Historical aspects about third molar removal versus retention and distal surface caries in the second mandibular molar adjacent to impacted third molars

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Key points

- Considers the global controversy about asymptomatic third molar management, chiefly related to distal surface caries in the adjacent second molar.
- Highlights the influences of third molar management in the UK.
- Emphasises the growing concern related to the increasing prevalence of distal surface caries in the lower second molar that is adjacent to an impacted mandibular third molar.

Abstract

This paper provides an insight into the historical recommendations regarding removal of mandibular third molars, as set out by the Royal College of Surgeons of England and the National Institutes of Health in the USA, as well as regional guidance from the National Institute for Health and Care Excellence and the controversy that surrounds surgical removal of third molars. The influences of third molar management as it developed in the UK, the historical economic evaluations, and the available evidence base on third-molar removal versus retention are described. This article seeks to address the growing concerns regarding the increasing frequency of distal surface caries (DSC) in mandibular second molar teeth when the decay is associated with asymptomatic, partially erupted, mandibular third molars, especially when they are mesially or horizontally impacted. Lastly, we illustrate radiographs of patients affected by DSC and how guidance that has been issued by a guideline institution regarding third molar surgery, even though it is based on insufficient evidence, is perceived as a strictly compulsory clinical strategy, and has been used in clinical practice in the UK for more than 20 years.

Introduction

In 1943, Broadbent reported that impaction of third molars occurred when full tooth emergence was prevented. He suggested that this was caused by a lack of space in the retromolar area, the presence of obstructions, or when tooth development had occurred in atypical positions within the jawbone. He reported that these factors alone or in combination might result in partial or, less frequently, no eruption of third molars. Consequently, third molars were classified as vestigial molars as they had lost most or all of their ancestral function.[1] Begg, in 1954, claimed that this was the result of environmental factors, such as changes in the diet of the human race over thousands of years, with a shift to softer food than that eaten by the first humans. It is thought that this dietary change affected the mesial drift of the dentition and resulted in a decrease in approximal attrition.[2] These evolutionary changes in the inherited trait have been encoded and are linked to the paired box 9 (PAX9) gene complex.[3] They have resulted either in alterations of the skull's anatomical characteristics, which have led in successive generations to impactions and partial eruptions, or in deletion of anatomical structures, which has led to agenesis of one or more third molars.[4] Andresson *et al.* (2010) reported a prevalence of 25% of agenesis in the third molar region in their study of a Swedish population. A few years later, Cater and Worthington (2016) performed a systematic review and meta-analysis to assess worldwide rates of third molar impaction and reported its prevalence across different morphological and demographic subgroups. They concluded that the average global impaction rate of third molars was 24.4%[5,6] but that the effect sizes were highly heterogeneous. Subgroup analyses showed that there were differences in geographic regions, that impaction occurred more frequently in the mandible in comparison to the maxilla, and that the most frequently observed orientation of impaction was mesioangular. This orientation comprised 42% of impactions; vertical and distal angulations comprised 26% and 12%, respectively; and horizontal angulation was reported as 11%. Atypical or aberrant positions in which impacted teeth were angled in buccolingual directions were seen much less frequently.[6,7]

Pathogenic consequences of third molar retention

The literature suggests that these anomalous angulations lead third molars and their surrounding hard and soft tissues to become more liable to developing a range of diseases and pathological conditions. Some of these conditions can be acute in nature and present

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suddenly with rapid onset of symptoms, while others may run a chronic course and develop over many years, which therefore leads to late presentation of these conditions in patients.[8] For example, retained third molars are at increased risk of periodontal disease, resorption and caries, which may develop over many years and cause irreversible damage, not only to the third molar teeth but also to their adjacent structures.[9,10]

Fejerskov and Kidd (2008) highlighted that partially erupted teeth did not participate in mastication and, for this reason, offered more favourable locations for bacterial accumulation than did fully erupted teeth.[11] Furthermore, Chu *et al.* (2003) claimed that mesioangularly and horizontally impacted teeth had their occlusal surfaces against the distal surfaces of the second molars, which formed a risk factor for plaque stagnation[12] (see Figure 1). In 1989, Newburn reported that fissure areas of the posterior teeth were the most common sites of decay and that there was a relationship between the depths of the fissures and caries susceptibility because food debris and microorganisms accumulated in the embrasure and fissures. The food debris and microorganisms could not be cleaned reliably from these locations by normal brushing and therefore caries developed. Consequently, Newburn concluded that tooth morphology was an important risk factor for caries development.[13]

Fig. 1 Impacted third molar with occlusal surface against the distal surface of the second molar

Fig. 2 Dental caries on the distal aspect of the mandibular second molar that is adjacent to a mesioangularly impacted third molar

Statement of problem

Caries is one of the most common reasons for mandibular third-molar removal,[14] but there is also an emerging incidence of distal surface caries (DSC) in the second molar that is adjacent to an impacted third molar.[15,16,17,18,19] Figure 2 illustrates this specific caries pattern.

