



Which factors are associated with difficult surgical extraction of impacted lower third molars?

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Abstract (J Korean Assoc Oral Maxillofac Surg 2016;42:251-258)

Objectives: The aim of this retrospective study was to investigate factors associated with increased difficulty in the surgical extraction of impacted lower third molars and to improve identification of difficult cases.

Materials and Methods: A total of 680 patients who required 762 surgical extractions of impacted lower third molars from 2009 to 2014 were enrolled in the study. Demographic factors, clinical factors, radiographic factors, surgical extraction difficulty, and presumed causes of difficulty were collected. Data were statistically analyzed using IBM SPSS Statistics version 23.

Results: Age, sex, depth of impaction, and blurred radiographic image influenced difficulty in surgical extraction. The position of the impacted tooth influenced surgical difficulty, especially when it was accompanied by other factors.

Conclusion: It is challenging to design a reliable and practical instrument to predict difficulty in surgical extraction of impacted lower third molars. To identify very difficult cases, root investigation using computed tomography is advised when impacted tooth position suggests difficult extraction.

Key words: Third molar, Mandible, Impaction, Tooth extraction, Difficulty

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I. Introduction

Surgical extraction of an impacted mandibular third molar is common, and an impacted third molar is one of the most investigated topics in oral and maxillofacial surgery. Extraction in these cases can result in sequelae and complications including pain, swelling, infection, and nerve injury, because the procedure requires incision, bone removal, tooth separation, and closure¹. The procedure can be difficult for the patient and challenging for the surgeon if proper evaluation of the impacted tooth is not performed before extraction. It is essential to thoroughly evaluate extraction difficulty and to fully inform the patient of the potential challenges.

Several methods have been proposed for preoperative eval-

uation of difficulty in surgical extraction. The Pell-Gregory classification² was reported in 1933 and has been widely cited in oral and maxillofacial surgery articles. The classification establishes nine groups of impacted lower third molars using level of impaction and ramal relationship but does not consider angulation of impacted teeth as included in the Pederson scale, another prominent measure. The usefulness of Pell-Gregory classification has been questioned, and García et al.² maintained that the classification is not reliable for extraction difficulty prediction, even in vertical impaction.

Winter's classification³, another system of impacted lower third molar classification, sorts impacted lower molars according to axis angulation as mesioangular, vertical, horizontal, and distoangular impactions. The Pederson index predicts surgical extraction difficulty using both Pell-Gregory classification and Winter's classification. Unlike Pell-Gregory classification, the Pederson index⁴ includes angulation factor, although some studies and analyses have concluded that it is not a reliable test for predicting surgical difficulty of third molar surgery and should not be employed as a sole instrument for preoperative assessment of difficulty^{4,6}.

Because these prediction methods consider only the position of teeth in radiographs and exclude factors of age, body

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Table 1. The Pell-Gregory classification

Level A	The occlusal plane of the third molar is as high as that of the second molar.
Level B	The occlusal plane of the third tooth is below the occlusal plane and above the cervical line of the second molar.
Level C	The occlusal plane of the third molar is below the cervical line of the second molar.
Class 1	The space between the ramus and the second molar is larger than the mesiodistal diameter of the second molar.
Class 2	The space between the ramus and the second molar is smaller than the mesiodistal diameter of the third molar.
Class 3	There is no space between the ramus and the second molar.

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mass index (BMI), root morphology, bone quality, and proximity to mandibular canal, which affect surgical extraction difficulty, surgeons can experience difficulties outside of the classifications and index system.

In this study, level of difficulty, presumed causes of difficulty, demographic factors, clinical factors, and radiographic findings were assessed, compared, and analyzed in order to identify very difficult surgical extraction cases.

II. Materials and Methods

1. Materials

The objects were impacted mandibular third molars that were extracted from 2009 to 2014 in the Department of Dentistry at Kosin University Gospel Hospital (Busan, Korea).

The patient number list was obtained using KCD (Korean Standard Classification of Disease) code. The cases without panoramic images were excluded. The medical records of each case were reviewed. If the record reported ‘uneventful,’ ‘easy,’ ‘not difficult,’ or nothing about difficulty, the case was assigned to the ‘not difficult group.’ If the medical record said ‘a little difficult,’ ‘somewhat difficult,’ or ‘moderately difficult,’ the case was sorted into the ‘moderately difficult group.’ If the case was noted as ‘very difficult’ or ‘extremely difficult,’ it was classified into the ‘very difficult group.’ The cases whose medical records included nothing about the causes of extraction difficulty were excluded.

