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Original Research Article

Reliability of two difficulty indexes in predicting the surgical extraction difficulty of impacted mandibular third molars

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Abstract – Introduction: The aim of this study was to compare the reliability and the agreement of the Pederson and Pernambuco difficulty indexes in predicting the surgical extraction difficulty of the impacted mandibular third molars. **Materials and methods:** A prospective observational cohort study was conducted on 83 patients who had undergone surgical removal of impacted mandibular third molar. The difficulty of extraction was determined preoperatively according to the total scores obtained from the Pederson and Pernambuco difficulty indexes, the operative difficulty was determined by the surgical technique and the duration of extraction. The accuracy of prediction of the surgical difficulty and the degree of agreement of the two indexes were calculated. **Results:** The accuracy of Pederson and Pernambuco indexes in predicting the operative difficulty measured by duration of surgery was 36.1% and 55.4% respectively, and with operative difficulty measured by the technique was 21.7% and 37.3% respectively with statistically significant differences. The agreement between the 2 indexes was poor. **Conclusion:** Both indexes were limited in predicting the surgical difficulty of impacted mandibular third molars although the Pernambuco index was better than the Pederson index and the agreement between the two indexes was poor.

Introduction

Impaction refers to the condition in which the tooth is prevented from reaching the normal functional position in the dental arch within the expected timeframe by bone, soft tissue, or adjacent tooth. Impacted mandibular third molars (IMTM) are frequently encountered in daily clinical dental practice [1].

Different studies have reported a varying prevalence for IMTM of 16.7% and 68.6% [2,3], and surgical removal of impacted molars is one of the most frequent procedures in the field of oral and maxillofacial surgery, it may be indicated for orthodontic purposes, caries, pericoronitis, external resorption of the adjacent tooth, or the presence of odontogenic cysts or tumors [4,5].

Extraction of IMTM may be associated with postoperative complications, such as swelling, pain, mouth opening limitation, dry socket, and inferior alveolar nerve injury, impairing the life quality of patients [6,7], therefore, sufficient preoperative analysis, treatment planning and evaluation of extraction difficulty are essential to design correct treatment strategy and to reduce the risk of complications, but having an optimal scale to predict IMTM extraction difficulty continues to challenge clinicians [8,9].

The classic Pell and Gregory classification and Winter's classification have consistently been applied, providing a simple preliminary judgment on the difficulty level of IMTM extraction [10]. The first model for assessing surgical difficulty was introduced by MacGregor, and this was followed by other indexes such as the Pederson difficulty index which uses radiographic variables for assessment and scoring based on third molar position, depth, and the relationship with the ramus [8,11].

de Carvalho and Vasconcelos in 2018 proposed a new difficulty index (Pernambuco index) which included clinical, demographic variables and radiographic variables and they validated their index by comparing it to the operative difficulty determined by technique and duration [12].

The objective of this study was to compare the reliability of the Pederson index, which uses only radiographic variables, and the Pernambuco index, which includes demographic and clinical variables along with the radiographic variables, in terms of their accuracy and agreement in predicting the surgical difficulty of extraction of IMTM.

Methods

This prospective observational cohort study included consecutive patients who underwent surgical extraction of impacted mandibular third molars under local anesthesia at the

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Table I. Pederson difficulty index [11].

Variable	Classification	Value
Position of the molar	Mesioangular	1
	Horizontal	2
	Vertical	3
	Distoangular	4
Relative depth	Class A	1
	Class B	2
	Class C	3
Relation with ramus and available space	Class 1	1
	Class 2	2
	Class 3	3
Difficulty score	**Total**	
Easy	3–4	
Moderate	5–6	
Difficult	7–10	

Table II. The Pernambuco index [12].

Variable	Classification	Value
Level of the occlusal plane (Pell and Gregory)	A	1
	B	2
	C	3
Available retromolar space (Pell and Gregory)	I	1
	II	2
	III	3
Impaction angle (Winter)	Vertical	1
	Mesioangular	2
	Horizontal	3
	Distoangular	4
Root curvature	Non-dilacerated	1
	Dilacerated	2
Number of roots	One fused root	1
	2 or more roots	2
	Tooth germ	3
Relationship to second molar	No contact	1
	Contact with crown alone	2
	Contact with root	3
Age (years)	25	1
	≥ 25	2
BMI (kg\m^2)	18.5–24.9 (ideal weight range)	1
	25 and more (overweight)	2
Surgical difficulty	**Index score**	
Low	8–12	
Moderate	12–17	
High	18–22	

Department of Oral and Maxillofacial Surgery, College of Dentistry, University of Baghdad during the period extending from December 2018 to September 2019. Patients who were medically compromised, pregnant women, patients with impacted teeth associated with acute infections, cysts or tumors, or patients with missing lower second molar on the side of surgery were excluded from this study.

The Research Ethics Committee of the College of Dentistry, University of Baghdad approved the protocol of this study (protocol # 039118) and each patient signed an informed consent to participate in the study. This study was reported following the strengthening the reporting of observational studies in epidemiology (STROBE) statement [13].

