




RESEARCH ARTICLE



Factors affecting number of third molars extracted in a single visit

Abiel Noro^a , Johanna Snäll^{a,b}  and Irja Ventä^a 

^aDepartment of Oral and Maxillofacial Diseases, Faculty of Medicine, University of Helsinki, Helsinki, Finland; ^bDepartment of Oral and Maxillofacial Diseases, Helsinki University Hospital, Helsinki, Finland

ABSTRACT

Objective: This cross-sectional study evaluated the number and characteristics of third molars extracted in a single visit in primary care and their associations with patient's age and sex and operator's experience.

Materials and methods: The data included all appointments where routine and surgical extractions of third molars were performed in 2016 in primary care of the City of Helsinki. Statistics included χ^2 and Mann–Whitney *U* tests, and binomial logistic regression.

Results: In total of 10,894 appointments, the number of extracted third molars was 12,728, yielding an average of 1.2 third molars per visit. Mean age of patients (55% women, 45% men) at extraction was 32.2 years (range 12–97 years). Most appointments (83.7%, $n=9,118$) comprised extraction of one, 15.8% two, 0.4% three, and 0.1% four third molars. Number of teeth extracted at a time did not differ by sex. Increasing age was associated with a reduction in the likelihood of several third molar extractions in a visit (OR 0.96; 95% confidence interval (CI) 0.96–0.97). Multiple third molars were extracted significantly more likely if the operator was experienced (OR 2.32; 95%CI 1.90–2.84). Multiple extractions were also associated with the mandible, operative extractions, unerupted teeth and caries.

Conclusions: Third molars were typically extracted one at a time. In health care units, it is appropriate to consider extraction of several third molars in a single visit, if need for extraction of other third molars exist. Concentrating the extractions of younger patients on experienced operators would reduce the number of patients' visits.

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Introduction

Due to the vast number of extractions, the third molar plays a significant economic role in oral health care. Usually, more than just one-third molar needs to be removed during a patient's lifespan, although most are extracted before the age of 40 years [1]. Postoperative recovery for a single third molar removal may necessitate the use of painkillers and antibiotics and may require sick leave. Hence, it is important to decide how many third molars and which ones, if not all, can be extracted in a single visit. The aims are thus to maximize the patient's overall recovery and to minimize the costs of the procedure to the patient, the oral health care unit, and society. However, this utilitarian aspect regarding the number of visits has not been a common subject of research.

The practices and recommendations on how third molars should be treated vary between countries. In the USA, third molars associated with disease or at high risk of developing disease are surgically managed [2]. In the UK, since the year 2000, prophylactic extractions have not been recommended, but pathological third molars are indicated for removal [3]. In Finland, extractions are performed according to signs or symptoms, and in addition, selected impacted third molars are removed by the age of 25 years [4].

The number of third molars removed in a single visit has been evaluated in some earlier studies. In a US study from the 1990s based on an enormous dataset for insured patients, 80% of patients in third molar surgery had all four teeth extracted and 94% had them extracted in a single visit [5]. In more recent US and Belgian studies from surgical units, the mean number of removed third molars per visit was 3.1 and 2.9, respectively [6,7]. Similarly, in a follow-up study on patients of general dental practices in the USA, most extractions comprised all existing third molars in a single visit [8]. In Japan, simultaneous bilateral extraction of mandibular third molars is only recommended under intravenous sedation and in a hospital setting [9].

Anaesthesia type likely affects the number of third molars extracted per visit. In the USA, third molar extractions under general anaesthesia are common at surgical units [6]. In the UK, use of general anaesthesia in primary care ended in 2002, while in secondary care local and general anaesthesia for impacted third molar surgery is used in 32% and 46% of cases, respectively [10]. In Belgian hospitals, two-thirds of procedures are done under sedation or general anaesthesia and one-third under local anaesthesia [7].

