Original article

DOES THE PEDERSON DIFFICULTY INDEX ACCURATELY PREDICT THE DIFFICULTY OF MANDIBULAR THIRD MOLAR EXTRACTION?

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Title of the Manuscript: Does Pederson Difficulty Index accurately predict the difficulty of mandibular third Molar extraction?

Running Title: Pederson Difficulty Index and third molar extraction

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Abstract

Context: To determine the relationship between the Pederson difficulty index and the modified Parant scale and to assess the effectiveness of the Pederson difficulty index

in predicting the difficulty of mandibular third molar extractions.

Settings and Design: This cross-sectional study recruited participants with indications for third molar extractions. Pederson's difficulty index was used to evaluate the anticipated difficulty of preoperative mandibular third molar extraction. Surgical extraction of impacted third molars was done under local anaesthesia and patients were then assessed postoperatively with the Modified Parant Scale.

Methods: In this study, 85 participants indicated for surgical extraction of mandibular third molars under local anaesthesia were enrolled between February 2018 and July 2018. The relationship between Pederson's difficulty index modified Parant scale and duration of extraction was evaluated.

Statistical analysis used: Sociodemographic variables of study participants were summarized with descriptive statistics. Student's T-test was utilized for mean differences between groups and correlations were computed between Pederson and modified Parant scale.

Results: This study comprised 85 participants with a mean age of 25.8 years ± 4.6, showing no significant difference across genders ($p=0.87$). Pederson difficulty index demonstrated a sensitivity of 46.4% and a specificity of 89.5% and a moderate correlation (0.35, $p<0.001$) was observed between Pederson difficulty index and surgery duration, ditto, between Pederson and modified Parant scores (0.36, $p<0.001$).

Conclusion: In conclusion, our study underscores the importance of pre-operative assessment for mandibular third molar extraction, highlighting the Pederson Difficulty Index's moderate predictive value but emphasizing concerns about its sensitivity.

Keywords: Pederson's difficulty Index, Modified Parant scale, Duration of surgery, Impacted mandibular third molar.

Introduction:

The surgical extraction of mandibular third molars, commonly referred to as wisdom teeth is a routine procedure performed by both the general dental practitioner and, oral and maxillofacial surgeons worldwide.[1] However, the complexity of these extractions can vary significantly among patients, and accurately assessing the anticipated difficulty is paramount for effective preoperative planning, risk management and appropriate specialist referral when necessary.[2] A foreknowledge of the surgical difficulty and possible complications expected will also aid the clinician in obtaining appropriate informed consent as relates to the clinical scenario. The patient will also be well informed about approximate surgery duration and expectations and thus will be mentally prepared for the procedure. The choice of general or local anaesthesia will also be influenced by the predicted difficulty of extraction amongst other factors including patient's age, and presence or absence of extreme anxiety. [3]

One of the commonly employed indices for preoperative evaluation of the difficulty of mandibular third molar extraction is the Pederson's difficulty index. Pederson's Difficulty Index[4], introduced in the field of oral and maxillofacial surgery in 1988, has been utilized for decades as a predictive tool to assess the complexity of extracting mandibular third molars. This index is a combination of the Pell and Gregory[5] and Winters classification[6] . It considers various anatomical factors, such as the spatial relationship, depth of impaction, and ramus relationship of the impacted tooth. Nevertheless, despite its widespread use, there remains a lack of consensus within the oral and maxillofacial surgery community regarding the accuracy and reliability of the

Pederson Difficulty Index in predicting the actual difficulty encountered during the surgical extraction of mandibular third molars.[7] Some authors[2,8-11] believe that while the anatomical position of the tooth incorporated in Pederson's difficulty index plays some role in predicting difficulty, actual difficulty is influenced by other factors such as age, gender, and weight of the patient.

An alternative method for assessing the difficulty of extraction is the Modified Parant Scale[12] , which evaluates the complexity of the extraction postoperatively based on operative maneuvers that were needed for the extraction of the impacted mandibular third molar. Unlike the Pederson Difficulty Index, the Modified Parant Scale offers a retrospective assessment, potentially providing a more accurate measure of the actual challenges faced during surgery.

