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# A retrospective overview of treatment choice and outcome in 126 cases with arrested eruption of mandibular second molars

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Abstract The purpose of the present retrospective study was to analyze treatment choice and outcome in patients with retention/impaction of the mandibular second molar. Radiographic material, from three large clinics, from 106 patients (60 males and 46 females) with 126 retained/impacted permanent mandibular second molars treated during the years 1985–2005 was evaluated for treatment choice and treatment outcome. Follow-up questionnaires were sent to dentists in cases where treatment outcome could not be determined from the radiographic material. Clinical evaluation was not possible as the patients were no longer associated with the clinic where they were treated. The cases were categorized into six groups: (A) no treatment; (B) orthodontic treatment; (C) surgical exposure of the second molar; (D) removal of the third molar; (E) removal of the second molar; and (F) other treatments. The various treatment choices performed during 1985-2005 showed acceptable results in 66 of the cases. In 23 cases, the results were unacceptable. In 37 cases, the radiographic material could not document the outcome nor was evaluation

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J. O. Andreasen Section of Rare Oral Diseases, Department of Oral and Maxillo-Facial Surgery, Copenhagen University Hospital (Rigshospitalet), Copenhagen, Denmark of the final outcome possible due to the patient's young age. Remarkable are the high percentages of unacceptable treatment outcome, 25.9% in group D (removal of third molar) and 23% in group E (removal of second molar). As the material was collected before new advanced methods of surgical uprighting and new methods of orthodontic uprighting had been introduced, these percentages are expectedly lower today. Even so, it is highly recommended to focus especially on these two groups in future studies on treatment outcome.

**Keywords** Eruption · Second molar · Orthopantomogram · Treatment outcome · Retention

### Introduction

Arrested eruption of the lower second molar is a rare condition, which often occurs unexpected for the dentist. In the literature, studies on this condition are usually case reports [1], but also more systematic overviews have been given [2]. The frequency of arrested eruption, also as designated retention or impaction of the permanent lower second molar, is between 0.6/1,000 and 10/1,000 [2, 3]. There are presently no precise guidelines in the literature for treatment of these cases based on specific dental characteristics. During the last 10 years, several reports on advanced surgical uprighting and on orthodontic uprighting have appeared in the literature [4–7].

Vedtofte et al. [8] showed that patients with arrested eruption of the mandibular permanent second molar had an increased sagittal jaw relationship (class II) when compared with a reference group. Specifically, the mandibular prognathism was less, the mandibular gonial angle reduced, the mandibular alveolar prognathism enlarged, and the maxillary incisor inclination was less than in the reference group. Furthermore, a more frequent occurrence of morphological tooth anomalies was observed, such as root deflections, invaginations, and taurodontism. However, none of the patients with arrested eruption of the second molar had agenesis of the lower third molar. The study did not reveal an association between the degree of inclination of the second molar and that of the first molar in the same region [8]. Several of these observations are recently confirmed by Cho et al. [3].

With regards to treatment, there are several ways to treat the arrested eruption of the mandibular permanent second molar, e.g., surgical exposure or orthodontic uprighting and extraction in cases with ankylosis (retention) [4–7, 9]. Different criteria for selecting extraction have been discussed by Dacre [10] who concluded that successful outcome of extraction of the second molar depends on space, position, and eruptional capacity of the third molar.

In a previous report on mandibular permanent first molar retention, distinction was made between primary and secondary failure of eruption [11]. That study showed that the permanent molar erupted successfully in cases where the molar had never penetrated the mucosa, i.e., in cases with primary failure of eruption. The study also showed that in cases of secondary failure of eruption of first molars, which had penetrated the mucosa, the first molars did not erupt further.

Based on the study by Nielsen et al. [11], the first hypothesis of the present study is that also in primary failure of eruption of second molars, the molars can erupt after surgical exposure or after orthodontic treatment if space is available. The retention may be caused by a malfunction of the crown follicle. The second hypothesis is that the second molars can also erupt in cases with reduced space if diagnosed early and if the third molar is extracted. The third hypothesis is that in secondary failure of eruption of the second molar, eruption does not occur regardless of treatment choice.

In order to verify the above mentioned hypotheses, the purpose of the present study was to perform a retrospective analysis of treatment choice and outcome on a radiographic material from a large group of patients with retention/ impaction of the second molar.