General anaesthesia requires the involvement of a multi-disciplinary team and leads to additional costs at least when

assessing a single visit. In addition, it cannot be performed at a dentist's office. Thus, in Finland the most typical anaesthesia type for third molar removal is local anaesthesia, used in up to 93% of third molar extractions [1]. In terms of cost-effectiveness, it is therefore appropriate to determine how many third molars can be removed in a single visit.

The aim of this study was to examine the number and characteristics of third molars extracted in a single visit in primary care and their associations with patient's age and sex and operator's experience. The hypothesis was that factors explaining the number of teeth extracted in a visit can be identified. On the basis of these findings, implications to patient care can be considered.

Materials and methods

Study design

A retrospective study on statistics drawn from the electronic patient register was designed and implemented at the Department of Social Services and Health Care of the City of Helsinki, Finland. The study was reported according to the guidelines of Strengthening the Reporting of Observational Studies in Epidemiology (STROBE).

From the patient register, data were acquired of all appointments during 2016 where third molars had been extracted according to a treatment code (Table 1). Extractions done in private clinics or hospitals were not included in this data. In this unit, the type of anaesthesia in third molar extractions is typically local anaesthesia in 93% of cases, sedation in 5%, and general anaesthesia in 2% [1]. The staff of this unit includes approximately 200 dentists, about ten of whom are specialists in oral surgery.

Study variables

The following measurements were recorded from the data: date of appointment, age and sex of patient as explanatory variables, and the following predictor variables: identification of tooth and jaw, method of extraction, diagnosis at extraction and surgical experience of the operator.

The primary outcome variable was the number of third molars extracted in a single visit grouped as either one or more than one. The age of the patient was categorized into the following age groups: 10–19, 20–29, 30–39, 40–49, 50–59, 60–69 and 70 years and older. Site of extraction was grouped as maxilla or mandible. Methods of extraction were categorized as routine extractions (codes EBA00, EBA05, EBA15 and EBA30) or operative extractions (EBA10, EBA12

and EBA20). Diagnosis at extraction was grouped according to the International Classification of Diseases (10th revision) code categories (Table 2). When more than one diagnosis was attributed to an appointment, only one was used in the regression analysis and coded in the order of frequency: K05, K02, K00, K01, K04 and other (for frequencies, see Results). Regular experience of an operator in third molar extractions during the study year was categorized into four groups: 1–50, 51–200, 201–500 and >500 extractions.

Ethical considerations

Permission to use the register-based data was granted by the Department of Social Services and Health Care of the City of Helsinki (registration no. HEL 2017-013965). Because this was a register-based and retrospective study without any patient interventions, there was no need for additional institutional ethics committee approval.

Statistical analysis

The observational unit was an appointment. Differences among various subgroups were evaluated using χ^2 test for frequencies and Mann–Whitney *U* test for means of independent groups. The significant level was set at $p < .01$. Analyses were performed using SPSS Statistics, version 28 (IBM Corporation, Armonk, NY).

Binomial logistic regression analysis was used to identify the impact of contributing variables on the number of third molars extracted at one appointment. Spearman's correlation coefficients among covariates showed no marked correlations. According to the Box–Tidwell procedure, the continuous independent variable (age) was linearly related to the logit of the dependent variable (Wald's test = 0.20; df = 1;

Table 2. Selected subclasses from the International Classification of Diseases (10th revision) for the entity of oral cavity, salivary glands and jaws [12].

Code	Diagnosis
K00	Disorders of tooth development and eruption
K01	Embedded and impacted teeth
K02	Dental caries
K03	Other diseases of hard tissues of teeth
K04	Diseases of pulp and periapical tissues
K05	Gingivitis and periodontal diseases (including pericoronitis)
K07	Dentofacial anomalies (including malocclusion)
K08	Other disorders of teeth and supporting structures (including retained root)
K13	Other diseases of lip and oral mucosa (including cheek biting)

These diagnoses were frequently attributed to third molars.

Table 1. Classification of codes for tooth extraction published by the Finnish Institute for Health and Welfare [11].

