A classification for assessing surgical difficulty in the extraction of mandibular impacted third molars: Description and clinical validation

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8 authors, including:

Claudio Stacchi
University of Trieste

Federico Berton
University of Trieste

Teresa Lombardi
Studio Odontoiatrico Hesire, Cassano allo Jonio, Italy

Giuseppe Perinetti
In Private Practice, Nocciano (PE) Italy

Claudio Stacchi

A classification for assessing surgical difficulty in the extraction of mandibular impacted third molars: Description and clinical validation

Claudio Stacchi, DDS, MSc[1]/Povilas Daugela, DDS, PhD[2]/Federico Berton, DDS, MSc[3]/Teresa Lombardi, DDS[4]/Tautvydas Andriulionis, DDS[5]/Giuseppe Perinetti, DDS, MSc, PhD[6]/Roberto Di Lenarda, DDS, MSc[7]/Gintaras Juodzbalys, DDS, MSD, PhD[8]

Objective: Surgical time prediction is an important factor to plan both clinical and organizational aspects of mandibular impacted third molar extraction. Many classifications have been proposed over the years, but their accuracy in surgical time prediction remained questionable. The present study introduced a modification of Juodzbalys and Daugela (JD) classification, and had the aim to validate its effectiveness in predicting the duration of the surgery. **Method and Materials:** Three centers treated patients needing impacted mandibular third molar extraction, following inclusion and exclusion criteria. Extractions were performed following a standardized approach, and surgical time was recorded. A blinded assessor assigned scores to each extracted tooth, according to original and modified JD classifications. Differences among the operators were evaluated though Kruskal-Wallis test, and backward multiple linear regressions were performed to evaluate the variables associated with surgical time, considered as the main outcome of the study. **Results:** 124 patients were treated with mandibular third molar extraction. Mean surgical time was 24.1 ± 22.2 minutes, with significant differences among the centers ($P = .001$). Surgical times among groups derived from both former and modified JD classifications were significantly different ($P = .002$ and $P = .001$, respectively). In the multivariate analysis, the statistical model including modified JD score was more efficient than the model with former JD score in predicting surgical time ($R^2 = .204$ and $R^2 = .126$, respectively). **Conclusion:** Modified JD classification resulted in a reliable tool for predicting surgical time of impacted mandibular third molar extraction; this could represent an adjunctive tool for clinician and patient in the decision-making process. *(doi: 10.3290/j.qi.a40778)*

Key words: diagnostic procedure, extraction, oral surgery, oral surgical procedures, radiography

[1] Adjunct Professor, Department of Medical, Surgical and Health Sciences, University of Trieste, Trieste, Italy.

[2] Lecturer, Department of Oral and Maxillofacial Surgery, Lithuanian University of Health Sciences, Kaunas, Lithuania.

[3] PhD Student, Department of Medical, Surgical and Health Sciences, University of Trieste, Trieste, Italy.

[4] Private Practice, Cassano allo Ionio, Italy.

[5] Postgraduate Student, Department of Oral and Maxillofacial Surgery, Lithuanian University of Health Sciences, Kaunas, Lithuania.

[6] Research Fellow, Department of Medical, Surgical and Health Sciences, University of Trieste, Trieste, Italy.

[7] Full Professor, Department of Medical, Surgical and Health Sciences, University of Trieste, Trieste, Italy.

[8] Full Professor, Department of Oral and Maxillofacial Surgery, Lithuanian University of Health Sciences, Kaunas, Lithuania.

Correspondence: Dr Claudio Stacchi, Corso Italia 121, 34170 Gorizia, Italy. Email: claudio@stacchi.it

The mandibular third molar is the most frequently impacted tooth,[1] with a worldwide prevalence varying from 16% to 73% of young adults.[2-5] Third molar extraction is therefore one of the most common procedures in oral surgery. In relatively rare cases, the third molar may present an ectopic localization, usually due to a dentigerous cyst driving the tooth in a non-physiologic area or for unknown reasons.[6,7] Indications for impacted and partially impacted third molar extraction include caries, recurrent pericoronitis or infections, periodontal defects involving the distal root of second molars, odontogenic cysts, and dental crowding.[8] According to the recommendations of the National Institutes of Health (NIH), both impacted and partially erupted mandibular third molars with evidence of enlargement of the follicular space should be removed and the associated soft tissue should be harvested for histologic examination.[9] A more recent position paper of the American Association of Oral and Maxillofacial Surgeons[10] stated that also disease-free patients with mandibular third molars should be monitored. Furthermore, accordingly to scientific evidence, a decision on the extraction should be taken before 25 years of age, because younger patients were found to have a lower risk of an extended operation time than older patients.[11]