This retrospective study included 680 patients and 762 impacted mandibular third molars, which were extracted by two oral and maxillofacial surgeons and three general dentists.

This study protocol was approved by the Institutional Review Board of Kosin University Gospel Hospital (KUGH-2015-10-023).

2. Methods

1) Variables

Panoramic images and clinical records were assessed by

Table 2. Pederson index

Classification		Value
Angulation	Mesioangular	1
	Horizontal/transverse	2
	Vertical	3
	Distoangular	4
Depth	Level A	1
	Level B	2
	Level C	3
Ramal relationship	Class 1	1
	Class 2	2
	Class 3	3

Levels A, B, C and Classes 1, 2, 3 have the same respective meanings in the Pell-Gregory classification. Minimally difficult: 3-4, moderately difficult: 5-6, very difficult: 7-10.

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one oral and maxillofacial surgeon. Demographic data of age, sex, and tooth position and operator characteristics (specialist or general dentist) were extracted from clinical records.

The level of extraction difficulty was investigated based on the operator’s subjective grade on a five-point difficulty scale, and the cases were classified into 3 groups, ‘not difficult’ (1-3), ‘moderately difficult’ (4), and ‘very difficult’ (5).

The presumed causes of difficulty were depth of impaction, relation to the second molar, relation to the mandibular canal, angulation, large and/or bulbous root, widely divergent roots, and ankylosis. Bulbous root⁷ refers to a complete root that is thicker in the middle than in the neck and does not separate. If the periodontal ligament space was too narrow to use sharp instruments like explorer and root tip picker, the tooth was regarded as ankylosed.

Using panoramic views, image haziness, relation to the mandibular canal, Pell-Gregory classification (Table 1), Winter’s classification, and Pederson index (Table 2) were evaluated. If the radiographic image did not exhibit well-defined roots and periodontal ligament space that appeared to fade or blend into bone, the image was regarded as blurred.

2) Data analysis and statistics

Data were statistically analyzed using IBM SPSS Statistics version 23 for Windows (IBM Co., Armonk, NY, USA), and

Table 3. Distributions of age, position, and sex

Position		Age (yr)						Total	
		10-19	20-29	30-39	40-49	50-59	60-69		70-79
Right (n=341)	Male	21	95	42	20	8	2	0	188
	Female	38	75	24	11	5	0	0	153
Left (n=421)	Male	25	120	52	22	6	1	1	227
	Female	33	119	28	8	4	2	0	194
Total (n=762)	Male	46	215	94	42	14	3	1	415
	Female	71	194	52	19	9	2	0	347

Values are presented as number of patients.

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Table 4. Distribution of difficulties by operator

Doctor	Difficulty			Total	P-value
	Not	Moderately	Very		
A	263 (68.7)	66 (17.2)	54 (14.1)	383	0.000
B	25 (100.0)	0	0	25	
C	100 (83.3)	4 (3.3)	16 (13.3)	120	
D	141 (63.8)	54 (24.4)	26 (11.8)	221	
E	13 (100.0)	0	0	13	

Values are presented as number (%) or total number.

Doctors A and B: specialists, Doctors C, D, and E: general practitioners.

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the *P*-value to indicate significance was set at 0.05. Associations among demographic data (sex, age, and tooth location), operator characteristics, level of extraction difficulty, presumed causes of difficulty, and radiographic findings were assessed through the chi-square test. Differences in means among groups according to presumed difficulty cause were tested through independent t-test or ANOVA.

III. Results

The demographic data are shown in Table 3.

Among 762 extractions, 542 were not difficult (71.1%), 124 were moderately difficult (16.3%), and 96 were very difficult (12.6%). The distribution of difficulties by operators is shown in Table 4, and the proportion of difficulty groups was different among operators ($P=0.000$).

Presumed causes of difficult extraction in order of frequency were large and/or bulbous root, root curvature, and ankylosis. There were 103 position-related causes and 200 root-related causes. The average number of causes in moderately-difficult cases was 1.34, while that of very-difficult cases was 1.69.(Table 5)

Using Pell-Gregory classification, B2 had the highest frequency and relatively high probability of difficult extraction.

