Cochrane Library

**Cochrane** Database of Systematic Reviews

# Surgical removal versus retention for the management of asymptomatic disease-free impacted wisdom teeth (Review)

Ghaeminia H, Nienhuijs MEL, Toedtling V, Perry J, Tummers M, Hoppenreijs TJM, Van der Sanden WJM, Mettes TG

Ghaeminia H, Nienhuijs MEL, Toedtling V, Perry J, Tummers M, Hoppenreijs TJM, Van der Sanden WJM, Mettes TG.
Surgical removal versus retention for the management of asymptomatic disease-free impacted wisdom teeth.
*Cochrane Database of Systematic Reviews* 2020, Issue 5. Art. No.: CD003879.
DOI: 10.1002/14651858.CD003879.pub5.

**www.cochranelibrary.com**





WILEY

# TABLE OF CONTENTS

[Intervention Review]

# Surgical removal versus retention for the management of asymptomatic disease-free impacted wisdom teeth

Hossein Ghaeminia[1], Marloes EL Nienhuijs[2], Verena Toedtling[3], John Perry[4], Marcia Tummers[5], Theo JM Hoppenreijs[6], Wil JM Van der Sanden[7], Theodorus G Mettes[8]

[1]Department of Oral and Maxillofacial Surgery, Rijnstate Hospital Arnhem, Arnhem, Netherlands. [2]Department of Oral and Maxillofacial Surgery, Radboud University Medical Center, Nijmegen, Netherlands. [3]Department of Oral and Maxillofacial Surgery, Division of Dentistry, Faculty of Biology, Medicine and Health, The University of Manchester, Manchester, UK. [4]Hospital Dental Department, Canterbury District Health Board, Christchurch, New Zealand. [5]Radboud Institute for Health Sciences, Department for Health Evidence, Radboud University Medical Center, Nijmegen, Netherlands. [6]Department of Oral and Maxillofacial Surgery, Rijnstate Hospital, Arnhem, Netherlands. [7]Department of Quality and Safety of Oral Health Care, College of Dental Science, Radboud University Medical Center, Nijmegen, Netherlands. [8]School of Dentistry, Radboud University Nijmegen Medical Centre, Nijmegen, Netherlands

**Contact address:** Hossein Ghaeminia, hos.ghaeminia@gmail.com.

**Editorial group:** Cochrane Oral Health Group.
**Publication status and date:** New search for studies and content updated (no change to conclusions), published in Issue 5, 2020.

**Citation:** Ghaeminia H, Nienhuijs MEL, Toedtling V, Perry J, Tummers M, Hoppenreijs TJM, Van der Sanden WJM, Mettes TG. Surgical removal versus retention for the management of asymptomatic disease-free impacted wisdom teeth. *Cochrane Database of Systematic Reviews* 2020, Issue 5. Art. No.: CD003879. DOI: 10.1002/14651858.CD003879.pub5.



## ABSTRACT

### Background

Prophylactic removal of asymptomatic disease-free impacted wisdom teeth is the surgical removal of wisdom teeth in the absence of symptoms and with no evidence of local disease. Impacted wisdom teeth may be associated with pathological changes, such as pericoronitis, root resorption, gum and alveolar bone disease (periodontitis), caries and the development of cysts and tumours. When surgical removal is performed in older people, the risk of postoperative complications, pain and discomfort is increased. Other reasons to justify prophylactic removal of asymptomatic disease-free impacted third molars have included preventing late lower incisor crowding, preventing damage to adjacent structures such as the second molar or the inferior alveolar nerve, in preparation for orthognathic surgery, in preparation for radiotherapy or during procedures to treat people with trauma to the affected area. Removal of asymptomatic disease-free wisdom teeth is a common procedure, and researchers must determine whether evidence supports this practice. This review is an update of an review originally published in 2005 and previously updated in 2012 and 2016.

### Objectives

To evaluate the effects of removal compared with retention (conservative management) of asymptomatic disease-free impacted wisdom teeth in adolescents and adults.

### Search methods

Cochrane Oral Health's Information Specialist searched the following databases: Cochrane Oral Health's Trials Register (to 10 May 2019), the Cochrane Central Register of Controlled Trials (CENTRAL) (the Cochrane Library, 2019, Issue 4), MEDLINE Ovid (1946 to 10 May 2019), and Embase Ovid (1980 to 10 May 2019). The US National Institutes of Health Trials Registry (ClinicalTrials.gov)and the World Health Organization International Clinical Trials Registry Platform were searched for ongoing trials. No restrictions were placed on the language or date of publication when searching the electronic databases. .

**Selection criteria**

We included randomised controlled trials (RCTs), with no restriction on length of follow-up, comparing removal (or absence) with retention (or presence) of asymptomatic disease-free impacted wisdom teeth in adolescents or adults. We also considered quasi-RCTs and prospective cohort studies for inclusion if investigators measured outcomes with follow-up of five years or longer.

**Data collection and analysis**

Eight review authors screened search results and assessed the eligibility of studies for inclusion according to the review inclusion criteria. Eight review authors independently and in duplicate conducted the risk of bias assessments. When information was unclear, we contacted the study authors for additional information.

**Main results**

This review update includes the same two studies that were identified in our previous version of the review: one RCT with a parallel-group design, which was conducted in a dental hospital setting in the United Kingdom, and one prospective cohort study, which was conducted in the private sector in the USA.

***Primary outcome***

No eligible studies in this review reported the effects of removal compared with retention of asymptomatic disease-free impacted wisdom teeth on health-related quality of life

***Secondary outcomes***

We found only low- to very low-certainty evidence of the effects of removal compared with retention of asymptomatic disease-free impacted wisdom teeth for a limited number of secondary outcome measures.

One prospective cohort study, reporting data from a subgroup of 416 healthy male participants, aged 24 to 84 years, compared the effects of the absence (previous removal or agenesis) against the presence of asymptomatic disease-free impacted wisdom teeth on periodontitis and caries associated with the distal aspect of the adjacent second molar during a follow-up period of three to over 25 years. Very low-certainty evidence suggests that the presence of asymptomatic disease-free impacted wisdom teeth may be associated with increased risk of periodontitis affecting the adjacent second molar in the long term. In the same study, which is at serious risk of bias, there is insufficient evidence to demonstrate a difference in caries risk associated with the presence or absence of impacted wisdom teeth.

One RCT with 164 randomised and 77 analysed adolescent participants compared the effect of extraction with retention of asymptomatic disease-free impacted wisdom teeth on dimensional changes in the dental arch after five years. Participants (55% female) had previously undergone orthodontic treatment and had 'crowded' wisdom teeth. No evidence from this study, which was at high risk of bias, was found to suggest that removal of asymptomatic disease-free impacted wisdom teeth has a clinically significant effect on dimensional changes in the dental arch.

The included studies did not measure any of our other secondary outcomes: costs, other adverse events associated with retention of asymptomatic disease-free impacted wisdom teeth (pericoronitis, root resorption, cyst formation, tumour formation, inflammation/infection) and adverse effects associated with their removal (alveolar osteitis/postoperative infection, nerve injury, damage to adjacent teeth during surgery, bleeding, osteonecrosis related to medication/radiotherapy, inflammation/infection).

**Authors' conclusions**

Insufficient evidence is available to determine whether asymptomatic disease-free impacted wisdom teeth should be removed or retained. Although retention of asymptomatic disease-free impacted wisdom teeth may be associated with increased risk of periodontitis affecting adjacent second molars in the long term, the evidence is very low certainty. Well-designed RCTs investigating long-term and rare effects of retention and removal of asymptomatic disease-free impacted wisdom teeth, in a representative group of individuals, are unlikely to be feasible. In their continuing absence, high quality, long-term prospective cohort studies may provide valuable evidence in the future. Given the current lack of available evidence, patient values should be considered and clinical expertise used to guide shared decision-making with people who have asymptomatic disease-free impacted wisdom teeth. If the decision is made to retain these teeth, clinical assessment at regular intervals to prevent undesirable outcomes is advisable.

## PLAIN LANGUAGE SUMMARY

### Surgical removal versus retention for the management of asymptomatic disease-free impacted wisdom teeth

**Review question**

We carried out this review, through Cochrane Oral Health, to find out whether impacted wisdom teeth in teenagers or adults should be removed if they are not causing any problems or they should be left alone and checked at regular intervals. This is an update of a review first published in 2012 and first updated in 2016.

**Background**

Wisdom teeth (also known as third molars) generally erupt between the ages of 17 and 26 years. They are the last teeth to come in, and normally erupt into a position closely behind the last standing teeth (second molars). Space for wisdom teeth can be limited and so they often fail to erupt or erupt only partially, because of impaction of the wisdom teeth against the teeth directly in front. In most cases, this occurs when second molars are blocking the path of eruption of third molar teeth and act as a physical barrier, preventing complete eruption. An impacted wisdom tooth is called 'asymptomatic' and 'disease-free' if there are no signs or symptoms of disease affecting the wisdom tooth or nearby structures.

Impacted wisdom teeth can cause swelling and ulceration of the gums around the wisdom teeth, damage to the roots of second molars, decay in second molars, gum and bone disease around second molars and development of cysts or tumours. It is generally agreed that removing wisdom teeth is appropriate if signs or symptoms of disease related to the wisdom teeth are present, but there is less agreement about how asymptomatic disease-free impacted wisdom teeth should be managed.

**Study characteristics**

The Cochrane Oral Health Information Specialist searched the medical literature up to 10 May 2019. We found two studies, one where the participants had been randomly chosen to have their wisdom teeth removed or not (a randomised controlled trial or RCT), and one where the study authors examined people who have opted themselves to either retain or remove their wisdom teeth (a prospective cohort study). The studies involved 493 people. The RCT was conducted at a dental hospital in the UK and included 77 adolescent male and female participants who had completed treatment with braces. The cohort study was conducted at a private dental clinic in the USA and involved 416 men aged 24 to 84 years who volunteered to take part.

**Key results**

The available evidence is insufficient to tell us whether or not asymptomatic disease-free impacted wisdom teeth should be removed.

The included studies did not measure health-related quality of life, costs or side effects of taking teeth out.

One study (the cohort study), which was at serious risk of bias, found that keeping asymptomatic disease-free impacted wisdom teeth in the mouth may increase the risk of gum infection (periodontitis) affecting the adjacent second molar in the long term, but this evidence was very uncertain. In the same study, the evidence was insufficient to draw any conclusions about the effect on the risk of caries in the adjacent second molar.

The other study (the RCT) was also at high risk of bias. It measured crowding of the teeth in the mouth, and found that this may not be significantly affected by whether impacted wisdom teeth are kept in the mouth or removed.

**Quality of the evidence**

We assessed the evidence provided by the two studies to be low to very low certainty, so we cannot rely on these findings. High-quality research is urgently needed to support clinical practice in this area.

**Conclusion**

There is a lack of scientific evidence on which dental health professionals and policy makers can base treatment decisions for asymptomatic disease-free impacted wisdom teeth. Dental professionals will therefore be guided by clinical expertise and local or national clinical guidance, taking patient preferences into account. Where asymptomatic disease-free impacted wisdom teeth are not removed, monitoring by a dental health professional at regular intervals will help identify and address any problems that may develop.