Code	Operation	Definition
EBA00	Routine extraction	With elevator and forceps
EBA05	Demanding routine extraction	Separating a tooth, without raising a flap
EBA10	Operative extraction	Raising a flap, followed mostly by osteotomy and separation of tooth
EBA12	Demanding operative extraction	Deep and difficult impactions
EBA15	Extraction of several teeth	Extraction of at least four teeth from a jaw when eradicating an infection
EBA20	Hemisection	Raising a flap, separation and extraction of part of a tooth
EBA30	Extraction of root	Extraction of a root with elevator and forceps

$p=.659$). After identifying outliers with standardized residual values greater than 2.5, four cases were excluded. Thus, 10,890 appointments were enrolled in the logistic regression analysis.

Results

In the study year, the number of appointments in which third molars were extracted was 10,894. Slightly more than half of the appointments were for women (Table 3). The mean age of all patients was 32.2 years (SD 12.1; median 28.0; range 12–97 years). Mean age at extraction was lower for women (30.8 years; SD 11.5) than for men (34.0 years; SD 12.6; Mann–Whitney U test $p<.001$). More than half of the appointments occurred between the ages 20 and 29 years, with peak age at 24–26 years (Table 3).

In these appointments, the total number of extracted third molars was 12,728, yielding an average of 1.2 third molars (SD 0.4; range 1–4 teeth) per appointment. Most appointments (83.7%, $n=9118$) comprised extraction of a single third molar (Figure 1). When more than one was extracted at a time, 15.8% ($n=1,726$) of all appointments included two, 0.4% ($n=42$) three and 0.1% ($n=8$) four third molars. At appointments with more than one extraction, the most frequent combinations were upper and lower third molars from the same side of the cheek (78%, $n=1,385$), followed by both upper third molars (10%, $n=177$).

Descriptive statistics in Table 4 reveal that patients who had one-third molar extracted were older on average than

those who had more than one extracted (32.9 vs. 28.5 years; Mann–Whitney U test, $p<.001$). The number of third molars extracted at a time did not differ by sex. It was more typical of multiple extractions than single extractions that the extraction procedure was operative and included third molars from both jaws. Diagnosis in multiple extractions was more frequently periodontal disease and less frequently periapical disease than in single extractions. The four most common diagnoses at extraction (periodontal disease, caries, unerupted and periapical disease) accounted for 90% of all diagnoses. Less experienced operators extracted more often only one-third molar, while experienced operators extracted more than one ($\chi^2 = 666.66$; $df = 3$; $p<.001$) (Table 4).

In the class of periodontal diseases (K05), the specific diagnosis was pericoronitis for 97% ($n=6160$) of the 6330 teeth in that class: acute pericoronitis (K05.2) 18% ($n=1,131$) and chronic pericoronitis (K05.3) 82% ($n=5,029$). At single tooth extractions, acute pericoronitis occurred more frequently than chronic pericoronitis (86% vs. 59%), while at multiple extractions the opposite was true (14% vs. 41%; $\chi^2 = 282.77$; $df = 1$; $p<.001$).

In the logistic regression analysis, the most remarkable covariates were age of patient, experience of operator, mandibular teeth and diagnosis at extraction (Table 5). The logistic regression model was statistically significant ($\chi^2 = 1615.61$; $df = 11$; $p=.001$), explained 23% (Nagelkerke R^2) of the variance in the number of third molars extracted at a time, and correctly classified 84% of cases. Of the six predictor variables, all, except for sex, had a significant effect on the

Table 3. Age and sex distribution of patients attending a total of 10,894 appointments.

