The wisdom behind third molar extractions

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ABSTRACT

The literature pertaining to the extraction of third molars is extensive. There is a large individual variation and a multitude of practitioners' beliefs and biases relating to the extraction of especially asymptomatic and pathology free third molars. With the current emphasis in dentistry being placed on clinicians to make evidence-based decisions, the routine removal of third molars has been re-assessed and questioned. The purpose of this paper was to evaluate past and present knowledge of third molar extractions and relate it to logical considerations relevant to science and the evidence-based decision-making process. This paper endeavours to encourage and stimulate clinicians to re-evaluate their views on third molar extractions based on suggested guidelines and current evidence.

Keywords: Third molars, extractions, orthodontics, impacted teeth.

Abbreviations and acronyms: BCI = biofilm gingival interface; GCF = gingival crevicular fluid; QOL = quality of life.

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INTRODUCTION

Third molars exhibit the greatest variability in timing in development, crown and root morphology and position. They are the last teeth to erupt into the oral cavity and supplement the function of the second molars. The average age for third molar crypt formation is around five to seven years with initial cusp calcification occurring between seven to 12 years.[1–3] Crypt formation has been shown to occur up to 16 years of age.[4] Third molars are the most commonly missing permanent teeth with the percentage of persons with one or more missing third molars ranging from 9 to 20 per cent.[1,5,6]

Third molars have been found to be the teeth most often impacted. Of the total number of molars present, Dachi and Howell found 29.9 per cent and 17.5 per cent of third molars were impacted in the maxilla and mandible, respectively.[7] Chu et al.,[8] however, found a greater prevalence of impacted mandibular third molars in comparison to maxillary third molars.

The eruption or impaction of these teeth is of important consideration in treatment planning and the long-term maintenance of the dentition and therefore of particular interest to the orthodontist and dentist. However, the extraction of these teeth over many decades has been based on a multitude of practitioners' beliefs, values, biases and anecdotal evidence. In the present age of evidence-based dentistry, dentists need to understand the basic tenets of science and research. Evidence-based dentistry is defined as the conscientious, explicit, and judicious use of current best evidence in making decisions about the care of each patient.[9–11] As evidence-based dentistry has its foundation in science, it is considered the best approach for acquiring knowledge because it is devoid of personal beliefs, values, attitudes, empiricism and emotions.

Third molars and crowding

One of the long-held dental and orthodontic tenets that has been refuted in the last decade has been the extraction of third molars to prevent late lower incisor crowding. Many potential aetiological factors have been attributed to lower arch or incisor crowding. The factors that have been investigated include anterior growth, rotations and remodelling of the mandible,[12–14] mesial migration of the posterior teeth,[15] anterior component of force on the occlusion,[16–19] lack of attrition,[20] effects of soft tissue maturation on the position of the teeth,[21,22] difference between the evolutionary reduction of tooth size and jaw size[23] and tooth size and shape.[24,25]

The one aetiological factor that has received more attention and debate over the many decades has been the relationship between the presence or position of the mandibular third molars and late lower anterior crowding. The numerous studies that have investigated

the influence of third molars on crowding have assessed their effect on the lower dental midline, anterior crowding and the influence of bilaterally and unilaterally missing third molars.[26–34] However, the results have been varied with the majority of the studies finding only a very small (minimal or no clinical significance) or no effect with large standard deviations, meaning that in some cases the crowding was greater in patients without third molars present. This may indicate that other factors exist that may play a more important role in late lower incisor crowding.

In a more recent and thorough prospective randomized study, Harradine et al.[28] investigated the effects of randomly assigning the extraction of third molars on late lower incisor crowding using Little's index of irregularity and intercanine width and arch length. In the group that had their third molars retained there was a slight increase in the mean difference for Little's irregularity of 1.1 mm compared to the group that had their third molars removed. This difference is small and statistically and clinically not significant.

A recent study[35] found that the differences in orthodontists' and oral and maxillofacial surgeons' beliefs about the association between third molar eruption and the development of crowding were significantly related to their graduation year. More recently graduated orthodontists were less likely to recommend prophylactic removal of third molars to prevent crowding, and surgeons were more likely to recommend removal if they graduated in the 1970s or 1980s. In the survey, 38.9 per cent of orthodontists and 56.9 per cent of oral and maxillofacial surgeons "generally" or "sometimes" recommended the removal of mandibular third molars to prevent lower incisor crowding, outlining the significant disagreement amongst practitioners.