### Material and methods

#### Radiographic material

From 106 patients (60 males and 46 females, aged 11 years 2 months–19 years 8 months) a complete material of dental film and panoramic radiographs of 126 retained/impacted

permanent mandibular second molars was available (Table 1). The material, collected between 1985 and 2005, originated from three different sources: (1) an archive of radiographs referred to Inger Kjær at the Department of Orthodontics, University of Copenhagen, Denmark, for diagnostics and treatment guidance; (2) the Municipal Dental Service of Frederiksberg, Denmark, and (3) the Section of Rare Oral Diseases, Department of Oral and Maxillo-Facial Surgery, Copenhagen University Hospital (Rigshospitalet), Denmark. In cases where the treatment result could not be determined from the radiographic material, three follow-up questions were sent to the dentists inquiring about treatment choice, treatment outcome, and any problems occurring during the treatment. The dentist was also asked to forward the patient's most recent radiograph.

If a panoramic radiograph was available, a morphological description of the dentition in general (crown/root morphology, agenesis, and eruption deviations) was performed as well as a specific description of the second and third molar regions. The cases were categorized into six groups according to choice of treatment:

- A. No treatment
- B. Orthodontic treatment
- C. Surgical exposure of the second molar
- D. Removal of the third molar
- E. Removal of the second molar
- F. Other

The treatment outcome was defined as acceptable when all molar cusps were in occlusion and unacceptable when not all molar cusps were in occlusion.

#### Control

All radiographs were examined by two authors (JK and IK) and the results were compared. If doubt/disagreement occurred whether findings were normal or pathological, the condition was agreed to be registered as normal. The same was decided for evaluation of treatment outcome. If there was doubt/disagreement, the result was registered as not successful.

### Results

An overview of the number of patients in each of the treatment groups (A–F) is presented in Table 1. This table also shows within each treatment group the number of patients with acceptable treatment outcome and the number of patients with unacceptable treatment outcome as well as the number of patients that could not be evaluated.

Group	Group A	Group B	Group C	Group D	Group E	Group F	Total
Number of teeth	13	7	10	27	61	8	126
Acceptable 66 (52.4%)	9 (66.7%)	7 (100%)	9 (90%)	9 (33.3%)	24 (39.3%)		8 (100%)
Unacceptable	2 (16.7%)	_	_	7 (25.9%)	14 (23%)	_	23 (18.3%)
Evaluation not possible	2 (16.7%)	_	1 (10%)	11 (37.9%)	23 (40.7%)	-	37 (29.4%)

Table 1 Treatment outcome of six groups of impacted/retained permanent mandibular second molars (A-F), arranged according to choice of treatment

Treatment outcome is listed according to a subdivision of the material with retained second molars in the following groups—A: no treatment; B: orthodontic treatment; C: surgical exposure (denudation) of second molar; D: removal of third molar; E: removal of second molar; F: other treatment choices. For each group, the number of second molars (n) is indicated

#### Summary of findings in each treatment group

# Group A: no treatment (13 impacted/retained second molars)

Of these 13 cases, the outcome of nine was acceptable and two were unacceptable. In the 13 cases, different factors seemed to have caused the arrested eruption. One factor was slightly reduced space which occurred in two cases. In both cases, the second molar had normal tooth morphology and one case completed normal eruption. Another factor seen in two cases was deviant root formation in the second molar in the form of taurodontic molar shape (Fig. 1). In the remaining cases, deviations in the position of the second molar and/or in the maturity of the second molar occurred. Definition of taurodontia (including mesotaurodontia and hypertaurodontia) was performed according to Ackermann et al. [12].

# *Group B: orthodontic treatment (7 impacted/retained second molars)*

Seemingly, the factor causing arrested eruption was the same as reported in group A in three of the seven cases. In a

fourth case, late development and late eruption of the second molar had indicated orthodontic treatment. In the three remaining cases, gracile and short molar roots had indicated orthodontic treatment. None of the second molars showed taurodontic root shape.

# Group C: surgical exposure of the second molar (10 impacted/retained second molars)

In all ten cases, the cause of retention was primary failure of eruption. After surgical exposure, and in two cases combined with removal of the third molar, the second molar erupted normally (Fig. 2). Two second molars had taurodontic root morphology.

## Group D: extraction or removal of the third molar (27 impacted/retained second molars)

Of these 27 cases with extraction or amotio of the third molar, reduced space and/or deviant molar inclination were the causative factors. The choice of treatment seemed random, and unacceptable results were most likely due to undiagnosed secondary retention of the second molar.

