Radiographic findings on 3rd molars removed in 20-year-old men

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In this study we assess radiographic findings characteristic of mandibular 3rd molars that had required either routine or surgical extraction. X-ray findings relating to acute pericoronitis were also examined. The material was collected by investigating patient records and rotational panoramic radiographs of 20-year-old Finnish male conscripts ($n = 738$) treated during military service because of 3rd-molar-related problems. The follicle around the crown of mandibular 3rd molars with acute pericoronitis was enlarged in 19% of cases and in 13% of chronic symptom-free pericoronitis cases (not statistically significant difference). Mandibular 3rd molars extracted surgically were more often mesially inclined than those extracted routinely (61% vs. 23%; $P < 0.001$), partially or totally intrabony impacted (92% vs. 66%; $P < 0.001$) and deep situated (on average 4.2 mm vs. 2.5 mm under the occlusal plane). Surgical extraction was also associated with the roots completely developed [92% vs. 84% of the teeth routinely extracted, odds ratio (OR) 2.6, 95% confidence interval (CI) 1.2–5.5] and with the absence of radiographic pericoronitis [around 27% vs. 39% of the teeth routinely extracted (OR 0.5, 95% CI 0.3–0.8)]. In 86% of cases the space between 2nd molar and ramus of the mandible was narrower than the 3rd molar extracted surgically, whereas this was 62% in routine extraction cases ($P < 0.001$). We conclude that there are some typical 3rd-molar findings in rotational panoramic radiographs that show a need for surgical extraction.

☐ *Molar, third; radiography, panoramic; tooth extraction; tooth, impacted*

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In order to avoid complications, the best time to extract a 3rd molar, if the decision to extract has been taken, is when the root is two-thirds formed, i.e. when contact to the mandibular canal is minimal (1, 2). Removal of a mandibular 3rd molar is more complicated the more inclined the tooth is, the more curved or enlarged the roots are, the deeper the tooth is positioned, and the shorter the mesiodistal space between the adjacent 2nd molar and the ramus of the mandible (3, 4). Caution is required if there is narrowing or bending of the mandibular canal at the apical region of a 3rd molar, bending of a root around the canal, interruption in density of the canal outline, or darkening of the root (5, 6).

On the basis of an examination of panoramic radiographs, Tanaka et al. (7) showed that the mandibular 3rd molars of subjects born in the 1990s were often at an abnormal angle and closer to the mandibular canal than those of subjects born in the 1970s. Our study (8) showed that today's Finnish 20-year-old conscripts have significantly more partially erupted lower 3rd molars than Finnish students had in 1940 (9), but significantly fewer had totally erupted lower 3rd molars. The presence of impacted 3rd molars is associated with reduced space between the lower 2nd molar and ramus of the mandible (10). It may not be too daring to hypothesize that surgical extraction of mandibular 3rd molars is more common today than in previous generations.

Only rarely have recent publications discussed radiographic findings related to difficulties and complications in 3rd molar surgery. This study was undertaken to recover and analyze typical X-ray findings related to routine extraction of mandibular 3rd molars and to compare them with X-ray findings related to more complicated operations and need for surgical extraction of the tooth.

Materials and methods

Subjects

The series was based on the data of all the 3rd-molar-related treatments of male conscripts over a period of 5 years in the hospitals of 2 large garrisons in southeastern Finland. During this period, 1510 conscripts made 3708 visits (on average 2.5 visits per man) to the garrison hospitals because of problems with their 3rd molars. The final material comprised 738 (49%) conscripts (mean age 20.5 years, *s* (standard deviation) 1.2) who had been examined with rotational panoramic radiography. Conscripts with no radiographs were excluded from further consideration here, as they had only been clinically examined or treated restoratively, or had had their maxillary 3rd molars extracted without preoperative radiographs being taken.

Clinical examination, classification of treatment

The clinical diagnoses of the 3rd molars examined and treated were recorded according to the International

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Classification of Diseases (11). The final treatment of every 3rd molar was classified as examination (information or drug prescriptions only), restorative treatment, operculectomy, extraction (requiring/not requiring soft tissue incision over the occlusal surface) and surgical extraction requiring buccal soft tissue incision following either bone removal or tooth sectioning or both.