## SUMMARY OF FINDINGS

### Summary of findings 1. Summary of findings

**Extraction (absence) compared with retention (presence) for managing asymptomatic disease-free impacted wisdom teeth**

**Population:** adolescents or adults with asymptomatic disease-free impacted wisdom teeth

**Setting:** clinics in university or primary care (UK and USA)

**Intervention:** extraction (absence) of wisdom teeth

**Comparison:** retention (presence) of wisdom teeth

| Outcomes | Assumed risk<br>Retention (presence) | Corresponding risk<br>Extraction (absence) | Relative effect (95% CI) | Number of participants (studies) | Certainty of the evidence (GRADE) | Comments |
|---|---|---|---|---|---|---|
| **Health-related quality of life** | Our primary outcome was not assessed in the included studies. | | | | | |
| Undesirable outcomes associated with retention (bony impaction):<br>**Periodontitis**<br>Distal alveolar bone loss second molar<br>Assessed by clinical and radiographic examination at follow-up ranging from 3 to 25 years | Not estimable[a] | | 0.32 (0.19 to 0.54) | 416 (1 observational study) | ⊕⊕⊖⊖ **very low** b,c,d | For soft tissue impaction, the RR was 0.11 (95% CI 0.06 to 0.22)<br>Also measured by distal probing depth > 4 mm second molar:<br>for bony impaction, the RR was 0.63 (95% CI 0.37 to 1.04); for soft tissue impaction, the RR was 0.15 (95% CI 0.07 to 0.34) |
| Undesirable outcomes associated with retention (bony impaction):<br>**Caries** affecting the second molar<br>Assessed by clinical and radiographic examination at follow-up ranging from 3 to 25 years | Not estimable[a] | | RR 0.69 (0.27 to 1.82) | 416 (1 observational study) | ⊕⊖⊖⊖ **very low** b,c,d,e | For soft tissue impaction, RR was 1.20 (95% CI 0.17 to 9.10) |
| Undesirable outcomes associated with retention:<br>**Dimensional changes in the dental arch** | Mean Little's index of irreg- | Mean Little's index of irregulari- | - | 77 (1 RCT) | ⊕⊕⊖⊖ **low** f,g | Also measured by:<br>• intercanine width: mean decrease in intercanine width in control group was 0.38 mm. Mean de- |

| | | | | |
|---|---|---|---|---|
| Assessed using digitised study models at follow-up of 66 months<br><br>Little's index of irregularity | ularity was 1.1 mm | ty in the interven-tion group was 0.30 mm lower (1.30 low-er to 0.70 higher) | | crease in intercanine width in intervention group was 0.01 mm lower (0.37 lower to 0.35 higher); and<br>• arch length: mean decrease in arch length in con-trol group was 2.13 mm. Mean decrease in arch length in intervention group was 1.03 mm lower (0.56 lower to 1.5 lower) |
| **Undesirable outcomes associated with removal** | Not measured | | | |
| **Costs** | Not measured | | | |

*The basis for the **assumed risk** (e.g. median control group risk across studies) is provided in footnotes. The **corresponding risk** (and its 95% confidence interval) is based on the assumed risk in the comparison group and the **relative effect** of the intervention (and its 95% CI).

**CI:** confidence interval; **RR:** risk ratio

**GRADE Working Group grades of evidence**

**High certainty:** we are very confident that the true effect lies close to that of the estimate of the effect.

**Moderate certainty:** we are moderately confident in the effect estimate; the true effect is likely to be close to the estimate of the effect, but there is a possibility that it is substantially different.

**Low certainty:** our confidence in the effect estimate is limited; the true effect may be substantially different from the estimate of the effect.

**Very low certainty:** we have very little confidence in the effect estimate; the true effect is likely to be substantially different from the estimate of effect.

[a] Results were presented at tooth level, not at participant level. However, adjusted RRs were presented at participant level

[b]Observational study downgraded one level for serious risk of bias due to confounding and missing data

[c]Only male participants were included, which does not reflect the overall population. No direct causal effect of gender and second molar pathology is expected. Therefore, not downgraded for applicability

[d]Participants enrolled in the study and returning for follow-up are likely to be more health aware than their age-matched peers in the community, and to practise better health behaviours. This would suggest more motivated participants in this study compared with the overall population. The presented significant effect may be greater in the overall population; however, we have not upgraded the quality of evidence for plausible confounding

[e]Owing to the wide CI, this outcome was downgraded one level for imprecision

[f]RCT downgraded one level for risk of bias owing to 'some limitations' for multiple criteria (allocation concealment and incomplete outcome data), sufficient to lower confidence in the estimate of effect

[g]Owing to the small number of participants and the high rate of loss to follow-up, the quality of evidence was downgraded one level for imprecision

# BACKGROUND

## Description of the condition

Wisdom teeth, or third molars, generally erupt between the ages of 17 and 26 years (Venta 1999; Kruger 2001). More than other teeth, wisdom teeth can fail to erupt or can erupt only partially, with a worldwide impaction prevalence of 24% (Carter 2015). Impaction occurs when complete eruption into a normal functional position is prevented and completion of root growth is fully established. This can be due to lack of space (in the mouth), obstruction by another tooth or development in an abnormal position (Venta 1999). A tooth that is completely impacted can be entirely covered by soft tissue, covered partially by bone and soft tissue or completely covered by bone. Partial eruption occurs when the tooth is visible in the dental arch but has not erupted into a normal functional position (RCS England 1997). Impacted wisdom teeth have been associated with pathological changes such as pericoronitis, root resorption, periodontal disease, caries and development of cysts or tumours. An impacted wisdom tooth is called 'trouble-free' if the patient does not experience signs or symptoms of associated pain or discomfort (Song 1997) and when the wisdom tooth is not associated with any signs of pathology. Other terms used in the literature include 'disease-free' and 'asymptomatic' (Dodson 2012).

The prevalence of asymptomatic disease-free impacted third molars varies widely and is influenced by age, sex and ethnicity (Bradley 1996). Impaction of wisdom teeth in the lower jaw is more common than in the upper jaw (Carter 2015; Celikoglu 2010). Most of the difficulties that follow surgical removal, such as postoperative morbidity, pain, discomfort and restricted activity, are related to lower wisdom teeth (Bienstock 2011).

When an impacted wisdom tooth cause pathological changes or pain, the tooth is no longer trouble-free. General agreement indicates that a wisdom tooth should be removed if pathology or symptoms are present. However, the management of asymptomatic disease-free wisdom teeth remains globally controversial (Kandasamy 2009).

## Description of the intervention

Prophylactic removal of asymptomatic disease-free impacted wisdom teeth is defined as the surgical removal of wisdom teeth in the absence of symptoms and with no evidence of local disease. Many dentists and their patients believe that removal of asymptomatic disease-free wisdom teeth is justified to avoid the possible future complications associated with these teeth. When surgical removal is performed on older patients, the risk of postoperative complications is increased (Chuang 2007;Ghaeminia 2017; Tate 1994). Furthermore, the healing of the periodontal tissues is better in younger people (Passarelli 2019). An impacted wisdom tooth almost never has a functional role in the mouth and might increase risk of caries, periodontal disease and external root resorption associated with the adjacent second molar (Fisher 2012; Oenning 2015). Another argument often given for the removal of asymptomatic wisdom teeth is to prevent late lower incisor crowding.

Removal of impacted wisdom teeth is a common surgical procedure with significant associated costs (Renton 2012). Short-term adverse effects of the removal of wisdom teeth include temporary nerve damage, alveolar osteitis (dry socket), infection, secondary haemorrhage, pain, swelling and trismus (restricted mouth opening). Long-term adverse effects of third molar surgery are uncommon but can include permanent nerve damage (in up to 0.5% of cases) (Chuang 2007)

Retention of impacted wisdom teeth is defined as monitoring the status of wisdom teeth. To avoid adverse effects and the costs of removing wisdom teeth, some advocate retention of asymptomatic disease-free impacted wisdom teeth (e.g. NICE 2000). This approach requires individuals to have regular dental reviews or 'checkups', so that the status of the wisdom teeth can be monitored.

## How the intervention might work

In many countries, prophylactic removal of asymptomatic disease-free wisdom teeth, whether impacted or fully erupted, was long considered as 'appropriate care' (Brokaw 1991; Tate 1994). Removal of wisdom teeth that may remain disease-free indefinitely is costly (Renton 2012) and can produce an unnecessary burden on healthcare resources (NICE 2000). However, concerns include the possibility that retained wisdom teeth will increase the risk of pathology to surrounding structures in the long term, and that their removal at an older age may cause more frequent and severe complications (McArdle 2012; Renton 2012).

## Why it is important to do this review

Cochrane Oral Health undertook an extensive prioritisation exercise in 2014 to identify a core portfolio of titles (Worthington 2015). This review was identified as a priority title by the oral and maxillofacial surgery expert panel (Cochrane OHG priority review portfolio). In addition, the review has a very high Altmetric score, which is a weighted measure to represent coverage of the article in the media (Wikipedia - Altmetric).

Wisdom tooth impaction is a common phenomenon (Carter 2015). Economic and personal costs are associated with removal of asymptomatic disease-free impacted wisdom teeth. Large variations have been noted in the management of asymptomatic disease-free impacted wisdom teeth (Cunha-Cruz 2014) , but clinicians' decisions should be based on an evidence-based approach that encompasses the best available research evidence, their own clinical expertise, local and national guidance, and patient values and preferences (Hyam 2018).

# OBJECTIVES

To evaluate the effects of removal compared with retention (conservative management) of asymptomatic disease-free impacted wisdom teeth in adolescents and adults.

# METHODS

## Criteria for considering studies for this review

### Types of studies

We considered randomised controlled trials (RCTs) for inclusion for all outcomes, with no restriction on their length of follow-up.

To assess long-term outcomes, we also considered quasi-RCTs and prospective cohort studies for inclusion only if outcomes were measured with follow-up of at least five years. We considered these non-randomised studies (NRSs) for inclusion in this review update,

as long-term outcomes of retention/removal of asymptomatic disease-free impacted wisdom teeth are extremely unlikely to be studied in randomised trials.

### Types of participants

Individuals (males and females of all ages) with asymptomatic disease-free impacted (maxillary or mandibular) wisdom teeth. An impacted tooth is defined as a tooth that has not erupted into a normal functional position. The tooth may be partially or completely covered by soft tissue and/or bone and might be visible, partially visible or invisible in the mouth.

### Types of interventions

Studies comparing removal (or absence) with retention (or presence) of asymptomatic impacted wisdom teeth. The control group (retention or presence of asymptomatic disease-free impacted wisdom teeth) was likely to have continued to receive routine oral examinations and may have undergone wisdom tooth removal if symptoms or disease became evident.

### Types of outcome measures

#### *Primary outcome*

Health-related quality of life measures associated with retention or removal of wisdom teeth (desirable and undesirable effects).

#### *Secondary outcomes*

**Outcomes associated with retention of wisdom teeth (undesirable effects)**

- Pericoronitis, infection and osteomyelitis
- Periodontitis (increased probing depths or alveolar bone loss affecting wisdom teeth or adjacent second molars)
- Caries (tooth decay affecting wisdom teeth or adjacent second molars (distal aspect)
- Root resorption affecting wisdom teeth or adjacent second molars
- Dimensional changes in the dental arch (crowding)
- Cyst formation
- Tumour formation
- Inflammation/infection

**Outcomes associated with removal of wisdom teeth (undesirable effects)**

- Alveolar osteitis, postoperative infection and osteomyelitis
- Nerve injury (lingual nerve and inferior alveolar nerve)
- Damage to adjacent teeth during surgery
- Bleeding
- Osteonecrosis related to medication/radiotherapy
- Inflammation/infection

**Costs**

- Days off work/study
- Direct costs associated with retention or removal of wisdom teeth and treatment of associated symptoms or complications

## Search methods for identification of studies

### Electronic searches

Cochrane Oral Health's Information Specialist conducted systematic searches in the following databases for randomised controlled trials and controlled clinical trials without language or publication status restrictions:

- Cochrane Oral Health's Trials Register (searched 10 May 2019) (Appendix 1);
- Cochrane Central Register of Controlled Trials (CENTRAL; 2019, Issue 4) in the Cochrane Library (searched 10 May 2019) (Appendix 2);
- MEDLINE Ovid (1946 to 10 May 2019) (Appendix 3);
- Embase Ovid (1980 to 10 May 2019) (Appendix 4).

Subject strategies were modelled on the search strategy designed for MEDLINE Ovid.