It would appear that the aetiology behind the late incisor crowding phenomenon is one that is multifactorial in nature. It involves a decrease in arch length, jaw/tooth size, shape and relationship, narrowing of the intercanine width, retroclination of the lower incisors, mesial movement of the posterior teeth, and skeletal and soft tissue changes during growth and the natural ageing process. As a result, the removal of third molars on the sole basis of preventing lower incisor crowding is unsubstantiated and should be based on other more sound reasons.

The third molar extraction decision

The removal of impacted third molars is the most common surgical procedure in dentistry and is one of the most common day case and in-patient surgical procedures in the National Health System (NHS).[36] As a result, the huge cost to health care providers and patients and the limitations associated with the distribution of government health care funds require that the

decision to extract third molars be based on sufficient evidence. There are well-established indications for the removal of symptomatic third molars. However, there still exists some controversy and debate about the routine removal of asymptomatic, pathology free third molars. It must be made clear at this stage that when reference is made to "asymptomatic", the authors refer to not only the absence of symptoms but also any sign of disease. As a result, oral and maxillofacial surgeons are expected to make evidence-based decisions about the surgical extraction treatments they carry out, especially when there is no pathology associated with the third molars.

A conference dedicated to third molars was sponsored by the National Institute of Dental Research in 1979. It was aimed at reaching a general consensus on when and under what circumstances third molar extraction was to be advised.[37] They reached an agreement on establishing well-defined criteria for third molar extraction. However, they could not come to a conclusion regarding the prophylactic removal of third molars. They suggested the need for well-designed prospective studies to address this in the future. Since then numerous studies have been carried out but they have been associated with sample selection bias and subjective interpretations, resulting in no clear-cut evidence. Difficulties associated with long-term prospective studies dealing with this issue are cost, feasibility, ethics, and issues pertaining to subject follow-up and dropout.

In the late 1990s, as the demand for evidence-based dentistry and medicine grew, and the pressure from managed health care systems increased, the American Association of Oral Maxillofacial Surgeons (AAOMS) and the Oral and Maxillofacial Surgery Foundation (OMSF) pledged an initial US$2 million over five years to conduct a multi-centre trial of third molar patient management. The OMSF's Committee on Research (COR) investigated the scientific merit of a third molar study that had been developed by OMS members and colleagues. The study had previously been given highly favourable critiques by independent federal research review committees. When the committee determined the study had scientific merit and significant clinical relevance, the Third Molar Clinical Trials commenced.[38,39] The study is still active and many of the related findings will be subsequently discussed.

Since the NIH third molar conference in 1979, two key groups established guidelines for the removal of third molars which serve as the foundation for ethical clinical practice today. They are the National Institute of Clinical Excellence (NICE) in 2000,[40] and the Scottish Intercollegiate Guidelines Network (SIGN) in 1999 and this was reviewed in 2005[41] (see modified summaries in Tables 1 and 2). They concluded that given the costs and risks (see Table 3) associated with third molar extractions, there was no valid evidence to support the prophylactic

Table 1. Guidelines for third molar extractions associated with pathology

- Unrestorable caries
- Periodontal disease
- Non-treatable pulpal and/or periapical pathology
- Cellulitis, abscess and osteomyelitis
- Internal/external resorption of the tooth or adjacent teeth
- Fracture of tooth
- Disease of follicle including cyst/tumour
- Recurrent pericoronitis
- When involved in or within the field of tumour resection

Table 2. Other indications for removal

- For the autogenous transplantation into another area
- Prophylactic removal of a third molar which is likely to erupt in the presence of certain specific medical conditions, where the risk of retention outweighs the complications associated with removal
- When there is atypical pain from an unerupted third molar to avoid any confusion with temporomandibular joint or muscle dysfunction
- When a partially erupted or unerupted third molar is close to the alveolar surface prior to denture construction or close to a planned implant
- In patients with predisposing risk factors whose occupation or lifestyle precludes ready access to dental care
- Where a general anaesthetic is to be administered for the removal of at least one third molar, consideration should be given to the simultaneous removal of the opposing or contralateral third molars when the risks of retention and a further general anaesthetic outweigh the risks associated with their removal
- When the eruption of the second molar prevented by the third molar
- When the third molar is impeding surgery or reconstructive jaw surgery

