


# Prevalence of and risk factors for postoperative complications after lower third molar extraction

## A multicenter prospective observational study in Japan

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### Abstract

Lower third molar extraction is the most common surgical treatment among routine dental and oral surgical procedures. While the surgical procedures for lower third molar extraction are well established, the difficulty of tooth extraction and the frequency of postoperative complications differ depending on the patient's background. To establish a management protocol for the lower third molars, the prevalence of and risk factors for postoperative complications after lower third molar extraction were investigated in a large number of Japanese patients in a multicenter prospective study. During 6 consecutive months in 2020, 1826 lower third molar extractions were performed at the 20 participating institutions. The medical records of the patients were reviewed, and relevant data were extracted. The prevalence of and risk factors for postoperative complications were analyzed. The prevalence of postoperative complications after lower third molar extraction was 10.0%. Multivariate analysis indicated that age ( $\leq 32$  vs  $> 32$ , odds ratio [OR]: 1.428, 95% confidence interval [95% CI]: 1.040–1.962,  $P < .05$ ), the radiographic anatomical relationship between the tooth roots and mandibular canal (overlapping of the roots and canal vs no close anatomical relationship between the roots and the superior border of the canal, OR: 2.078, 95% CI: 1.333–3.238,  $P < .01$ ; overlapping of the roots and canal vs roots impinging on the superior border of the canal, OR: 1.599, 95% CI: 1.050–2.435,  $P < .05$ ), and impaction depth according to the Pell and Gregory classification (position C vs position A, OR: 3.7622, 95% CI: 2.079–6.310,  $P < .001$ ; position C vs position B, OR: 2.574, 95% CI: 1.574–4.210,  $P < .001$ ) are significant independent risk factors for postoperative complications after lower third molar extraction. These results suggested that higher age and a deeply impacted tooth might be significant independent risk factors for postoperative complications after lower third molar extraction.

**Abbreviations:** AAOMS = American Association of Oral and Maxillofacial Surgeons, AUC = area under the ROC curve, CI = confidence interval, OR = odds ratio, ROC = receiver operating characteristic.

**Keywords:** extraction, lower third molar, Pell and Gregory classification, postoperative complication, risk factor

We obtained full informed consent from all study participants.

The authors have no funding and conflicts of interest to disclose.

The datasets generated during and/or analyzed during the current study are available from the corresponding author on reasonable request.

The study protocol was approved by the ethics committee of Shinshu University School of Medicine (No. 4489).

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## 1. Introduction

Lower third molar extraction is the most common surgical treatment among routine dental and oral surgical procedures. The age and comorbidities of patients that undergo lower third molar extraction vary markedly, and while the surgical procedures for lower third molar extraction are well established, the difficulty of tooth extraction and the frequency of postoperative complications differ depending on the patient's background. The surgical extraction of an impacted lower third molar that does not exhibit symptoms or pathological findings as a preventative measure remains controversial among clinicians.<sup>[1,2]</sup> According to a White Paper produced by the American Association of Oral and Maxillofacial Surgeons (AAOMS), third molars associated with disease or a higher risk of disease progression are recommended for extraction.<sup>[3]</sup> In addition, the AAOMS suggested that surgical intervention or the removal of third molars prior to the development of pathology should be considered in patients who have insufficient physiological space for eruption, and maintenance should be performed once optimal postsurgical healing has been achieved and the risk of complications is low.<sup>[4]</sup> Postoperative complications make patients uncomfortable, and patients fear complications that result in additional dental visits and treatment.<sup>[5]</sup> Therefore, before the extraction of lower third molars patients must be provided with full information, including regarding the advantages and disadvantages of the surgical procedure and any potential intraoperative or postoperative complications.