The duration of surgery is often a reflection of the difficulty of surgical extraction. [13] It is an indirect measure of the intricacy and challenges encountered during the extraction procedure. Longer surgical extraction durations often correlate with factors such as anatomical complexities, impaction depth, bone density, proximity to vital structures, and intraoperative complications.[13,14] Some insurance systems in Asia have found it a valuable tool in evaluating surgical difficulty.[15]

This study aims to address the critical question of whether the Pederson Difficulty Index accurately predicts the difficulty of mandibular third molar extraction. By examining the relationship between Pederson's Difficulty Index, the Modified Parant Scale, and the duration of extraction, we seek to contribute valuable insights into the efficacy of these assessment tools in clinical practice. The findings of this study hold significant implications for oral and maxillofacial surgeons and dental professionals, as they rely on accurate preoperative assessments to ensure the safe

and successful extraction of mandibular third molars. Furthermore, enhancing our understanding of the predictive value of the Pederson Difficulty Index can contribute to improved patient outcomes, reduced surgical complications, and more precise treatment planning in the field of oral and maxillofacial surgery.

2. Subjects and Methods:

Ethical approval (IRB/IEC/004553, Protocol number ERC/2016/09/03) for this study was obtained from the institutional review board of the Obafemi Awolowo University Teaching Hospitals Complex. Informed consent was obtained from all participants before their inclusion in the study. The study adhered to the principles outlined in the Declaration of Helsinki regarding the ethical treatment of human subjects in research.

This cross-sectional study comprised 85 participants, aged between 18 and 35 years, who consented to this study. Participants were recruited based on an indication for surgical extraction of mandibular third molars under local anesthesia. The recruitment period spanned from February 2018 and July 2018, and all participants were enrolled at the Oral and Maxillofacial Surgery clinic of Obafemi Awolowo University Teaching Hospitals Complex, Ile-Ife, Nigeria. Pre-operatively, standardized peri-apical radiographs were obtained for all participants. The Pederson difficulty index was used to evaluate the anticipated difficulty of mandibular third molar extraction preoperatively. This was based on spatial relationship (1-4 points), depth of impaction (1-3 points), and ramus relationship (1-3 points) of the impacted tooth as assessed on the peri-apical radiograph. The total Pederson index score was determined by adding the score in each category (spatial relationship, depth of impaction and ramus relationship). The difficulty index was defined as follows: Minimally Difficult (3-4 points), Moderately Difficult (5-6 points),

Very Difficult (7-10 points, Table 1). Pederson score for all participants was determined by the same investigator.

Table 1: Pederson Difficulty Index

Classification	Value
Spatial Relationship	
Mesioangular	1
Horizontal	2
Vertical	3
Distoangular	4
Depth	
Level A: high occlusal level	1
Level B: medium occlusal level	2
Level C: low occlusal level	3
Ramus relationship/space available	
Class 1: sufficient space	1
Class 2: reduced space	2
Class 3: no space	3
Difficulty index	
Very Difficult	7-10
Moderately Difficult	5-6
Minimally Difficult	3-4

Intra-operatively, a three-sided mucoperiosteal flap was raised in all participants. Surgical extraction of impacted third molars was done under local

anaesthesia using the buccal guttering technique. Tooth delivery method was either by osteotomy and tooth elevation, osteotomy and crown sectioning, or osteotomy and root sectioning which was determined by the spatial relationship of the tooth, its relations with the adjacent mandibular second molar and the amount of bone coverage. After tooth delivery, the bone edged were filed and the surgical site was irrigated copiously with 0.9% normal saline. Haemostasis was achieved and the mucoperiosteal flap was sutured using 3/0 black silk sutures.

Duration of extraction; time from incision to the placement of the last suture was recorded in minutes for all participants. Postoperatively, the modified Parant scale was also used to assess the actual difficulty encountered during the surgical extraction. The Modified Parant Scale considers the method of tooth extraction. It includes 4 classes in increasing order of difficulty: Easy I- extraction requiring forceps only, Easy II- extraction requiring osteotomy, Difficult III- extraction requiring osteotomy and crown sectioning, Difficult IV- Complex extraction requiring osteotomy and root sectioning (Table 2).