### Searching other resources

We searched the following trials registries:

- US National Institutes of Health Ongoing Trials Register ClinicalTrials.gov (http://clinicaltrials.gov/; searched 10 May 2019) (Appendix 5);
- World Health Organization International Clinical Trials Registry Platform (apps.who.int/trialsearch; searched 10 May 2019) (Appendix 6).

We did not perform a separate search for adverse effects of interventions; we considered these in included studies only.

We searched the reference lists of included studies and relevant systematic reviews for further studies.

We checked that none of the included studies in this review were retracted due to error or fraud.

## Data collection and analysis

### Selection of studies

Eight review authors (Hossein Ghaeminia (HG), John Perry (JP), Marloes Nienhuijs (MN), Verena Toedling (VT), Marcia Tummers (MT), Theo Hoppenreijs (TH), Wil van der Sanden (WvdS) and Dirk Mettes (DM)), in duplicate, independently and not blinded, assessed the titles, keywords, abstracts and/or methods sections of studies identified by the search strategy. The search was designed to be sensitive and include controlled clinical trials; these were filtered out early in the selection process if they were not randomised. We obtained relevant articles identified by reference searching as well as full-text articles selected by the review authors. We read in full the articles on which review authors disagreed and made the decision to include or exclude upon discussion. Eligibility criteria were:

- studies comparing the removal (or absence) with retention (or presence) of (maxillary or mandibular) asymptomatic disease-free impacted wisdom teeth;
- studies providing data on at least one of the selected primary or secondary outcomes;
- studies reporting quantitative outcomes; and

- studies with a suitably matched control or comparison group.

### Data extraction and management

Five review authors (HG, JP, VT, MT and DM) extracted relevant data from the included studies independently and in duplicate. We recorded the following types of data: study design, risk of bias, studied outcome measures, year of publication, duration of follow-up, sample size, number and characteristics of participants in each group and reported results. We assessed the comparability of participant characteristics at baseline, how researchers dealt with confounding, eligibility criteria and the methodology used in measuring outcomes. We discussed the results until we reached agreement. In cases of uncertainty, we contacted study authors for clarification. Should uncertainty persist, we did not use the data.

### Assessment of risk of bias in included studies

All review authors assessed risk of bias of included studies independently and in duplicate. We resolved disagreements by discussion.

#### *Randomised controlled trials (RCTs)*

We used the tool of The Cochrane Collaboration for assessing risk of bias along with a 'risk of bias' table to assess each study, as outlined in Chapter 8 of the *Cochrane Handbook for Systematic Reviews of Interventions* version 5.1.0 (Higgins 2011).

We assessed several domains as having 'low risk' of bias, 'high risk' of bias or 'unclear risk' of bias, including:

- random sequence generation (selection bias);
- allocation concealment (selection bias);
- blinding of outcome assessment (detection bias);
- incomplete outcome data (attrition bias);
- selective outcome reporting (reporting bias); and
- other bias.

We further assessed the randomisation procedure, sample size calculation, definitions of eligibility criteria, definitions of success criteria and comparability of control and treatment groups at the start of the trial. We contacted study authors to seek clarification when data were uncertain. We reported these assessments for each individual study in the 'Risk of bias' table and under Characteristics of included studies.

We performed an overall assessment of risk of bias for primary and secondary outcomes (across domains) across RCTs (Higgins 2011). Within a study, we assigned a summary assessment of low risk of bias when risk of bias was low for all key domains, unclear risk of bias when risk of bias was unclear for one or more key domains and high risk of bias when risk of bias was high for one or more key domains. Across studies, we rated a summary assessment as having low risk of bias when we derived most information from studies at low risk of bias, unclear risk of bias when we obtained most information from studies at low or unclear risk of bias and high risk of bias when we gathered most information from studies with risk of bias high enough to affect interpretation of results.

#### *Non-randomised studies (NRSs)*

We used the Cochrane Risk of Bias Assessment Tool for Non-Randomized Studies of Interventions (ACROBAT-NRSI) when assessing risk of bias of NRSs (Sterne 2014).

We assessed various domains for each primary or secondary outcome as 'low risk' of bias, 'moderate' risk of bias, 'serious' risk of bias, 'critical' risk of bias or 'no information', including

- bias due to confounding;
- bias in selection of participants into the study;
- bias in measurement of interventions;
- bias due to departure from intended interventions;
- bias due to missing data;
- bias in measurement of outcomes; and
- bias in selection of the reported result.

##### Control for confounding

We prespecified age, oral and general health status as critically important confounding domains.

We assessed which of these confounding domains had an impact on the specific outcome, and whether they were balanced at baseline or at outcome assessment in studies where participants were allocated to groups on the basis of their outcome. We also assessed whether the confounding domains were balanced between groups or at the design stage through matching when participants were allocated to groups or through statistical adjustments at the analysis stage.

Oral health status included the frequency of routine dental check-ups, the DMFS/T (Decayed Missing Filled Surfaces/Teeth) index, frequency of oral hygiene and carbohydrate intake from which at least one of these variables required to be balanced or adjusted for.

No critically important co-interventions were expected to influence the long-term outcomes.

We undertook risk of bias assessment for each primary and secondary outcome (across domains) within each non-randomised study (Sterne 2014). Within a study for each outcome, we assigned low risk of bias when risk of bias for all key domains was low, moderate risk of bias when risk of bias for one or more key domains was moderate, serious risk of bias when risk of bias for one or more domains was serious, critical risk of bias when risk of bias for one or more key domains was critical and ‘no information’ when no clear indication suggested that the outcome was at serious or critical risk of bias and information was insufficient in one or more key domains of bias. We considered certain risks of bias to be additive, so that certain risks of bias in multiple domains led to an overall judgement of greater risk of bias.

### Measures of treatment effect

For RCTs and prospective studies with dichotomous outcomes, we expressed the estimates of treatment effects of an intervention as risk ratios (RRs) (outcome present or absent) together with 95% confidence intervals (CIs). For continuous outcomes, we used mean differences (MDs) and standard deviations (SDs).

### Unit of analysis issues

We assessed the carry-over effect for all split-mouth studies. If a split-mouth design was deemed inappropriate for investigating the outcome or outcomes assessed in a particular study, we excluded the study. If we had included split-mouth studies, we intended to approximate a paired analysis, as recommended by the *Cochrane Handbook for Systematic Reviews of Interventions* (Higgins 2011). In the case of an ideal study (i.e. one that reported means and SDs for both groups, and MDs and SDs/standard errors (SEs) between two groups), we intended to calculate intragroup correlation coefficients (ICCs); if we identified more than one ideal study, we intended to calculate the mean ICC, which we would have adopted in calculating the MD and SD/SE for other, similar split-mouth studies. If no ideal study was identified, then we assumed that the ICC was 0.5.

For clustered data, in trials where the unit of analysis was the tooth, and the number of teeth included in the trial was not more than twice the number of participants, we treated the data as if the unit of analysis was the individual. We recognised that the 95% confidence intervals produced would appear narrower (i.e. the estimate would seem to be more precise) than they should have been, and we therefore interpreted these accordingly.

### Dealing with missing data

We assessed incomplete data during the risk of bias assessment. If data were absent, we recorded the presence of reporting bias. We captured missing data on the data extraction form and reported them in the risk of bias tables. We contacted study authors to try to acquire missing data for inclusion.

### Assessment of heterogeneity

We would have carried out assessment of heterogeneity in quantifying inconsistency across studies by using the $I^2$ statistic, as described in Section 9.5.2 of the *Cochrane Handbook for Systematic Reviews of Interventions*.

### Assessment of reporting biases

We assessed reporting bias as between-study publication bias or within-study reporting bias. We assessed within-study reporting bias by comparing outcomes reported in the published report against the study protocol, whenever this could be obtained. If we could not obtain the protocol,we compared outcomes listed in the methods section with those whose results were reported. If non-significant results were mentioned but were not reported adequately, we considered that bias was likely to occur in a meta-analysis, and we sought further information from the authors of study reports. Otherwise, we noted this meta-analysis as having high risk of bias. If information was insufficient to judge the risk of bias, we noted this meta-analysis as having unclear risk of bias. If any meta-analysis had included a sufficient number of trials (more than 10), we would have assessed publication bias according to the recommendations on testing for funnel plot asymmetry, as described in Section 10.4 of the *Cochrane Handbook for Systematic Reviews of Interventions* (Higgins 2011). If asymmetry had been identified, we would have examined possible causes or assessed the asymmetry by using a table to list the outcomes reported by each study included in the review, to identify whether any studies did not report outcomes that had been reported by most studies.

### Data synthesis

For RCTs, we planned to conduct a meta-analysis if sufficient studies reported the same outcome measure. We planned to combine risk ratios and calculate 95% confidence intervals for dichotomous data, and to combine mean differences with 95% confidence intervals for continuous data. We planned to use the fixed-effect model unless more than three studies were included in each meta-analysis, or if clinical heterogeneity among studies existed, in which case we would have used the random-effects model.

Given that data from NRSs are prone to bias and are often heterogeneous, we would have carried out separate meta-analyses for NRSs and presented results according to different study designs and outcomes. For NRSs, we would not have performed a meta-analysis in cases of severe methodological and clinical heterogeneity, or when we found too few NRSs. In this instance, we would group the studies by outcome and present results as a narrative summary in the text, as well as in tables and in the form of a forest plot without an overall summary statistic.

We would not have included in any analyses data from NRSs with a critical risk of bias.

### Subgroup analysis and investigation of heterogeneity

Owing to lack of data, we did not perform a subgroup analysis. If sufficient data had been present, we would have performed a subgroup analysis for participant age (younger than 18 years, 18 to 25 years, 26 to 30 years, over 30 years).

### Sensitivity analysis

For any pooled analyses, we planned to undertake sensitivity analyses to examine the effects of randomisation, allocation concealment and blinded outcome assessment on overall estimates of effect.

For meta-analyses of NRSs, we planned to undertake sensitivity analyses after removing NRSs that had not adequately adjusted for significant differences in confounding domains.

### Presentation of main results

We prepared a 'Summary of findings' table (SoF) for the primary and secondary outcomes of this review using GRADE (Grading of Recommendation, Assessment, Development and Evaluation Working Group) profiler software. We assessed the overall quality of the evidence, using GRADE criteria, as high, moderate, low or very low (Higgins 2011). GRADE guidance states that RCTs are considered to present high quality evidence and are downgraded as necessary on the basis of overall risk of bias of included studies, directness of the evidence, consistency of the results, precision of the estimates, risk of publication bias and magnitude of effect. Sound observational studies are considered to present low quality evidence but can be upgraded if a large effect size is reported with no obvious bias to explain that effect.

