Improving Diagnostic Models for Temporomandibular Disease Using Cost-Effective Variables: An Analysis of the Dimitroulis Classification

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Abstract

Background: Temporomandibular disorders (TMD) are a class of degenerative musculoskeletal and neuromuscular conditions involving the temporomandibular joint (TMJ) complex and surrounding musculature. The etiology of TMD is multifactorial, including biological, environmental, social, emotional, and cognitive triggers. Due to the complexity of the disease's signs and symptoms, the diagnosis and correct treatment of TMD remain a challenge. The Dimitroulis classification (DC) divides TMD into five categories (DC1, DC2, ..., DC5) based on the degree of disease severity with an indication for treatment. The classification is based on history and physical examination and diagnostic imaging is used to access intra-articular derangements. This process presented some subjectivity in the analysis and, has significant associated costs. The present study aims to identify variables based on patient complaints with lower associated costs and more objective, prompt, and less burdensome classification.

Methods and Results: 535 patients were included using an online database: EUROTMJ. The main complaints and final diagnosis were accessed. DC was recorded as the response variable and considered the gold standard classification; complaints were considered explanatory variables. The DC distribution (absolute frequency) for each severity category is: DC1-116; DC2-133; DC3-71; DC4-54; DC5-0. The sample was split into two parts: training with 70% of the observations and testing with the remaining 30%. Initially, the severity categories from the Dimitroulis classification were considered. However, due to the multicategory response variable and the binary nature of the explanatory variables, multinomial logistic regression was determined to be the appropriate statistical method. A variable selection process was then conducted using the bidirectional stepwise method, resulting in a multivariable model with the explanatory variables being TMJ locking, tinnitus, cervical muscle tension, and limitation of mouth opening. Despite the application of the multinomial logistic model, the achieved accuracy rate was only 42.9%, indicating poor performance. Consequently, the analysis was simplified to consider only two categories: not having a TMJ disorder (corresponding to Dimitroulis category 1) and having a TMJ disorder (corresponding to Dimitroulis categories 2, 3, and 4). This led to the use of a generalized linear model with a logistic link function for further analysis. The probabilities of having TMD were obtained as the corresponding classifications, determined by the cut-point maximizing sensitivity and 1-specificity, measured on the Receiver Operating Characteristic (ROC) curve. Preliminary results indicate a model with improved accuracy $(68,9\%)$ and satisfactory discriminatory power, measured by the Area Under the Curve of the Receiver Operating Characteristic curve (AUC), of 0.76 in the model based on the test sample.

Conclusion: This study has enabled the identification of some of the most relevant explanatory variables in the diagnosis of TMD, resulting in a model that can make a classification of having the disease based on these variables. The measurements in this set of variables are easily obtainable and incur no cost. However, the authors suggest that shortly, to increase accuracy, the model could be improved by including more observations in all categories of Dimitroulis classification, particularly in higher severities categories.

Keywords

Dimitroulis Scale, Temporomandibular disorders, Logistic Regression, Receiver Operating Characteristic curve, bidirectional stepwise method.

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