Table 3. Risks of third molar extractions[47–51]

- Temporary (0.4–8.4%) and permanent (up to 1%) inferior alveolar nerve damage
- Temporary (0–5.3%) and permanent (up to 1%) lingual nerve damage
- Minor postoperative complications such as alveolar osteitis (0.3–26%), infection (0.8–4.2%) and secondary haemorrhage (0.2–5.8%)
- Postoperative complaints such as pain, trismus, swelling and generalized malaise occurs in about 50% of patients within the first few days
- Damage to the adjacent tooth and its periodontium or the development of a deep pocket distal to the second molar
- Rare complications include oro-antral fistulas (0.008–0.25%), maxillary tuberosity fractures (0.6%) and mandibular fractures (0.0049%)

removal of pathology free (asymptomatic) third molars. However, the SIGN guideline did have a broader range of indications for third molar removal. To date, both the SIGN and NICE guidelines have not incorporated the latest findings from the AAOMS Third Molar Trials. More recently, the AAOMS, following the development of a task force comprising primarily of individuals with a dental/oral surgical background, published their white paper related to third molars and their removal.[42] Their thorough review, unlike the others, leaned more towards the removal of asymptomatic third molars on the basis that they are a potential source of chronic inflammation predisposing patients to various periodontal and systemic problems in the future. Further, decision analysis models[43–45] have also been employed in an attempt to address the issue of prophylactic removal of third molars. The conclusions from these studies were that the patients' perceptions of non-intervention were of greater significance than the incidence of problems from third molars and that given the chance of pathology, probability of extraction complications and associated disability with each complication, the extraction of third molars should only be carried out in the presence of pathology.[43–45] In 2005, the Cochrane Review Group carried out a systematic review on the topic of the removal of asymptomatic third molars.[46] They reached a very similar conclusion in that although there were clear indications for third molar removal in the presence of pathology, removal when there is no pathology present is not indicated. They recommended that the watchful monitoring of asymptomatic third molar teeth may be a more prudent strategy.

Despite the guidelines, reviews and risks associated with the extraction of third molars, clinicians still continue to routinely remove pathology free third molars. Some health care institution audits have shown that the percentage of patients that have had their third molars removed for no valid reason ranged from 18 to 60 per cent.[46–49] Proponents for the removal of pathology free third molars believe that these third molars will cause problems in the future, and if they do, there will be greater costs, risk of complications and morbidity in older patients.

Cost versus benefit

Advocates for the early removal of pathology free third molars believe that the cost to society is greater when extractions are carried out in adults as opposed to children in their teens. The time off from work and the compromised quality of life is purported to impose a greater burden to society.[50] This reasoning is flawed on many levels. Firstly, the alternative view, relates to the fact that the removal of third molars without good reason involves unnecessary expenditure to all parties involved and unnecessary time off work and postoperative complications. Time off work has been shown to range from 0 to 10 days, with averages ranging from 1.26 to 3 days.[48,51] Secondly, the decision to extract third molars should be based on the presence of disease or other sound reasons for removal. Thirdly, the likelihood of legal action is greater if complications arise from surgery when the patient did not have any pre-operative signs or symptoms of disease.[52] Further, patients need to be made aware of not only the risks of pathology arising from retaining their third molars but also the risks of complications arising from their

extractions. They need to be aware of the possibility of an overall improvement in their quality of life (QOL) versus the immediate and possible long-term reduction in QOL as a result of surgery and the associated complications. An improvement in QOL is most likely to occur if patients experienced symptoms with their third molars pre-operatively than if they didn't. Patients need to be involved in the decision-making process[53] and their utility for treatment needs to be assessed, i.e., what they are willing to "sacrifice" in terms of QOL given their pre-operative symptoms, or lack of, to what they will gain in QOL postoperatively.[54]

Age and other risk factors

There is some evidence that indicates that an increase in age is associated with an increase in morbidity following third molar removal.[8,55–58] These studies vary in the differences found among age groups with some older age groups exhibiting less complications than younger age groups. This variance may be due to the type of samples used based on demographics, socio-economic and health status, reasons for removal and the limitations in relying on statistical models to eliminate confounding variables, and the derived conclusions. It must be mentioned that age *per se* is not a predisposing factor to increased complications but rather that with an increase in age there is an increase in health risk factors which then influence postoperative recovery. Other risk factors include smoking, gender, oral contraceptive use, experience of the surgeon, the presence of pathology associated with the third molars before surgery, mandibular third molars over maxillary third molars and deeper impactions.[8,38,55–59] Advocating the earlier removal of third molars on the sole basis that their future extraction will result in greater complications and morbidity is unjustified.