Age (years)	Men		Women		Total	
	<i>n</i>	%	<i>n</i>	%	<i>n</i>	%
10–19	138	3	214	4	352	3
20–29	2173	45	3505	58	5678	52
30–39	1421	29	1404	23	2825	26
40–49	494	10	405	7	899	8
50–59	360	7	247	4	607	6
60–69	191	4	150	2	341	3
≥70	95	2	97	2	192	2
Total	4872	45	6022	55	10,894	100

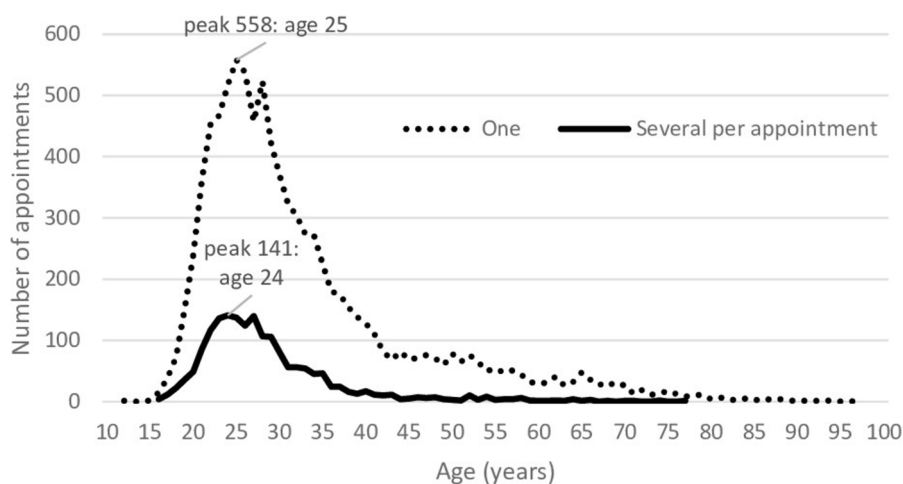


Figure 1. Frequency of appointments ($N=10,894$) with one or several third molars extracted at a time, by patients' ages.

Table 4. Comparison of characteristics of 10,894 appointments according to number of third molars extracted per appointment.

Characteristic	Number of third molars extracted per appointment		p Value
	One n (%)	More than one n (%)	
Total appointments	9118 (84)	1776 (16)	
Patients			
Age (years)			
Mean [SD]	32.9 [12.6]	28.5 [8.2]	<.001 ^a
Range	12–97	16–77	
Sex			
Men	4106 (45)	766 (43)	.140 ^b
Women	5012 (55)	1010 (57)	
Third molars			
Site			
Maxilla alone	4408 (48)	177 (10)	<.001 ^b
Mandible alone	4710 (52)	108 (6)	
Both jaws	0 (0)	1491 (84)	
Extraction method			
Routine alone	6152 (67)	573 (32)	<.001 ^b
Operative alone	2966 (33)	211 (12)	
Both methods	0 (0)	992 (56)	
Diagnosis^c (n = 14,572)			
Periodontal disease (K05)	4064 (41)	2266 (50)	<.001 ^b
Caries (K02)	2600 (26)	1055 (23)	
Unerupted (K00, K01)	1171 (12)	695 (15)	
Periapical disease (K04)	1202 (12)	115 (2)	
Other	963 (9)	441 (10)	
Operator's experience			
Third molar extractions/year			
1–50	3022 (33)	195 (11)	<.001 ^b
51–200	2547 (28)	313 (18)	
201–500	2047 (22)	694 (39)	
>500	1502 (17)	574 (32)	

^aMann–Whitney *U* test^b χ^2 test^cA tooth could have more than one diagnosis for extraction, for example, caries and pericoronitis.

number of third molars extracted in a visit. Increasing age was associated with a reduction in the likelihood of several third molar extractions in a visit (OR 0.96; 95%CI 0.96–0.97) (Table 5). Several third molars were more likely extracted if the procedure also included mandibular teeth compared with maxillary teeth alone (OR 6.70; 95%CI 5.51–8.13). Among all diagnoses, caries had the highest odds of predicting several third molar extractions at a time (OR 1.63; 95%CI 1.41–1.88). At diagnosis of periapical disease, it was more probable that only one tooth was extracted. Multiple third molars were more than twice as likely to be extracted if the operator was experienced (OR 2.32; 95%CI 1.90–2.84) (Table 5).