Table 5. The prevalence of presumed causes of difficult extraction

Cause	Difficulty		Total
	Moderately	Very	
Depth	19 (15.3)	18 (18.8)	37 (16.9)
Close to second molar	10 (8.1)	16 (16.7)	26 (11.8)
Mandibular canal	13 (10.5)	19 (19.8)	32 (14.5)
Inclination	4 (3.2)	4 (4.2)	8 (3.6)
Large, bulbous root	34 (27.4)	43 (44.8)	77 (35.0)
Curvature of root	44 (35.5)	16 (16.7)	60 (27.3)
Divergent roots	6 (4.8)	3 (3.1)	9 (4.1)
Ankylosis	25 (20.2)	29 (30.2)	54 (24.5)
Other	11 (8.9)	14 (14.6)	25 (11.4)
Teeth	124	96	220

Values are presented as number (%) or total number.

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Using Winter's classification, horizontal impaction was the most difficult and showed the largest frequency of difficult extractions.(Table 6)

With regard to demographic factors, it was easier to extract impacted lower third molars in younger patients and in women than in older patients and men ($P=0.000$). However, tooth position (right or left) was not associated with extraction difficulty ($P=0.186$).(Table 7)

Whether or not the operator was a specialist did not influence difficulty ($P=0.851$).(Table 7) But the teeth that specialists extracted had higher Pederson index ($P=0.041$) and more presumed causes of difficult extraction ($P=0.000$).(Table 8)

On radiographic findings, teeth that had blurred image haziness ($P=0.000$) or lower level of impaction ($P=0.016$) were statistically associated with more difficult extraction. Relationship to mandibular canal ($P=0.768$), ramal relationship ($P=0.393$), Winter's classification ($P=0.114$), and Pederson index ($P=0.066$) were not associated with difficulty.(Table 7)

Table 6. Pell-Gregory classification, Winter's classification, Pederson index, and extraction difficulty

		Difficulty			Total
		Not	Moderately	Very	
PG	A1	153 (72.9)	35 (16.7)	22 (10.5)	210
	A2	180 (73.2)	41 (16.7)	25 (10.2)	246
	A3	2 (40.0)	1 (20.0)	2 (40.0)	5
	B1	62 (81.6)	6 (7.9)	8 (10.5)	76
	B2	120 (66.3)	35 (19.3)	26 (14.4)	181
	B3	2 (66.7)	0 (0.0)	1 (33.3)	3
	C1	8 (50.0)	3 (18.8)	5 (31.3)	16
	C2	12 (54.5)	3 (13.6)	7 (31.8)	22
	C3	3 (100.0)	0 (0.0)	0 (0.0)	3
W	Mesioangular	239 (72.2)	57 (17.2)	35 (10.6)	331
	Vertical	114 (79.7)	17 (11.9)	12 (8.4)	143
	Horizontal	173 (65.3)	47 (17.7)	45 (17.0)	265
	Distoangular	9 (69.2)	2 (15.4)	2 (15.4)	13
	Others	7 (70.0)	1 (10.0)	2 (20.0)	10
PI	3	95 (72.5)	25 (19.1)	11 (8.4)	131
	4	140 (77.3)	22 (12.2)	19 (10.5)	181
	5	146 (67.9)	42 (19.5)	27 (12.6)	215
	6	109 (68.1)	26 (16.3)	25 (15.6)	160
	7	42 (67.7)	9 (14.5)	11 (17.7)	62
	8	7 (77.8)	0 (0.0)	2 (22.2)	9
	9	1 (50.0)	0 (0.0)	1 (50.0)	2
	10	2 (100.0)	0 (0.0)	0 (0.0)	2

(PG: Pell-Gregory classification, W: Winter's classification, PI: Pederson index)

Values are presented as number (%) or total number.

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IV. Discussion

Most research on the difficulty of surgical extraction of impacted mandibular third molars has included demographic, clinical, and anatomical factors, with various results reported.

Among the demographic factors evaluated in this study, it was easier to extract impacted lower third molars in younger patients. Patient age has a demonstrated effect on the difficulty reported by operators, in agreement with previous studies⁸⁻¹¹. The relevance of age to difficulty is likely attributable to the fact that it is easiest to surgically extract impacted lower third molar with roots formed from 1/3 to 2/3, and bone hardness and ankylosis increase with age.

In this study, operators experienced more difficulty when they extracted the impacted mandibular third molars of men than of women. This coincides with the results of other research that found that sex influences extraction difficulty^{9,12}. The large sizes of the crown and roots of men's third molars might explain the difference.