Assessment of the surgical complexity of third molar extraction is a crucial step to formulate an optimal treatment plan, balancing advantages and disadvantages of the surgical procedure. An accurate evaluation is also essential to plan a proper surgical intervention, in order to minimize and manage intraoperative complications and postoperative pain and swelling,[12] or to refer cases of impacted third molars to other specialists. Moreover, the patient should be provided with an accurate and reliable prediction about surgical complexity and risks of complications, in order to obtain a solid informed consent to the intervention. Finally, reliable prediction of the surgical time is an important factor to optimize the daily schedule both for operators and patients.

Various classifications for impacted third molar surgery have been proposed to predict the surgical complexity and/or the risk of intraoperative complications. Most of them are based on radiologic parameters (those of Winter,[13] Pell and Gregory,[14] Pederson,[15] WHARFE,[16] and Maglione et al[17]), whereas a recent interesting proposal by Mozzati et al[18] considered a combination of radiologic, anatomical, and systemic factors. The effectiveness and clinical utility of these classifications have been discussed; prospective studies demonstrated that some of these scales are almost useless for predicting a difficult extraction, showing no significant association between classification score and surgical time.[19,20]

In 2013, Juodzbalys and Daugela[21] (JD) proposed a comprehensive classification stratified by tooth impaction and other clinical items, in order to generate a global score expressing the general grade of surgical complexity. The present study introduces a modification of JD classification, with a different scoring interpretation, in order to provide a reliable tool for predicting surgical complexity of impacted mandibular third molar surgery. The aim of this prospective study was to validate the present classification by evaluating its effectiveness in predicting surgical difficulty of impacted mandibular third molar extraction, by comparing it with former JD classification.

METHOD AND MATERIALS

This prospective multicenter study was conducted in accordance with the recommendations of the Declaration of Helsinki as revised in Fortaleza, Brazil (2013), for investigations with human subjects. The study protocol had been approved by the relevant Ethical Committees (Lithuanian University of Health Sciences Bioethics Centre, Lithuania, code BEC-OF-367; C.E.R.U. Regione Friuli Venezia Giulia, Italy, code 62/2015) and registered in ClinicalTrials.gov (NCT02519426). Patients were thoroughly informed about the study protocol, the treatment, its alternatives, benefits, and possible risks, and signed written informed consent for the participation in the study was obtained.

Patients were enrolled and treated in three centers: the Hospital of Lithuanian University of Health Sciences Kaunas Clinics (Lithuania), a private practice in Cassano allo Ionio (Italy), and Trieste University Hospital (Italy).

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Table 1 Juodzbalys and Daugela classification[21]

	Position of the mandibular third molar	Risk degree of presumptive intervention (score)			
		Conventional (0)	Simple (1)	Moderate (2)	Complicated (3)
Mesiodistal position in relation to the second molar (M) and the mandibular ramus (R)	Relation to the second molar (M)	Crown directed at or above the equator of the second molar	Crown directed below the equator to the coronal third of the second molar root	Crown/roots directed to the middle third of the second molar root	Crown/roots directed to the apical third of the second molar root
	Relation to the mandibular ramus (R)	Sufficient space in the dental arch	Partially impacted in the ramus	Completely impacted in the ramus	Completely impacted in the ramus in distoangular or horizontal position
Apicocoronal position in relation to the alveolar crest (A) and the mandibular canal (C) (IAN injury risk)	Relation to the adjacent alveolar crest (from the uppermost point of the tooth) (A)	Tooth is completely erupted	Partially impacted, but widest part of the crown (equator) is above the bone	Partially impacted, but widest part of the crown (equator) is below the bone	Completely encased in the bone
	Relation to the mandibular canal (from the lowermost point of the tooth) (C)	≥ 3 mm to the mandibular canal	Contacting or penetrating the mandibular canal, wall of the mandibular canal may be identified	Contacting or penetrating the mandibular canal, wall of the mandibular canal may be unidentified	Roots surrounding the mandibular canal
Buccolingual position in relation to the mandibular lingual and buccal walls (B) (LN injury risk)	Relation to mandibular lingual and buccal walls (B)	Closer to buccal wall	In the middle between lingual and buccal walls	Closer to lingual wall	Closer to lingual wall, when the tooth is partially impacted or completely encased in the bone (A2 or A3)
Spatial position (S)	Spatial position (S)	Vertical (90 degrees)	Mesioangular ≤ 60 degrees	Distoangular ≥ 120 degrees	Horizontal (0 degrees) or inverted (270 degrees)