The common postoperative complications of lower third molar extraction include swelling; pain; temporomandibular joint symptoms, such as trismus; hemorrhaging; a dry socket; infection; and sensory alterations relating to the inferior alveolar or lingual nerve.<sup>[6,7]</sup> The postoperative complications rate following lower third molar extraction has been reported to range from 4.6% to 30.9%.<sup>[8–11]</sup> In a recent nationwide population-based cohort study conducted in Taiwan, the incidence rates of dry sockets, surgical site infections, and temporomandibular joint symptoms were reported to be 3.6%, 0.17%, and 0.41%, respectively.<sup>[7]</sup> The prevalence of inferior alveolar nerve injuries was reported to range from 1.2% to 13.0%,<sup>[12–14]</sup> and the prevalence of lingual nerve injuries was reported to range from 0.02% to 4%.<sup>[15,16]</sup> Postoperative complications after lower third molar extraction have been found to be associated with various factors, including age, medical history, the patient's health conditions, the depth of the impacted tooth, the surgeon's experience, smoking habits, the use of contraceptive medication, the patient's oral hygiene level, and the surgical procedure.<sup>[10,17]</sup> However, there have been few large prospective studies of the postoperative complications that can occur after lower third molar extraction.<sup>[13,16]</sup> Therefore, to establish a management protocol for lower third molars, the prevalence of and risk factors for postoperative complications after lower third molar extraction were investigated in Japanese patients in a multicenter prospective study involving a large number of cases.

## 2. Patients and Methods

The study protocol was approved by the Committee on Medical Research of Shinshu University (#4489). We obtained informed consent from all study participants.

This was a nonrandomized, multicenter prospective observational study, which included pooled data for individual patients from 20 institutions. During 6 consecutive months in 2020, 1826 lower third molar extractions were performed at the 20 institutions. The medical records of these patients were reviewed, and relevant data were extracted.

Data regarding patient characteristics, including age; sex; and the presence/absence of comorbidities, such as diabetes mellitus, hypertension, immunosuppressive factors, diarrhea, and cerebral infarctions, were extracted from the patients' medical records.

The preoperative use of antibiotics or nonsteroidal antiinflammatory drugs and the number of cases of postoperative complications were also investigated. As lower third molar-related factors, the depth of the impacted lower third molar (impaction depth) and the anatomical relationship between the mandibular ramus and the lower third molar were investigated based on the Pell and Gregory classification.<sup>[18]</sup> The radiographic findings of the lower third molars, such as disappearance of the periodontal ligament space and the anatomical relationship between the tooth roots and the mandibular canal, were also investigated with panoramic radiography. Bone removal, tooth sectioning, primary wound closure, the surgeon's experience, and the operation time were investigated as surgical factors. During the initial tooth extraction, the use of a hemostat (oxidized cellulose), suturing, or a surgical splint were investigated as procedure-related factors. The use of a hemostat (oxidized cellulose, Surgicel; Ethicon, Somerville, NJ), sutures (5-0 silk), surgical splints, and antibiotic or antiinflammatory drugs was based on the surgeon's discretion.

The optimal age cutoff value for predicting postoperative complications after lower third molar extraction was determined based on receiver operating characteristic (ROC) curve analysis. Univariate analyses of the risk factors for postoperative complications after lower third molar extraction were performed using Fisher exact test, Wilcoxon test, or Pearson chi-square test, and multivariate analysis was performed with multivariate logistic regression analysis. All of the variables that were found to be associated with postoperative complications in the univariate analyses were included in the multivariate logistic regression analysis. Multivariate odds ratios (ORs) and 95% confidence intervals (CIs) were calculated for the factors that exhibited significance. Decision-tree analysis was also performed as an alternative way of investigating the factors related to postoperative complications after lower third molar extraction. All statistical analyses were conducted using JMP ver.13 (SAS Institute Inc., NC). *P* values of < 0.05 were considered to be significant.

