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ORIGINAL ARTICLE

Should removal of lower third molars be included in the pre-graduate curriculum for dental students? An evaluation of post-operative complications after student operations

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Abstract

Objective. To evaluate guidelines for selection of lower third molars (M3) to be removed by dental students (DS) and to compare M3 surgery performed by oral surgeons (OS) and DSs with regard to operation time and post-operative complications. ***Materials and methods.*** Three hundred and thirteen patients with 313 lower M3 were assigned to be operated by either a DS or an OS, depending on the estimated difficulty of the surgery. During the post-operative week patients recorded pain (VAS) and other complications. Complications were also recorded objectively 1 week post-operatively. ***Results.*** Operations performed by DSs lasted longer than operations performed by OSs ($P < 0.001$). There was no difference in immediate post-operative pain intensity between the two groups. There were no differences in patients' perception of bleeding, trismus, bad taste, use of analgesics, absence from work/school and seeking professional help between the two groups. Dry socket occurred more frequently though in patients in the DS group ($P = 0.008$). There was no difference in the frequency of objectively assessed swelling, paraesthesia or infection. ***Conclusions.*** When appropriately selected, patients operated by DSs did not perceive more immediate post-operative pain or complications than patients operated by OSs. However, dry socket and the risk of severe pain caused by this condition occurred more frequently in patients operated by DSs. The criteria used for selection of operations for DSs seem acceptable.

Key Words: *dental education, oral surgery, wisdom tooth*

Introduction

According to some European dental pre-graduate curriculae training in removal of impacted lower third molars is offered, while others state that the theory behind surgical removal is lectured, but students are not offered training in performing the operation [1]. If surgical training is included in the curriculum, the guidelines usually imply that students should be able to remove non-complicated impacted and semi-impacted teeth [2], but not deeply impacted or otherwise complicated molars. An argument against students performing the operation has been that removal of even 'non-complicated' mandibular third molars is an unpredictable task [3], which should be reserved for post-graduate specialist training.

The patient is entitled to information on the risk of complications connected with third molar removal and most dental schools and dental practices obtain informed consent before the operation [4]. The difference among dental school curriculae invites the question whether the operation of selected, 'non-complicated' third molars performed by undergraduate students implies a high risk of post-operative complications. If this is the case, the patient must be informed of the risks before the surgery and thus have the chance to opt out.

No study has evaluated whether existing guidelines for selection of lower third molars for student operations implies severe post-operative complications for the patients. The aim of this study was to assess the operation and the post-operative course following

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removal of selected lower third molars performed by dental students with regard to: operation time, patient's perception of post-operative pain and swelling and objectively examined post-operative complications. More complicated operations performed by the oral surgeons who had trained the students were included as reference. The working hypothesis was that patients operated by dental students and oral surgeons would experience the same levels of pain and frequency of post-operative complications.

Materials and methods

Subjects

During the fourth and fifth year of the 5-year curriculum, dental students (DS) at our university are taught third molar surgery. A dentist with experience in oral surgery or an oral surgeon (OS) supervises the operation and aids the DS only in the case of complications and another DS is the chair-side assistant. All patients referred to the Department of Oral and Maxillofacial Surgery and Oral Pathology for removal of a lower third molar during a 2-year period (September 2005–October 2007) underwent a radiographic and clinical examination to determine whether removal was indicated. The initial radiographic examination consisted of a panoramic or intraoral radiograph and additional images were recorded when needed, e.g. stereo-scanograms [5] for assessment of the relationship between the third molar and the mandibular canal if the root was projected over the canal on the initial image [6]. The clinical examination consisted of an anamnesis to clarify the patient's health conditions, use of medication, use of oral contraceptives, dental history and current symptoms from the teeth and jaws and a clinical examination of the dentition, temperomandibular joint, masticatory muscles and oral mucosa. The state of impaction, the angulation of the tooth, root number and morphology and the relation to the mandibular canal were assessed on the radiographs and recorded. Based on the clinical and radiographic examinations, the OS determined whether or not removal of the third molar was indicated. Indications for removal included recurring episodes of pericoronitis, resorption, caries or marginal bone loss on the distal surface of the adjacent second molar, unrestorable caries or other pathology associated with the third molar and orthodontic reasons.