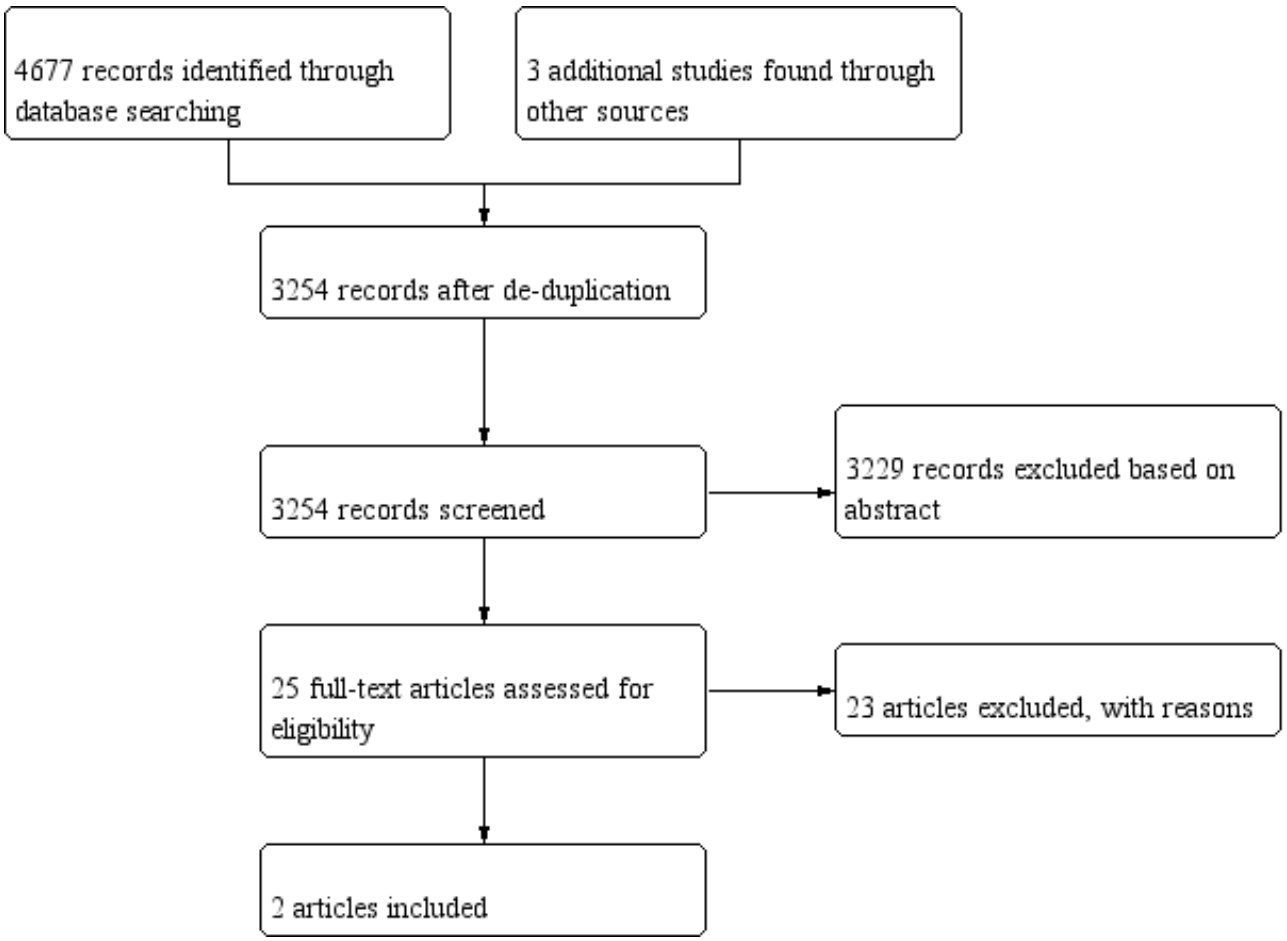
# RESULTS

## Description of studies

### Results of the search

After performing the search up to 10 May 2019, we retrieved a total of 4677 references; this resulted in 3254 records after de-duplication. We found no additional studies or ongoing studies after searching the trial registers. After screening the titles and abstracts of these references, we found no new studies and we included only the two studies from our previous review. See Figure 1 for a study flow diagram of the search update.

**Figure 1. Study selection flow diagram**




### Included studies

The 2012 version of this review included one RCT (Harradine 1998), which compared surgical removal with retention of asymptomatic disease-free impacted wisdom teeth in adolescent participants who had previously undergone orthodontic treatment. We assessed this study including 164 participants to be at overall high risk of bias. In the previous review update (2016), we added one prospective cohort study and included a total of two studies with 1395 participants (493 analysed participants). We have provided summary details in the Characteristics of included studies table. No additional studies have been added to this current review update.

### Characteristics of study settings

We included in this review two studies involving data from 493 analysed participants: one RCT with a parallel-group design conducted in a dental hospital setting in the United Kingdom (Harradine 1998), and one prospective cohort study conducted in the private sector in the USA (Nunn 2013).

### Characteristics of participants

The RCT recruited 164 adolescents (55% female) who had previously undergone orthodontic treatment and had 'crowded' wisdom teeth, in which the long axis and the presumed path of eruption of the wisdom teeth was through the adjacent second molar (Harradine 1998).

The prospective cohort study recruited 1231 healthy male volunteers, aged 24 to 84 years, who had both first and second molars present in at least one quadrant at baseline and had undergone at least one follow-up examination (at three years) (Nunn 2013). Wisdom teeth at baseline were categorised as absent (previous removal or agenesis), erupted, 'soft tissue' impacted or 'bony' impacted.

### Characteristics of interventions

The RCT compared surgical removal with retention of asymptomatic disease-free impacted wisdom teeth (Harradine

1998). The prospective cohort study compared absence (previous removal or agenesis) with erupted and unerupted asymptomatic disease-free impacted wisdom teeth (Nunn 2013). The latter was split into soft and hard tissue impaction.

### Characteristics of outcome measures

The RCT measured the secondary outcome - dimensional changes in the dental arch - at baseline and five years later (Harradine 1998). Study authors assessed three measures of dimensional change in the dental arch (Little's irregularity index, intercanine width and arch length) using digitised study models.

The prospective cohort study measured secondary outcomes - periodontitis and caries associated with the distal aspect of the adjacent second molar - during a follow-up period of 3 to 25+ years (Nunn 2013). Probing depths of greater than 4 mm associated with the distal surface of the adjacent second molar were assessed clinically, and a trained, calibrated periodontist assessed alveolar bone loss and caries associated with the distal aspect of the adjacent second molar, both clinically and radiographically.

### Excluded studies

We have provided summary details in the Characteristics of excluded studies table. After screening the full text of the identified NRSs, we excluded 23 studies because:

- three studies had follow-up less than five years (Blakey 2009; Coleman 2011; Huang 2014);
- six studies used an inappropriate study design (Ades 1990; Lindqvist 1982; Moss 2007; Moss 2007a; Offenbacher 2012; Rahman 2009; Venta 1993a);
- seven studies did not have a suitably matched control or comparison group (Dicus 2010; Fisher 2012; Fisher 2013; Garaas 2012; Golden 2015; Haug 2005; Venta 2015); and
- six studies included an inappropriate study population (Dicus-Brookes 2013; Moss 2009; Moss 2013; Moss 2013a; Nemcovsky 1997; Venta 1993).

## Risk of bias in included studies

We have reported risk of bias separately for the RCT and the prospective cohort study. See Characteristics of included studies and Table 1.

The RCT had adequate sequence generation (Harradine 1998). Study authors did not explicitly describe the method of allocation concealment, and this gave rise to high risk of selection bias. It was impossible for participants and operators to be blinded to the intervention, but the outcome assessor was blinded. We assessed risk of performance and detection bias to be low. Fifty-three per cent of the original participants (N = 87) were lost to follow-up at five years. More participants were lost from the retention group (49/82 = 60%) than from the removal group (38/82 = 46%), and study authors were unable to contact these participants. study authors provided no data on the gender balance between groups of those who completed the study compared with those who did not. We assessed this trial to be at high risk of attrition bias, which could have affected overall results. We assessed risk of bias due to selective reporting as unclear. We could identify no other major potential sources of bias. We considered this RCT to be at high risk of bias overall.

We assessed the prospective cohort study to be at serious risk of bias owing to confounding and missing data (Nunn 2013). Study authors adjusted analyses for baseline age, smoking status, education and baseline second molar measures but did not measure oral health status. These factors may contribute to the development of second molar pathology; therefore this study is at serious risk of bias owing to confounding. In the first Dental Longitudinal Study, beginning in 1969, 1231 volunteers were enrolled (Kapur 1972). Eventually only 416 met the inclusion criteria and were analysed. Data regarding the excluded participants are missing. Participants with pathology associated with their wisdom teeth are likely to have had them removed before the study was initiated; therefore, this study is at serious risk of bias owing to missing data. We assessed this study to be at low risk of bias in measurement of interventions and outcomes. We assessed risk of bias due to selection of participants into the study, departures from intended interventions and selection of reported results as moderate. We considered this prospective cohort study overall to be at serious risk of bias for all assessed outcomes. See Table 1.

## Effects of interventions

See: **Summary of findings 1** Summary of findings

### Primary outcome - health-related quality of life

Neither of the two included studies investigated health-related quality of life measures associated with retention or removal of asymptomatic disease-free impacted wisdom teeth.

### Secondary outcomes - outcomes associated with retention of wisdom teeth (undesirable effects)

#### *Periodontitis (increased probing depths or alveolar bone loss affecting wisdom teeth or adjacent second molars)*

The prospective cohort study with 416 analysed participants (with 804 wisdom teeth) reported relative risks for probing depths greater than 4 mm and alveolar bone loss associated with the distal of the adjacent second molar in the absence compared with the presence of asymptomatic disease-free impacted wisdom teeth (Nunn 2013). 'Soft tissue' and 'bony' impactions were calculated at the participant level.

In the absence of wisdom teeth, the risk of probing depths greater than 4 mm associated with the distal of the adjacent second molar was significantly less than if soft tissue impacted wisdom teeth were present (RR 0.15, 95% CI 0.07 to 0.34) (very low-certainty evidence). There was no statistically significant difference in the risk of probing depths greater than 4 mm associated with the distal of the adjacent second molar in the absence compared with the presence of bony impacted wisdom teeth (RR 0.63, 95% CI 0.37 to 1.04) (very low-certainty evidence).

In the absence of wisdom teeth, the risk of alveolar bone loss associated with the distal of the adjacent second molar was significantly less than if soft tissue (RR 0.11, 95% CI 0.06 to 0.22) or bony impacted wisdom teeth (RR 0.32, 95% CI 0.19 to 0.54) were present (very low-certainty evidence).

#### *Caries (tooth decay affecting wisdom teeth or adjacent second molars (distal-cervical))*

The prospective cohort study with 416 analysed participants (804 wisdom teeth) reported relative risks for caries associated with the

distal of the adjacent second molar in the absence compared with retention of asymptomatic disease-free impacted wisdom teeth (Nunn 2013). 'Soft tissue' and 'bony' impactions were calculated at the participant level.

The evidence was very uncertain for the prevalence of distal caries associated with the adjacent second molar in the absence compared with the presence of bony impacted wisdom teeth (RR 0.69, 95% CI 0.27 to 1.82) and soft tissue impacted wisdom teeth (RR 1.20, 95% CI 0.17 to 9.10) (very low-certainty evidence).

#### *Dimensional changes in the dental arch (crowding)*

The RCT with 77 analysed participants reported mean differences with 95% confidence intervals for dimensional changes in the dental arch for surgical removal compared with retention of asymptomatic disease-free impacted wisdom teeth (Harradine 1998). There were no statistically significant differences between groups for the outcomes of Little's irregularity index (MD -0.3 mm, 95% CI -1.3 to 0.7) and intercanine width (MD -0.01 mm, 95% CI -0.37 to 0.35) (low-certainty evidence). There was a small but statistically significant difference between groups in arch length (MD -1.03 mm, 95% CI -0.56 to -1.50, P value = 0.0001), but this difference is unlikely to be clinically significant (low-certainty evidence). These findings appear to be inconsistent with each other but may be explained, as the study authors' note, by persistent residual premolar extraction space in some participants at study entry.

#### *Other outcomes associated with retention*

No included studies reported pericoronitis, root resorption, cyst formation, tumour formation or inflammation/infection.

### Outcomes associated with removal of wisdom teeth (undesirable effects)

No included studies measured outcomes or adverse events associated with removal of asymptomatic disease-free impacted wisdom teeth (alveolar osteitis/postoperative infection, nerve injury, damage to adjacent teeth during surgery, bleeding, osteonecrosis related to medication/radiotherapy, inflammation/infection).

### Costs

The included studies did not measure days off work/study or direct costs associated with retention or removal of wisdom teeth and treatment of associated symptoms or complications.

## DISCUSSION

### Summary of main results

No eligible studies in this review reported the effects of removal compared with retention of asymptomatic disease-free impacted wisdom teeth for the primary outcome measure: health-related quality of life.