## 3. Results

One thousand, eight hundred twenty-six patients underwent lower third molar extraction during the study period and were included in the study population. The patients' characteristics are shown in Table 1. Among the 1826 patients, 756 (41.4%) were male, and 1070 (58.6%) were female. The median age at extraction was 31.4 ± 12.4 years (range: 13–88 years). The surgeons had a mean of 9.0 ± 8.6 years' experience. The mean operation time was 26.5 ± 17.5 minutes. The prevalence of postoperative complications after lower third molar extraction was 10.0% (183/1826 patients). Among the postoperative complications seen after lower third molar extraction, a dry socket was the most common (59 patients; prevalence rate: 3.2%), followed by inferior alveolar nerve injuries (31 patients; 1.7%) and postoperative pain (30 patients; 1.6%) (Table 2). The prevalence of postoperative hemorrhaging was 0.3% (6/1826 patients). All postoperative complications were resolved within 6 months.

The univariate analyses indicated that the occurrence of postoperative complications after lower third molar extraction was associated with age (OR: 1.539, *P* < .01), the preoperative use of antibiotics (OR: 1.646, *P* < .01), the radiographic anatomical relationship between the tooth roots and mandibular canal (*P* < .001), the Pell and Gregory classification (class and position, *P* < .001), bone removal (OR: 2.426, *P* < .05), and tooth sectioning (OR: 2.144, *P* < .05) (Table 3). Although there was no significant association, the perioperative use of painkillers tended to be associated with postoperative complications (*P* = .083). No associations were observed between the occurrence of postoperative complications after lower third molar extraction and sex, comorbidities, the radiographic disappearance of the periodontal ligament space, or primary wound closure. There were

**Table 1****The characteristics of the patients (n = 1826).**

Variables	Number (%)	Variables	Number (%)
Gender		Disappearance of periodontal ligament space	
Male	756 (41.4)	No	1492 (81.7)
Female	1070 (58.6)	Yes	334 (18.3)
Age (average ± SD)	31.4 ± 12.4	Radiographical association between root and inferior alveolar canal	
Diabetes mellitus		No association between root structure and the superior border of the canal	820 (44.9)
No	1803 (98.7)	Root structure impinging the superior border of canal	760 (41.6)
Yes	23 (1.3)	Overlapping root structure and canal	246 (13.5)
Immunosuppressor factor		Pell and Gregory classification	
No	1799 (98.5)	Class I	475 (26.0)
Yes	27 (1.5)	Class II	1084 (59.4)
Hypertension		Class III	267 (14.6)
No	1761 (96.4)	Position A	772 (42.3)
Yes	65 (3.6)	Position B	902 (49.4)
Cerebral infarction		Position C	152 (8.3)
No	1813 (99.3)	Bone removal	
Yes	13 (0.7)	No	172 (9.4)
Drinking habit		Yes	1654 (90.6)
No	1484 (81.3)	Tooth sectioning	
Yes	342 (18.7)	No	173 (9.5)
Diarrhea		Yes	1653 (90.5)
No	1813 (99.3)	Primary wound closure	
Yes	13 (0.7)	No	275 (15.1)
Comorbidities		Yes	1551 (84.9)
No	1473 (80.7)	Postoperative complication	
Yes	353 (19.3)	No	1643 (90.0)
Preoperative use of antibiotic		Yes	183 (10.0)
No	1349 (73.9)	Operation time (min ± SD)	26.5 ± 17.5
Yes	477 (26.1)	Surgeon's experience (y ± SD)	9.0 ± 8.6
Preoperative use of painkiller			
No	1790 (98.0)		
Yes	36 (2.0)		

**Table 2****The contents and prevalence of the postoperative complications after the lower third molar extraction (n = 183).**

Postoperative complication	Number (%)
Inferior alveolar nerve paralysis	31 (1.7)
Lingual nerve paralysis	4 (0.2)
Wound infection	26 (1.4)
Prolonged wound healing	15 (0.8)
Dry socket	59 (3.2)
Postoperative pain	30 (1.6)
Postoperative hemorrhage	6 (0.3)
Tooth residue	6 (0.3)
Allergy due to postoperative use of antibiotic	6 (0.3)

no significant associations between the occurrence of postoperative complications after lower third molar extraction and the surgeon's experience or the operation time (Wilcoxon test, data not shown).