McArdle and Renton (2006) suggested that the prevalence of second molar caries was the reason for 5% of mandibular third molar removals in the population of England and Wales.[20] However, data from different authors suggest that the prevalence is much higher. Van der Linden *et al.* (1995) reported caries in 42.7% of adjacent molars (1,227 of 2,872 teeth) in their study population.[21] Knutsson *et al.* (1996) reported a caries frequency of 31% with impactions, which was most common in patients between 20–29 years, followed by the 30–39-year-old group.[22] In summary, a growing number of international clinical studies have described a rising DSC prevalence across the globe, that ranges from 5–51% in several populations in different care settings.[23,24,25,26,27] Nevertheless, so far, no formal causal link has been established, and fear of second molar caries is not currently a justification for prophylactic removal of third molars in the UK.[28]

Third molar management in the UK: consequences of non-intervention strategy

In 1979, a consensus conference of the US National Institutes of Health regarding third molars received major media attention and, as a result, influenced the surgical practice of third molar removal in the UK. It reported that impaction or malposition of third molars in itself was not a pathological condition. The conclusion was that impaction was an abnormality in development that merely predisposed a patient to pathological changes and therefore that prophylactic removal should not be performed.[29] This view was and remains widely accepted in the UK and led to the abolition of prophylactic removal of impacted third molars. However, in the USA, where this view originated, it has met considerable opposition, because surgical removal of impacted third molars is perceived as interceptive and not as prophylactic.[30] The American Association of Oral and Maxillofacial Surgeons has a clear recommendation that treatment should be provided before the pathology adversely affects the patient's oral and/or systemic health and that the aim should be to limit surgical side-effects and to provide an environment for optimal healing.[31]

Prophylactic removal of impacted third molars began in the UK during the 1970s. Third molar surgery became one of the most commonly performed surgical procedures within the NHS. The associated UK healthcare costs were considerable.[32,33] In the 1990s, the annual cost of third molar surgery was estimated to be more than £30 million. In response to such financial statistics, guidelines were developed by the Faculty of Dental Surgery of the Royal College of Surgeons of England (RCSEng) in 1997, which were published as *Current clinical practice and parameters of care: the management of patients with third molar (syn: wisdom) teeth*. These guidelines were based on evidence collected from research that had been conducted in the UK, Canada and Scandinavia. Reference was also made to the practice in the USA and numerous similarities in care with regard to indications of the need for third molar removal existed at that point in time.[34] Prior to 1997, surgical practice in the UK and USA included both the removal of impacted third molars that had caused pathological changes and the prophylactic removal of pathology-free, impacted third molars to prevent future problems.[29]

It is estimated that the implementation of the RCSEng 1997 guideline resulted in a 22% reduction in the annual cost of third molar surgery (compared with 1994/1995 NHS data), which amounted to almost £7 million annually. However, approximately one-in-five third molar removals were still considered unnecessary. The awareness of this substantial expenditure, together with a general economic downturn in the UK, stimulated research into healthcare resources and cost-effectiveness.[35] Worall *et al.* (1998) found that, during this period, at least 20–30% of third molar removals were purely prophylactic; yet a study by Pratt *et al.* (1998) estimated this figure to be as low as 2.4%.[36] Nevertheless, the Government set up and urged the formation of professional advisory groups in England and Scotland, which issued two independent leadership documents that were designed to restrict the removal of third molars to specific therapeutic indications. In England and Wales, the National Institute for Health and Care Excellence (NICE) published *Technology appraisal guidance number 1 (TA1), guidance on the extraction of wisdom teeth*[37] and the Scottish Intercollegiate Guidelines Network (SIGN) published *Management of unerupted and impacted third molar teeth.*[38] Both sets of guidelines came into force around 2000 and replaced the less strict RCSEng document.[34] Although both UK-based documents referred to this 1997 RCSEng publication, they listed different therapeutic indications for third molar removal. The SIGN guidelines were much more inclusive and encouraged clinicians to take into account each patient's medical history, their ability to access care and the treatment setting. In comparison, the NICE guidelines limited the indications of the need for third molar removal to: one severe episode of pericoronitis; recurrent episodes of pericoronitis; unrestorable third molar (caries and fracture); internal/external resorption of third and/or second molar; non-treatable pulpal and/or periapical pathology; cyst/tumour formation; cellulitis or abscess formation; osteomyelitis; orthognathic surgery; reconstructive jaw surgery; and a third molar that was involved in tumour resection. These limitations on the removal of third molars were estimated to result in an additional cost reduction of approximately £5 million to the NHS annually.[39]