Studies have provided only low- or very low-certainty evidence of the effects of removal compared with retention of asymptomatic disease-free impacted wisdom teeth for a limited number of secondary outcome measures. Very low-certainty evidence from one prospective cohort study suggests that the presence of asymptomatic disease-free impacted wisdom teeth may be associated with increased risk of periodontitis associated with the adjacent second molar in the long term. The same study provided insufficient evidence about the risk of caries affecting the adjacent second molar. Low-certainty evidence from a single randomised controlled trial (RCT) included in this review found no evidence to suggest that removal of asymptomatic disease-free impacted wisdom teeth has a clinically significant effect on dimensional changes in the dental arch.

No included studies have reported other outcomes or adverse events associated with removal (alveolar osteitis/postoperative infection, nerve injury, damage to adjacent teeth during surgery, bleeding, osteonecrosis related to medication/radiotherapy, inflammation/infection) or retention (pericoronitis, root resorption, cyst formation, tumour formation, inflammation/infection) of asymptomatic disease-free impacted wisdom teeth.

### Overall completeness and applicability of evidence

Substantial differences are evident between participants in the two included studies, and these participants are not representative of the general population with asymptomatic disease-free impacted wisdom teeth.

The included RCT focused only on adolescent patients who had completed orthodontic treatment. Loss to follow-up was a major obstacle in obtaining data about the effects of extraction of asymptomatic disease-free impacted wisdom teeth, as participants are likely to be recruited towards the end of their high school years and are difficult to follow up as they move to higher education, go travelling or change locations when seeking employment.

The prospective cohort study included only male participants aged 24 to 84 years from a single geographic area who were self selected volunteers. Participants enrolled in the study who returned for follow-up are likely to be more health aware than their age-matched peers in the community and to practise better health behaviours. This would suggest that participants in this study were more motivated than the overall population. Retained wisdom teeth in this group of participants were associated with increased risk of periodontal disease affecting the adjacent second molar. Risk of damage to the second molar might be even greater in populations with poor oral health. If wisdom teeth or adjacent second molars need to be removed at an older age owing to disease, the personal and financial costs may be greater than at a young age. However, included studies have provided no information on quality of life measures and costs.

Included studies have provided no information regarding other adverse effects of removal (alveolar osteitis/postoperative infection, nerve injury, damage to adjacent teeth during surgery, bleeding, osteonecrosis related to medication/radiotherapy, inflammation/infection) or retention (pericoronitis, root resorption, cyst formation, tumour formation, inflammation/infection) of asymptomatic disease-free impacted wisdom teeth.

We chose the primary outcome of health-related quality of life to capture the benefits and harms associated with removal and retention of asymptomatic disease-free impacted wisdom teeth. We chose this outcome measure because of the difficulties of comparing various outcomes (e.g. rate of complications after surgical removal, incidence of pathological change in cases of retention, rate of complications due to delayed surgical removal) (Song 2000). Unfortunately, the included studies did not assess this primary outcome. The Oral Health Impact Profile is a valid and

reliable measure of oral health-related quality of life in general dental practice and is responsive to impacted third molar clinical change (Fernandes 2006). It is suitable for measuring the effects of removal or retention of asymptomatic disease-free impacted wisdom teeth on oral health-related quality of life in future studies.

### Quality of the evidence

The single RCT included in this review provided low-certainty evidence of the effects of surgical removal of asymptomatic disease-free impacted wisdom teeth on dimensional changes in the dental arch at five years' follow-up. We considered this trial to be at high risk of bias overall owing to limitations of allocation concealment and incomplete outcome data sufficient to lower confidence in the estimate of effect. In addition, the small number of participants and the high rate of loss of participants to follow-up led to imprecision in the estimate of effect.

As RCTs investigating longer-term and rare effects of removal or retention of asymptomatic disease-free impacted wisdom teeth are unlikely to be feasible, we considered non-randomised studies (NRSs) for inclusion in this review update. A high quality prospective cohort study might be a more suitable design for evaluating the outcomes of retained wisdom teeth. However, NRSs are likely to be at higher risk of bias compared with RCTs. With the introduction of the Cochrane Risk of Bias Tool for NRSs (ACROBAT-NRSI, Sterne 2014), it is possible to assess the risk of bias in NRSs more systematically. (The tool was updated in 2016 and is now called ROBINS-I).

We assessed the included prospective cohort study, Nunn 2013, to be at serious risk of bias because of confounding. Study authors adjusted the analyses for baseline age, smoking status, education and baseline second molar measures but did not measure oral health status. Oral health status may contribute to the development of pathology associated with wisdom teeth and adjacent second molars. A recent study that measured the frequency of dental checkups reported no effects of wisdom tooth removal on the incidence of pathology associated with the second molar (Huang 2014). However, this study provided only two years of follow-up and was not eligible for inclusion in this review. As pathology may develop in a wisdom tooth or in the adjacent second molar over the whole of a person’s lifetime, studies with long-term follow-up are needed.

The evidence available from the two studies included in this review provides only low- to very low-certainty evidence, so we cannot rely on these findings to guide clinical practice.

### Agreements and disagreements with other studies or reviews

Despite the lack of evidence, clinical practice guidelines (CPGs) on the management of impacted wisdom teeth have been available for 20 years. The Scottish Intercollegiate Guideline Network published a CPG for the management of unerupted and impacted wisdom teeth in 1999 (SIGN 1999), though this was withdrawn in 2015 due to lack of evidence. The National Institute for Health and Care Excellence in the UK published a CPG for removal of wisdom teeth in 2000 (NICE 2000). NICE concluded that in light of the costs and risks associated with removal, no valid evidence supports the prophylactic removal of asymptomatic disease-free wisdom teeth. It has been debated whether this is an appropriate strategy for all patients with impacted wisdom teeth (McArdle 2012; Renton 2012). Well-designed RCTs investigating the long-term and rare effects of retention and removal of asymptomatic disease-free impacted wisdom teeth, in a representative group of individuals, are unlikely to be feasible. The Finnish Current Care Guidelines 2014 and Dutch Clinical Care Guidelines 2020 focused on a more individualised approach, based on the risk of developing pathology of the wisdom teeth in the future, and the risk of complications following removal of the wisdom teeth. Both CPGs conclude that the prophylactic removal of asymptomatic disease-free wisdom teeth is indicated in selected cases based on a patient-tailored risk assessment.

Disagreement regarding the removal of asymptomatic disease-free impacted wisdom teeth is ongoing (Huang 2014), and the key question remains: why should impacted wisdom teeth be removed in the absence of symptoms or pathological conditions? Unfortunately, reliable estimates of the onset of pathology related to retained impacted wisdom teeth are unavailable (Venta 2004), in large part because of the widespread practice of routine removal over past decades. Recently, an assessment of the prevalence of distal surface caries (DSC) in the second molar adjacent to third molars in a systematic review and meta-analysis revealed that European studies suggest that DSC may be present in about 25% of third molar assessment referrals and that the risk is considerably higher in those with convergent third molar impactions (Toedtling 2019).

Cross-sectional studies performed in elderly individuals in the USA (Fisher 2010) and Finland (Venta 2019) have reported that most wisdom teeth are removed over a lifetime, and that up to 80% of surviving wisdom teeth have associated pathology such as caries or periodontitis in patients over the age of 74 years. The incidence of severe pathology associated with wisdom teeth, such as cysts and tumours, is low (< 2%). Evidence from these cross-sectional studies is very unreliable, and studies assessing the outcomes of retained wisdom teeth are rare because of problems associated with a complex long-term prospective study design (Van der Sanden 2002). Actuarial lifetime tables have shed some light on the natural history of asymptomatic impacted lower wisdom teeth, but longer follow-up periods are required (Fernandes 2010).

In the late 1990s, the American Association of Oral and Maxillofacial Surgeons acknowledged the absence of evidence to guide clinical decision-making for the management of asymptomatic disease-free impacted wisdom teeth, and allocated a significant amount of money for a multi-centre study (Kandasamy 2009). More than 70 papers have been published as a result of this study, including a large cohort study that documents the incidence of adverse effects following more than 8000 third molar extractions in participants of 25 years of age or older (Haug 2005). Large studies have documented the incidence of complications associated with retention of asymptomatic disease-free wisdom teeth. Most of these studies did not focus on asymptomatic disease-free impacted wisdom teeth but investigated the occurrence of pathology associated with 'visible teeth'. This resulted in serious risk of selection bias in all of these studies; therefore we did not include them in this review. The American Association of Oral and Maxillofacial Surgeons "leans more towards the removal of asymptomatic disease-free third molars on the basis they are associated with increased periodontal probing depths and are therefore a potential source of chronic inflammation" (Kandasamy 2009). However, it should be questioned whether only pocket

depths are indicative of periodontal pathology. A 4-mm pocket depth in the second molar may be influenced by the eruption status of the third molar, without inflammation or other pathology. The prospective cohort study included in this review found increased risk of second molar periodontal pathology adjacent to impacted third molars when distal alveolar bone loss was assessed radiographically in addition to distal probing depths (Nunn 2013).

The decision about whether to recommend removal or retention of asymptomatic disease-free wisdom teeth may be influenced by cost (whether publicly funded, covered through insurance or borne by the patient) and by professional liability. Patient values and preferences should play a more prominent role in deciding whether asymptomatic disease-free impacted wisdom teeth should be removed.

## AUTHORS' CONCLUSIONS

### Implications for practice

Insufficient evidence is available to support the surgical removal or retention of asymptomatic disease-free impacted wisdom teeth. Although some evidence suggests that retaining asymptomatic disease-free impacted wisdom teeth may increase the risk of periodontitis associated with adjacent second molars in the long term, we assessed this evidence has having very low certainty. Given the lack of evidence from scientific studies, patient values should be considered and clinical expertise and local and national guidance used to guide shared decision-making with people who have asymptomatic disease-free impacted wisdom teeth. If the decision is made to retain asymptomatic disease-free impacted wisdom teeth, clinical assessment at regular intervals to prevent undesirable outcomes is advisable.

### Implications for research

Long-term, well-designed prospective studies comparing removal or retention of asymptomatic disease-free impacted wisdom teeth are urgently needed. Well-designed RCTs investigating the long-term and rare effects of retention and removal of asymptomatic disease-free impacted wisdom teeth, in a representative group of individuals, are unlikely to be feasible. If randomisation is not possible, studies should register important baseline data such as age and general and oral health status, including the frequency of dental checkups, the DMFS/T (Decayed Missing Filled Surfaces/Teeth) index or frequency of oral hygiene. These confounding domains should be balanced at baseline or adjusted for with appropriate analyses.

There is a need for research investigating the primary outcome in this review, oral health-related quality of life, in the context of managing impacted wisdom teeth (Duarte 2018). Future review updates may focus on a different primary outcome measure to accommodate for this current lack of evidence.

The secondary outcomes described in this review are also of great importance for decision-making in the management of asymptomatic disease-free impacted wisdom teeth and should be measured in future studies. Because pathology may develop in a wisdom tooth or in the adjacent second molar over the whole of a person's lifetime, studies with long-term follow-up (at least five years) are needed. This is very challenging, as young participants are difficult to contact when they move to higher education, travel or change locations while seeking employment.

## ACKNOWLEDGEMENTS

We would like to thank Anne Littlewood at Cochrane Oral Health for her guidance and coaching in searching the literature, Helen Worthington, Anne-Marie Glenny and Laura MacDonald for their support at the editorial base of Cochrane Oral Health, and Richard Grol and Alphons Plasschaert for initiating this review. For the previous version of the review, we would like to thank our referees Scott L Tomar, Tara Renton, Eleni Besi and Julian Yates for their feedback, and Dolores P Matthews for copy editing.

# REFERENCES

## References to studies included in this review

**Harradine 1998** *{published data only}*

Harradine NW, Pearson MH, Toth B. The effect of extraction of third molars on late lower incisor crowding: a randomized controlled trial. *British Journal of Orthodontics* 1998;**25**(2):117-22.