Multivariate analysis indicated that age ( $\leq 32$  vs  $> 32$ , OR: 1.428, 95% CI: 1.040–1.962,  $P < .05$ ), the radiographic anatomical relationship between the tooth roots and mandibular canal (overlapping of the roots and canal vs no close anatomical relationship between the roots and the superior border of the canal, OR: 2.078, 95% CI: 1.333–3.238,  $P < .01$ ; overlapping of the roots and canal vs roots impinging on the superior border of the canal, OR: 1.599, 95% CI: 1.050–2.435,  $P < .05$ ), and impaction depth according to the Pell and Gregory classification<sup>[18]</sup> (position C vs position A, OR: 3.7622, 95% CI: 2.079–6.310,  $P < .001$ ; position C vs position B, OR: 2.574, 95% CI: 1.574–4.210,  $P < .001$ ) are significant independent risk factors for postoperative complications after lower third molar extraction (Table 4). The frequency of postoperative

complications after lower third molar extraction differed significantly between Pell and Gregory classification class II and class I (OR: 1.565, 95% CI: 1.006–2.435,  $P < .05$ ). These results suggested that higher age and a deeply impacted tooth are significant independent risk factors for postoperative complications after lower third molar extraction.

An additional investigation of the factors related to postoperative complications after lower third molar extraction was performed with decision-tree analysis (Fig. 1). The findings of the latter analysis were consistent with those of the multivariate analysis. The decision-tree analysis revealed significant associations between postoperative complications after lower third molar extraction and higher age, a deeply impacted tooth, or a close radiographic anatomical relationship between the tooth roots and mandibular canal. The optimal age cutoff value for predicting postoperative complications after lower third molar extraction was 35 years (area under the ROC curve [AUC]: 0.567, sensitivity: 0.415, specificity: 0.705) according to the ROC analysis (Fig. 2).

#### 4. Discussion

The postoperative complications that occur after lower third molar extraction can have serious implications for both patients and clinicians. When obtaining informed consent from patients for lower third molar extraction, the prevalence of postoperative complications and the risk factors for such complications represent important information. Therefore, in this multicenter prospective observational study we aimed to investigate the prevalence of postoperative complications after lower third molar extraction and the risk factors for such complications in Japan. As a result, it was suggested that age and impaction depth are significant independent risk factors for postoperative complications after lower third molar extraction.