Along with clinical examination, a preoperative panoramic radiograph was obtained for all the patients. In order to determine the surgical extraction difficulty preoperatively, the criteria set forth by the Pederson index [11] (Tab. I) and the Pernambuco index [12] (Tab. II) were followed. The radiographic evaluation included the assessment of the angulation by Winter's classification, position and depth of impaction by Pell and Gregory classification, and the assessment of the root number and curvature, in addition to the evaluation of space or contact of the impacted lower third molar in relation to the mandibular second molar. The body mass index (BMI) was calculated according to the following equation: BMI = patient's weight (in kg)/patient's height (in m^2).

The degree of difficulty of the surgical extraction was determined preoperatively by an oral and maxillofacial surgeon (SYB) with more than 10 years of experience and was categorized as low, moderate, or high according to the total scores obtained by applying the criteria of the two indexes. The operator was blinded to the score of difficulty.

All the surgical extractions were performed by a single operator (MTA) with 5 years of experience. Under local anesthesia, a triangular flap was reflected and elevators were used to extract the teeth unless bone removal or tooth sectioning was needed, the duration of surgery was calculated in minutes starting from the first incision to the last suture. The operative difficulty was determined by the surgical technique and the duration of extraction [12]. With respect to the surgical technique, the degree of difficulty was considered low when the extraction was performed by elevators alone, moderate when bone removal (ostectomy) was required, and high when ostectomy and tooth sectioning was required for tooth extraction. For the duration of surgery, the difficulty was considered low when the duration of surgical extraction was less than 15 min, moderate when the duration was 15–30 min, and high when the surgery lasted more than 30 min.

The independent variables in this study were the preoperative predictions of the degree of difficulty of the surgical extraction of the IMTM using the criteria of the Pederson index and the Pernambuco index and the degree of surgical difficulty determined by the technique of surgical extraction and the duration of surgery. The dependent

Table III. The distribution of the surgical extractions according to preoperative prediction and operative difficulty.

Difficulty	Preoperative prediction/number of cases (%)		Operative difficulty/number of cases (%)	
	Pederson	Pernambuco	Technique	Duration
Low	16 (19.3%)	30 (36.1%)	25 (30.1%)	38 (45.8%)
Moderate	46 (55.4%)	53 (63.9%)	24 (28.9%)	32 (38.6%)
High	21 (25.3%)	0 (0%)	34 (41%)	13 (15.6%)
Total	83 (100%)	83 (100%)	83 (100%)	83 (100%)

Table IV. The accuracy of difficulty indexes/operative difficulty.

Difficulty index/operative difficulty by duration	Number of cases (%)		P value
	Accurate	Inaccurate	
Pernambuco	46 (55.4%)	37 (44.6%)	0.0192 [S]*
Pederson	30 (36.1%)	53 (63.9%)	
Difficulty index/operative difficulty by technique			
Pernambuco	31 (37.3%)	52 (62.7%)	0.0406 [S]*
Pederson	18 (21.7%)	65 (78.3%)	

*Fisher's exact test, [S] Significant.

(outcome) variable was the accuracy of prediction of the surgical difficulty using the two indexes which were calculated as the number of the correctly predicted cases/number of all the cases and the degree of agreement of the two indexes. Other variables included the age, gender, height, weight, and BMI of the patients, the indications of extraction, and the angulation of the impacted teeth, in addition to the positions and classes of impacted teeth according to Pell and Gregory classification.

The statistical analysis was performed using GraphPad Prism version 6 for Windows (GraphPad Software, La Jolla, CA). Descriptive statistical analysis included calculation of percentages and mean ± standard deviation (SD) and inferential analysis included Fisher's exact test and Cohen's kappa 3×3 interrater reliability test. P values of <0.05 were considered statistically significant.

Results

Eighty-three patients participated in this study. These were 56 (67.5%) females and 27 (32.5%) males. Their age range was 19–39 years, with a mean ± SD of 24.4 ± 4.8 years. The patients' height range was 150–196 cm, with a mean ± SD of 165.8 ± 10.4, and their weight range was 40–102 kg with a mean ± SD of 69.7 ± 13.7. The calculated BMI of these patients was <25 in 43 patients (51.8%) and ≥25 in 40 patients (48.2%).

The indications of extraction were chronic pericoronitis in 63 (75.8%) patients, dental caries in 10 (12.1%) and for orthodontic treatment in 10 (12.1%) patients. The distribution of the IMTMs according to angulation was as follows; mesioangular in 33 (39.7%) patients, followed by vertical ($n = 23$, 27.7%), Horizontal ($n = 15$, 18.1%) and distoangular ($n = 12$, 14.5%). According to Pell and Gregory classification, 48 (57.8%) impacted teeth were in position A and 35 (42.2%) were in position B. According to classes; most of the impacted teeth ($n = 70$, 84.3%) were classified as class II, followed by class I ($n = 9$, 10.8%) and class III ($n = 4$, 4.9%).