Discussion

In terms of effectiveness, the aim of the study was evaluating the number and characteristics of third molars extracted in a single visit and their associations with patient's age and sex and operator's experience. The main finding was that in 84% of appointments only one-third molar was extracted at a time. The results supported our hypothesis, and factors explaining the number of teeth extracted in a visit were identified: multiple extractions in a visit were most likely performed when the patient was young, and the operator was experienced.

Economic evaluation concerning the number of third molars extracted at a time has not yet been published. Criteria for the number of teeth per visit haven't been suggested either. However, in an economic evaluation from Sweden, indirect costs (travelling costs, absence from work, etc.) of third molar removal were higher than direct costs

Table 5. Binomial logistic regression model^a predicting the likelihood of extracting more than one third molar at a time, based on age, sex, site of extraction, method of extraction, diagnosis for extraction and experience of the operator (*n* = 10,890 appointments).

Categories	Coefficient	SE	p Value ^b	OR	95%CI
Age	−0.04	0.00	<.001	0.96	0.96; 0.97
Sex					
[Male]					
Female	0.02	0.06	.780	1.02	0.91; 1.14
Site of extraction					
[Maxilla alone]					
Mandibular teeth also	1.90	0.10	<.001	6.70	5.51; 8.13
Extraction method					
[Routine extractions alone]					
Operative extractions also	0.15	0.08	.042	1.17	1.01; 1.35
Diagnosis of extraction					
[Periodontal diseases K05]					
Unerupted (K00, K01)	0.32	0.10	.001	1.38	1.13; 1.68
Caries (K02)	0.49	0.07	<.001	1.63	1.41; 1.88
Periapical disease (K04)	−1.33	0.21	<.001	0.26	0.18; 0.40
Other	−0.03	0.19	.861	0.97	0.67; 1.40
Operator's experience					
[1–50 third molar extractions/year]					
51–200	0.23	0.10	.023	1.26	1.03; 1.55
201–500	0.76	0.10	<.001	2.14	1.76; 2.61
>500	0.84	0.10	<.001	2.32	1.90; 2.84
Constant	−2.58	0.15	<.001	0.08	

Reference group is in square brackets. SE: standard error; OR: odds ratio; CI: confidence interval.

^aHosmer and Lemeshow's test for the model indicated good fit ($\chi^2 = 11.01$; *df* = 8; *p* = .201).^bWald's test.

(costs of labour, materials, radiographs, pharmacy, etc.): €333 vs. €217 [13]. Another recent assessment from the UK concluded that prophylactic removal of third molars is more cost-effective than retaining and watching when patient's quality of life was measured [14]. These findings imply that it would be more cost-effective to extract as many third molars as possible in a single visit than to wait for symptoms to appear. However, according to our results, extraction of third molars was mostly performed one at a time.

In this study, experience of an operator was assessed according to the number of extracted third molars during the study year, irrespective of the academic degree. In earlier studies, experience has mainly been classified according to the number of years since qualified and examined in relation to morbidity after third molar extractions [15,16]. Both measures of experience as a predictor variable document the same outcome, namely that with higher experience more third molars can be extracted in a single visit and morbidity of the patient is lower.

From a patient's point of view, postoperative morbidity should be as low as possible and the recovery rapid. Some information from the patient's perspective is reported in a Spanish study on operative extraction of one mandibular third molar under local anaesthesia; 98% of the patients were satisfied with the treatment and 91% would recommend it, however, only 59% would repeat the treatment [17]. Another recent study from Belgium showed that multiple extractions involving third molars both in the maxilla and in the mandible were associated with higher occurrence of pain, trismus and swelling on the third postoperative day, and on day 10 after surgery multiple extractions were still significantly associated with persistent pain as opposed to extracting only one-third molar [16]. This finding of higher morbidity associated with multiple extractions may favour extracting a single third molar at a time and may be one of the arguments in the present treatment unit of outpatient care using mostly local anaesthesia.