**Table 3**  
**The univariate analysis of the postoperative complications after the lower third molar extraction.**

Variables	No. of Postoperative complications (%)				Variables	No. of Postoperative complications (%)			
	No	Yes	OR	P value		No	Yes	OR	P value
Gender					Disappearance of periodontal ligament space				
Male	686 (37.6)	70 (3.8)	1.157	NS	No	1345 (73.7)	147 (8.1)	1.105	NS
Female	957 (52.4)	113 (6.2)		.385	Yes	298 (16.3)	36 (2.0)		.615
Age, y					Radiographical association between root and inferior alveolar canal				
<32	1034 (56.6)	96 (5.3)	1.539	<.01	No association between root structure and the superior border of the canal	759 (41.6)	61 (3.)	–	<.001*
≥32	609 (33.4)	87 (4.6)			Root structure impinging the superior border of canal	680 (37.2)	80 (4.4)		
Diabetes mellitus					Overlapping root structure and canal	204 (11.2)	42 (2.3)		
No	1622 (88.8)	181 (9.9)	0.853	NS	Pell and Gregory classification				
Yes	21 (1.2)	2 (0.1)		1.000	Class I	446 (24.4)	29 (1.6)	–	<.001*
Immunosuppressor factor					Class II	968 (53.0)	116 (6.4)		
No	1619 (88.7)	180 (9.9)	1.124	NS	Class III	229 (12.5)	38 (2.1)		
Yes	24 (1.3)	3 (0.2)		.747	Position A	722 (42.3)	50 (2.7)	–	.001*
Hypertension					Position B	806 (44.1)	96 (5.3)		
No	1585 (86.8)	176 (9.6)	1.087	NS	Position C	115 (6.3)	37 (2.0)		
Yes	58 (3.2)	7 (0.4)		.833	Bone removal				
Cerebral infarction					No	164 (9.0)	8 (0.4)	2.426	.05
No	1630 (89.3)	183 (10.0)	0	NS	Yes	1479 (81.0)	175 (9.6)		
Yes	13 (0.7)	0 (0)		.632	Tooth sectioning				
Drinking habit					No	164 (9.0)	9 (0.5)	2.144	<.05
No	1335 (73.1)	149 (8.2)	0.989	NS	Yes	1479 (81.0)	174 (9.5)		
Yes	308 (16.9)	34 (1.9)		1.000	Primary wound closure				
Diarrhea					No	250 (13.7)	25 (1.4)	1.134	NS
No	1631 (89.3)	182 (10.0)	0.747	NS	Yes	1393 (76.3)	158 (8.7)		.633
Yes	12 (0.7)	1 (0.1)		1.000					
Comorbidities									
No	1333 (73.0)	140 (7.7)	1.321	NS					
Yes	310 (17.0)	43 (2.4)							
Preoperative use of antibiotic									
No	1231 (67.4)	118 (6.5)	1.646	<.01					
Yes	412 (22.6)	65 (3.6)							
Preoperative use of painkiller									
No	1614 (88.4)	179 (9.8)	2.214	NS					
Yes	29 (1.6)	7 (0.4)		.083					

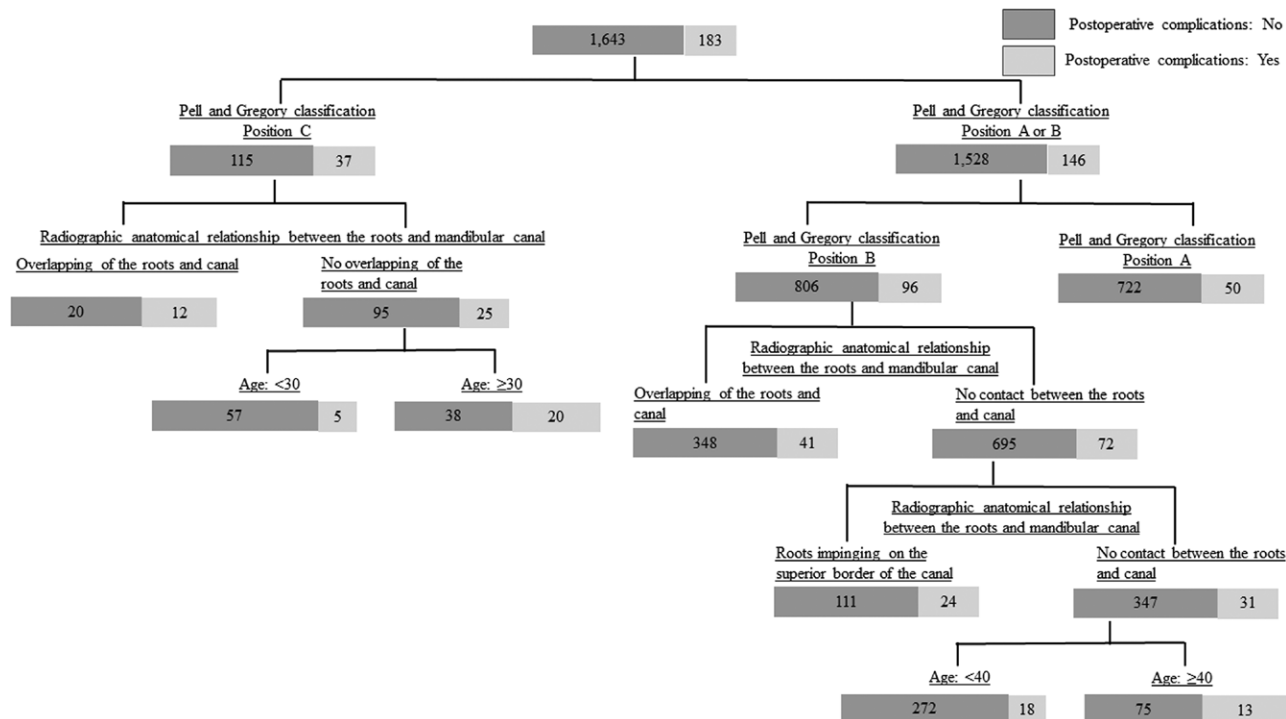
NS = not significant, OR = odd ratio.  
 \*Pearson chi-square test; Fischer exact test.