Risk of future pathology

Many proponents of the prophylactic removal of impacted third molars believe that they are benefiting these patients because at some point in the future these individuals will develop third molar related pathology. Taking into consideration the low incidence of 1–2 per cent of adverse consequences, such as odontogenic tumors, cysts and mandibular angle fractures developing from impacted third molars, it would seem difficult to justify the removal of asymptomatic third molars routinely.[50,60] As an aside, the radiographic criteria indicating the possibility of pathology associated with the dental follicle of an impacted third molar is a follicular width of greater than 2.5 mm.[61] Ideally, we would prefer to be able to predict the cases in which pathology will occur. The widespread practice of the routine removal of impacted third molars over the past several decades has

resulted in compromising our ability to make reliable estimates of the onset of pathology in relation to non-intervention. As such we currently have no reliable predictors for the cases in which pathology is going to develop.[46]

Periodontal pathology

The recent findings from the AAOMS and OMFS sponsored Third Molar Clinical Trials have shed considerable light in the area pertaining to patients with retained third molars and periodontal disease. Due to the significance of the findings, these trials have been extended through 2009.

Based on these trials, these authors have found that current models of the pathogenesis of periodontal disease essentially focuses on the interaction of specific pathogens with the individual's immune system at the biofilm gingival interface (BCI).[62] Elevated levels of "red" (*B. forsythus*, *P. gingivalis* and *T. denticola*) and "orange" (*P. intermedia* and *C. rectus*) complex microorganisms as well as increased levels of gingival crevicular fluid (GCF), interleukin 1-β (IL-1β) and prostaglandin E_2 (PGE_2) have been found in individuals with periodontitis and those who exhibit pocket depths of ≥ 5 mm in the third molar region.[63,64] On average, 25 per cent of individuals with asymptomatic erupted third molars were found to exhibit at least one periodontal probing depth ≥ 5 mm with attachment loss in the third molar region, the distal of the second molars or around the third molars. These patients were otherwise periodontally healthy at other sites. Sixty-six per cent exhibited at least one third molar pocket depth of ≥ 4 mm.[65] Over approximately a two-year follow-up, 25 per cent of patients with a starting pocket depth ≥ 4 mm worsened by ≥ 2 mm, indicating a predisposition to a deteriorating periodontal condition.[66,67] Subjects with at least one third molar with a pocket depth ≥ 4 mm were found to be at an increased risk (about 10 per cent) of developing at least one region of pocketing of ≥ 4 mm at a non-third molar region.[68]

Patients with retained erupted third molars who exhibited at least one area of pocketing ≥ 4 mm between the second and third molars were found to be at a 12-fold increased risk of developing pocketing at four other third molar areas ≥ 4 mm at follow-up in six years. Furthermore, those with third molar pocketing ≥ 4 mm were found to be at a four-fold risk of developing pocketing at non-third molar sites over time in comparison to those with no third molar pocketing.[69]

Individuals with pericoronitis associated with the third molars were found to have 20 per cent more areas of pocketing ≥ 4 mm than those with no pericoronitis.[70] On average, approximately one-third of patients with erupted third molars were found to exhibit caries on at least one third molar. If the first and second

molars are caries free, the likelihood of caries at the third molar is less than 2 per cent.[71]

Associations have also been found between periodontal pathology and systemic disease. It is purported that chronic periodontal inflammation results in a portal for inflammatory mediators and pathogenic bacteria to enter the bloodstream, possibly inducing some systemic issues or disease at a distant site.[72,73] Associations have been found between chronic periodontal inflammation and preterm births in obstetric patients.[74] Third molar periodontal pathology have been linked to pocketing in non-third molar regions which in many patients may be the first site of inflammation.[68] If this is the case, the authors stress the importance of the risk of disease progression and the associated risk with preterm births. Other systemic illnesses that may be associated with periodontal pathology are renal vascular disease, coronary artery disease, stroke, and diabetes.[63]