Fig. 1 Radiographs from a girl before (a) and after (b) eruption of the permanent mandibular second molar. This case belongs to group A (impacted/retained second molars) where no treatment was initiated. Note the taurodontic root morphology of the second molar





Fig. 2 Radiographs from a girl before (a) and after (b) eruption of the permanent mandibular second molar. This case belongs to group C (impacted/retained second molars) where surgical exposure had been

performed. Note the tendency to taurodontic root morphology of the second molar

An example of unacceptable outcome is exemplified in Fig. 3. The nonerupting second molars had predominantly taurodontic root morphology in four cases. It is remarkable that the treatment outcome was unacceptable in 25.9% of the cases (Table 1).

# Group E: extraction or removal of the second molar (61 impacted/retained second molars)

In these 61 cases secondary retention (19 cases), reduced space (24 cases) and deviant molar inclination (39 cases) were the predominant causative factors. In several cases, more than one factor was observed. Of the 61 cases, 35 were primarily retained. As in group D, the choice to remove either the second or third molar seems to be random although space conditions were clearly considered. An example of a case with acceptable outcome is shown in Fig. 4. Taurodontic root shape was observed in six second molars. It is remarkable that the treatment outcome was unacceptable in 33% of the cases.

# *Group F: other treatments (8 impacted/retained second molars)*

In these eight cases, extraction and autotransplantion of a third molar was the predominant choice of treatment. In one case, extraction of the first molar was the choice of treatment due to root resorption diagnosed on the first molar.

In conclusion, the various treatment choices and their outcomes in 126 cases showed that in 66 of the cases the results were acceptable. In 23 cases, the results were unacceptable. In 37 cases, no sufficient radiographic material could document the outcome or the evaluation of the final outcome was not possible due to the patient's young age at the time of the last consultation. Remarkable for this retrospective study are the high percentages of unacceptable treatment outcome, 25.9% in group D

(removal of third molar) and 23% in group E (removal of second molar). Lower percentages are expected today after introduction of new treatment methods.

### Discussion

The present study is a retrospective overview of treatment choice and outcome in cases with arrested eruption of mandibular permanent second molars treated during 1985–2005. This overview provides preliminary information based on subgrouping of the cases according to choice of treatment. In the present study, there are more males than females with impaction/retention of the permanent mandibular second molars. This is in agreement with a study by Varpio and Wellfelt [13] who analyzed 56 males and 32 females in a similar group.

The present study has its strengths and weaknesses. The strengths are the size of the material and the fact that it is based on orthopantomograms. Additionally, the study only focuses on second molars in the mandible which reduces errors and misinterpretations due to different growth patterns in the mandible and maxilla. Furthermore, it is an advantage that the material originates from three different clinics with different treatment traditions. The weakness of the study is that it is a retrospective study which does not reflect the reality of today after the introduction of new orthodontic and surgical methods of uprighting second molars using, for example, miniscrews [14, 15]. Because the material is retrospective and the patients are no longer associated with the dental services where they were treated, further clinical evaluation is not possible today. Another problem was the fact that in 30% of the sample, evaluation was not possible. These patients could have been excluded from the treatment outcome analyses, but as they are needed for categorizing of groups, they were included in the study. Another problem is that the detailed treatment Fig. 3 Radiographs from a boy with retained/impacted permanent mandibular second molar before (a) and after (b) removal of the permanent mandibular third molar, group D. The treatment outcome is unsuccessful due to arrest in eruption of the second molar and its close relation to the anterior border of the mandibular ramus



method was not always evident from the patient records accompanying the referred radiographic material.

When evaluating the information given in the patient records, it is evident that some cases of arrested molar eruption are easy to diagnose and easy to treat and some are extremely complicated. The causes of failure of eruption are not given and not discussed in this study. In the records, the diagnostics is often random for the second molar except when considering space and tooth inclination. What is lacking is an assessment of whether the mandibular permanent second molar has a primary or secondary failure of eruption. It is assumed that a second molar in primary retention can often erupt if there is sufficient space while a second molar with secondary failure of eruption will never erupt even if space is available [11].