**Nunn 2013** *{published data only}*

Nunn ME, Fish MD, Garcia RI, Kaye EK, Figuerosa R, Gohel A, et al. Retained asymptomatic third molars and risk for second molar pathology. *Journal of Dental Research* 2013;**92**(12):1095-9.

## References to studies excluded from this review

**Ades 1990** *{published data only}*

Ades AG, Joondeph DR, Little RM, Chapko MK. A long-term study of the relationship of 3rd molars to changes in the mandibular dental arch. *American Journal of Orthodontics and Dentofacial Orthopedics* 1990;**97**(4):323-35.

**Blakey 2009** *{published data only}*

Blakey GH, Parker DW, Hull DJ, White RP Jr, Offenbacher S, Phillips C, et al. Impact of removal of asymptomatic third molars on periodontal pathology. *Journal of Oral and Maxillofacial Surgery* 2009;**67**(2):245-50.

**Coleman 2011** *{published data only}*

Coleman M, McCormick A, Laskin DM. The incidence of periodontal defects distal to the maxillary second molar after impacted third molar extraction. *Journal of Oral and Maxillofacial Surgery* 2011;**69**(2):319-21.

**Dicus 2010** *{published data only}*

Dicus C, Blakey GH, Faulk-Eggleston J, Hoverstad E, Offenbacher S, Phillips C, et al. Second molar periodontal inflammatory disease after third molar removal in young adults. *Journal of Oral and Maxillofacial Surgery* 2010;**68**(12):3000-6.

**Dicus-Brookes 2013** *{published data only}*

Dicus-Brookes C, Partrick M, Blakey GH, Faulk-Eggleston J, Offenbacher S, Phillips C, et al. Removal of symptomatic third molars may improve periodontal status of remaining dentition. *Journal of Oral and Maxillofacial Surgery* 2013;**71**(10):1639-46.

**Fisher 2012** *{published data only}*

Fisher EL, Garaas R, Blakey GH, Offenbacher S, Shugars DA, Phillips C, et al. Changes over time in the prevalence of caries experience or periodontal pathology on third molars in young adults. *Journal of Oral and Maxillofacial Surgery* 2012;**70**(5):1016-22.

**Fisher 2013** *{published data only}*

Fisher EL, Blakey GH, Offenbacher S, Phillips C, White RP Jr. Mechanical debridement of subgingival biofilm in participants with asymptomatic third molars does not reduce deeper probing depths in the molar regions of the mouth. *Journal of Oral and Maxillofacial Surgery* 2013;**71**(3):467-74.

**Garaas 2012** *{published data only}*

Garaas RN, Fisher EL, Wilson GH, Phillips C, Shugars DA, Blakey GH, et al. Prevalence of third molars with caries experience or periodontal pathology in young adults. *Journal of Oral and Maxillofacial Surgery* 2012;**70**(3):507-13.

**Golden 2015** *{published data only}*

Golden BA, Baldwin C, Sherwood C, Abdelbaky O, Phillips C, Offenbacher S, et al. Monitoring for periodontal inflammatory disease in the third molar region. *Journal of Oral and Maxillofacial Surgery* 2015;**73**(4):595-9.

**Haug 2005** *{published data only}*

Haug RH, Perrott DH, Gonzalez ML, Talwar RM. The American Association of Oral and Maxillofacial Surgeons Age-related Third Molar Study. *Journal of Oral and Maxillofacial Surgery* 2005;**63**(8):1106-14.

**Huang 2014** *{published data only}*

Huang GJ, Cunha-Cruz J, Rothen M, Spiekerman C, Drangsholt M, Anderson L, et al. A prospective study of clinical outcomes related to third molar removal or retention. *American Journal of Public Health* 2014;**104**(4):728-34.

**Lindqvist 1982** *{published data only}*

Lindqvist B, Thilander B. Extraction of third molars in cases of anticipated crowding in the lower jaw. *American Journal of Orthodontics* 1982;**81**(2):130-9.

**Moss 2007** *{published data only}*

Moss KL, Beck JD, Mauriello SM, Offenbacher S, White RP. Third molar periodontal pathology and caries in senior adults. *Journal of Oral and Maxillofacial Surgery* 2007;**65**(1):103-8.

**Moss 2007a** *{published data only}*

Moss KL, Serlo AD, Offenbacher S, Beck JD, Mauriello SM, White RP. The oral and systemic impact of third molar periodontal pathology. *Journal of Oral and Maxillofacial Surgery* 2007;**65**(9):1739-45.

**Moss 2009** *{published data only}*

Moss KL, Oh ES, Fisher E, Beck JD, Offenbacher S, White RP Jr. Third molars and periodontal pathologic findings in middle-age and older Americans. *Journal of Oral and Maxillofacial Surgery* 2009;**67**(12):2592-8.

**Moss 2013** *{published data only}*

Moss KL, Offenbacher S, Beck JD, White RP. The presence of visible third molars negatively influences periodontal outcomes in the maternal oral therapy to reduce obstetric risk study. *Journal of Oral and Maxillofacial Surgery* 2013;**71**(6):988-93.

**Moss 2013a** *{published data only}*

Moss KL, Offenbacher S, Beck JD, White RP. The presence of visible third molars negatively influences periodontal outcomes in the maternal oral therapy to reduce obstetric risk study. *Journal of Oral and Maxillofacial Surgery* 2013;**71**(6):988-93.

**Nemcovsky 1997** *{published data only}*

Nemcovsky CE, Tal H, Pitaru S. Effect of non-erupted third molars on roots of approximal teeth. A radiographic, clinical and histologic study. *Journal of Oral Pathology & Medicine* 1997;**26**(10):464-9.

**Offenbacher 2012** *{published data only}*

Offenbacher S, Beck JD, Moss KL, Barros S, Mendoza L, White RP. What are the local and systemic implications of third molar retention? *Journal of Oral and Maxillofacial Surgery* 2012;**70**(9):S58-65.

**Rahman 2009** *{published data only}*

Rahman NA, Daud MKM, Yaacob MF, Yusoff A. Mandibular third molar impaction and dental caries among patients attending Hospital Universiti Sains Malaysia (HUSM). *Internal Medicine Journal* 2009;**16**(1):53-6.

**Venta 1993** *{published data only}*

Venta I, Meurman JH, Murtomaa H, Turtola L. Effect of erupting third molars on dental caries and gingival health in Finnish students. *Caries Research* 1993;**27**(5):438-43.

**Venta 1993a** *{published data only}*

Venta I, Turtola L, Murtomaa H, Ylipaavalniemi P. Third molars as an acute problem in Finnish university students. *Oral Surgery, Oral Medicine, and Oral Pathology* 1993;**76**(2):135-40.

**Venta 2015** *{published data only}*

Venta I, Kylatie E, Hiltunen K. Pathology related to third molars in the elderly persons. *Clinical Oral Investigations* 2015;**19**(8):1785-9.

## Additional references

**Bienstock 2011**

Bienstock DA, Dodson TB, Perrott DH, Chuang SK. Prognostic factors affecting the duration of disability after third molar removal. *Journal of Oral and Maxillofacial Surgery* 2011;**69**(5):1272-7.

**Bradley 1996**

Bradley JG, Zia MJ, Hamilton N. Patient preferences for control in medical decision making: a scenario-based approach. *Family Medicine* 1996;**28**(7):496-501.

**Brokaw 1991**

Brokaw WC. The third molar question: when and why should we recommend removal? *Virginia Dental Journal* 1991;**68**(4):18-21.

**Carter 2015**

Carter K, Worthington S. Morphologic and demographic predictors of third molar agenesis: a systematic review and meta-analysis. *Journal of Dental Research* 2015;**94**(7):886-94.

**Celikoglu 2010**

Celickoglus M, Miloglus O, Kazanci F. Frequency of agenesis, impaction, angulation, and related pathologic changes of third molar teeth in orthodontic patients. *Journal of Oral and Maxillofacial Surgery* 2010;**68**(5):990-5.

**Chuang 2007**

Chuang SK, Perrott DH, Susarla SM, Dodson TB. Age as a risk factor for third molar surgery complications. *Journal of Oral and Maxillofacial Surgery* 2007;**65**(9):1685-92.

**Cunha-Cruz 2014**

Cunha-Cruz J, Rothen M, Spiekerman C, Drangsholt M, McClellan L, Huang GJ, Northwest Practice-Based Research Collaborative in Evidence-Based Dentistry. Recommendations for third molar removal: a practice-based cohort study. *American Journal of Public Health* 2014;**104**(4):735-43.

**Dodson 2012**

Dodson TB. How many patients have third molars and how many have one or more asymptomatic, disease-free third molars? *Journal of Oral and Maxillofacial Surgery* 2012;**70**(9):4-7.

**Duarte 2018**

Duarte-Rodrigues L, Miranda EFP, Souza TO, de Paiva HN, Falci SGM, Galvão EL. Third molar removal and its impact on quality of life: systematic review and meta-analysis. *Quality Life Research* 2018;**10**:2477-89.

**Dutch Clinical Care Guidelines 2020**

KIMO Kennisinstituut Mondzorg. Third Molar [Derde molaar]. www.hetkimo.nl/richtlijnen/derde-molaar/introductie/ (accessed 1 March 2020).

**Fernandes 2006**

Fernandes MJ, Ruta DA, Ogden GR, Pitts NB, Ogston SA. Assessing oral health-related quality of life in general dental practice in Scotland: validation of the OHIP-14. *Community Dentistry and Oral Epidemiology* 2006;**34**(1):53-62.

**Fernandes 2010**

Fernandes MJ, Ogden GR, Pitts NB, Ogston SA, Ruta DA. Actuarial life-table analysis of lower impacted wisdom teeth in general dental practice. *Community Dentistry and Oral Epidemiology* 2010;**38**(1):58-67.

**Finnish Current Care Guidelines 2014**

Working group set up by the Finnish Medical Society Duodecim and the Finnish Dental Society Apollonia. Third Molar. www.kaypahoito.fi/hoi50074 (accessed 1 March 2020).

**Fisher 2010**

Fisher EL, Moss KL, Offenbacher S, Beck JD, White RP Jr. Third molar caries experience in middle-aged and older Americans: a prevalence study. *Journal of Oral and Maxillofacial Surgery* 2010;**68**(3):634-40.

**Ghaeminia 2017**

Ghaeminia H, Hoppenreijs TJ, Xi T, Fennis JP, Maal TJ, Bergé SJ, et al. Postoperative socket irrigation with drinking tap water reduces the risk of inflammatory complications following surgical removal of third molars: a multicenter randomized trial. *Clinical Oral Investigations* 2017;**21**(1):71-83.

**Higgins 2011**

Higgins JPT, Green S (editors). Cochrane Handbook for Systematic Reviews of Interventions version 5.1.0 [updated

March 2011]. The Cochrane Collaboration, 2011. www.cochrane-handbook.org.

**Hyam 2018**

Hyam DM. The contemporary management of third molars. *Australian Dental Journal* 2018;**63 Suppl 1**(Suppl 1):19-26.

**Kandasamy 2009**

Kandasamy S, Rinchuse DJ. The wisdom behind third molar extractions. *Australian Dental Journal* 2009;**54**(4):284-92.

**Kapur 1972**

Kapur KK, Glass RL, Loftus ER, Alman JE, Feller RP. The Veterans Administration longitudinal study of oral health and disease. *International Journal of Aging & Human Development* 1972;**3**:125-37.

**Kruger 2001**

Kruger E, Thomson WM, Konthasinghe P. Third molar outcomes from age 18 to 26: findings from a population-based New Zealand longitudinal study. *Oral Surgery, Oral Medicine, Oral Pathology, Oral Radiology, and Endodontics* 2001;**92**(2):150-5.

**McArdle 2012**

McArdle LW, Renton T. The effects of NICE guidelines on the management of third molar teeth. *British Dental Journal* 2012;**213**(8):394.

**NICE 2000**

National Institute for Health and Clinical Excellence. NICE Technology Appraisal Guidance, TA1. Guidance on the Extraction of Wisdom Teeth. London: National Institute for Health and Clinical Excellence, 2000.

