Thoracolumbar burst fracture conservative treatment indications

- Rigid spine injuries - A comprehensive review on diagnostic and therapeutic challenges
- Indications for Nonsurgical Treatment of Thoracolumbar Spine Fractures: WFNS Spine Committee Recommendations
- The treatment of osteoporotic thoraco-lumbar burst fractures by unilateral percutaneous kyphoplasty: A prospective observation study
- Lumbar spine fusion: what is the evidence?
- The Conservative Treatment of Traumatic Thoracolumbar Vertebral Fractures
- Three-dimensional thoracoscopic vertebral body replacement at the thoracolumbar junction
- Percutaneous vertebral augmentation in fragility fractures-indications and limitations
- The complement of the load-sharing classification for the thoracolumbar injury classification system in managing thoracolumbar burst fractures

---

Conservative treatment for thoracolumbar burst fractures is indicated in selected cases where surgical intervention is not necessary. The main criteria for choosing conservative treatment include the following:

1. Neurological Status Intact Neurology: Patients with no neurological deficits are generally suitable for conservative management. Stable Neurology: Patients with transient or minor neurological symptoms that do not progress may also be considered.

2. Spinal Stability No Significant Instability: Load-sharing criteria indicate a stable fracture. Posterior ligamentous complex (PLC) is intact, as assessed clinically or via imaging (MRI or CT).

Kyphosis Angle: Acceptable if less than 30°. Vertebral Body Compression: Less than 50% of the anterior vertebral body height.

3. Fracture Characteristics Minor Retropulsion of Fragments: Retropulsed bone fragments should not significantly compromise the spinal canal (usually less than 50% canal compromise). Minimal Deformity: Deformity should not cause severe kyphosis or scoliosis.

4. Patient-Related Factors Compliance: Patients must be able to adhere to bracing protocols and physical therapy. General Health: Patients should not have significant comorbidities that affect fracture healing (e.g., severe osteoporosis).

5. Pain Control Conservative treatment is viable if pain can be managed with medications and immobilization without escalating doses or requiring hospitalization.

Retrospective prognostic accuracy studies

A study aimed to assess the utility of machine learning models (MLMs) in predicting the need for surgery in patients with these fractures who do not respond to conservative management.

Methods: A retrospective analysis of 357 patients with traumatic thoracolumbar burst fractures treated conservatively between January 2017 and October 2023 was conducted. Various potential risk factors for treatment failure were evaluated, including age, gender, BMI, smoking, diabetes, vertebral body compression rate, anterior height compression, Cobb angle, interpedicular distance, canal compromise, and pain intensity. Three MLMs-random forest (RF), support vector machine (SVM), and k-nearest neighborhood (k-NN)-were used to predict treatment failure, with the RF model also identifying factors associated with treatment failure.

Results: Among the patients studied, most (85.2%) completed conservative treatment, while 14.8% required surgery during follow-up. Smoking (OR: 2.01; 95% CI: 1.54-2.86; p = 0.011) and interpedicular distance (OR: 2.31; 95% CI: 1.22-2.73; p = 0.003) were found to be independent risk factors for treatment failure. The MLMs demonstrated good performance, with SVM achieving the highest accuracy (0.931), followed by RF (0.911) and k-NN (0.896). SVM also exhibited superior sensitivity and specificity compared to the other models, with AUC values of 0.897, 0.854, and 0.815 for SVM, RF, and k-NN, respectively.

This study underscores the effectiveness of MLMs in predicting conservative treatment failure in patients with thoracolumbar burst fractures. These models offer valuable prognostic insights that can aid in optimizing patient management and clinical outcomes in this specific patient population [1)].

Strengths of the Study Innovative Approach:

The application of machine learning models (MLMs) to predict treatment failure in thoracolumbar burst fractures is a novel and timely contribution to clinical practice, particularly given the rising interest in AI-driven decision-making in healthcare. Robust Dataset:

The study analyzed data from 357 patients over a period of nearly seven years. This extensive retrospective dataset enhances the generalizability and reliability of the findings. Use of Multiple MLMs:

Employing three distinct MLMs (RF, SVM, k-NN) allowed for a comparative analysis of their predictive accuracy, offering insights into the strengths and limitations of each model. Clinical Relevance:

By identifying independent risk factors such as smoking and interpedicular distance, the study contributes directly to understanding patient-specific characteristics influencing conservative treatment outcomes. Performance Metrics:

The high accuracy and AUC values, especially for the SVM model, demonstrate the potential of these tools in clinical decision-making. The study's focus on sensitivity and specificity ensures a balanced evaluation of the models' capabilities. Limitations of the Study Retrospective Design:

Retrospective analyses are inherently limited by their dependence on existing records, which may be subject to inconsistencies or missing data. Lack of External Validation:

The MLMs were tested on the same dataset used for training, raising concerns about overfitting. External validation on an independent cohort would strengthen the claims of predictive accuracy. Selection Bias:

The dataset comprises patients treated at a single institution, which may limit the generalizability of

the results to other populations or healthcare settings. Limited MLM Diversity:

While RF, SVM, and k-NN are well-established MLMs, incorporating deep learning approaches or ensemble models could provide additional insights and potentially improve predictive power. Missing Variables:

Other clinically relevant factors, such as physical activity, socioeconomic status, or compliance with conservative management protocols, were not considered. These could also influence treatment outcomes. Interpretability Issues:

While the RF model provided insights into risk factors, MLMs like SVM and k-NN are often criticized for being “black boxes.” Greater transparency in feature importance could improve clinical acceptance. Unclear Clinical Integration:

Although the study demonstrates the models’ predictive capabilities, it does not address how these predictions can be seamlessly integrated into existing clinical workflows or decision-making processes. Potential Improvements and Future Directions Prospective Validation:

Future research should involve prospective studies to validate the findings and test the practicality of implementing MLMs in real-time clinical scenarios. Broader Dataset:

Incorporating multicenter data would enhance the robustness and generalizability of the results across different patient populations and healthcare settings. Ensemble Models and Feature Engineering:

Exploring ensemble approaches and advanced feature engineering techniques could further optimize the performance of the MLMs. Cost-Effectiveness Analysis:

Assessing the economic implications of integrating MLMs into clinical practice would provide additional value for healthcare providers and policymakers. User-Friendly Interfaces:

Development of clinician-friendly tools that integrate MLM predictions with actionable recommendations would improve adoption in practice. Conclusion This study is an important step in leveraging machine learning for personalized medicine in spinal trauma. However, to maximize its clinical impact, further validation and efforts to address its limitations are needed. Despite these shortcomings, the high performance of the MLMs, particularly the SVM model, highlights their potential as a supplementary tool for predicting treatment failure and guiding decision-making in thoracolumbar burst fractures.

1)
Alimohammadi E, Arjmandnia F, Ataee M, Bagheri SR. Predictive accuracy of machine learning models for conservative treatment failure in thoracolumbar burst fractures. BMC Musculoskelet Disord. 2024 Nov 18;25(1):922. doi: 10.1186/s12891-024-08045-1. PMID: 39558324.