The postoperative complications rate after lower third molar extraction was 10.0% in this study. Among the observed postoperative complications, the most common were a dry socket (3.2%), inferior alveolar nerve injuries (1.7%), wound infections (1.4%), and lingual nerve injuries (0.2%). These prevalence rates were consistent with the findings of previous studies.<sup>[7–16,19,20]</sup> The onset of postoperative complications is influenced by various factors. The risk factors for a dry socket were reported to include the difficulty of extraction, age, female sex, smoking, oral hygiene, the complexity of odontectomy, and a history of gingivitis or pericoronitis.<sup>[7,8,21–25]</sup> Inferior alveolar nerve injuries were reported to be significantly associated with deviation of the mandibular canal; a greater impaction depth; intraoperative hemorrhaging within the socket/nerve exposure; a longer operation time; surgical difficulty; radiographic signs, such as loss of the white lines of the roots and diversion of the mandibular canal; and the presence of a multirrooted third molar.<sup>[12–14,19]</sup> Lingual nerve injuries were reported to be associated with female sex, being aged ≥ 26 years, lingual flap retraction, an impaction depth of ≥ 10mm, an operation time of ≥30min, and distoangular impaction.<sup>[16,26]</sup> Although it was reported that there were no significant risk factors for surgical site infections after lower third molar extraction, delayed-onset

infections were reported to be associated with younger age and long surgical procedures.<sup>[20]</sup> As described above, age, impaction depth, and radiographic risk factors have been reported to influence postoperative complications after lower third molar extraction. These findings were consistent with the results of our multicenter prospective observational study. Since the administrations of nonsteroidal antiinflammatory drugs and antibiotics has been reported to increase the risk of the postoperative bleeding, especially in patients with anticoagulants,<sup>[27–31]</sup> the effects of these drugs on the postoperative complications in this study. However, these factors were not significant independent risk factor for the postoperative complications after the lower third molar extractions.

Although it was reported that surgical morbidity did not increase with age,<sup>[32]</sup> age has been reported to affect the mandible and the lower third molars, for example, a higher age is associated with increased bone density, a reduction in bone elasticity, hypercementosis, complete root formation, and a reduced capacity for healing.<sup>[11,33]</sup> A rise in age of 1 year increased the OR of developing nerve damage by 6.9%.<sup>[32]</sup> In addition, more deeply impacted lower third molars are located closer to the mandibular canal, which increases the risk of an inferior alveolar nerve injury. Deeper impaction of a