Table 2: Modified Parant Scale

	Class
Easy I	Extraction requiring forceps only
Easy II	Extraction requiring osteotomy
Difficult III	Extraction requiring osteotomy and coronal section
Difficult IV	Complex extraction (root resection)

Data analysis was performed using R and R Studio (Version 2023.06.1+524). Sociodemographic variables of study participants were summarized in means, median, frequencies and percentages. Assumption testing germane to each statistical analysis technique was conducted after assumptions had been performed using Shapiro Wilk's method for normality and Levene's test for homogeneity of variances. Type 3 ANOVA tests were utilized for mean differences due to imbalance of observations across variables and Welch's t-test were used where variances were inequal between groups. Where any of these laws were breached, relevant non-parametric alternatives were utilized. Analysis of Variance and T- Student's test were used to compare the differences between dichotomous groups and more respectively. Additional association between these variables and gender and educational status were also analyzed. Associations were computed between Pederson and modified Parant scale using either Pearson (r) and Spearman (rs) correlations as necessary. Sensitivity, and specificity analysis of the Pederson difficulty index was done using a modified Parant scale as a standard. Significance for all associations was set at $p<0.05$.

Results

In this study involving 85 participants, the mean age across participants was 25.8 years ± 4.6 with no statistical difference in mean age across genders (p=0.87). Pericoronitis accounted for the primary indication for exodontia (n=63, 74.1%, Table 4).

Table 3: Sociodemographic characteristics of study participants

Variable	Freq (%) N=85
Gender	

Male	33 (38.8)
Female	52 (61.2)
Age	
Between 18- 25	49 (57.6)
Between 25-35	36 (42.4)
Age *Mean (SD*) = 25.8 (4.6)	

Table 4: Clinical Characteristics of Participants

Variable	Frequency (%)
Impaction type	
Mesioangular	25 (29.4)
Horizontal	21 (24.7)
Vertical	25 (29.4)
Distoangular	14 (16.5)
Indication for surgical extraction	
Pericoronal indications	63 (74.1)
Pulpal indications	22 (25.9)
Modified Parant Scale	
Simple Forceps extraction	0 (0.0)
Ostectomy + elevation and forceps	57 (67.1)
Ostectomy + Coronal section	20 (23.5)
Complex extraction (root resection)	8 (9.4)

Impaction pattern of participants

Vertical and mesioangular impaction types were the most common impaction patterns in our study at 29.4% each (n=25, Table 4). Distoangular impaction was the least type observed at 16.5%(n=14). Distoangular however had the highest mean age of presentation at 29 years ± 5.3 while patients with horizontal impaction had a mean age of presentation at 24.3 years ± 3.4. The mean age difference is statistically significant at p=0.026. (Figure 1)

The duration of surgery was also significantly different across impaction types ($p<0.0001$, Figure 2) with distoangular impaction surgeries reporting the highest mean time of 38.1 minutes ± 9.7. Tukey's posthoc revealed significant differences in the mean duration of surgery between distoangular and vertical impaction at $p<0.001$, distoangular and mesioangular impaction at $p<0.001$and between horizontal and mesioangular impaction at $p=0.01$ (Figure 2).

Sensitivity and Specificity of the Pederson Difficulty Index

Using the modified Parant scale as a standard, the Pederson difficulty index was evaluated for its ability to predict the level of difficulty associated with surgical extraction of mandibular third molars. Thirteen of the 28 extractions that the modified Parant scale classed as difficult also received a difficult classification from the Pederson difficulty index, which demonstrated a sensitivity of 46.4% and a specificity of 89.5%, (Table 5).

Sensitivity = (TP / (TP + FN)) x 100;
Sensitivity= (13/13+15) x 100 = 46.4%

Specificity= (TN / (TN + FP)) x 100;
Specificity= (0+7+0+44) / ((0+7+0+44) + (0+6)) x 100 = 89.5%, where TP is true positive, FN is false negative, TN is True negative and FP is false positive.

Pederson difficulty Index also reported a positive predictive value of 68.4% (TP/TP+FP) and a negative predictive value of 77.3% (TN/(FN+TN)).