The present retrospective study can serve as a preliminary study based on various treatment approaches. Further studies of each of the six treatment groups are necessary. Also, more recent material including new surgical and orthodontic treatment methods is needed. An interesting observation seen in all groups was that taurodontic root morphology delays both root formation and eruption, and therefore taurodontic morphology is an important symptom to diagnose. This is exemplified in Figs. 1, 2, and 4. Taurodontia and its association with other dental anomalies have been described by Ackermann et al. [12].

When the different groups are compared, it appears that groups A and B (no treatment/orthodontic treatment) could possibly have been combined into one group, because the second molar erupted without surgical treatment. This is in opposition to group C (surgical exposure). As mentioned earlier, the treatment choices in groups D and E were possibly randomly chosen (removal of either second or third molar). The cases with unsuccessful treatment outcome should be discussed individually as improvement may occur later.

The main result of this study on molar impaction/ retention is that in the future, focus ought to be given to careful diagnostics, not only of space and molar inclination but also of root morphology, root maturity, and distinction between primary or secondary failure of eruption. These symptoms should be related to the age of the individual, to the choice of treatment, and to the findings in the dentition in general.

In the present study, deviations in the dentition in general as suggested by Vedtofte et al. [8], have not been included in



Fig. 4 Radiographs from a girl with primary failure of eruption of the permanent mandibular second molar before (a) and after (b) removal of the second molar. This case belongs to group E where removal of the second molar had been performed. The treatment outcome is acceptable

this analysis of treatment outcome; neither the inclination of the molars nor the skeletal profiles of the individuals as sufficient radiographic material was available.

Maturity of the permanent roots of neighboring teeth as described by Nielsen et al. [11] in a study on first molar retention should also be included in future studies, as this assessment may help to determine whether the condition is congenital or acquired. This is a new aspect which has never been elucidated.

The first hypothesis of the present study was that primary molar retention may be caused by malfunction of the crown follicle. This hypothesis was confirmed in group C showing that surgical exposure (denudation) of the second molar where the crown follicle was removed (Fig. 2) results in eruption. The second hypothesis was that the second molar can also erupt in cases with reduced space if diagnosed early and if the third molar is extracted. This hypothesis was partly confirmed in group D showing that 33.3% had acceptable results and 25.9% had unacceptable results after removal of the third molar. These differences in outcome should be discussed further.

The third hypothesis of the present study was that in secondary failure of eruption of the second molar, eruption does not occur regardless of treatment choice. This hypothesis was not confirmed, but the unacceptable cases in group D may be due to secondary retention. It is important in future studies to include histological investigations of second molar roots in order to establish whether the retention is primary or secondary.

In a recent retrospective study on treatment outcome in patients with second molar impaction and retention in the maxilla and mandible, 20% of the molars were untreated. Of these 20%, 44% erupted into good occlusion [16]. This is in agreement with the present study. In 80% of the cases treated either surgically or orthodontically in the study by Magnusson & Kjellberg, only 42% achieved successful results. This percentage is very close to the one in the present study when acceptable results in groups B, C, D, E, and F were summarized (all together 57 successful cases out of 126). A problem with this comparison is that the Magnusson & Kjellberg study [16] includes both second molars in the maxilla and mandible, while the present study focuses solely on the second molars in the mandible. This is a particular problem when comparing the treatment outcome for second and third molars because successful outcome depends on the growth patterns in the maxilla and in the mandible.

The present study illustrates the value of gaining an overview of treatment outcome. It clearly shows significant problems, particularly when considering which molar to remove. It is important in the future to focus on new treatment methods and analyze how these have changed treatment outcome especially on the phenotypes of groups D (removal of third molar) and E (removal of second molar). Improved diagnostics is needed as it is connected with serious problems for the patient and the dentist to remove a molar in order to provide space for another molar that never erupts. Also, in the cases where none of the molars have the ability to erupt, sufficient diagnosis is important before treatment. This severe condition may be due to ankylosis as described histologically by Raghoebar et al. [17] and by scanning electron and light microscopy by Raghoebar et al. [18].

The study showed that in the two largest groups of patients (D and E) analyzed in this retrospective study, the percentages of unacceptable treatment outcome were 25.9% and 23%, respectively. These percentages are expectedly lower today due to new treatment methods. It is highly recommended to focus especially on these two groups in future studies, partly to visualize how new treatment methods have improved the success rate and partly to control whether changes have occurred in the professional diagnosis and treatment plans of the difficult cases of retention of second permanent molars.

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