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# Critical Analysis of Commonly Used Difficulty Indices for Pre-Operative Evaluation during Mandibular Third Molar Surgeries

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**ABSTRACT:**The importance of pre-operative evaluation of the anticipated difficulty during mandibular third molar surgery has been a topic of concern for surgeons for the last many decades. Numerous indices have been prepared and some of them are also commonly used in day-to-day practice around the globe. However, none of the established indices utilise accurate and objective clinical and radiological variables together, and some of the variables already proposed seem to have certain logical flaws. This article aims to critically analyse commonly used indices, namely Winter's WAR lines, WHARFE assessment, Pederson index, Pernambucco index and the Zhang index with pertinent literature support, and to highlight the growing need for an index that emphasises on both clinical and radiological variables that will aid the surgeon to accurately assess the difficulty of surgically removing a mandibular third molar.

**KEYWORDS:** impaction, mandibular, third molars, difficulty, index, pre-operative evaluation

## I. INTRODUCTION

Surgical removal of impacted mandibular third molars are among the most widely performed surgeries by oral and maxillofacial surgeons. Although the surgery is termed as a minor oral surgical procedure in literature, this procedure does involve the surgeon to assess the difficulty that may be faced during the surgery, and this knowledge aids in the ability of the operating doctor to plan and execute the procedure with minimal intervention and reduce the post-operative sequalae intensity, that may constitute into a harrowing experience for the patient.

Various tools and indices have been laid down previously in literature to aid the surgeon in making this pre-operative assessment, most relying on radiographic variables. Some of the newly proposed indices have added other clinical and demographic variables to better assess the pre-operative difficulty levels, however the very nature of these variables makes the scoring system an extremely subjective task for the surgeon and does not accurately assess the same. This article aims to critically analyse thecommonly used difficulty indices in day-to-daypractice and highlight the drawbacks of the variables chosen by them to assess the pre-operative difficulty levels during the surgical removal of impacted mandibular third molars, namely Winter's WAR lines, WHARFE assessment, Pederson difficulty index, Pernambucco index and Zhang index. [5,9,10,13,14]

## II. DISCUSSION

Winter's lines:

This was proposed by Winter et al in the year 1926[13], wherein 3 imaginary lines were traced on the pertinent section of the OPG of the patient, and these lines were denoted as the white (W), amber (A) and red (R) lines. The white line denotes the occlusal level of the third molar in relation to the adjacent 2nd molar, the amber line denotes the amount of bone coverage associated with the 3rd molar and the red line denotes the depth at which the 3rd lies within the mandible.

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These lines provide a primitive 2-dimensional orientation of the 3rd molar within the bone to the surgeon. However, there are certain flaws associated with the parameters.

1. Firstly, there is a definite overlap in the representation given by the white line and the amber line. The occlusal level of the 3rd molar is in part a qualitative measure of the amount of bone coverage associated with 3rd molar, that is if the occlusal level is below the adjacent 2nd molar, then it is obvious that the tooth is imbedded further inside the bone. Also, there is no clear demarcating reference point on the 3rd molar that is to be utilised to compare the occlusal levels, meaning if the angulation is anything apart from being vertical, it isn't clear which point on the 3rd molar is to be taken to compare the occlusal levels, rendering it arbitrary.
2. Secondly, the amber line fails to provide a quantitative measure of the amount of bone coverage and after tracing, the idea framed by the surgeon is completely subjective in nature. There is no reference line that is available to compare the amber line to and thus provide a more objective measure of the amount of bone coverage.
3. Thirdly, the red line does not provide an accurate measure of how difficult the surgical removal of the third molar will be, as even if the depth appears to be more than 5mm, the surgeon may not face enough challenges during the surgery if adequate visualization and instrumentation is achieved. Thus, the measure fails to remain objective about predicting pre-operative difficulty. Also, the red line isindicative of the point of application of elevator during tooth delivery. This reference point on the tooth is typically taken as near the CEJ junction. However, depending on tooth morphology and other associative factors, the surgeon may opt for delivering the tooth in sections. Thus, in those cases, the red line, and the point of application so denoted, is rendered redundant.

WHARFE Assessment:

McGregor et al [9]in 1976, expanded upon the already existing Winter's lines and added several other radiological factors to enable a better predictive model in assessing the difficulty in removing third molars. Although MacGregor was unable to develop a multivariate model of predictive value from the comprehensive set of variables, he was able to construct a semiquantitative model based on relatively few radiographic factors that were not interrelated.[3]

Most of the radiological factors that are taken into consideration do provide a certain idea about how difficult the operation may be, but certain variables such as the height of the mandible and the angulation of the adjacent second molar are arbitrary in nature.

The impact of the height of the mandible, measured distal to the 2nd molar, on the difficulty that is faced, does not have sound logical reasoning behind it. The technique for bone removal that is used is the Moore-Gillbe's Collaring technique, that requires the bone to be removed around the 3rd molar in a collar like fashion to expose its greatest contour at the CEJ without reducing the height of the mandible. Thus, whatever may be the measured height, it cannot have a significant effect on the ostectomy part of the surgery. If the 3rd molar is completely deep seated in the mandible, then the surgeon usually adopts other methods of exposing the tooth, but this cannot be applied to routine third molar extractions that are done.

The angulation of the adjacent second molar, also, does not objectively denote the amount of difficulty that is to be faced. In general, whatever may be the angulation of the 2nd molar, it depends on the skill, expertise, and experience of the operating surgeon to negotiate the lack of direct visibility if the 2ndmolar is angulated more posteriorly, and in such cases the increase in difficulty cannot be accurately assessed, apart from being a subjective measure of the same.