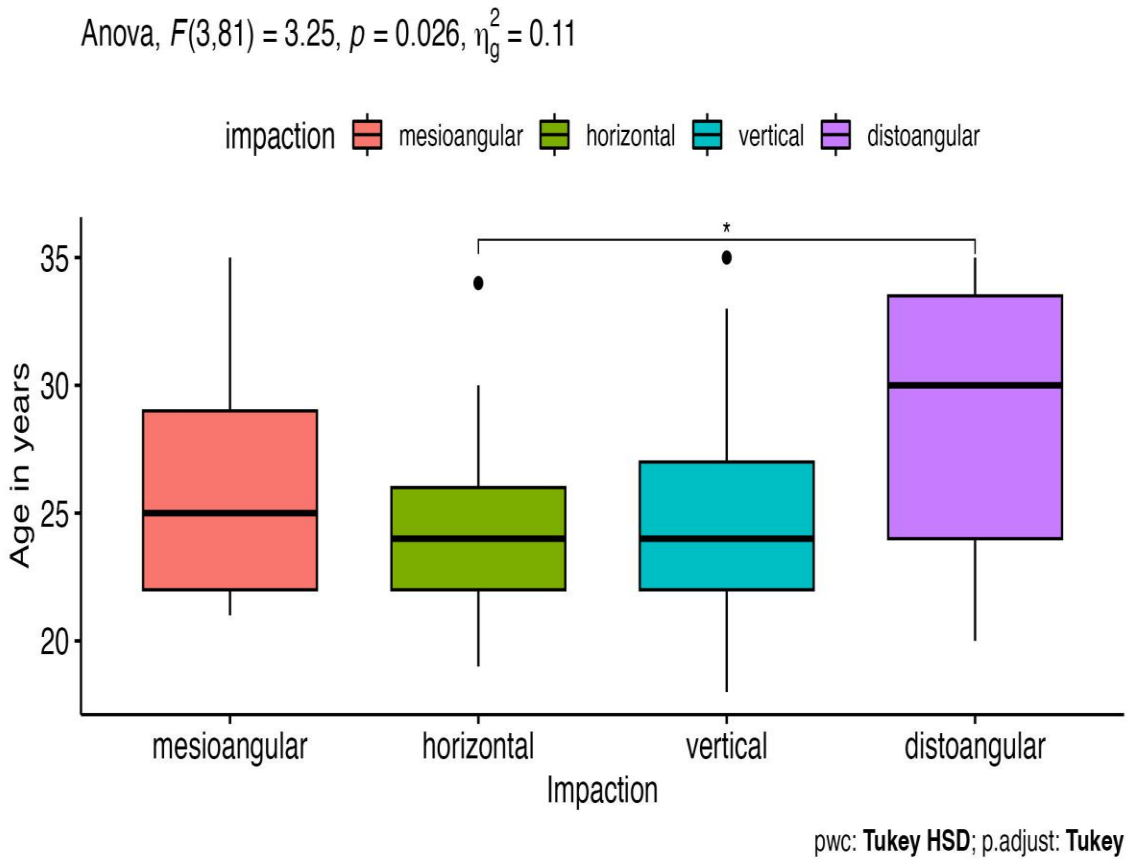

Figure 1: Mean Age Difference Across Impaction Types

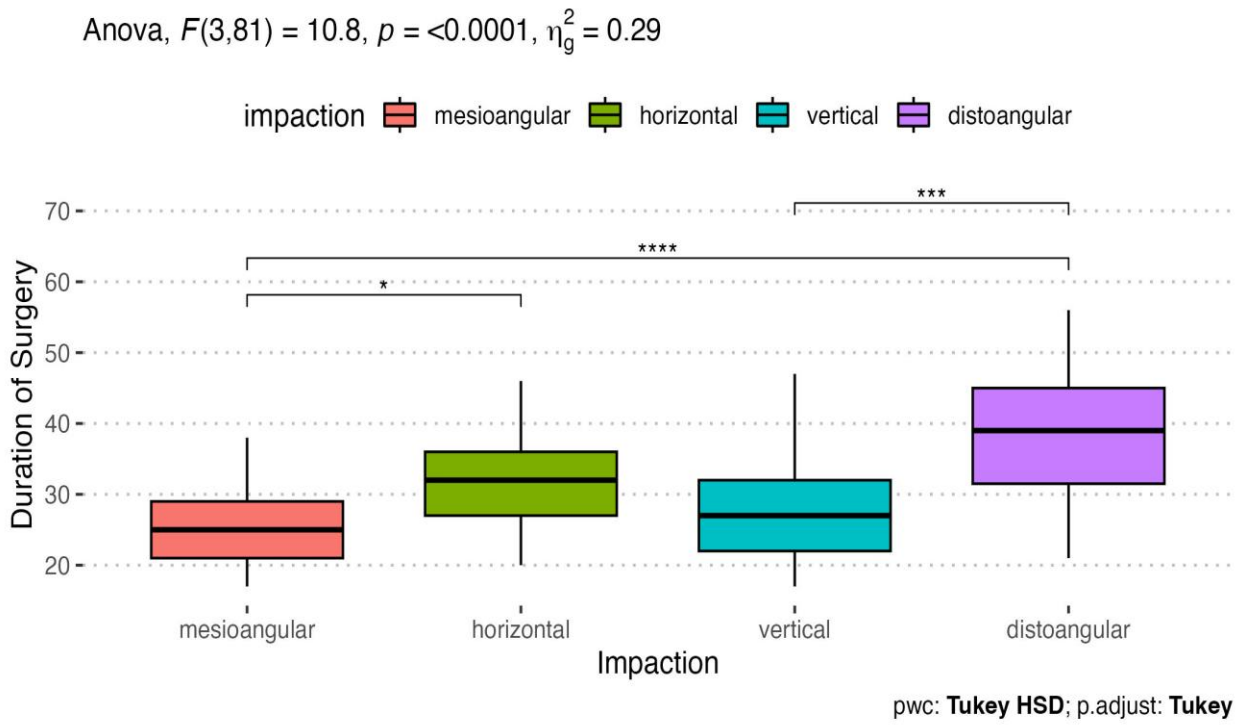

Figure 2: Mean Duration of Surgery (Minutes) Across Impaction Types

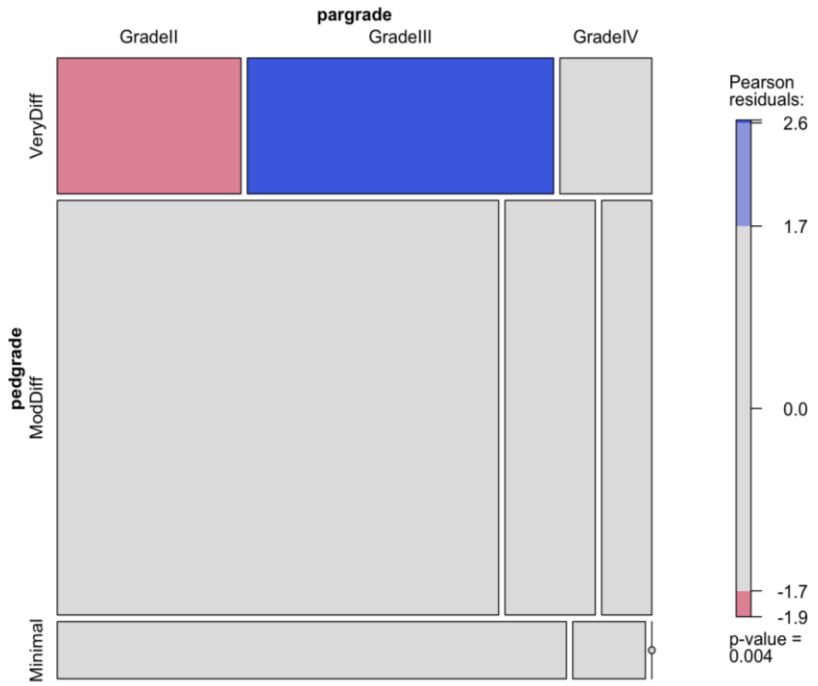

Figure 3: Mosaic Plot Showing the Association between Grades of Pederson Index and Modified Parant Index

Table 5: Sensitivity and Specificity of Pederson Difficulty Index using Modified Parant Scale as a Standard.