The distribution of the patients according to the surgical difficulty determined preoperatively by the two difficulty indexes and the operative difficulty categorization according to surgical technique and duration are summarized in Table III. The accuracy of Pederson index in predicting the operative difficulty measured by duration of surgery was 36.1% (30/83 cases) compared with 55.4% (46/83 cases) for the Pernambuco index with a statistically significant difference, whereas the accuracy of the Pederson index in predicting the operative difficulty measured by the technique was 21.7% (18/83 cases) compared with 37.3% (31/83 cases) for Pernambuco index and again with a statistically significant difference (Tab. IV). The agreement of the 2 indexes was poor with Cohen's kappa of 0.1221 (Tab. V).

Discussion

Prediction of operative difficulty before the extraction of IMTM allows a design of treatment that minimizes the risk of complications [11] but it constitutes a constant challenge for dental surgeons [14]. Many indexes have been proposed to evaluate the difficulty of extraction of IMTM, prominent among these indexes is the Pederson index which uses exclusively radiographic variables [15] unlike more recent indexes that

Table V. The agreement between the Pederson and the Pernambuco indexes.

		Pernambuco index			
		Low	Moderate	High	Total
Pederson index	Low	9	7	0	16
	Moderate	14	32	0	46
	High	7	14	0	21
	Total	30	53	0	83
Agreement		9	32	0	41
By chance		5.78	29.37	0	35.16

Cohen's kappa: 0.1221.
Poor agreement.

include demographic and clinical variables along with the radiographic variables such as the Pernambuco index [12]. This study aimed to compare the reliability of the Pederson and Pernambuco indexes and to determine the degree of agreement between them.

Generally both indexes, in this study, were limited in their accuracy of prediction of the surgical difficulty compared with the operative difficulty determined by the surgical technique and duration of surgery, however, the Pernambuco index demonstrated better results than the Pederson index in both operative difficulty determinants. We also observed that both indexes were relatively more accurate when the preoperative difficulty was compared with operative difficulty determined by the duration of surgery. Many studies determine the surgical difficulty by the duration and the technique of surgical extraction of impacted teeth [14,16,17], others add the operator's judgment as an additional indicator of difficulty [18]. Duration of surgery is used as the method of estimating the surgical difficulty in most studies [19] as it is strongly related to both pre and post-treatment assessments of difficulty and is proven to be the best measure of surgical difficulty [16].

This study is in keeping with previous studies that reported the unreliability of the Pederson index; Bali *et al.* [20] concluded, in their systematic review and meta-analysis, that the Pederson index was not reliable in assessing the difficulty of surgical extraction of IMTM, this may be related to the fact that this index considers only radiographic variables obtained from plain radiographs and does not include any clinical or demographic variables that may affect the difficulty of extraction. The use of plain radiographs has its limitations such as being two-dimensional and the overlap of structures, and they do not allow accurate prediction of IMTM extraction difficulty [21]. Cone beam computed tomography (CBCT) can provide more accurate imaging and hence better analysis of other variables that can affect the degree of difficulty of extraction, however, this is associated with higher radiation exposure and cost [8].

Many authors have investigated and introduced other variables to provide better reliability for difficulty indexes, of these were the morphology of the root [8,17], the mouth opening, tongue size, cheek flexibility, depth of point of elevation of the tooth, the angulation of the external oblique ridge [22], the bone density and the buccolingual position of the tooth [18] and the relation with the mandibular canal [8,18].

The Pernambuco index added age and BMI to the factors that may increase surgical difficulty [12], the elevated BMI is probably related to reduced cheek flexibility [22] which may reduce visibility and access to the surgical field. In a recent systematic review, overweight was identified as a patient variable that increases the difficulty of extraction of third molars [19], the authors also reported that increased patient's age increases the difficulty of extraction. The relationship between surgical difficulty and age has been linked to the increased bone density associated with older individuals and patients older than 30 years were found to have more difficult extractions [16]. The inclusion of these patient factors may account for the better reliability of the Pernambuco index in this study and the poor agreement with the Pederson index.

One limitation of this study is the small sample size which was derived from consecutive patients who attended our institution during a specified timeframe, another limitation is the level of experience of the operator which might affect the results of this study. Sánchez-Torres *et al.* [19] connected the difficulty of extraction to the experience of the surgeon but they observed that there is no threshold for classifying the experience of the operator considering that arbitrarily 10 years or more would represent a high level of experience. This study did not aim to evaluate factors other than those already present in the investigated difficulty indexes and all the procedures were performed by one operator for standardization and to reduce bias that may result from the experience of the operator.

Conclusion

Within the limitations of this study, it demonstrated that both indexes were limited in predicting the surgical extraction difficulty of IMTM although the Pernambuco index showed better accuracy than the Pederson index with poor agreement between them.

Authors' contribution

S. Bede: Conceptualization, Methodology, Supervision, and Final approval of the manuscript. M. Albayati: Data collection and analysis, Literature review, Writing the original draft.

Conflict of interest

The authors declare that they have no conflict of interest.

Informed consent

Each patient signed an informed consent form to participate in the study.

Source of funding

None.

Ethical approval

The study protocol was approved by the Research Ethics Committee of the College of Dentistry, University of Baghdad (protocol # 039118).

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