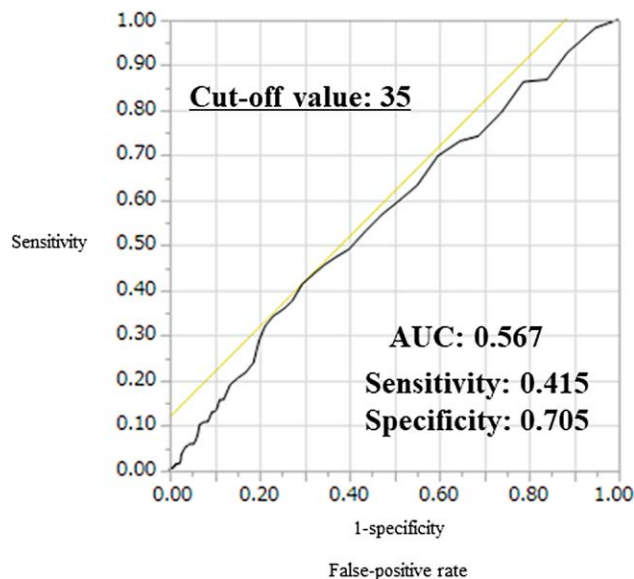


**Figure 1.** Decision-tree analysis of the factors affecting the risk of postoperative complications after lower third molar extraction (n = 1826). The decision-tree analysis revealed significant associations between postoperative complications after lower third molar extraction and age, impaction depth, and a close radiographic anatomical relationship between the tooth roots and mandibular canal.

lower third molar reduces surgical accessibility and visibility, which can also contribute to postoperative morbidity.<sup>[33]</sup> The difficulty of extraction was reported to increase 3 times with every 1-mm increase in the impaction depth.<sup>[34]</sup> Hasegawa et al<sup>[19]</sup> reported that although there was no significant association between the Pell and Gregory classification and inferior alveolar nerve hypoesthesia, the surgical removal of a deeply impacted tooth may require more extensive manipulation and bone removal close to the inferior alveolar nerve, which may increase the risk of postoperative inflammation and both direct and indirect nerve injuries. Since there is a close anatomical relationship between the roots of the lower third molars and the mandibular canal, the distance between the roots and the mandibular canal was also identified as a major predictor of postoperative complications.<sup>[19]</sup> However, it is impossible to evaluate the anatomical relationship between the roots of lower third molars and the mandibular canal using the Pell and Gregory classification. In a study investigating the anatomical differences among lower third molars according to panoramic radiographs and cone-beam computed tomography, it was found that if a panoramic radiograph indicated that the roots of a lower third molar overlapped with more than one-third of the mandibular canal (position B or C), there was a close anatomical relationship between the lower third molar and the mandibular canal. In addition, a good correlation was observed between the proximity of the lower third molar roots to the mandibular canal and complications after lower third molar removal.<sup>[35]</sup> Thus, our findings indicate that age, impaction depth, and the radiographic anatomical relationship between the lower third molar roots and the mandibular canal might be very useful predictors of postoperative complications after lower third molar extraction.

In this study, ROC analysis indicated that the optimal age cutoff value for predicting postoperative complications after lower third molar extraction was 35 years old. In previous studies, the optimal age cutoff values for predicting such complications were reported to be 25 to 26 years.<sup>[14,16,36]</sup>

However, the AUC, sensitivity, and specificity values associated with these cutoff values were relatively low. It has been reported that age (25 years old) and various widely used panoramic radiography indicators can be employed as criteria for defining risk groups,<sup>[14]</sup> which suggests that other factors, such as impaction depth and radiographic findings, should be considered as potential predictors of postoperative complications.



**Figure 2.** The optimal age cutoff value for predicting postoperative complications after lower third molar extraction. The optimal age cutoff value for predicting postoperative complications after lower third molar extraction was 35 years old (AUC: 0.567) according to ROC analysis. AUC = area under the ROC curve, ROC = receiver operating characteristic.