**Oenning 2015**

Oenning AC, Melo SL, Groppo FC, Haiter-Neto F. Mesial inclination of impacted third molars and its propensity to stimulate external root resorption in second molars - a cone-beam computed tomographic evaluation. *Journal of Oral and Maxillofacial Surgery* 2015;**73**(3):379-86.

**Passarelli 2019**

Passarelli PC, Lajolo C, Pasquantonio G, D'Amato G, Docimo R, Verdugo F, et al. Influence of mandibular third molar surgical extraction on the periodontal status of adjacent second molars. *Journal of Periodontology* 2019;**90**(8):847-55.

**RCS England 1997**

The Faculty of Dental Surgery of the Royal College of Surgeons of England. National Clinical Guidelines 1997. The management of patients with third molar (syn: wisdom) teeth. In: Current Clinical Practice and Parameters of Care. London: Royal College of Surgeons of England, 1997.

**Renton 2012**

Renton T, Al-Haboubi M, Pau A, Sepherd J, Gallagher JE. What has been the United Kingdom's experience with retention of third molars? *Journal of Oral and Maxillofacial Surgery* 2012;**70**(9):48-57.

**SIGN 1999**

Scottish Intercollegiate Guidelines Network. Management of Unerupted and Impacted Third Molar Teeth. A National Clinical Guideline. SIGN Publication No 43. Edinburgh: Scottish Intercollegiate Guidelines Network, 1999.

**Song 1997**

Song F, Landes DP, Glenny AM, Sheldon TA. Prophylactic removal of impacted third molars: an assessment of published reviews. *British Dental Journal* 1997;**182**(9):339-46.

**Song 2000**

Song F, O'Meara S, Wilson P, Golder S, Kleijnen J. The effectiveness and cost-effectiveness of prophylactic removal of wisdom teeth. *Health Technology Assessment* 2000;**4**(15):1-55.

**Sterne 2014**

Sterne JAC, Higgins JPT, Reeves BC, on behalf of the Development Group for ACROBAT-NRSI. A Cochrane Risk of Bias Assessment Tool for Non-Randomized Studies of Interventions (ACROBAT-NRSI), version 1.0.0, September 2014. http://www.riskofbias.info (accessed 24 July 2016).

**Tate 1994**

Tate TE. Impactions: observe or treat? *Journal of Californian Dental Association* 1994;**22**(6):59-64.

**Toedtling 2019**

Toedtling V, Devlin H, Tickle M, O'Malley L. Prevalence of distal surface caries in the second molar among referrals for assessment of third molars: a systematic review and meta-analysis. *British Journal of Oral and Maxillofacial Surgery* 2019;**57**:505-14.

**Van der Sanden 2002**

Van der Sanden WJM, Mettes DG, Plasschaert AJ, Grol RP, Van't Hof MA, Knutsson K, et al. Effect of selected literature on dentists' decisions to remove asymptomatic, impacted lower third molars. *European Journal of Oral Sciences* 2002;**110**(1):2-7.

**Venta 1999**

Venta I, Turtola L, Ylipaavalniemi P. Change in clinical status of third molars in adults during 12 years of observation. *Journal of Oral and Maxillofacial Surgery* 1999;**57**(4):386-91.

**Venta 2004**

Venta I, Ylipaavalniemi P, Turtola L. Clinical outcome of third molars in adults followed during 18 years. *Journal of Oral and Maxillofacial Surgery* 2004;**62**(2):182-5.

**Venta 2019**

Ventä I, Vehkalahti MM, Suominen AL. What kind of third molars are disease-free in a population aged 30 to 93 years? *Clinical Oral Investigations* 2019;**3**:1015-22.

**Worthington 2015**

Worthington H, Clarkson J, Weldon J. Priority oral health research identification for clinical decision-making. *Evidence-based Dentistry* 2015;**16**(3):69-71.

## References to other published versions of this review

### Ghaeminia 2016

Ghaeminia H, Perry J, Nienhuijs ME, Toedtling V, Tummers M, Hoppenreijs TJ, et al. Surgical removal versus retention for the management of asymptomatic disease-free impacted wisdom teeth. *Cochrane Database of Systematic Reviews* 2016, Issue 8. [DOI: 10.1002/14651858.CD003879.pub4]

### Mettes 2005

Mettes TG, Nienhuijs ME, van der Sanden WJ, Verdonschot EH, Plasschaert AJ. Interventions for treating asymptomatic impacted wisdom teeth in adolescents and adults. *Cochrane Database of Systematic Reviews* 2005, Issue 2. [DOI: 10.1002/14651858.CD003879.pub2]

### Mettes 2012

Mettes TD, Ghaeminia H, Nienhuijs ME, Perry J, van der Sanden WJ, Plasschaert A. Surgical removal versus retention for the management of asymptomatic impacted wisdom teeth. *Cochrane Database of Systematic Reviews* 2012, Issue 6. [DOI: 10.1002/14651858.CD003879.pub3]

## CHARACTERISTICS OF STUDIES

## Characteristics of included studies *[ordered by study ID]*

### Harradine 1998

| ***Study characteristics*** | |
|---|---|
| Methods | Randomised controlled trial, parallel-group design, 2 treatment groups<br><br>Location: Bristol, UK<br><br>Single centre<br><br>Research aim: to investigate prospectively the effects of early extraction of third molars on late lower incisor crowding |
| Participants | Inclusion criteria: individuals who had previously undergone orthodontic treatment but were no longer wearing orthodontic appliances or retainers. Orthodontic treatment comprised active treatment in the upper arch with only removable appliances or a single-arch fixed appliance, with no treatment or pre-molar extractions carried out in the lower arch. Individuals with crowded molars (third molars whose long axis and, therefore, presumed path of eruption was through the adjacent second molar)<br><br>Exclusion criteria: residual premolar extraction space<br><br>Number randomised: 164 individuals (55% were female)<br><br>Number evaluated after 5 years: 77 individuals completed the trial (58% were female)<br>Age of entry to the trial (mean ± standard deviation (SD)): 14 years 10 months ± 16.2 months<br>Baseline characteristics: reported for overall group sample, not per study group |
| Interventions | Group I: extraction of third molars (N = 44 evaluated)<br>Group II: retention of third molars (N = 33 evaluated) |
| Outcomes | Outcome measures<br><br>• Little's irregularity index (LII). Mean differences ± SD for change<br>• Intercanine width (ICW). Mean differences ± SD for change<br>• Arch length (AL). Mean differences ± SD for change<br><br>Length of follow-up: 5 years, mean length of follow-up was 66 ± 12.6 months<br>For the upper arch, investigators found no statistical differences between the 2 groups for the 3 out-come variables |
| Notes | Sample size calculation: not described<br>Analysis (linear modelling) of measurements of casts demonstrated no systematic differences between individuals who completed the trial and those lost to follow-up<br>Baseline characteristics per study group for comparability at entry would have been appropriate |

**Harradine 1998** *(Continued)*

***Risk of bias***

| Bias | Authors' judgement | Support for judgement |
|---|---|---|
| Random sequence generation | Low risk | Quote: "...a list of randomly generated numbers was used to allocate..." |
| Allocation concealment | High risk | Quote: "...a list of randomly generated numbers was used to allocate..."<br>Comment: The method of concealment is not fully described; it is likely that selection bias could affect the outcome of the study |
| Blinding of outcome assessment | Low risk | Quote: "the third molar status was unknown to the digitizer in order to eliminate sub-conscious bias" |
| Incomplete outcome data | High risk | Quote: "...no systematic differences existed between those patients who entered the trial and completed, and those who entered and did not complete"<br>Comment: 53% attrition overall, evaluation of 44 and 33 participants in extraction and non-extraction groups (54% and 40%, respectively) and reasons for non-completion are given as "loss of contact with occupiers of their previous address". No data are available on the gender balance of those who completed compared with those who did not, for each treatment group. Trial authors report only the results of modelling of 44 non-responders. This trial would seem to be at high risk of attrition bias |
| Selective reporting | Unclear risk | Comment: The only outcomes reported in the paper are orthodontic indices. No adverse effects of treatments or symptoms are reported |
| Other sources of bias | Low risk | Comment: More specific characteristics per study group for comparability at entry would have been appropriate |

**Nunn 2013**

| ***Study characteristics*** | |
|---|---|
| Methods | Prospective cohort study, part of Longitudinal Veterans Affairs Normative Aging Study, beginning in 1961 (Kapur 1972)<br>Location: United States (greater Boston area)<br>Research aim: to examine the association of third molar status with prevalent and incident caries and periodontal outcomes in adjacent second molars |
| Participants | Healthy male patients who had both first and second molars present in at least 1 quadrant at baseline and had at least 1 follow-up. Examinations were performed every 3 years with duration to > 25 years<br>Number of participants: 416 (804 third molars) from 1231 enrolled patients met the inclusion criteria<br>Age of entry to the trial (mean ± standard deviation (SD)): 45.8 years 9 months ± 7.4 years<br>Baseline characteristics: Analyses were adjusted for baseline age, smoking status, education and baseline second molar measures |
| Interventions | Retention of asymptomatic wisdom teeth compared with absence of wisdom teeth (previous extraction or agenesis at baseline) |
| Outcomes | Second molar pathology |

| | |
|---|---|
| **Nunn 2013** *(Continued)* | • Caries<br>• Distal probing depth > 4 mm<br>• Distal alveolar bone loss<br><br>These outcomes were measured every 3 years<br><br>Clinical outcomes (caries and probing depths > 4 mm) measured by a trained, calibrated periodontist. Radiological outcome (alveolar bone loss and caries) measured by board-certified oral and maxillofacial surgeon and a board-certified oral and maxillofacial radiologist. Alveolar bone loss was measured with a Schei ruler |
| Notes | Risk of bias is assessed to be serious for this study. See Table 1 for details |

**Characteristics of excluded studies** *[ordered by study ID]*

| Study | Reason for exclusion |
|---|---|
| Ades 1990 | Retrospective design |
| Blakey 2009 | Short follow-up (< 5 years), not impacted third molars |
| Coleman 2011 | Short follow-up (< 5 years) |
| Dicus 2010 | Comparison of 2 different cohorts |
| Dicus-Brookes 2013 | Only symptomatic third molars included |
| Fisher 2012 | No comparison between retention and extraction or absence and presence of third molars |
| Fisher 2013 | No comparison between retention and extraction or absence and presence of third molars. Short follow-up (< 5 years) |
| Garaas 2012 | No comparison between retention and extraction or absence and presence of third molars |
| Golden 2015 | No comparison between retention and extraction or absence and presence of third molars |
| Haug 2005 | No comparison between retention and extraction or absence and presence of third molars |
| Huang 2014 | Short follow-up (< 5 years) |
| Lindqvist 1982 | Split-mouth study, which is an inappropriate design for evaluation of crowding of teeth |
| Moss 2007 | Cross-sectional design |
| Moss 2007a | Cross-sectional design |
| Moss 2009 | Only obstetric patients with periodontal disease were included |
| Moss 2013 | Only obstetric patients with periodontal disease were included |
| Moss 2013a | Only obstetric patients with periodontal disease were included |
| Nemcovsky 1997 | Removal of second molars (not third molars) |

| Study | Reason for exclusion |
|---|---|
| Offenbacher 2012 | Cross-sectional design |
| Rahman 2009 | Cross-sectional design |
| Venta 1993 | Data were not presented at patient level, but at sextant level. Participants who had wisdom teeth removed during the study were excluded from analyses. The senior study author was contacted successfully, but the complete dataset was not available |
| Venta 1993a | Retrospective design |
| Venta 2015 | No comparison between retention and extraction or absence and presence of third molars |