Radiographic examination

Rotational panoramic radiographs were taken using OP 10 (Palomex Co., Finland) and Cranex DC 2 (Soredex Co., Finland) units. Slight differences in the shape of sharply depicted layer (12) and vertical magnification (13) between the units were taken into account when interpreting the radiographs. The radiographs were evaluated by an experienced consultant in oral radiology (J.P.).

The numbers of radiographically missing and decayed 3rd molars were recorded. Inclination of 3rd molars was measured and the tooth was classified as vertical if it was 85–95° inclined with respect to the mandibular and maxillary occlusal plane. A horizontal line drawn between the most superior points of the occlusal surfaces of the 1st and 2nd molars corresponds to the occlusal plane. Radiographically, a vertical 3rd molar is defined as 0–10° mesially inclined in the mandible, but 10–20° distally inclined in the maxilla. Level of eruption (vertical depth in mm) was recorded with respect to mandibular or maxillary occlusal plane. Development of the roots was classified as either incomplete or complete. The 3–6 mm enlargement of the distal follicle and enlargement over 6 mm (possible follicular cyst) were noted. The mandibular retromolar space at the occlusal level was classified by comparing the width of the 3rd molar to the space between 2nd molar and anterior border of the ascending ramus. The impaction of mandibular 3rd molars was classified according to ADA: no impaction, soft tissue impaction, partially impacted in bone, and totally impacted in bone. Radiographic findings of pericoronitis were as follows: crown follicle or bone margin adjacent to mandibular 3rd molar was broken or diffuse and/or there was sclerosis due to inflammation in the nearby bone.

Special attention was paid to the treatment given relative to the radiographic findings above.

Statistics

To evaluate intra-examiner (J.P.) reliability, agreement percentages and Kappa indices (14) were calculated. Thirty-five randomly chosen radiographs were evaluated a second time 2 weeks after the first examination. The percentage agreement for different items studied varied from 91.4 to 99.2 and Kappa indices from 0.83 to 0.99. The chi-squared test (the 5% level was used as significant throughout) and logistic regression analysis (SPSS 10.0) were used to explain associations between mandibular radiographic findings and the surgical method used (extraction vs. surgical extraction). The radiographic findings 'complete root development', 'follicle not enlarged', and 'no pericoronitis' were hypothesized to increase need for surgical extraction which was explained by odds ratio (OR) and 95% confidence interval (95% CI). Only vertical (±10°, in other words 75–105° with respect to occlusal plane) mandibular 3rd molars with eruption level 5 mm or less under the occlusal plane were included in the regression analysis ($n = 366$ teeth extracted routinely and 142 teeth extracted surgically). The goodness-of-fit of the models was tested by means of the Hosmer-Lemeshow test; models had a reasonably good fit ($P > 0.05$).

Table 1. Distribution of treatments of 3rd molars (numbers of teeth and percentages) in 738 conscripts

	Maxilla		Mandible		Total	
Treatment	*n*	%	*n*	%	*n*	%
Extraction	408	81.8	146	15.1	554	37.8
Requiring first soft tissue incision	26	5.2	354	36.6	380	25.9
Surgical extraction	10	2.0	358	37.0	368	25.1
Examination only	19	3.8	71	7.3	90	6.1
Restorative treatment	35	7.0	28	2.9	63	4.3
Operculectomy	1	0.2	10	1.1	11	0.8
Total	499	100	967	100	1466	100

Results

Patient records

During the 5-year period, a total of 1302 third molars were removed from 738 conscripts, on average 1.8 teeth per man (Table 1). The most common diagnosis was pericoronitis, followed by abnormal position (Table 2). Of the 404 acute pericoronitis cases, 27.5% required medication; 15.8% required antimicrobial drugs and 11.6% of cases were treated with chlorhexidine mouth rinses only.