Table 4

## The multivariate analysis of the postoperative complications after the lower third molar extraction.

Variables	OR	95% CI	P value
Age ( $\geq 32$ / $>32$ )	1.428	1.040–1.962	<.05
Use of preoperative antibiotic (yes/no)	1.214	0.857–1.720	NS (.276)
Use of preoperative painkiller (yes/no)	1.661	0.668–4.132	NS (.275)
Radiographical association between root and inferior alveolar canal (root structure impinging the superior border of canal/No association between root structure and the superior border of the canal)	1.300	0.908–1.860	NS (=152)
(Overlapping root structure and canal/no association between root structure and the superior border of the canal)	2.078	1.333–3.238	<.01
(Overlapping root structure and canal/root structure impinging the superior border of canal)	1.599	1.050–2.435	<.05
Pell and Gregory classification (class II/class I)	1.565	1.006–2.435	<.05
(Class III/class I)	1.148	0.637–2.066	NS (.646)
(Class III/class II)	0.733	0.461–1.167	NS (.191)
(Position B/position A)	1.407	0.971–2.041	NS (.072)
(Position C/position A)	3.622	2.079–6.310	<.0001
(Position C/position B)	2.574	1.574–4.210	<.001
Bone removal (yes/no)	1.558	0.657–3.696	NS (.314)
Tooth sectioning (yes/no)	1.171	0.516–2.660	NS (.706)

CI = confidence interval, NS = not significant, OR = odd ratio.

Since age, impaction depth, and the radiographic anatomical relationship between the lower third molar roots and the mandibular canal might be very useful predictors of postoperative complications after lower third molar extraction in this study, the extraction of impacted lower third molar, which have a deep impacted depth and its apex of the tooth is close to the mandibular canal, requires caution with aging. However, the establishment of a management protocol for the lower third molars has been controversial. In the pilot study investigating the unpredictable lower third molar migration, the unpredictable migrations were reported the relation to any type of lesion.<sup>[37]</sup> Considering the unpredictable behavior of the lower third molar, impacted lower third molar recommends to evaluate periodically and radiographically, even if surgical extraction is not indicated.<sup>[37]</sup> The establishment of the management protocol would be needed for the lower third molar.

Although, due to the SARS-CoV-2 pandemic, medical and dental treatments were restricted in Japan during the study period, and the accumulation of cases did not progress as expected, the main strengths of the present study were that it was the first to investigate the prevalence of and risk factors for postoperative complications after lower third molar extraction based on a relatively large number of cases and that it was a multicenter prospective study. In order to prevent the infection of the SARS-CoV-2, although the extraoral vacuum aspirator had used for the decreasing the dust during the lower third molar extractions, this infection prevention method had no effects on the results of this study. The main limitation of this study was that the results may have been affected by the surgeon's experience. However, no significant association was detected between the surgeon's experience or the operation time and postoperative complications after lower third molar extraction. Regarding the reason for this, we speculate that it may have been due to "real-world" case selection based on the patient's age and the expected difficulty of tooth removal; that is, that more experienced clinicians or specialists were selected as surgeons for cases involving deeply impacted teeth or older or systemically compromised patients.<sup>[7]</sup>

In conclusion, the present study provides information about the prevalence of and risk factors for postoperative complications after lower third molar extraction in Japan. The prevalence of such complications was 10.0%. Multivariate analysis revealed that increased age, deeper impaction of the third molar, and radiographic overlapping between the roots and mandibular canal may be significant independent risk factors for postoperative complications after lower third molar extraction.

Although various other factors may have affected our results, it was found that the optimal cutoff age for predicting postoperative complications after lower third molar extraction is 35 years.

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### Author contributions

Conception and design of the study: Y.S. and K.H.; Analysis and interpretation of data: Y.S.; Collection and assembly of data: Y.S., H.T., Y.N., H.Y., N.T., S.N., M.H., Y.H., U.N., Y.Y., O.H., T.A., N.Y., I.E., A.D., I.R., S.S., K.K., K.S., H.H., K.Y., M.Y., N.H., A.M., K.T., S.Y., and U.M.; Drafting of the article: Y.S.; Critical revision of the article for important intellectual content: Y.S.; Final approval of the article: K.H.

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