Based on the radiographic information the surgeon estimated whether the removal of the tooth would be 'complicated' or 'non-complicated'. A 'complicated' third molar was defined as: pronounced distal angulation (more than ~ 10°), deep bony impaction or close relation to the mandibular canal (example in Figure 1). A 'non-complicated' molar was defined as the absence of all these four criteria (Figure 2). 'Complicated' molars were assigned to be removed by

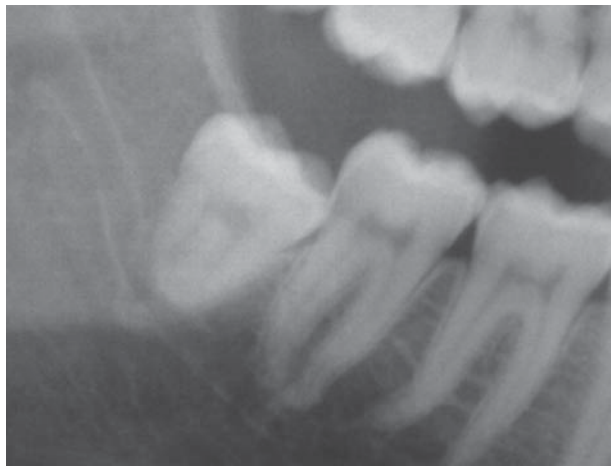

Figure 1. Third molar operated by OS.

OSs while 'non-complicated' molars were assigned to be removed by DSs. If the stereo-scanograms suggested a close relation between the third molar and the mandibular canal, the patient was assigned to an OS. If not, the patient was included in the DS group, provided the third molar was otherwise non-complicated. The patients were informed about the general risks and benefits of the surgery and gave their written informed consent. During the data collection period, 150 DSs and 10 OSs participated in the third molar operations.

Operation of the lower third molar

A standard buccal flap surgical procedure was used by the DSs as well as the OSs. After raising a mucoperiostal flap, bone was removed with a bur if necessary. The tooth was delivered in one piece if possible and, if not, a bur was used to split the tooth into two or more pieces. After delivery of the tooth, any inflammatory tissue or sharp bony edges were removed, the socket and the

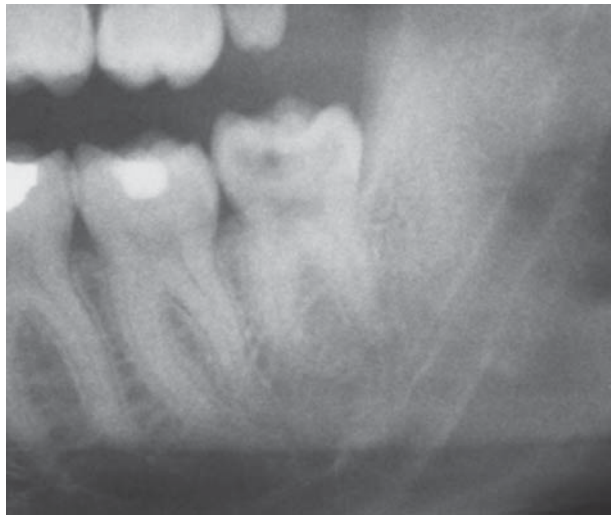

Figure 2. Third molar operated by DS.

operation field were thoroughly irrigated and the wound was sutured. Operation time was recorded in minutes from the time of the incision to the time of the last suture.

After the surgery, the patient was given oral and written information about the post-operative course. Pain control was to be achieved by taking Ibuprofen (600 mg up to three times daily), if necessary combined with Paracetamol (2 × 500 mg up to four times daily). The patient was instructed to avoid chewing hard food until suture removal and not to use a toothbrush in the operated region. Furthermore, the patient was to rinse the mouth in a 0.12% chlorhexidine solution twice daily. The patient was instructed to refrain from strenuous physical activity for the first 48 h. If necessary, patients were given a prescription for antibiotics (penicillin) and instructed how to take the medication. The patient was given an appointment 1 week post-operatively to have the sutures removed and was encouraged to contact the department if any questions arose. The patient filled out a questionnaire during the post-surgery week and returned it at the 1-week visit.