Edwards et al[7], in their study found a poor correlation between WHARFE index and the surgeon's anticipated difficulty levels. Chandler et al[4], in their study also preferred to assess the difficulty face intra-operatively as they felt that a surgeon typically overestimates the difficulty based on sole radiological factors.

Pederson Index:

This index was proposed by Pederson[10] as a modification to the Pell and Gregory classification of lower mandibular third molars. A total score obtained by which the difficulty is judged, is solely based on radiological variables, and does not include other clinical variables that may directly impact the level of difficulty face by the surgeon. For example, the spatial arrangement of the 3rd molar is judged based on a 2-D OPG radiograph, that does not provide an accurate

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picture of the angulation of the crown of the third molar, that is if it is buccally or lingually tilted. The angulation of the 3rd molar is decided using the long axis of the adjacent second molar as the reference structure, and in its absence, the index fails to provide an accurate angulation of the 3rd molar. The index also fails to include variables related to the root morphology of the 3rd molar, which has a direct variable to the difficulty faced by the surgeon.

Freitas et al[6] in their study found that the Pederson index had a sensitivity of 23.8% and a specificity of 76.2%, and in comparison, to other established indices to assess difficulty faced,it was not as accurate in measuring the same. Akadiri et al[1] also found a sensitivity of 94.9% and a specificity of 45% respectively. Bali et al[2] conducted a systematic review and a meta-analysis and found that the Pederson index was not a reliable predictor of the difficulty faced by the surgeon as the study showed a lower comparable sensitivity and specificity values, and a lower positive and negative likelihood ratio. Janjua et al[8] conducted a study to assess the accuracy of Pederson index when comparing it to the Modified Parant scale and found that both indices were not able to provide accurate measure of difficulty and that if the root configuration was to be included then the sensitivity was significantly better. Sekhar et al[12] compared the variables of Pederson index and the WHARFE assessment and found that the WHARFE assessment was better in comparison as it included variables related to the root pattern and morphology which was missing in the Pederson index.

Pernambucco Index:

This index was prepared by de Carvalho in the year 2017. The proposed index was developed on a statistical basis using two outcome variables for difficulty, these being the duration of surgery and the surgical technique, and showed significant evidence for clinical, demographic, and radiographic factors.The size of the total sample studied was determined by sampling, not empirically. The index was later verified, showing it to have high sensitivity (93.1%), specificity (87.9%) and accuracy (90.4%). With the use of reference statistics in the development and quality assurance processes, this statistically structured instrument has proven to be an efficient and reliable tool and is better indicators of difficulty than the Pederson index. However, the only ambiguous variable that was utilised in this index was the BMI of the patient. The authors did not substantiate the way in which this parameter affects surgical difficulty, as there is no logical basis that a patient with a BMI suggestive of being overweight will necessarily have any imparted locoregional factor at or around the operative side that will increase the difficulty faced by the surgeon. [3,5]

Zhang Index:

In this index, a mathematical model and regression analysis were performed to explore six main factors (age, number of roots, degree of bone impaction, shape of roots, impaction angle and its relation). Comparison of the Pederson index and new index with operating time showed k agreements of 65.30 and 77.9%, respectively ($P<0.01$), suggesting that the prediction results of the new index are more objective and accurate. For statistical analysis, the total score was classified as ‘‘low,’’ ‘‘moderate’’ or ‘‘high’’ based on quartiles of the scores (i.e., quartile B 1, low; quartiles 1 to 3, moderate; quartile C 3, high). The minimum score was 15 and the maximum score was 30. Though variations of the roots, maximal mouth opening, and cheek dispensability were not considered, this study used a panoramic radiograph, which has limitations of two-dimensional imaging and the overlap of structures. Compared to other studies conducted, this index still manages to be more reproducible, concise, and straightforward. [3,14]

## III. CONCLUSION

After critical analysis of these indices, it is imperative that a newer index be proposed that incorporates more objective clinical variables such as mouth opening, tongue size and cheek flexibility and many more as such, as these have a more direct impact on the assessment of pre-operative surgical difficulty by the operating surgeon. Apart from these, radiological factors are a must to be added as they semi-quantitatively provide an understanding of the spatial arrangement of the 3rd molar to the adjacent 2nd molar as well as its relation to the mandibular ramus. The importance of root morphology and pattern is well established as they objectively add onto the amount of difficulty faced by the surgeon. The relationship of the root apices to the underlying inferior alveolar nerve canal is also an important consideration as iatrogenic injury to this structure can cause per-operative uncontrollable bleeding and more significantly post-operative paraesthesia, and both these complications make the surgery a harrowing experience for the patient and increase the

likelihood of intensified post-operative sequalae such as pain, trismus and swelling.

The radiological assessmentfor the spatial arrangement of the 3rd molar must now be done using more accurate and objective methods such as a CBCT which provides details in a 3-dimensional manner that will aid the surgeon in constructing a more precise surgical plan to lessen the complications faced, as a 2-D OPG radiograph is not as accurate. Considering all these clinical and radiological factors, a consensus must be reached to aid in the development of an all-inclusive index that is easily reproducible, straightforward and precise, that will help the surgeon in the pre-operative setup to plan for better visualization of the surgical site, better retraction of the flaps to avoid iatrogenic injury to the surrounding vital structures and better instrumentation to achieve the goal of the surgery with minimal intervention to lessen the post-operative sequalae of these surgeries.

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