Whether or not the operator was a specialist did not make a difference in difficulty. However, in third molars that were extracted by specialists, the averages of Pederson index and number of presumed causes of difficult extraction were higher than in those of general practitioners. This might be

the result of referring difficult cases to specialists. If this had been a randomized trial, the results could have been different.

For general practitioners, there was no difference in Pederson index among 3 difficulty groups; however, this index increased according to difficulty for specialists. The average of number of presumed causes of difficult extraction in the moderately difficult group was almost equal to that of very difficult group in general practitioners. However, in specialists, this average increased markedly from 1.52 to 2.19 in the very difficult group. These findings indicate that the anatomic condition of an impacted tooth does not influence the difficulty experienced by general practitioners, but does affect that of specialists. Inexperience rather than anatomy might be the main cause of difficult extraction for general practitioners.

After extraction, the operator judged the level of difficulty and the likely causes of the difficulty in extraction. The frequency order of causes was large and/or bulbous root, root curvature, and ankylosis, all of which are related to roots. Because root-related causes were twice as numerous as position-related causes, it seems clear that classification methods of impacted lower third molars and difficulty predicting indices that only consider position will not be reliable.

In the very difficult group, the number of root curvatures

Table 7. The relationships between extraction difficulty and demographic and radiographic variables

		Difficulty			P-value
		Not	Moderately	Very	
Sex	Male (n=415)	258 (62.2)	84 (20.2)	73 (17.6)	0.000
	Female (n=347)	284 (81.8)	40 (11.5)	23 (6.6)	
Age (yr)	10-19	102 (87.2)	10 (8.5)	5 (4.3)	0.000
	20-29	298 (72.9)	62 (15.2)	49 (12.0)	
	30-39	92 (63.0)	30 (20.5)	24 (16.4)	
	40-49	32 (52.5)	17 (27.9)	12 (19.7)	
	≥ 50	18 (62.1)	5 (17.2)	6 (20.7)	
Position	Left	310 (73.6)	60 (14.3)	51 (12.1)	0.186
	Right	232 (68.0)	64 (18.8)	45 (13.2)	
Operator	Specialist	288 (70.6)	66 (16.2)	54 (13.2)	0.851
	General dentist	254 (71.8)	58 (16.4)	42 (11.9)	
X-ray	Im	Blurred	69 (26.3)	48 (18.3)	0.000
		Sharp	397 (79.4)	48 (9.6)	
	MC	Contact	68 (15.9)	57 (13.3)	0.768
		Away	240 (71.6)	39 (11.6)	
Depth	A	335 (72.7)	77 (16.7)	49 (10.6)	0.016
	B	184 (70.8)	41 (15.8)	35 (13.5)	
	C	23 (56.1)	6 (14.6)	12 (29.3)	
Ramal relationship	1	223 (73.8)	44 (14.6)	35 (11.6)	0.393
	2	312 (69.5)	79 (17.6)	58 (12.9)	
	3	7 (63.6)	1 (9.1)	3 (27.3)	
W	Mesioangular	239 (72.2)	57 (17.2)	35 (10.6)	0.114
	Vertical	114 (79.7)	17 (11.9)	12 (8.4)	
	Horizontal	173 (65.3)	47 (17.7)	45 (17.0)	
	Distoangular	9 (69.2)	2 (15.4)	2 (15.4)	
PI	Others	7 (70.0)	1 (10.0)	2 (20.0)	0.066
	Easy	235 (75.3)	47 (15.1)	30 (9.6)	
	Moderate	297 (68.0)	77 (17.6)	63 (14.4)	
	Difficult	10 (76.9)	0	3 (23.1)	

(Im: sharpness of image, MC: mandibular canal, A: high occlusal level, B: moderate occlusal level, C: deep occlusal level, 1: sufficient space in ramal relationship, 2: reduced space in ramal relationship, 3: no space in ramal relationship, W: Winter's classification, PI: Pederson index) Values are presented as number (%).

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Table 8. Comparison of specialists' Pederson indexes and number of presumed causes of difficult extraction with those of general practitioners

Operator	Difficulty	No. of patients	Pederson index	No. of causes ¹
Specialist	Not	288	4.83±1.399	0.00±0.000
	Moderately	66	4.67±1.269	1.52±0.662
	Very	54	5.57±1.159	2.19±0.913
	Total	408	4.90±1.373	0.53±0.948
General practitioner	Not	254	4.79±1.167	0.00±0.000
	Moderately	58	4.90±1.119	1.14±0.605
	Very	42	4.64±1.322	1.05±0.539
	Total	354	4.79±1.177	0.31±0.583

¹Number of presumed causes of difficult extraction.