Higher age of the patient has been shown to be associated with higher rate of complications in third molar surgery. This is also reported in extractions performed under local anaesthesia [15]. According to the present study, awareness of the age aspect can be considered fair, as the median age in third molar surgery was 28 years, and 81% of all third molar extractions were performed before the age of 40 years. Relative to an earlier study from the same Finnish treatment unit [1], fortunately, both the mean and median ages have decreased by four years.

As regards the indications for third molar extractions, the most common indications (periodontal disease, caries, unerupted tooth and periapical pathology) accounted for 90% of all diagnoses, which is in line with a recent Belgian study where the same four diagnoses accounted for 97% [7]. However, a distinctive difference appeared in the proportions of asymptomatic and symptomatic indications; in the present study, asymptomatic indications (K00, K01) were the minority (13%), compared with the Belgian study in which prophylactic asymptomatic indications accounted for 67%. This difference can be explained by single tooth extractions performed mostly under local anaesthesia in primary care of

the present study vs. the Belgian study from university hospitals with referred patients.

There are significant differences between countries in third molar strategies, mainly due to the structure of the health care system and the preference for anaesthesia. Studies from the USA indicate that in most appointments all four third molars are extracted at a time by oral surgeons in hospital settings, especially for insured adolescent patients [5,6]. General anaesthesia was used in 65% of those cases [6]. Findings of a telephone survey from Australia also confirm the association of dental insurance with a higher number of third molar extractions [18]. However, according to studies from Belgium and Japan, unilateral extraction of third molars is performed under local anaesthesia, while bilateral extractions are done under sedation or general anaesthesia [7,9]. In Belgium, 62% of appointments in the hospitals examined comprised simultaneous extraction of all four third molars [7]. Thus, the extracting strategies of Belgium and Japan for unilateral extractions resemble ours.

Population studies on the prevalence of third molars reveal that the occurrence of third molars is markedly lower in older persons than in younger persons and that more than one-third molar has been removed during a patient's lifespan [19–21]. Originally, the global rate for all four third molars being congenitally missing is 3.4% of individuals [22]. Thereafter, according to a nationwide population study with panoramic radiographs, the prevalence of persons with all third molars gone in the age group of 30–39 years is 38% and in those aged 70 years and over, 81% [21]. As the present study showed that generally one-third molar was extracted at a time, this means that several appointments are needed to extract all four third molars.

The findings of this study can be generalized to health care units where the majority of third molar extractions are performed under local anaesthesia in outpatient care. Further research is needed on patients' preferences regarding how many third molars should be extracted in a single visit. Research is also warranted on the strategy of extracting only one-third molar at a time and to elucidate whether the methods and indications for removal at older age differ from those at younger age.

A limitation of the study was that the data did not include information on individual patients, such as anamnesis, use of antibiotics, patient's wish for the number of teeth extracted in a visit, or whether there were several appointments during the study year when subsequent third molars were extracted and how soon after the preceding appointment this occurred. Some evidence of repeat procedures is available from the UK, where 95% of patients underwent a single procedure for third molar removals in a general hospital and the rest had repeat extraction visits [23]. After presenting the costs of repeat procedures, the authors of that study encouraged performing additional prophylactic extractions when an indication exists for a single diseased third molar to be removed under general anaesthesia [23].

In conclusion, extraction of third molars mainly under local anaesthesia was typically performed one at a time. However, with higher experience of the operator, several teeth were extracted in a single visit, especially in younger

patients. As repeated visits for third molars put a strain on both the patient and the health care system, performing additional third molar extractions in a single visit if new extractions are anticipated later is recommended. It may be effective to allocate younger patients' extractions to experienced operators.

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ORCID

Abiel Noro  <http://orcid.org/0000-0001-7723-9122>
 Johanna Snäll  <http://orcid.org/0000-0002-8514-5764>
 Irja Ventä  <http://orcid.org/0000-0003-2753-8444>

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