Patient's questionnaire recording during the post-operative week

The patient recorded post-operative pain after 4 (after cessation of the anaesthetics before any analgesics were taken), 8 and 24 h on 100 mm VAS (with 'no pain' and 'worst pain imaginable' as the end-points) and, further, bleeding (no bleeding/little bleeding/massive bleeding), swelling (no swelling/little swelling/massive swelling), bad taste (yes/no) and trismus (yes/no) were recorded. The categorized variables were recorded 24 h after surgery. Number of days absent from work/school (none/one day/2 days/>2 days), number of days with analgesics (none/on the day of surgery/2 days/2–5 days/>5 days) and the need to seek professional help (none/dental school/private dentist/medical doctor/other) were recorded at the end of the week.

Surgeon's recording of complications one week post-operatively

The patient's post-operative questionnaire was collected and complications were recorded by a DS supervised by an OS: alveolitis sicca dolorosa/dry socket (yes/no), infection (yes/no), swelling (yes/no) or sensory disturbances (yes/no, if yes, which nerve was affected). Dry socket was recorded when the patient reported severe pain unresponsive to analgesics, pain migrating towards the ear and a foul smell or taste and when inspection of the wound revealed an empty socket. The operator did not examine his/her own patient.

Data treatment

The program used for data treatment was SPSS 13.0. Operation time and operative factors were recorded during/after surgery. Prescribed antibiotics, the presence of dry socket, infection, swelling and sensory disturbances were recorded from the patient's chart. Patient-recorded variables were recorded using the questionnaires.

Recordings of pain on VAS were measured to the nearest millimetre. Since there were few positive answers to the following variables, they were re-grouped to yes/no variables: seeking professional help, absence from work/school and patient-reported bleeding, swelling and sensory disturbances. Number of days with analgesics was grouped as none+few/many (>5 days).

Paired *t*-tests were used to test for differences in pain intensity at 4, 8 and 24 h post-operatively. Group *t*-tests were used to test differences in pain intensity between the DS and OS groups at 4, 8 and 24 h post-operatively. Group *t*-tests also tested differences in age and in operation time between patients operated by DSs and OSs. Chi-square tests were used to test differences between patients operated by OSs and DSs in patient-reported swelling, bleeding, trismus, bad taste, seeking professional help, absence from work/school and few or many days on analgesics and surgeon-recorded swelling, sensory disturbances, dry socket, infection 1 week after surgery and need for antibiotics. The level of significance was set at $P < 0.05$.

Results

Three hundred and thirteen patients (127 males, 186 females; mean age 27.0 years, range 18.7–70.7 years) each had one lower third molar removed. One hundred and ninety-nine patients were operated by a DS (80 males, 119 females; mean age 26.3 years) while 114 patients were operated by an OS (47 males, 67 females; mean age 28.5 years). Seventy-two (38 in the OS group, 34 in the DS group) patients had stereo-scanograms taken after viewing the initial radiographic image.

Patients operated by OSs were significantly older than those operated by DSs (Δ years 2.2, $P = 0.007$). Operation time was twice as long for a DS as for an OS, the difference being statistically significant (Δ minutes 34, $P < 0.001$) (Table I).

Pain intensity was approximately the same after 4 and 8 h and dropped after 24 h post-operatively.

Table I. Mean operation time (minutes (SD)) and patient-reported pain (mm VAS (SD)).

Variable	DS	OS	*P*
Operation time *n* = 286	66.8 (23.2) *n* = 183	32.9 (17.9) *n* = 103	<0.001
Pain at 4 h *n* = 312	43.8 (26.3) *n* = 198	41.5 (25.2) *n* = 114	NS
Pain at 8 h *n* = 271	49.7 (27.7) *n* = 175	48.8 (25.0) *n* = 96	NS
Pain at 24 h *n* = 309	38.5 (27.5) *n* = 198	40.5 (26.7) *n* = 111	NS

There was no significant difference in pain intensity at any time period (Table I) between patients operated by DSs and by OSs ($P > 0.4$). There were no significant differences in patient-reported bleeding ($P = 0.90$), trismus ($P = 0.52$), bad taste ($P = 0.73$), swelling ($P = 0.82$), use of analgesics ($P = 0.91$), absence from work/school ($P = 0.48$) and seeking professional help ($P = 0.17$) among patients operated by DSs and by OSs (Table II). A number of patients had not reported on swelling.