Values are presented as number or mean±standard deviation.

In two-way ANOVA of Pederson index, *P*-value of operator was 0.041, and *P*-value of interaction term of operator and difficulty was 0.002. In two-way ANOVA in number of causes, *P*-values of operator, difficulty, and interaction term of operator and difficulty were all 0.000.

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decreased, and those of large and/or bulbous root and ankylosis increased. Large and/or bulbous root and ankylosis seem to greatly impact the difficulty of extraction. Increase in the number of presumed causes increased the perceived difficulty by the operator. Cases in which deep impaction accompa-

nied a close relationship to the second molar, deep impaction was accompanied by ankylosis, ankylosis was accompanied by a close relationship to the second molar, deep impaction accompanied widely divergent roots, and ankylosis accompanied large and/or bulbous root were very difficult rather

than moderately difficult. When deep impaction or ankylosis accompanied other causes, difficult surgical extraction was more likely.

Among radiographic variables, close relationship with the mandibular canal was not associated with difficult surgical extraction ($P=0.768$), although it is known that a close relationship with the mandibular canal can complicate surgical extraction. This proximity becomes a problem only when a root fracture develops in the vicinity of the canal. A small percentage of such root fractures seems to be the reason why close relationship with the mandibular canal was not statistically associated with difficult surgical extraction.

According to Pell-Gregory classification, the probability order of difficult extractions was C2, B2, and B3. Pell-Gregory classification sorts impacted lower third molars according to depth of impaction and ramal relation. This study considered the two factors separately and demonstrated that depth of impaction was statistically associated with extraction difficulty, while ramal relation has no association. This affirms the claim of Akadiri et al.¹³ that depth of impaction is the singular most important determinant of surgical difficulty, and that operators do not consider it difficult to develop flaps, reduce bone, or separate teeth in the ramal area.

Using Winter's classification, the probability order of difficult extraction was horizontal, distoangular, mesioangular, and vertical impactions. This runs counter to the Pederson index, which regards vertical impaction as more difficult than mesioangular and horizontal impactions. This might be one reason to question the reliability of the Pederson index.

According to Pell-Gregory classification and Winter's classification, there was no difference between the probability of moderately difficult cases and that of very difficult cases in

each class. Classification based on tooth position alone does not predict difficulty very well, and other causes, especially root-related causes, should be considered for a more robust prediction.

The Pederson index score was not proportional to difficulty in the moderately difficult group, but it was directly proportional to difficulty in the very difficult group. (Table 6, Fig. 1) This suggests that tooth position has a considerable effect on difficulty only when there are a large number of presumed causes. When the Pederson index score is low, other causes, except position-related causes, might not impact extraction difficulty. However, the operator should investigate the relation to the second molar, relation to the mandibular canal, root form, and ankylosis in order to distinguish very difficult cases when the index score is high. This confirms the study of Akadiri et al.⁶, which posited that the Pederson index should not be employed as a sole instrument for preoperative

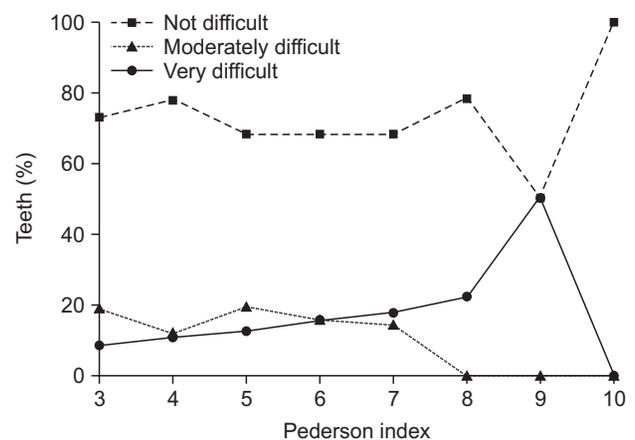


Fig. 1. Difficulty group distribution in Pederson index. Kyeong-Lok Park: Which factors are associated with difficult surgical extraction of impacted lower third molars? J Korean Assoc Oral Maxillofac Surg 2016

