition being studied Ossification of the posterior longitudinal ligament (OPLL) was first identified in Japan and is commonly seen in elderly and Asian patients . OPLL is a pathological process involving bone deposition, most commonly located in the cervical spine, and is thought to be a common etiological cause of cervical spinal cord compression. This condition results in the narrowing of the spinal canal, leading to irreversible spinal cord injury and disability.

METHODS

Search strategy This review was conducted using the Web of Science, PubMed, and search using Boolean operations on ("finite element" OR "FEA" OR "computational model") AND ("posterior longitudinal ligament ossification" OR "degenerative cervical myelopathy"). All relevant studies were identified up to June 1, 2024, and duplicate articles were removed. The abstracts and titles of all retrieved articles were then screened, and the snowballing method was utilized along with a citation check to ensure no papers were missed (31-33).

Participant or population Patients with ossification of the posterior longitudinal ligament were studied in this review.

Intervention No intervention was included in this review.

Comparator Not applicable.

Study designs to be included Finite element modeling studies on ossification of the posterior longitudinal ligament were included in this review.

Eligibility criteria (1) an original article in an English journal; (2) the article described the modeling process in detail and included at least the FE modeling of the OPLL and the spinal cord; and (3) the mechanical behavior of the OPLL and the stress distribution in the spinal cord of patients with OPLL were demonstrated by finite element analysis.

Information sources This review was conducted using the Web of Science, PubMed, and search using Boolean operations on ("finite element" OR "FEA" OR "computational model") AND ("posterior longitudinal ligament ossification" OR "degenerative cervical myelopathy"). All relevant studies up to June 1, 2024, were identified, and duplicate articles were removed. The abstracts and titles of all retrieved articles were then screened, and the snowballing method was utilized along with a citation check to ensure no papers were missed.

Main outcome(s) For the main outcomes, all the information included in the literature was categorized into the following three categories: (1) research objectives and findings/conclusions; (2) medical 3D reconstruction; and (3) finite element simulation processing.

Additional outcome(s) None.

Data management For the extraction of information from all the articles, two authors strictly adhered to the research objectives of this paper and the routine process of medical finite element analysis. This process was determined through agreement in discussions with another author and was ultimately summarized in a table by the first author. All the information included in the literature was categorized into the following three categories: (1) research objectives and findings/conclusions; (2) medical 3D reconstruction; and (3) finite element simulation processing. Disagreements in data extraction were resolved by the corresponding authors.

Quality assessment / Risk of bias analysis The methodological quality of all included studies was assessed by two authors using the Methodological Quality Assessment for Computational Orthopaedic-Specific Finite Element Analysis (MQSSFE)(34). Inconsistencies were resolved by another author. In the MQSSFE, “Y” represents a score of 1, and “N” represents a score of 0, with higher scores indicating higher quality models.

Strategy of data synthesis Desktop Reference Management Software (Mendeley Ltd., Netherlands) was utilized to organize articles, analyze data, and generate citations.

Subgroup analysis The subgroup analysis includes, 1) Research objectives and findings/conclusions; 2) Medical three-dimensional reconstruction; 3) Finite element simulation analysis.

Sensitivity analysis Not applicable.

Language restriction English.

Country(ies) involved China, Hungary.

Other relevant information No.

Keywords finite element analysis, the ossification of the posterior longitudinal ligament, degenerative cervical myelopathy, spinal cord, Biomechanics.

Contributions of each author

Author 1 - Zhenghan Cheng - Author Zhenghan Cheng conceived the presented idea, developed the framework, and wrote the manuscript. drafted the manuscript.
Email: 2311040043@nbu.edu.cn
Author 2 - Caiting Zhang - Author Caiting Zhang conceived the presented idea, developed the framework, and wrote the manuscript. drafted the manuscript.

Email: zhangcaiting_nbu@foxmail.com
Author 3 - Xuanzhen Cen - Author Xuanzhen Cen provided critical feedback and contributed to the final version.
Email: cenxuanzhen@outlook.com
Author 4 - Qiaolin Zhang - Author Qiaolin Zhang provided critical feedback and contributed to the final version.
Email: zhang.qiaolin@phd.uni-obuda.hu
Author 5 - Ee-Chon Teo - Author Ee-Chon Teo provided critical feedback and contributed to the final version.
Email: eechonteo@nbu.edu.cn
Author 6 - Dong Sun - Author Dong Sun provided critical feedback and contributed to the final version.
Email: sundong@nbu.edu.cn
Author 7 - Yang Song - Author Yang Song conceived the presented idea, developed the framework, and wrote the manuscript.
Email: yangsong@polyu.edu.hk