There was no significant difference in the frequency of surgeon-reported swelling, sensory disturbances or infection between the two groups ($P > 0.5$). Two patients in each group experienced sensory disturbances from the inferior alveolar nerve (three permanent and one temporary) and one patient in each group experienced sensory disturbances from the lingual nerve (one permanent and one unknown). Patients operated by OSs had a significantly lower frequency of dry socket (1.8%) than patients operated by DSs (9.5%) ($P = 0.008$). The figures are shown in Table III. Some patients experienced a combination of dry socket and infection ($n = 4$), dry socket and swelling ($n = 8$), swelling and infection ($n = 9$) or all three ($n = 1$).

To illustrate the inter-relationship between the operator and other factors, which could determine the presence of dry socket, logistic regression analyses were performed. Initially it was shown that women had dry socket more frequently than men (9.1% and 3.1%, $P = 0.040$) and that the use of oral contraceptives (48 women in the OS group (60%), 93 women in the DS group (68%)) or antibiotics (14 patients in the OS group (12%), 11 patients in the DS group (6%)) did not affect the frequency of dry socket ($P > 0.2$). In the final multivariate logistic regression analysis, sex (male/female), age (interval-scale variable entered ascending), operator (DS/OS) and operation time (interval-scale variable entered ascending) were entered as independent variables with dry socket as the outcome (dependent) variable (Table IV). The results were that a patient operated by a DS had an almost 10-times higher risk of getting a dry socket than a patient operated by an OS and that a woman had a four-times higher risk than a man. Age was just non-significant and operation time had no impact.

To determine whether dry socket caused patients to seek help, a chi-square test was performed. This showed that patients with dry socket sought help more frequently (76.2%) than patients without dry socket (14.2%; $P < 0.001$). Patients with dry socket were not significantly more absent from work than patients who did not have dry socket (66.7% vs 49.5%, $P = 0.097$).

Table II. Patient-reported post-operative complications.

Variable	DS	OS	Total
Bleeding, $n = 313$, no/yes	76/123	45/69	121/192
Trismus, $n = 313$, no/yes	32/167	15/99	47/266
Bad taste, $n = 313$, no/yes	90/109	54/60	144/169
Use of analgesics, $n = 310$ ≤5 days/>5 days	108/90	62/50	170/140
Work absence, $n = 310$, no/yes	100/96	53/61	153/157
Professional help, $n = 309$, no/yes	156/41	96/16	252/57
Swelling, $n = 141$, no + little/yes	54/33	25/29	79/62

Table III. Surgeon-reported post-operative complications.

	DS	OS	Total	*P*
Dry socket, no/yes	180/19	112/2	292/21	0.008
Swelling, no/yes	142/57	86/28	228/85	NS
Sensory disturbances, no/yes	196/3	111/3	307/6	NS
Infection, no/yes	188/11	108/5	296/16	NS

Discussion

Patients who accept to be treated in a university clinic by dental students may get the benefit that the treatment is costless; however it is also more time-consuming. The patient has the right to be informed of the time use and possible risks and complications related to dental treatment and it should be underlined if the risks are higher when the treatment is performed by dental students. It seems that research is lacking on risks for errors and complications in treatments performed by dental students. Such research is not easily conducted since for many treatments long observation times are needed and for many types of treatment it would not be ethical to perform a randomized trial between students and dentists.

Removal of impacted lower third molars may be seen as a specialist task to be part of post-graduate rather than pre-graduate dental education. Alternatively, virtual methods could be used to train dental surgery. Whereas suitable models exist for training e.g. apicectomies, third molar surgery is not yet virtually available [7].

Table IV. Multivariate logistic regression analysis with dry socket as the outcome variable. The group in brackets is the reference group.

	OR	*P*	95% CI
Operator (OS)	9.46	0.010	1.70–52.70
Age (ascending)	1.06	0.060	0.99–1.14
Sex (female)	4.02	0.031	1.13–14.29
Operation time (ascending)	0.99	0.451	0.97–1.01

In most Scandinavian dental schools, students operate so-called 'non-complicated' third molars with little help from their tutors. The criteria for determining a third molar 'non-complicated' to remove are based on knowledge from previous studies that deeply impacted, disto-angulated molars are difficult to remove resulting in more severe complications [8–10] and that a close radiographic relationship between the tooth and the mandibular canal is a sign that may lead to sensory disturbances after the operation [11,12]. Studies have further shown that surgery performed by experienced oral surgeons resulted in less severe post-operative pain and fewer complications than when performed by less experienced surgeons [13–15]; but one study found no such difference [16].