Concluding remarks

From the above findings it would appear that if asymptomatic erupted third molars exhibit caries and/or pocketing ≥ 4 mm the likelihood of this getting worse with time is greater than if no caries or pocketing was present to begin with. Further, following a critical analysis of the literature, Dodson *et al.*[75] found that following the removal of third molars, the periodontal health at the distal aspect of the second molars should remain unchanged or improve, if there was pre-existing periodontal pocketing or attachment loss. However, individuals with no pathology associated with their third molars (healthy periodontal status) have shown to be at an increased risk for developing periodontal pockets (48 per cent) after third molar removal.[75,76]

It must be mentioned that periodontal pathology in the third molar region is difficult to eliminate effectively. The clinician has two options; third molar extraction or regular periodontal maintenance. The key appears to be that the routine removal of asymptomatic erupted third molars is not recommended. However, there is indication to remove them once signs of periodontal pocketing are detected, especially if patient compliance with oral hygiene measures are average or if periodontal maintenance is not feasible. Following consideration of all factors, a decision can then be made for that particular individual.

With regard to asymptomatic impacted third molars either partially or fully encased in bone, it would seem sound clinical practice to leave them and monitor them periodically based on the available evidence. Studies have all demonstrated that these teeth improve in angulation and vertical position with time, especially in the first three decades of life and beyond, but to a lesser degree.[42,77–79] Extracting them early when individuals are in their teenage years simply leads to a more invasive surgical extraction procedure, increasing the likelihood of complications and it also prematurely commits them to extractions when the third molars may not have caused any problems or may have erupted favourably in the future.

Figure 1 is a simple decision flow chart outlining the evidence-based decision tree available to clinicians in deciding when to extract asymptomatic third molars.

Factors affecting third molar eruption/impaction

Methods of prediction

Many authors have concentrated on finding the best method in predicting the favourable eruption of third
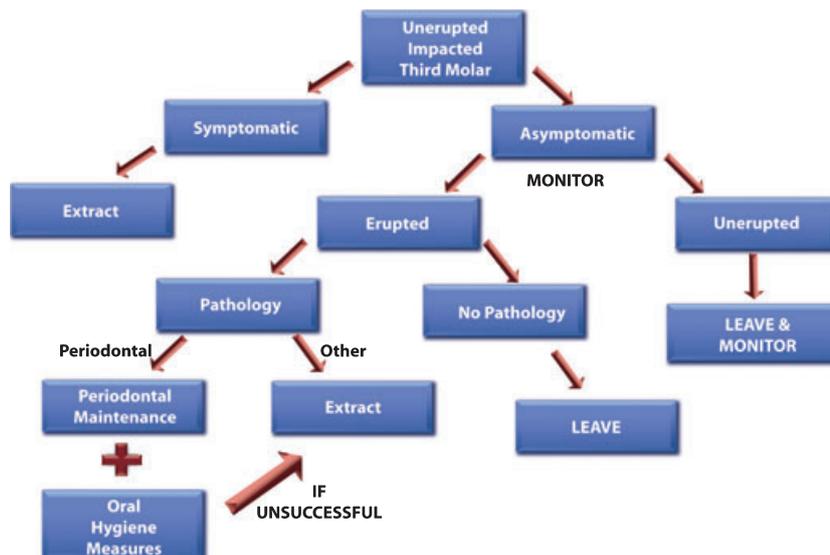

Fig 1. Simplified decision tree illustrating the process involved in third molar management.

molars. Most applied techniques for the prediction of third molar impaction or eruption have involved the use of panoramic radiographs, lateral and postero-anterior cephalograms focusing essentially on the relationship between the third molar and the space available in the retromolar area.[13,80–83] Although some relationships have been found with established ratios and formulae, they do not appear to be reliable and feasible to be used routinely.[84] Given that the current evidence-based thinking leans toward retaining asymptomatic impacted third molars, these methods appear to be futile today.