	Modified Parant Scale			Total
	Easy		Difficult	
	I	II	I	II
Pederson Index				
Minimaly Difficult	0	7	1	0
Moderately Difficult	0	44	9	5
Very Difficult	0	6	10	3
Total	0	57	20	8
Sensitivity	46.4%		Specificity	89.5%
Positive predictive value (PPV)	68.4%		Negative predictive Value (NPV)	77.3%

Relationship of the Pederson Difficulty Index, Duration of Surgery and Modified Parant Index

The median Pederson scores in this study is 6 (IQR =1), with distoangular impaction having the highest median score at 7 (IQR=0.75). The mean duration of surgery increases significantly (p=0.008) with the grade of Pederson difficulty with the highest mean duration at 34.8 minutes for “very difficult” grade and mean duration of 27.9 minutes for “minimally difficult” grade. Additionally, a moderate correlation was observed between Pederson's difficulty index and duration of surgery at 0.35 ($p<0.0001$, CI= 0.15 - 0.53). In tandem with the duration of surgery across Pederson grade, the mean duration of surgery is also statistically different ($p<0.001$) with the grade of modified Parant index.

There is also a moderate correlation between the modified Parant scores and Pederson index scores at 0.36 ($p<0.001$, CI = 0.16 - 0.54). The association between the Modified Parant grade and the grade of the Pederson difficulty index is statistically significant at $p=0.006$ (Figure 3).

Discussion

The pre-operative assessment of the difficulty associated with mandibular third molar extraction is a crucial step in ensuring optimal treatment planning in the management of impacted mandibular third molars. [16] Despite its routine nature, the extraction of impacted mandibular third molars can pose significant challenges, particularly when dealing with cases complicated by significant impaction depth, proximity to vital structures, and anatomical variations.[17] Pre-operative assessment is therefore important in evaluating the complexity of such extractions, facilitating appropriate treatment planning and minimizing the risk of intraoperative complications and optimizing patient outcomes.[8] Several studies[2,5,6,9-11,18-23] have attempted to develop pre-operative difficulty indices used to evaluate the difficulty of impacted mandibular third molars. The Pederson difficulty index is one of the common indices used in predicting the complexity of this procedure, taking into consideration anatomical factors such as spatial relationship, depth of impaction, and ramus relationship of the impacted tooth. However, the accuracy and reliability of this index has been a subject of debate within the oral and maxillofacial surgery community. In this cross-sectional study, we aimed to elucidate the relationship between the Pederson Difficulty Index, the duration of surgery, and the post-operative Modified Parant Scale in predicting the difficulty of mandibular third molar extraction.

The study population, predominantly comprised females (61.2%) with an age range of 18-35 years. The primary indication for surgical extraction was pericoronitis (74.1%), and periodontal pocket emerged as the most common pathology associated with the extracted teeth (62.3%). The commonest types of lower third molar impaction in this study were mesioangular and vertical impaction, each accounting for 29.4% of participants (Table 2). This is similar to the results of previous studies where Mesioangular impaction was the commonest type of impaction.[24-26] Bataineh et al[27] in Jordan and Almendros et al[28] in Saudi also reported that vertical impaction was the most common type of impaction which aligns with the results from our study. Distoangular impaction accounted for the least frequency of impaction in our study (16.5%, Table 4). This is similar to reports from other studies. [24,29]

Importantly, we observed a statistically significant increase in the mean duration of surgery with increasing Pederson difficulty grades (p=0.008). Surgical procedures categorized by Pederson as "very difficult" exhibited the highest mean duration of 34.8 minutes, compared to a mean duration of 27.9 minutes for procedures classified as "minimally difficult" grade. Furthermore, our analysis revealed a moderate positive correlation between Pederson difficulty scores and the duration of surgery, with a correlation coefficient of 0.35. This suggests that as the Pederson difficulty index increases, there is a corresponding increase in the duration of surgical procedures. The correlation coefficient of 0.35 indicates a positive moderate association with a statistical significance ($p<0.0001$) and confidence interval (CI= 0.15 - 0.53). This finding is however in contrast to reports from the study by Diniz-Freitas et al. [30] were they reported that Pederson difficulty index did

not significantly correlate with the duration of surgery (p=0.055).