Radiographic findings

One to four 3rd molars were preoperatively missing in

Table 2. Distribution of clinical diagnoses (numbers and percentages) of the 3rd molars examined and treated in 738 conscripts

	Maxilla		Mandible		Total	
Diagnosis	*n*	%	*n*	%	*n*	%
Abnormal position	300	54.6	208	16.6	508	28.2
Chronic pericoronitis	15	2.7	409	32.6	424	23.5
Acute pericoronitis	46	8.4	358	28.6	404	22.4
Caries	123	22.4	87	6.9	210	11.6
Unspecified pain	20	3.6	142	11.3	162	8.9
Cheek biting	34	6.2	29	2.3	63	3.5
Pulpitis or pulp necrosis	9	1.6	12	1.0	21	1.2
Apical periodontitis	3	0.5	6	0.5	9	0.5
Others	0	0	3	0.2	3	0.2
Total	550	100	1254	100	1804	100

Table 3. Radiographic characteristics of mandibular 3rd molars either extracted ($n = 454$) or surgically extracted ($n = 351$)

	Extraction	Statistical difference	Surgical extraction
Inclination			
Mesioangular	23%	$P < 0.001$	61%
Vertical[1]	38%		16%
Distoangular	39%		23%
Level of eruption[2]	–2.5 mm (1.5)		–4.2 mm (2.3)
Complete root development[3]	84.4%	$P = 0.014$; OR 2.6 (1.2–5.5)[4]	92.3%
Follicle enlarged[3]	13.6%		16.9%
Radiographic pericoronitis[3]	38.5%	$P = 0.017$; OR 0.5 (0.3–0.8)[4]	26.8%
Space, 2nd molar – ramus			
Tooth wider than space	62.4%	$P < 0.001$	86.0%
Impaction according to ADA			
Partly or totally imp. in bone	65.9%	$P < 0.001$	91.5%
Radiographic caries	11.9%		6.6%

[1] Inclination was clinically 85–95° with respect to occlusal plane.
[2] With respect to occlusal plane, mean with standard deviation.
[3] Inclusion criteria: vertical tooth ±10° (75–105° with respect to occlusal plane), level of eruption 5 mm or less under the occlusal plane ($n = 366$ teeth extracted routinely and $n = 142$ teeth extracted surgically).
[4] Odds ratio with 95% confidence interval in parentheses.

21.5% of the subjects; 14.0% had one or both the maxillary 3rd molars missing (9.1% of the maxillary 3rd molars); and 11.2% of the subjects concerning the mandible (6.8% of the mandibular 3rd molars). Caries were found in 238 third molars (8.6% of the 3rd molars present), and 55 third molars (2.0%) were healthy but filled.

The distal follicle of the mandibular 3rd molars was enlarged in 11% of cases and follicular cyst was detected (width of the follicle over 6 mm) in 1%. Enlarged follicle was recorded in 18.9% of cases with mandibular pericoronitis needing medication versus 13.1% of cases with chronic symptom-free pericoronitis. The percentages were not statistically different, nor had inclination of mandibular 3rd molars any association with the seriousness of pericoronitis.

With regard to maxillary 3rd molars, 99% of the teeth extracted routinely were mesially inclined versus 82% of the teeth extracted after soft tissue incision over the occlusal surface. The respective percentages of vertical maxillary 3rd molars were 1% versus 14% ($P < 0.001$). Maxillary 3rd molars extracted after soft tissue incision were more deeply situated (65% of the teeth situated 6 mm or more deeply from the occlusal plane) than the teeth extracted routinely (15%, $P < 0.001$).

The mandibular 3rd molars extracted surgically were more frequently mesially inclined (61%) and deeply situated (39% of the teeth had eruption level 5 mm or more under the occlusal plane) compared with the teeth extracted routinely [23% for mesial inclination ($P < 0.001$) and 8% for eruption level ($P < 0.001$)] (Table 3).

The commoner the complete apical root development, the more complicated the extraction [92.3% of the mandibular 3rd molars extracted surgically had the root apex closed versus 84.4% of the teeth extracted routinely ($P = 0.014$, OR 2.6, 95% CI 1.2–5.5)]. Radiographic pericoronitis was rarer in the surgical extraction group (26.8%) than in the routine extraction group (38.5%, $P = 0.017$, OR 0.5, 95% CI 0.3–0.8). Enlargement of the follicle did not explain the requirement for surgical extraction (Table 3).

Related to the ADA impaction classification, mandibular 3rd molars extracted surgically were more often partially or intrabony impacted than were teeth extracted routinely (91.5% vs. 65.9%; $P < 0.001$). If the mandibular 3rd molar was surgically extracted, the mesiodistal space between the 2nd molar and the ramus mandible was wider than the tooth in 14% of cases compared with 37.6% of the routine extraction cases ($P < 0.001$) (Table 3). Behind the restoratively treated mandibular 3rd molars, the space was wider than the tooth in 75% of cases ($P < 0.001$, in comparison with extraction cases).