IAN, inferior alveolar nerve; LN, lingual nerve.

Inclusion criteria were the following: any healthy patient (≤ 2, according to American Society of Anesthesiology [ASA] score) with age ≥ 18 years, with indications for mandibular impacted third molar extraction and with the tooth showing complete roots formation by cone beam computed tomography (CBCT) and/or panoramic radiograph.

Exclusion criteria were the following: heavy smoking (> 10 cigarettes/day); presence of neoplastic lesions (benign or malignant) in contiguity with the impacted tooth; presence of radiolucent lesions with a diameter > 1 cm at the impacted tooth level; presence of acute inflammation and/or infection in the area of interest; absence of the second molar; systemic conditions potentially altering oral microbiota and/or immunologic system and/or inflammatory response (eg, Crohn syndrome, leukemia); pharmacologic treatments altering oral microbiota and/or immunologic response (eg, corticosteroids); head and neck radiotherapy or chemotherapy in the last 24 months; patient already participating in this study with the contralateral mandibular third molar.

Surgical procedures

Surgical procedures were performed following a standardized approach[22] by one expert surgeon in each center (PD-TL-FB). Systemic antibiotic prophylaxis (amoxicillin 2 g or clarithromycin 500 mg in allergic patients) was administered 1 hour prior to surgery[23]