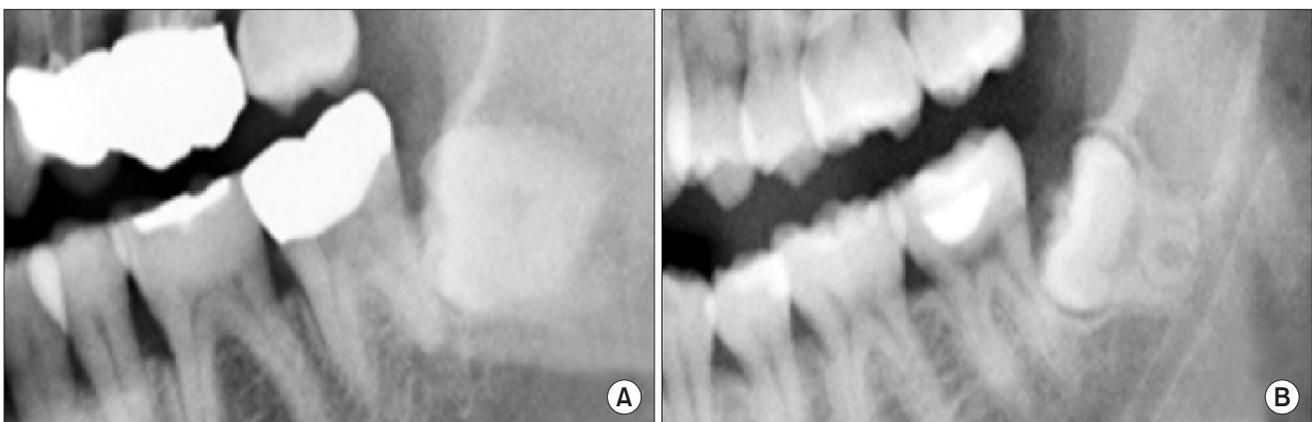


Fig. 2. Two types of radiographic images. A. A panoramic image that shows blurred root image and indistinct border. B. A panoramic image that shows relatively clear root anatomy and sharp border. Kyeong-Lok Park: Which factors are associated with difficult surgical extraction of impacted lower third molars? J Korean Assoc Oral Maxillofac Surg 2016

assessment of difficulty in third molar surgery.

This study investigated the association between blurred panorama images and extraction difficulty. (Fig. 2) The result was that blurred images were relevant to extraction difficulty. Radiography of an ankylosed tooth does not show a well-defined root or periodontal ligament space, which appears to fade into bone¹⁴. In the absence of ankylosis, blurred images can result when the object drops out of the focal trough or the roots are overlapped with one another. It is assumed that large and/or bulbous roots and widely divergent roots are such cases and can increase extraction difficulty.

There are many factors that influence difficulty in surgical extraction of impacted mandibular third molars. Age, BMI, body surface area, ethnicity, operator experience, method, number of extracted teeth, depth of impaction, ramal relation, angulation of tooth, development of root, root curvature, relationship to the mandibular canal, width of root, patient anxiety, and other factors are thought to impact extraction difficulty, although there is disagreement among researchers about their relative impacts^{8-13,15-18}.

The existing Pell-Gregory classification, Winter's classification, and Pederson index have proven unreliable, and newly developed classifications and difficulty prediction methods are overly complex or unreliable^{7,19-21}. The presence of many factors and disagreement among researchers make it very challenging to design a new practical and reliable predictor of surgical extraction difficulty.

In this study, the distribution of difficulty groups by operator showed significant differences. (Table 4) This could be the result of different operator's criterion of difficulty and/or proportion of difficult extractions. All cases of two operators (one specialist and one general practitioner) were classified into the not difficult group by the criteria for classification. This might be a limit of the retrospective study. However, it does not seem problematic, because the proportion of their cases was very small (5.0%), and the objective of this study was to identify impactful factors not the ratio of difficult extractions.

There are many factors that are not objective or quantifiable in a surgical extraction difficulty study. Therefore, some researchers^{15,18} have used subjective methods in their studies. In this retrospective study, the subjective decision of the operator was used as a variable. Additional studies are necessary to verify the findings of this study.

V. Conclusion

In this study, several causes of difficulty such as large and/

or bulbous root, ankylosis, and deep impaction had a strong effect on determination of very difficult cases. It is therefore important to evaluate root-related factors when position-related factors suggest difficult extraction. Cone-beam computed tomography is frequently used in dentistry and shows root anatomy more reliably than panoramic imaging²². Therefore, in cases with a high Pederson index (8-10), deep impaction, or blurred images, root-related factors using computed tomography are useful in predicting very difficult extraction.

Conflict of Interest

No potential conflict of interest relevant to this article was reported.

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