Discussion

Chandler & Laskin (15) showed that panoramic radiographs cannot be used to accurately estimate the amount of bone overlying a 3rd molar. However, according to our results, the difference between need for surgical extraction compared to routine extraction can be roughly estimated from panoramic radiographs. The estimate was made by measuring the mesiodistal space available for the 3rd molar between the mandibular 2nd molar and the ramus of the mandible, and by comparing that space with the mesiodistal width of the crown of the mandibular 3rd molar. A typical mandibular 3rd molar requiring surgical extraction is wider than the mesiodistal space as defined, or the tooth is mesioangularly inclined or is partially or totally impacted in bone. In addition, we preferred to base our estimate on the mesiodistal space because the inclination of the 3rd molar does not seem to be important where mesiodistal width is concerned (16). In clinical practice, this method may be useful in our deciding how a

particular 3rd molar should be removed when only a radiograph is available during the preliminary consultation.

The distally inclined mandibular 3rd molars have an odds ratio about 5 to 12 times higher of developing pathologic conditions, mostly pericoronitis, in comparison with mandibular 3rd molars with other inclination positions (17). The risk for pathology is 22 to 34 times higher for partially erupted mandibular 3rd molars than for teeth completely covered by soft or bone tissue (17). Typical findings for pericoronitis are close contact with the adjacent 2nd molar and eruption level at a little above or at the occlusal plane (18). Ventä (19) showed that if all the mandibular 3rd molars with enlarged follicle were removed, the incidence of acute pericoronitis would decrease by almost 40%. In the present study, the most common indication for treatment of 3rd molars was acute or chronic pericoronitis (46%) followed by abnormal position (28%). In a study by Lysell & Rohlin (20) involving subjects with a mean age of 27 years, the most common indication for removal was 'prophylactic' (27%), while earlier episodes of pericoronitis accounted for 25%. However, the difference between 'chronic pericoronitis' and 'normal' symptoms during tooth eruption is unclear, as is the difference between 'abnormal position' and 'lack of space'.

Whether or not impaction of 3rd molars is a pathologic condition, and whether such 3rd molars should be removed or not, has been widely debated in recent years. Song et al. (21) concluded that there is no reliable research evidence in the dental literature supporting prophylactic removal of pathology-free impacted 3rd molars, and retention of these teeth may be more effective and cost-effective than prophylactic removal. Third molars in Finland erupt at an average age of 20 years (9). Eruption of upper 3rd molars takes from 2 to 5 months, whereas eruption of lower 3rd molars takes longer and has not been exactly determined (9). However, Ventä et al. (22) recently followed same patients from age 20 to 32 and showed that considerable radiographic changes may occur involving inclination and state of impaction of 3rd molars during that 12-year period. Hattab & Alhaija (10) showed that 83% of the crowns of impacted 3rd molars were wider than the space between 2nd molar and the ramus of the mandible, whereas the percentage was only 31% when measuring the teeth that erupted normally. The average space/crown width ratio in the impacted group was 0.78 and in the erupted group 1.06.

Concerning our radiographic method, kappa indices for intra-examiner variation were adequate (0.83 to 0.99) in the evaluation of all variables. The slight difference in the vertical magnification of the units (1.25 for OP 10 and 1.3 for Cranex DC 2) was taken into account using specific rulers. Consequently, all figures correspond to real measures. Horizontal measurements were taken only if measurement of the enlarged follicle was not possible otherwise. The horizontal magnification factor increases towards the rotation centre of the beam and decreases towards the film in different positions of the patient's head. In the lateral parts of the image the horizontal variation is much less pronounced (12), so horizontal measures are acceptable in the region of a 3rd molar. Since position of the patient's head during the exposure affects the inclination of 3rd molars, a tolerance of 10° was used when judging whether a tooth was vertically situated or not (23).

We have presented some of the specific radiographic findings that are related to requirement of surgical extraction of mandibular 3rd molars. These may help a general practitioner to decide whether to consult oral and maxillofacial surgeon preoperatively.

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