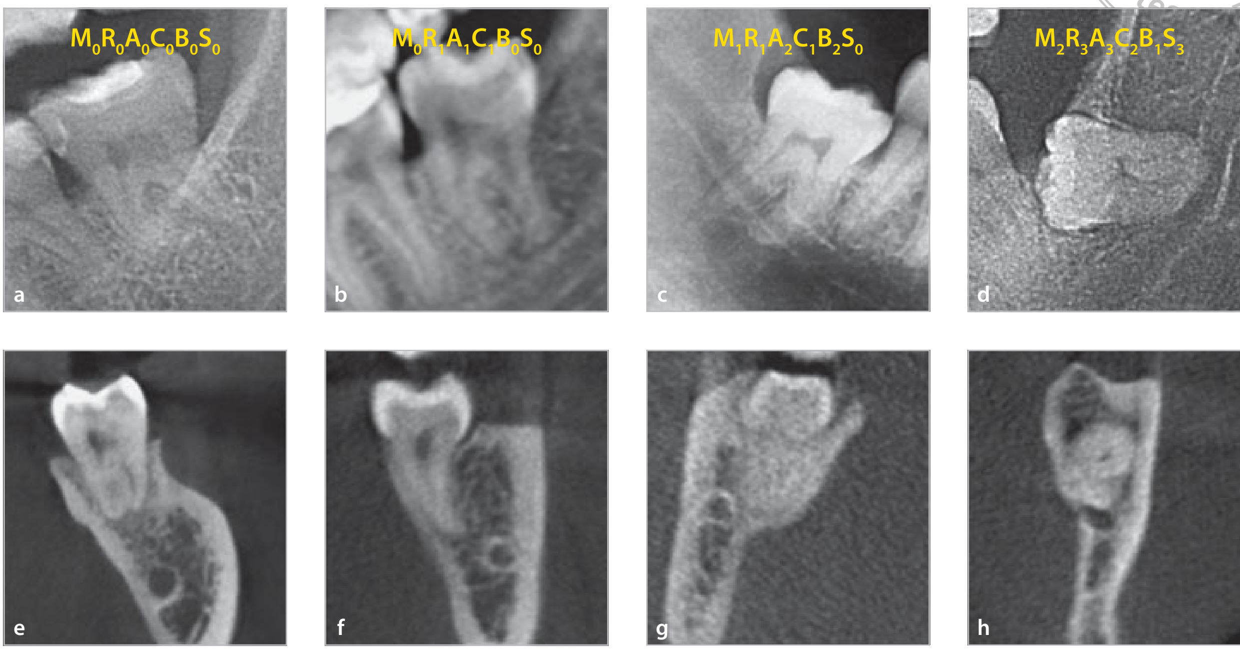

Fig 1 Two-dimensional *(a to d)* and three-dimensional *(e to h)* images, predicting various extraction difficulty scores.

together with local antisepsis immediately before surgery (chlorhexidine 0.2% 1-minute rinse). Surgical time from flap incision to the complete tooth removal was recorded (excluding sutures), together with the technical variables of each intervention (flap design, ostectomy, coronectomy, roots separation) and possible intraoperative complications (eg, apex fracture, profuse bleeding). Patients were prescribed with nonsteroidal anti-inflammatory drugs (NSAIDs) and antiseptics (ibuprofen 600 mg when needed and 0.12% chlorhexidine 1-minute rinse twice a day) and postoperative recommendations. Sutures were removed after 7 days and eventual postoperative complications were recorded. An expert surgeon (CS) performed a postoperative blinded assessment of CBCTs and panoramic radiographs, and assigned scores to each extracted tooth, according to Winter,[13] Pell and Gregory,[14] and JD classifications.[21]

Modification of the Juodzbalys & Daugela classification

Modification of JD classification[21] consists in a different interpretation of the final score, in order to predict surgical difficulty and surgical time. Indexes and their evaluation remained unaltered. Briefly, the impacted mandibular third molar is evaluated by considering its relationships with adjacent anatomical boundaries (second molar, mandibular ramus, alveolar crest, mandibular canal, corticals of the mandible) and its spatial position.

The classification attributes a score from ranging from 0 to 3 (0 = conventional; 1 = simple; 2 = moderate; 3 = complicated) to six items (M, R, A, C, B, S), according to the tooth position (according to FDI notation; Table 1 and Fig 1).

Surgical difficulty and surgical time can be predicted from the total score of the evaluated tooth (range from 0 to 18 points). Total score is divided into three classes: class I (from 0 to 6 points – simple), class II (from 7 to 12 points – moderate) and class III (from 13 to 18 points – complicated).

Sample size calculation

The sample size was calculated by considering the duration of the procedure as the main parameter to evaluate surgical difficulty. Surgical time from a prelim-