Growth, orthodontic treatment and extractions

Orthodontic treatment carried out during active dento-alveolar and skeletal growth in all dimensions may significantly influence the development of the dentition. Although third molars are generally the last teeth in the arches to develop and are located at the posterior limits of the dentition, their eruptive potential is primarily dependent upon the space available at the posterior ends of the arch. This space is influenced by both natural growth and active treatment. Growth influences on these spaces are largely expressed as arch-lengthening by apposition at the maxillary tuberosities or resorption at the anterior borders of the mandibular rami. Other skeletal variables that may predispose to third molar impaction are reduced mandibular length, reduced protrusion of the dentition, and a vertical condylar growth pattern.[85,86]

Orthodontic treatment aimed at treating patients without premolar extractions typically involves the holding back (arch length preservation) or the distal-ization of the permanent molars. In the maxillary arch, distalization primarily occurs through the use of extra-oral headgears[87–90] or various non-patient compliant intra-oral molar distalizers.[91–94] In the mandibular arch, treatment is aimed at arch length or leeway space preservation, allowing for the alignment of teeth anterior to the first molars with the use of an active or a passive lingual arch[95–97] or various other appliances such as utility arches[98,99] or lip bumpers.[100–102]

Allowing or inhibiting the mesial movement of the first and second molars greatly influences the space available for the third molars to erupt. Lack of mesial movement of the first and second molars and the ''driving'' of these molars distally, coupled with the lack of tuberosity growth and resorption at the anterior border of the mandibular rami inevitably leads to the third molars becoming deeply impacted.[103–106] Orthodontic treatment involving the extraction of premolar teeth generally results in the mesial movement of the first and second molars during space closure, greater space in the third molar region, a general improvement in the angulations of the third molars in relation to the occlusal plane, resulting in a clinically significant reduction in the rate of third molar impaction in comparison with non-premolar

extraction treatments.[83,86,107–114] However, this does not guarantee favourable eruption and the amount of space available posteriorly depends greatly on how the residual space is resolved. Residual space refers to that space remaining following the initial resolution of arch-crowding. Other factors must also be taken into account and include molar anchorage considerations, the treatment goals for final lower incisor positioning, the amount of expected mandibular growth, and the amount of resorption of the anterior border of the ramus.[115]

Many authors have studied the effects of second molar extraction on third molar eruption.[116–120] The removal of second molars significantly reduces the number of unerupted and impacted third molars in comparison to premolar extraction. Third molars rarely have insufficient space to erupt, however this does not guarantee a favourable contact point relationship or angulation with the first molar on eruption.

For treatments involving orthodontics and ortho-gnathic surgery, third molars are generally removed as they are usually in the anatomic region of the planned osteotomy or they pose a problem in achieving a tripodized occlusion at surgery. Third molars, however, can be retained when premolar, or first or second molar extractions are planned as part of the pre-surgical phase of orthodontics. This usually results in greater space availability in the posterior region, facilitating third molar eruption.[121]

Many practitioners prematurely advocate third molar extraction without taking into consideration the effects of the planned orthodontic extraction treatment plan and facial growth related changes. In addition, the majority of these clinicians assume that if failure of eruption or impaction is likely to occur, then these patients will be predisposed to problems in the future. They therefore recommend the extraction of third molars that otherwise do not necessarily need extraction.

CONCLUSIONS

It would appear that the decision to remove pathology free third molars should be based on the risks and benefits of the extractions as well as the consequences of their retention in the mouth. The patient should be involved in the decision and informed of all possible options. As health care providers, we are involved in treating patients who exhibit large biologic variation which deems the rigid adherence to individual biases or practice philosophies that extend to all patients as not only not evidence-based but unethical. In the medical profession this has clearly been seen in the changes that have occurred over the past few decades in the practice of the removal of adenoids, tonsils and appendices, whereby removal only takes place following the consideration of a multitude of factors.

Following a thorough review of the literature, we may conclude that the removal of third molars to avoid late incisor crowding is not justified. There exists clear indications for the removal of third molars associated with pathology. However, asymptomatic erupted impacted third molars are best left alone and monitored regularly. Asymptomatic partially or fully erupted third molars are to be also monitored periodically. When asymptomatic partially or fully erupted third molars exhibit periodontal pathology such as pocketing ≥ 4 mm, bleeding on probing or attachment loss then a conservative approach involving periodontal maintenance is advised. The clinician is also justified in deciding to extract the third molar(s) if oral hygiene is average and disease progression is likely, when periodontal maintenance is neither successful nor feasible or following the consideration of other factors such as the risks of retaining the teeth given the overall medical condition of the patient and the potential for systemic involvement.

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