Our study also demonstrates a statistically significant moderate correlation between the modified Parant scores and Pederson index scores, with a correlation coefficient of 0.36 ($p<0.001$, CI = 0.16 - 0.54). This finding suggests that there is an association between the two scales, indicating that as the difficulty level assessed by the modified Parant scale increases, there is a corresponding increase in the difficulty level assessed by the Pederson score. While the correlation coefficient of 0.36 indicates a moderate degree of association, the statistical significance and confidence interval further validate the robustness of this relationship (Figure 3).

The Pederson difficulty index demonstrates moderate predictive value in identifying difficult extractions (Table 5). Out of the 28 extractions classified as difficult by the modified Parant scale, 13 also received a difficult classification from the Pederson difficulty index. This yielded a sensitivity of 46.4%, indicating that the Pederson index successfully identified nearly half of the truly difficult cases as defined by the modified Parant scale. On the other hand, the specificity of the Pederson index was notably higher, at 89.5%. This indicates that the Pederson index accurately identified a vast majority of cases that were not difficult according to the modified Parant scale. This finding is similar to reports from the studies by Yuasa et al.[31] and Diniz-Freitas et al.[30] Yuasa et al., in their study involving 44 patients reported that Pederson's index had a sensitivity of 50% and a specificity of 92%. Diniz-Freitas et al.[30] reported that the Pederson index had a sensitivity of 23.8 % and a specificity of 76.2 % using the modified Parant scale by Garcia–Garcia et al.[12] as a standard.

In our study, the positive predictive value (PPV) of the Pederson difficulty index was found to be 68.4%, indicating that

approximately two-thirds of extractions classified as difficult by the index were truly difficult according to the modified Parant scale. Conversely, the negative predictive value (NPV) was calculated to be 77.3%, indicating that the index accurately ruled out the majority of cases that were not difficult according to the modified Parant scale. This is similar to the results from the study by Akadiri et al.[32] involving seventy-nine cases of impacted mandibular third molar where the Pederson index reported a positive predictive value (PPV) of 67.2 % and a negative predictive value of 90%. These findings suggest that while the Pederson difficulty index has some ability to predict the difficulty of mandibular third molar extractions, it may not be entirely reliable as a standalone measure. The moderate sensitivity also implies that the index may fail to identify a significant proportion of truly difficult cases, potentially leading to an underestimation of surgical complexity and increased risk of complications. However, the high specificity suggests that the index is effective in ruling out cases that are unlikely to be difficult, thereby potentially aiding in surgical planning.

In conclusion, our study highlights the critical role of pre-operative assessment in mandibular third molar extraction, emphasizing the importance of accurately predicting surgical difficulty to optimize treatment planning and patient outcomes. The Pederson Difficulty Index, despite its widespread use, remains subject to debate regarding its accuracy and reliability in predicting difficulty of surgical extraction of mandibular third molars.[30] While our study demonstrates the Pederson index's moderate predictive value, particularly in ruling out cases unlikely to be difficult, its sensitivity remains a concern. The index's ability to accurately identify truly difficult cases is limited, potentially leading to underestimation of surgical complexity and

increased risk of complications. Nonetheless, the index's high specificity suggests its effectiveness in efficiently planning surgeries by ruling out cases unlikely to pose significant challenges. The limitations of the Pederson index thus underscore the need for complementary assessment tools and careful clinical judgment. Further research and refinement of pre-operative assessment methods are warranted to enhance predictive accuracy and ultimately improve patient care in the management of impacted mandibular third molars.

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Contribution Details:

Role	
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Design.	Azuka Njokanma, Olasunkanmi Kuye
Statistical analysis.	Adetayo Aborisade, Mcking Amedari
Investigation.	Azuka Njokanma, Ada Njokanma

Manuscript writing. Azuka Njokanma,

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Editing. All authors