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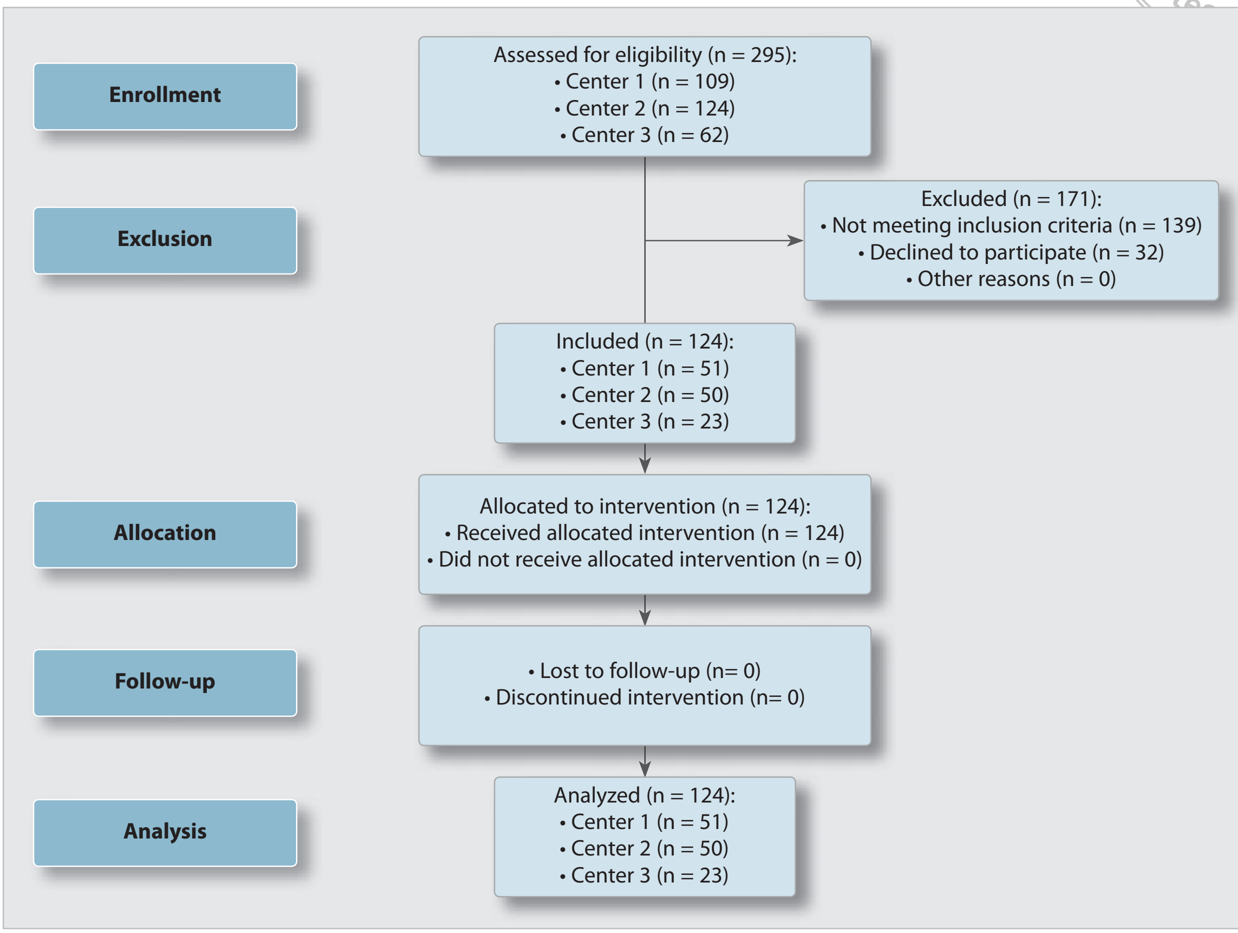

Fig 2 Selection process of patients participating in this study.

inary pool of 25 patients was evaluated, by dividing them into two groups according to modified JD score ($x \leq 9 < y$). A sample size of 52 subjects per group was calculated to be necessary to detect a mean difference of 10 minutes in the surgical time between the two groups, with an expected standard deviation (SD) of 18 minutes. Power was set at 80% and alpha at .05.

Statistical analysis

When dealing with continuous data, normality of the datasets and the equality of variance among them were evaluated by the Shapiro-Wilk test and Levene test, respectively. Nonparametric tests where used when necessary. The significance of the difference in age between genders was evaluated though an independent sample *t* test. The significance of the differences in the surgical time among the operators, or the categories of the different score system calculations was evaluated though a Kruskal-Wallis test.

Backward multiple linear regressions were performed to evaluate the variables associated with surgical time considered as the main outcome (dependent variable): original JD classification scores (as the greatest item score, defined as the individual single score among the ones corresponding to the six items) and modified JD classification scores (as the clustered sum of the item scores, defined as the individual sum of the six items and clustered as 1 [0 to 6 points], 2 [7 to 12 points], and 3 [13-18 points]) were separately tested in subsequent multivariate analysis. In particular, two dif-

Table 2 Preoperative indications of surgical intervention

Indication	No. of patients
Prophylactic	61
Orthodontic	7
Chronic infection	38
Periodontal	12
Endodontic	6
Total	124

Table 3 Distribution of postoperative complications in the different centers

Center	No. of patients	Postoperative complications
1	50	5
2	51	0
3	23	2
Total	124	7