The introduction of this changed guidance was justified in terms firstly of the avoidance of surgery, and secondly in the reduction of expenditure and of the associated surgical and anaesthetic risks, in particular the risks of injuries that could affect the lingual and inferior alveolar nerves.[37,38] The cost savings that were associated with these changes in third molar surgery might be attributable to the reduction in rates of prophylactic removal of third molars; however, a review of the use of general anaesthesia (GA) led to tightened regulations regarding the prescription of GA at about the same time, and this would also have led to significant cost reductions to the NHS.[40,41,42] Data on oral surgery procedures taken from the Dental Practice Board and the Department of Health's hospital episode statistics in the UK, which were reported by Dhariwal *et al.* (2002), revealed that the use of GA fell by 77% from 260,763 procedures in oral surgery in 1998 to 59,004 such procedures in 2000. GA seems to have been the principal method of anaesthesia for third molar surgery.[39,43] The NHS welcomed the reductions in the occurrence of GA-related complications and in associated costs.

In 2000, however, the National Centre of Health Technology concluded in its review of third molar-related complications that the likelihood that third molars would cause problems in the future was high and that, by comparison, the incidence of complications after operating on them was relatively low. Also, Bienstock *et al.* reported in 2011 that most postoperative morbidities in oral surgery were related to mandibular third molars, although, as with any surgical procedure, various short- and long-term complications, as well as adverse effects, might occur. The researchers reported that the overall complication rate, which included minor complaints, varied between 4.6–36% and included pain, trismus, swelling, secondary haemorrhage and disruption of regular activities in daily life.[44] The frequency of development of postoperative infection varied between 0.5–2.8% and the incidence of alveolitis between 0.1–14.9%. In a Finnish population, long-term complications of oral surgery, such as damage to adjacent teeth and mandibular fractures (one per 22,000 operations), were found to be uncommon.[44,45] The incidence of temporary impairment of the lingual and inferior alveolar nerves has been estimated to range from 0.5–20%, although permanent iatrogenic injury is reported to be much less frequent, at 0.01–1% in low-risk cases and 2% in high-risk cases.[46]

The NICE rules and guidelines regarding surgery on third molars have been adopted by national guideline organisations and centres of expertise in several countries. Examples of derived guidelines are those of the Ministry of Health in Malaysia (2005) and the Health Partners Dental Group in the USA. This illustrates that NICE's view and its very strict indications for the removal of third molars have a worldwide impact.[47,48]

Methods used for economic evaluations

At approximately the same time as the NICE guidelines were introduced, Edwards and co-workers investigated the most effective and cost-effective strategies for the management of trouble-free, mandibular third molars.[49] The authors assessed the effects of removal or retention of asymptomatic, disease-free, mandibular third molars at the University of Wales Dental Hospital. A decision-tree model was constructed with the use of probability data and possible outcomes of retention or removal of these teeth. The authors concluded that mandibular third molar retention was less expensive for the NHS than removal (£170 versus £226, respectively). Taking into account both the cost and effects, the authors found that retention of the lower third molars

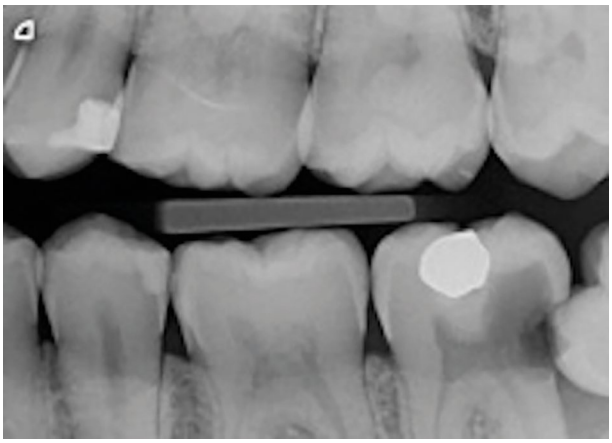

Fig. 3 Example illustrates late diagnosis of DSC

Fig. 4 This example shows how restoration of the distal surface of the second molar may not be possible with the third molar *in situ*

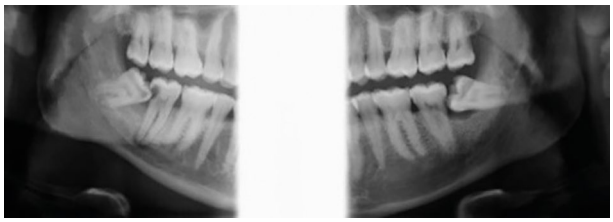

Fig. 5 Dental panoramic radiograph of mandibular mesioangularly impacted third molars in a patient at low risk of caries but who exhibits bilateral DSC in the adjacent second molars

was generally more effective than removal but that if pericoronitis, caries or other issues developed, it became more cost-effective to remove an impacted lower third molar.[49] A small number of economic evaluations have been performed. These evaluations found that, at a population level, the watch-and-wait policy was less cost-effective than prophylactic removal. Furthermore, none of these studies took into account any long-term societal perspectives, costs related to the consequences of third molar retention such as development of DSC, or the consequent removal. The latter outcome has been researched by Ventä *et al.* (2011), who showed that 70% of third molars had been removed once people had reached 38 years of age.[50]