## ADDITIONAL TABLES

**Table 1. Risk of bias assessed using ACROBAT-NRSI for Nunn 2013**

| Bias | Authors' judgement | Support for judgement |
|---|---|---|
| Confounding | Serious risk | Analyses were adjusted for baseline age, smoking status, education and baseline second molar measures. However, oral health status such as oral hygiene and frequency of dental checkups was not measured. These factors may contribute to the development of second molar pathology. However, "participants enrolled in the study returning for follow-ups are likely to be more health aware than their age-matched peers in the community and practice better health behaviors". This would suggest more motivated participants in this study compared with the overall population. Therefore the predicted direction of bias due to oral health status confounding favours retention (presence), and it is likely that the effect estimate would be even higher if was adjusted |
| Selection of participants into the study | Moderate risk | Only male volunteers were included. However, gender is not expected to contribute to the development of second molar pathology. Some participants lost third molars before the start of follow-up – in the target randomised trial for this study, participants would be followed from the time the third molars were removed. As third molars were removed before the start of follow-up, a potentially important amount of follow-up time is missing |
| Measurement of interventions | Low risk | Intervention status was well defined and was based solely on information collected at the time of intervention |
| Departure from intended interventions | Moderate risk | Switching of participants from retention to removal was likely, but this switching occurs as part of the natural course of events |
| Missing data | Serious risk | 1231 volunteers enrolled in the Dental Longitudinal Study beginning in 1969 (Kapur et al. 1972), but only 416 analysed. This first study could not be obtained. Those with problems from third molars were likely to have them removed before the study was initiated; therefore, this study has serious risk of bias due to missing data |
| Measurement of outcomes | Moderate risk | Caries, probing depths and alveolar bone loss were assessed clinically and on radiographs adequately. Blinding was not possible, but we do not expect that non-blinding would have influenced the results |
| Selection of reported results | Moderate risk | There is no evidence to suggest that multiple outcome measurements and/or multiple analyses were conducted for each outcome. Only participants with both first and second molars in at least 1 quadrant were included in the study, rather than the |

**Table 1. Risk of bias assessed using ACROBAT-NRSI for Nunn 2013** *(Continued)*

| | |
|---|---|
| | whole subset of 1231 volunteers in the Dental Longitudinal Study. No a priori measurement or analysis plan was included |

## APPENDICES

### Appendix 1. Cochrane Oral Health's Trials Register search strategy

Cochrane Oral Health's Trials Register is available via the Cochrane Register of Studies. For information on how the register is compiled, see https://oralhealth.cochrane.org/trials.

From June 2015, searches of the Cochrane Oral Health Trials Register were conducted using the Cochrane Register of Studies and the search strategy below:

1 (("third molar*" or "wisdom tooth" or "wisdom teeth" or "3rd molar*" or third-molar):ti,ab) AND (INREGISTER)
2 (retain* or retention or present* or presence):ti,ab
3 ((extract* or remov* or absent* or missing or absence):ti,ab) AND (INREGISTER)
4 #2 and #3
5 (asymptom*:ti,ab) AND (INREGISTER)
6 ((symptomless or symptom-free or "symptom free"):ti,ab) AND (INREGISTER)
7 (("trouble free" or trouble-free):ti,ab) AND (INREGISTER)
8 (#5 or #6 or #7) AND (INREGISTER)
9 #4 or #8
10 (#1 and #4 and #9) AND (INREGISTER)

Previous searches of this database were conducted using the Procite software and the search strategy below:

(("third molar*" OR "molar third" OR "wisdom teeth" or "wisdom tooth" OR "third-molar*" or "3rd molar*") AND (impact* or unerupt*) AND ("Tooth extraction" or extract* or remov* or asymptom* or "trouble free" or trouble-free or "symptom free"))

### Appendix 2. Cochrane Central Register of Controlled Trials (CENTRAL) search strategy

#1 [mh ^"molar, third"]
#2 ("third molar*" or "wisdom teeth" or "wisdom tooth" or "3rd molar*" or third-molar*)
#3 #1 or #2
#4 [mh ^"Tooth extraction"]
#5 (extract* or remov* or absent* or missing or absence)
#6 #4 or #5
#7 (retain* or retention or present* or presence)
#8 #6 and #7
#9 asymptom*
#10 (symptomless or symptom-free or "symptom free")
#11 (trouble-free or "trouble free")
#12 {or #9-#11}
#13 #8 or #12
#14 #3 and #13

### Appendix 3. MEDLINE Ovid search strategy

1. Molar, Third/
2. ("third molar*" or "wisdom tooth" or "wisdom teeth" or "3rd molar*" or third-molar).mp.
3. 1 or 2
4. Tooth extraction/
5. (extract$ or remov$ or absent$ or missing or absence).mp.
6. 4 or 5
7. (retain$ or retention or present$ or presence).mp.
8. 6 and 7
9. asymptom$.mp.
10. (symptomless or symptom-free or "symptom free").mp.
11. (trouble-free or "trouble free").mp.

12. or/9-11
13. 8 or 12
14. 3 and 13

### Appendix 4. Embase Ovid search strategy

1. Molar tooth/
2. ("third molar$" or "wisdom tooth" or "wisdom teeth" or "3rd molar$" or third-molar$).mp.
3. 1 or 2
4. Tooth extraction/
5. (extract$ or remov$ or absent$ or missing or absence).mp.
6. 4 or 5
7. (retain$ or retention or presence).mp.
8. ((present or presence) adj3 (tooth or teeth or molar)).mp.
9. 7 or 8
10. 6 and 9
11. asymptom$.mp.
12. (symptomless or symptom-free or "symptom free").mp.
13. (trouble-free or "trouble free").mp.
14. or/11-13
15. 10 or 14
16. 3 and 15

### Appendix 5. US National Institutes of Health Ongoing Trials Register (ClinicalTrials.gov) search strategy

asymptomatic and third and molar

asymptomatic and wisdom and tooth

asymptomatic and wisdom and teeth

### Appendix 6. World Health Organization International Clinical Trials Registry Platform search strategy

asymptomatic and third molar

asymptomatic and wisdom tooth

asymptomatic and wisdom teeth

## WHAT'S NEW

| Date | Event | Description |
|---|---|---|
| 28 February 2020 | New citation required but conclusions have not changed | No change to conclusions as no new studies were added.<br>Minor change to author order. |
| 24 February 2020 | New search has been performed | We ran a new search but did not identify any additional studies for inclusion. |

## HISTORY

Protocol first published: Issue 1, 2002
Review first published: Issue 2, 2005

| Date | Event | Description |
|---|---|---|
| 26 June 2016 | New citation required and conclusions have changed | We added 1 new longitudinal study in this review update |

| Date | Event | Description |
|---|---|---|
| | | Conclusions have changed. In the original review, we concluded that "watchful monitoring of asymptomatic impacted wisdom teeth may be a more prudent strategy". However, the available evidence is very low quality and there are insufficient data on which to base clinical decisions about the management of asymptomatic disease-free impacted wisdom teeth |
| 9 June 2015 | New search has been performed | Search strategy changed: trials investigating short- and long-term risks and complications of retention/removal of asymptomatic disease-free impacted wisdom teeth are unlikely to be feasible. We included non-randomised studies (NRSs) in this review update if they assessed long-term outcomes, i.e. over 5 years. The introduction of a new Cochrane Risk of Bias Tool for NRSs means we can now assess the risk of bias in NRSs more systematically |
| 14 May 2012 | New search has been performed | New search was conducted. Title was changed to "Surgical removal versus retention for the management of asymptomatic impacted wisdom teeth" |
| 14 May 2012 | New citation required and conclusions have changed | As the result of changes in methodology, we have deleted 1 previously included study. We have revised the review conclusions because evidence is insufficient to determine effects of prophylactic extraction of asymptomatic wisdom teeth |

## CONTRIBUTIONS OF AUTHORS

For this update:

- Literature search update and study selection: Hossein Ghaeminia, John Perry, Marloes Nienhuijs, Verena Toedtling, Marcia Tummers, Theo Hoppenreijs, Wil van der Sanden, Dirk Mettes;
- Risk of bias and quality assessment: Hossein Ghaeminia, John Perry, Marcia Tummers, Marloes Nienhuijs, Verena Toedtling, Theo Hoppenreijs, Wil van der Sanden, Dirk Mettes; and
- Editing of the review: Hossein Ghaeminia, John Perry, Marcia Tummers, Marloes Nienhuijs, Verena Toedtling, Theo Hoppenreijs, Wil van der Sanden, Dirk Mettes.

## DECLARATIONS OF INTEREST

The participating review authors declare that they have no financial conflicts of interest, nor do they have any associations with industry regarding the topic of this review.

Hossein Ghaeminia: none known
John Perry: none known
Marloes EL Nienhuijs: none known
Verena Toedtling: none known
Marcia Tummers: none known
Theo J M Hoppenreijs: none known
Wil JM van der Sanden: none known
Theodorus (Dirk) G Mettes: none known

## SOURCES OF SUPPORT

### Internal sources

- Radboud University Medical Centre, Nijmegen, Netherlands

### External sources

- School of Dentistry, The University of Manchester, UK

- National Institute for Health Research (NIHR), UK

  This project was supported by the NIHR, via Cochrane Infrastructure funding to Cochrane Oral Health. The views and opinions expressed therein are those of the review authors and do not necessarily reflect those of the Systematic Reviews Programme, NIHR, NHS or the Department of Health
- Cochrane Oral Health Global Alliance, Other

  The production of Cochrane Oral Health reviews has been supported financially by our Global Alliance since 2011 (oralhealth.cochrane.org/partnerships-alliances). Contributors in the last two years have been the American Association of Public Health Dentistry, USA; AS-Akademie, Germany; the British Association for the Study of Community Dentistry, UK; the British Society of Paediatric Dentistry, UK; the Canadian Dental Hygienists Association, Canada; the Centre for Dental Education and Research at All India Institute of Medical Sciences, India; the National Center for Dental Hygiene Research & Practice, USA; New York University College of Dentistry, USA; and Swiss Society of Endodontology, Switzerland.

## DIFFERENCES BETWEEN PROTOCOL AND REVIEW

- Title - we added 'disease-free'.
- Types of participants. In the original protocol, the intention was to include only studies on adult participants (over 17 years of age). However, review authors identified no suitable trials. It was therefore decided to expand the remit to include studies on adolescent participants. The change in the age of participants is not expected to have any clinical implications because little clinical difference has been noted between adolescents (14 to 17 years of age) and young adults (18 to 25 years of age).
- Types of studies. Long-term outcomes of retention/removal of asymptomatic disease-free impacted wisdom teeth are extremely unlikely to be studied in randomised controlled trials (RCTs). Therefore, we considered non-randomised studies (NRSs) for inclusion in this review update, if outcomes were measured with follow-up of at least five years.
- Types of interventions. Presence and absence of wisdom teeth were added to investigate the long-term outcomes of retention or removal of wisdom teeth. This enabled us to study the effects of absence or presence of wisdom teeth on adjacent structures such as the second molar.
- Types of outcomes. More than 15 years after the initial protocol, many publications have addressed periodontitis as a possible undesirable effect of retention of wisdom teeth. Furthermore, attention to medication/radiotherapy-related osteonecrosis of the jaw associated with surgical extractions is increasing. Therefore, we added these secondary outcomes to the methods. We expanded other outcomes.
- Because we considered NRSs for inclusion in the review update, we used the Cochrane Risk of Bias Assessment Tool for Non-Randomized Studies of Interventions (ACROBAT-NRSI) for the risk of bias assessment of NRSs (Sterne 2014).
- As we were including NRSs, we executed the search without an RCT study design filter, and the results of the full search are reported in Figure 1.

## INDEX TERMS

### Medical Subject Headings (MeSH)

Asymptomatic Diseases; Molar, Third [*surgery]; Prospective Studies; Randomized Controlled Trials as Topic; Tooth Extraction [*methods]; Tooth, Impacted [*surgery]; Watchful Waiting

### MeSH check words

Adolescent; Adult; Aged; Aged, 80 and over; Female; Humans; Male; Middle Aged