Table 4 Distribution of the surgical time in the different centers

		Time (minutes)	
Center	No. of patients	Mean ± SD	Min–Max
1	50	28.6 ± 20.6	2.0–120.0
2	51	18.7 ± 20.7	1.0–120.0
3	23	26.4 ± 26.9	1.0–98.0
Total	124	24.1 ± 22.2	1.0–120.0

Min-Max, minimum and maximum surgical time.
Significant differences were seen between the centers (Kruskal-Wallis test; *P* = .001).

ferent models were run entering the following independent variables: age, gender, Center 1, and Center 3 (entered as dummy variables, thus having Center 2 as reference category). The cut-off levels of significance used were .05 and .10 for entry and removal, respectively. Although the surgical time had a skewed distribution, parametric methods were used, since the central limit theorem ensures that sample means are normally distributed for large samples (ie, above 100 units).

SPSS software (IBM) was used to perform the data analysis. A *P* value < .05 was considered as being statistically significant.

RESULTS

One hundred and twenty-four patients, 61 males (mean age 30.5 ± 10.7 years) and 63 females (mean age 27.5 ± 11.3 years), were enrolled and treated from October 2015 to April 2016 by Center 1 (n = 50), Center 2 (n = 51), and Center 3 (n = 23). A flow chart diagram summarizing the patient selection process is presented in Fig 2. Indications for tooth extraction and postoperative complications are listed in Tables 2 and 3, respectively. All patients recovered from postoperative complications without any sequelae in 1 to 3 months. Mean surgical time was 24.1 ± 22.2 minutes (range 1.0 to 120.0 minutes), with significant differences among the centers (Kruskal-Wallis test; *P* = .001). Complete results are listed in Table 4.

According to the original JD classification,[21] the present sample presented three teeth with score 0, 30 teeth with score 1, 66 teeth showing score 2, and 25 teeth classified as score 3. Difference in surgical time among these four groups was evaluated by Kruskal-Wallis test and was statistically significant (*P* = .002). Complete results are reported in Table 5.

According to the modified JD classification, 66 teeth were classified as class I, 53 to class II, and 5 to class III (with increasing surgical difficulty). Surgical time showed statistically significant differences among the three classes (Kruskal-Wallis test, *P* = .001). Detailed results are listed in Table 6.

Detailed information regarding the backward multiple regression models are reported in Table 7. The statistical model including modified JD classification score was more efficient than the model with original JD score in predicting surgical time (R^2 = .204 and R^2 = .126, respectively).

DISCUSSION

Factors influencing the surgical complexity of impacted mandibular third molar extraction can be divided into

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Table 5 Surgical time distribution according to Juodzbalys and Daugela classification (N = 124)[21]

	Score				
	0 (n = 3)	1 (n = 30)	2 (n = 66)	3 (n = 25)	Diff.
Time (minutes, mean ± SD)	20.0 ± 8.7	13.1 ± 11.1	26.0 ± 23.4	32.8 ± 25.5	.002*

Diff, significance of the difference in surgical time among the different groups.
*Statistically significant (Kruskal-Wallis test) ($P < .05$).

Table 6 Surgical time distribution according to modified Juodzbalys and Daugela classification (N = 124)

	Class			
	I (0–6) (n = 66)	II (7–12) (n = 53)	III (13–18) (n = 5)	Diff.
Time (minutes, mean ± SD)	15.4 ± 16.0	33.4 ± 24.8	40.8 ± 17.7	.001*

Diff, significance of the difference among the different clusters.
*Statistically significant (Kruskal-Wallis test) ($P < .05$).

Table 7 Results of the multiple backward linear regression analysis for estimates of association of surgical time with the different explanatory variables (N = 124)

	Model, explanatory variable(s)	β (SE)	*t*	Significance
Model 1, Juodzbalys and Daugela score; $R^2 = .126$	JD classification score	9.598 (2.608)	3.680	.001*
	Center 1	9.664 (3.880)	2.491	.014*
Model 2, Modified Juodzbalys and Daugela score; $R^2 = .204$	Modified JD classification score	16.150 (3.125)	5.169	.001*
	Center 1	7.771 (3.662)	2.122	.036*

All the models included age, gender, and Center 1 and Center 3 (entered as dummy variables) as explanatory variables. SE, standard error of the β coefficient.
*Statistically significant ($P < .05$).