Since 2000, the NICE guidance on third molar removal has been widely criticised for its non-intervention strategy as an increasing number of studies have reported the consequences of long-term third molar retention, such as caries development.[19,21,51] The process of this development usually affects the second molar and has been associated strongly with the presence of impacted mandibular third molars, especially for mesioangular impactions.[23] Knutsson *et al.* (1996) noted that horizontally and mesioangularly positioned third molars had more effects on adjacent second molars because impacted teeth in these positions impinged on the distal surface of the second molar.[22,23] In many cases, the development of caries in the second molars remains unnoticed for a long time, partly due to the difficulty in detecting caries via visual examination (Fig. 3), and partly because there is a lack of detailed recommendations or guidance for dentists regarding screening for this issue.[16] Various cariology studies have shown that third molar removal is required ultimately in the majority of these cases, with additional dental restorations of the adjacent second mandibular molars. In some cases, the adjacent second molars have to be removed too (Fig. 4) due to lack of restorability (Fig. 5).

Surgical removal versus retention of third molar: evidence base

At present, robust scientific evidence to support the removal or retention of third molars is scarce throughout the world. Originally, a Cochrane review by Mettes *et al.* in 2012 assessed the available evidence and concluded that there was insufficient evidence against routine prophylactic removal of asymptomatic third molars, or that watchful monitoring of asymptomatic third molars might be a more prudent strategy.[52] However, there was also no evidence to suggest that watchful monitoring provided a better outcome. Therefore, one could debate the interpretation and exactitude of this conclusion, which has been quoted many times throughout the literature and has been used as a basis for numerous

international third molar strategies and guideline documents.[53,54,55,56,57]

The SIGN guideline on third molar management has been considered for review several times since it was published in 1999; on each occasion, insufficient research evidence to justify the guideline was identified. Therefore, SIGN removed the guideline from its programme in February 2015. SIGN stated that, without a full review of the evidence, it was not possible to be certain that the guideline: 1) remained relevant to the NHS in Scotland; 2) made recommendations that were based on the most up-to-date evidence for best practice; 3) recommended safe practice; or (4) complied with current mandatory advice or government policy.[38]

However, the NICE guidance has not been retracted. The result is that most clinicians and surgeons in England, Wales and Scotland continue to follow and quote the watch-and-wait policy, even though there is no reliable evidence that this is the optimal treatment for patients. To address this problem, there has been a recent modernisation on guidelines for lower third molar management in the UK by the RCSEng Faculty of Dental Surgery called *Parameters of care for patients undergoing mandibular third molar surgery 2020,* which places emphasis on a tailormade treatment plan with patient involvement at the centre of the decision-making and clear communication of the risks and benefits of third molar removal, as well as retention.[58]

Nevertheless, further high-quality research is needed to underpin the third molar removal indications. It has been reported that one clinical trial was initiated in Denmark and another in the USA many years ago, with the intention of long-term follow-up.[32] However, to our knowledge, the results have not been disseminated. It is unclear whether these trials are still continuing or whether their results will ever become available. Performance of well-designed randomised controlled trials that would compare the effects of prophylactic removal of asymptomatic third molars with those of retention and long-term follow-up would be very challenging. Such trials are unlikely to be feasible given the enormous costs; therefore, non-randomised studies, such as those of practice-based cohorts, are considered to offer the next best but achievable evidence regarding long-term outcomes, such as caries.[59,60]

Conclusion

There is considerable suspicion that the strict NICE guidance regarding third molar removal contributes to the high incidence of DSC that clinicians see currently[61] because it promotes third molar retention and restricts the removal of decay-related third molars to situations in which caries renders the tooth unrestorable. The existing NICE guidance was based on evidence from an assessment report that was published by Song *et al.* in 1999 and which refers to research evidence that was gathered almost four decades ago. It must be highlighted that this research was conducted during a period when large numbers of third molars were removed prophylactically. Tellingly, the assessment report documented a very low rate of DSC in mandibular second molars of 1–4.5%;[32] currently, when few third molars are removed prophylactically, the literature states that this range is 15–51%.[33,62]

Author contributions

Verena Toedtling, Tim Forouzanfar and Henk S. Brand were responsible for the conception, design, drafting and critical appraisal of the manuscript. All authors gave their final approval and agree to be accountable for all aspects of the work.

Ethics declarations

The authors declare no conflict of interest.

This article did not require ethical approval as the content is freely available in the public domain and the analysis and data has been obtained from other published research with anonymised data.

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