For ethical reason dental students are therefore allowed to operate only third molars which, based on their radiographic appearance, do not fall into the category 'complicated'. Nevertheless, studies should still assess whether the selection criteria for 'non-complicated' molars to be operated by students in fact do not result in severe patient complications and to our knowledge such studies have not been performed. Such studies may be determined quality control studies and can for ethical reasons not be conducted as randomized trials.

Based on the literature it could be presumed that operations by students would lead to more post-operative complications for the patient, but since students only operated the 'non-complicated' molars, this 'student factor' was unknown and could not be estimated from previous research. The working hypothesis was therefore that patients operated by dental students and oral surgeons would experience the same level of pain and frequency of post-operative complications.

This hypothesis could not be rejected for the majority of post-operative variables that were assessed. The level of reported pain during the first 24 h after surgery for DS patients as well as OS patients was lower than or similar to that reported in other studies on pain after removal of lower third molars [16–18].

One important finding, however, was the difference in number of dry sockets, which occurred much more frequently in patients operated by students (10% with dry socket) than in those operated by surgeons (2% with dry socket). These frequencies are within the range of those found by others [8,19–22]. Operation time was also longer for a student than for a surgeon, but time was not a factor affecting the occurrence of dry socket in the logistic regression analysis. Moreover, dry socket occurred more frequently in women than in men. The reasons for dry socket are not completely clarified. Some studies indicate that age, sex, smoking, use of oral contraceptives, use of antibiotics as well as some tooth-related factors and operative factors can play a role in the development of dry socket [8,10,20–23]. Smoking was not registered in our study, but the background population is known to have a low smoking frequency. There was a tendency towards a higher occurrence of dry socket with older age, but it was not a statistically significant factor. The higher frequency of dry socket did not result in a higher level of pain reported by the patients operated by students, but this might be explained since the pain intensity was only reported at 4, 8 and 24 h post-operatively and dry socket typically occurs 2–3 days after surgery. However, there were no significant differences in the fraction of patients who sought professional help during the 1-week post-operative period between the OS and DS group. Patients who had dry socket more frequently sought professional help. However, the occurrence of dry socket did not result in more days absent from work. Patients with dry socket were treated with a gauze soaked in eugenol for 24 h, repeated if necessary. This treatment was sufficient in all cases.

Patients operated by surgeons were on average older than those operated by students, which enhances the difference in dry socket found between the two operator groups since several studies have shown a higher complication rate after third molar removal with increasing age [13,22,24–26]. One study showed a higher rate of dry socket in patients operated by general practitioners than patients operated by trained oral surgeons [24], which is consistent to our findings that less experience resulted in a higher frequency of dry socket. Severe surgical 'trauma' and inadequate irrigation during surgery have been suggested as other risk factors for development of dry socket [26] and these factors cannot be excluded when inexperienced students are operating. However, it should be kept in mind that, although the frequency of dry socket was significantly higher for the DS group compared to the OS group, it is not higher than that found in another study where patients were operated by oral surgery residents [19].

It may be speculated why two patients in the student-operated group experienced sensory disturbances of the inferior alveolar nerve since the third molars that they operated were selected on the basis that the relationship between the tooth and the mandibular canal was not close. However, a two-dimensional radiograph cannot always reproduce a three-dimensional structure and an apparently safe distance between the mandibular canal and the tooth can be deceiving. A sensory disturbance can also be caused by the needle during the injection. In the surgeon-operated group also two patients experienced disturbances of the inferior alveolar nerve, but these molars both had a radiographically observed close relationship to the canal. This prevalence for sensory disturbances of 2.6% is within the range of that reported in other studies [16,24,27–29]. Four of the six sensory disturbances persisted after 1 year (all OS patients and one DS patient with disturbance

of the inferior alveolar nerve), one was temporary (DS patient with disturbance of the inferior alveolar nerve) and the last case was not available for questioning about the sensory disturbance since he had not shown up for appointments 1 year post-operatively (DS patient with disturbance of the lingual nerve).

In conclusion, the present findings indicate that patients with so-called non-complicated third molars, who are operated by dental students, should be informed that the operation time on average is more than 1 h, which is double the time that surgeons use for even more complicated operations. The patient should also be informed that the longer operation time does not influence the immediate post-operative pain intensity, swelling or days absent from work, however there is a risk of almost 10% that a dry socket will occur and that severe pain may result from this condition. This risk was higher than when oral surgeons operated even more complicated third molars.

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