three main groups: factors related to tooth shape and position, operative variables (surgical technique and operator experience), and demographic variables (age, gender, ethnicity, body mass index).[24]

Tooth shape and position have been regarded for many years as the main parameters to be evaluated in presurgical planning: Winter (1926)[13] and Pell and Gregory (1933)[14] are still the most widespread classifications used to define the grade of inclusion of mandibular third molars on panoramic radiographs. These well-known classifications are useful tools to identify the pathway of inclusion, to communicate with colleagues, and to outline inclusion criteria in scientific studies, but they do not provide any stratification of surgical complexity, correlated with the clinical reality. Numerous studies tried to match Pell and Gregory, Winter, and Pederson scales with different clinical aspects of the extraction of the impacted mandibular third molar,[19,20,25] such as surgical time or intraoperative complications, but results remained questionable. In this regard, Garcia et al[19] and Diniz-Freitas et al[20] reported the inadequacy of these classifications in predicting the duration of the intervention.

Juodzbalys and Daugela[21] recently proposed a classification based on anatomical and radiologic features, with potential direct clinical implications in terms of prediction of surgical difficulty, which needed a clinical validation to be introduced in daily clinical routine. This classification is divided into three parts: the first considers the relations with the second molar and the mandibular ramus; the second considers the relations with the alveolar crest and the mandibular canal; the third with the mandibular cortical walls and the general spatial position. These three groups define the amount of ostectomy that will be necessary during surgery, the risk of damage to the inferior alveolar nerve and lingual nerve, and the spatial position, respectively. It is interesting to note that the assessment of tooth impaction is evaluated from the alveolar crest, because the surgical difficulty is mainly determined by the depth of impaction into the bone and, eventually, in the ramus. Nevertheless, the occlusal plane of the second molar has been considered for years as a landmark by previous classifications.[14,19]

The classification proposed in the present study is a modification of JD scale: the single items to be presurgically evaluated and recorded remained unaltered, but the final interpretation of the score was different. In the present study, the duration of intervention was considered as the primary outcome and indication of surgical complexity, as previously reported.[26] For this purpose, the operative time from flap incision to the complete removal of the tooth was recorded.

Former and modified JD classifications were demonstrated to be significantly predictive of the duration of the intervention. However, the results of the multivariate analysis showed that modified classification was the most effective tool in predicting the influence of tooth shape and position on surgical time among the other confounding factors related to the specific surgical procedure. Relatively low R^2 values obtained from the multiple regression models for both the classification scores (Table 7) suggest that other factors (eg, operative variables, demographic variables, patient compliance) may also be involved in the determination of the surgical time. In this regard, more investigations are warranted.

A reliable preoperative risk assessment of possible injury to the inferior alveolar and lingual nerves is the other important objective that should be achieved by a classification for clinical use.

Rood and Shehab[27] identified several radiographic indicators of high risk position of the tooth in relation with the mandibular canal, and recent studies demonstrated that the most important parameters for neurologic involvement prediction are third molar root apices inside or in contact with the mandibular canal[28] and the absence of cortication around it.[29]

Both former and modified JD classifications have specific items to evaluate the risk of injury of both inferior alveolar and lingual nerves. However, in the present study it was not possible to perform any statistical evaluation of this specific issue due to the low number of cases with neurologic complications. Further investigations with an adequate number of patients are needed to answer this question.

CONCLUSION

The findings of the present study showed that modified JD classification is a reliable tool for predicting surgical time of impacted mandibular third molar extraction; this could be an adjunctive tool for the clinician and the patient in the decision-making process. Furthermore, a more precise surgical time prediction could help to manage more efficient daily planning both in hospital departments and in dental offices. In cases needing conscious sedation or general anesthesia in particular, reliable time prediction could help in minimizing the use of sedative drugs and related complications, together with human and economic resources. The educational role of this classification could be exploited mainly in university hospitals; it could be possible to balance operative difficulties with the skills of the surgeon in training, by grading the surgical procedure. Finally, future scientific works on impacted mandibular tooth extraction could benefit from this classification to stratify surgical difficulty in order to standardize the recorded data, analyzing them in a more consistent and predictable way.

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