

SECIB



DIAGNOSIS AND INDICATIONS FOR THIRD MOLAR EXTRACTION

Update 2023

(THIRD MOLAR EXTRACTION)

1. PRESENTATION OF THE SECIB

The Spanish Society of Oral Surgery (SECIB) is a very active society that has been looking to the future with the eyes of the present for more than two decades, with a fixed course towards its consolidation as one of the main national scientific societies in the field of dentistry; it is moving towards recognition as an institutional reference in the field of Oral Surgery; it is moving towards the achievement of the official speciality in Oral Surgery.

On a more formal level, the SECIB is a scientific, non-profit society, with its own legal personality and full capacity to act nationally, created by dental professionals themselves in response to the need to bring together and provide a suitable forum for all those professionals who demand a specific space for Oral Surgery. Specifically, the SECIB brings together dentists, stomatologists, oral surgeons, maxillofacial surgeons, doctors, as well as other clinical and university specialists in the area of Health Sciences with activity in Oral Surgery or links to it. In short, its main objective is to bring together professionals in Dentistry, Stomatology, Medicine and Health Sciences who have a clinical or scientific interest in Oral Surgery, as a means of achieving the following objectives:

- To contribute to the continuing education of all its members and to promote the scientific development of Oral Surgery.
- To advise official, public and private institutions and organisations on any social, clinical and scientific aspect related to Oral Surgery.
- To facilitate and increase relations between Oral Surgery professionals, universities, professional associations and the sector's industry.
- To promote political and social initiatives aimed at achieving the recognition of Oral Surgery as an official speciality by the relevant bodies, as established in the guidelines and regulations of the European Union.
- To collaborate with other national and international societies and scientific bodies, as well as with professional associations, in all those aspects that favour the consolidation of Oral Surgery as an official speciality of Dentistry and to offer them advice and stimulate the carrying out of joint activities.

2. AUTHORSHIP

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3. INTRODUCTION OF THE WORKING GROUP

In 2014, the SECIB convened a group of experts coordinated by Prof. Dr Cosme Gay Escoda, to develop the Guidance on Diagnosis and Indications for Third Molar Extraction, which was finally published in 2017. This guidance was intended to assist professionals and the general population in making decisions regarding the management of third molars (3Ms) based on the best available evidence.

Since the implementation of the NICE guidance (3), the indications for prophylactic tooth extraction were drastically restricted, but after several years of clinical application, far from decreasing the number of surgical interventions, what was observed was a change in the indications (4). It has become clear that, although in many cases the patient is asymptomatic, the incidence of 2M and 3M cavities, together with periodontal pathology with a distal location of the 2M, has increased to a significant level, and consequently, in cases of submucosal or semi-erupted mesioangular and horizontal eruption, prophylactic extraction is becoming less and less debatable as an indication (5,6,7).

For the development of this update we have reconsidered the clinical questions, the need to update them, the deletion or inclusion of others that could provide new useful tools for decision-making by patients and professionals.

4. METHODOLOGY

We understand a CPG as a systematised set of recommendations aimed at helping health professionals and patients to take the most appropriate action in the face of a specific health problem. As such, it is an important source of evaluated evidence and should therefore be based on an extensive literature review, as well as a thorough critical appraisal of the articles retrieved.

The project includes the update of the CPG entitled Diagnosis and indications for third molar extraction. Update. 2023. A working group of eight professionals, selected for their profile as specific experts in the field, was set up for its preparation. Two external reviewers were also involved as independent professionals.

Finally, the guidance was evaluated and validated by the following scientific societies:

- SVCBMF: Venezuelan Society of Oral and Maxillofacial Surgery
- SECA: Spanish Society for Quality Assistance

5. SCOPE AND OBJECTIVES

Background information

3M extraction is the most common surgical intervention in the field of Oral Surgery. Therefore, the intention of the SECIB is to develop a CPG that provides recommendations for good clinical practice, based on the best available scientific evidence, specifically on the indications and clinical and radiological diagnostic criteria for patients presenting with 3Ms. The main objectives of the CPG are to promote uniformity among the different healthcare professionals in the field of dentistry regarding the need for treatment to prevent complications and to improve the quality of patient care.

Need for guidance

Erupted or impacted 3Ms are extremely common in the general population and can be the cause of various complications. These include infection, periodontal pathology, 2M and 3M caries, root resorption, cysts, and associated tumours. In cases where there is evident clinical evidence or when asymptomatic with the presence of pathology, the

indication for extraction is generally accepted (1-8).

However, there is controversy regarding the removal of asymptomatic, pathology-free erupted or formed/impacted 3Ms given the morbidity of the surgical procedure itself or the possibility of future complications (if it is decided not to remove them). This depends, among other factors, on age, gender, surgical technique, anatomical associations, general health status, as well as patient preferences and lifestyle (1, 9-12).

Other widely accepted CPGs have been published, although not all are up to date. Although the same bibliographic sources are generally consulted, the interpretation of the results shows some differences (13- 25).

In view of the need to update the scientific evidence of this CPG produced in our country, the SECIB aims to adapt the different aspects evaluated on erupted or impacted 3Ms present in other CPGs, adapting them to the national context. The intention is to obtain a document that can help in the diagnosis and therapeutic indications according to the different clinical situations, identifying which patients may benefit from surgical extraction or when it is not necessary.

1. CLINICAL PROBLEMS ANALYSED

Q1. In which patients with 3Ms showing associated pathology is a better clinical evolution (fewer complications) obtained when the extraction is performed or when a conservative therapeutic attitude (clinical and radiological controls) is carried out?

The extraction of erupted 3Ms is the most common surgical procedure in dentistry. For this reason, the decision to remove 3Ms must be based on sufficient scientific evidence. There are well-established indications for the removal of symptomatic 3Ms. However, there is still some controversy about the removal of asymptomatic 3Ms (1,2). However, it should be clear that, when referring to the term “asymptomatic”, the authors only refer to the absence of symptoms, but do not rule out that pathology may be present (1).

Most authors consider the removal of 3Ms with

associated pathology to be indicated (3-7). Therefore, professionals should normally advise the removal of erupted and formed 3Ms, especially when they cause considerable pain, are infected, are associated with pathological bone destruction, caries, or when they negatively affect the health of adjacent teeth. Moreover, those that may be problematic for planned prostheses, which are in the position where osteotomies have to be performed, or that interfere with planned orthodontic movements should be removed.

However, the current data are not enough to refute or support removal versus retention of asymptomatic, disease-free 3Ms (6), hence the advice for monitoring (2). However, if extraction is considered, the risk-benefit ratio should always be analysed (3,4).

One of the pathologies most frequently associated with 3M is pericoronitis, an inflammatory periodontal condition characterised mainly by pain, often accompanied by erythema, oedema and suppuration in the affected region. Regional lymphadenopathy, fever, trismus and painful swallowing may also occur. This condition is usually associated with the lower 3Ms and is one of the reasons why removal is indicated. However, there is some controversy about the decision to extract 3Ms with episodes of pericoronitis, even in published guidance (2): some authors support abstention and observation in patients with one or two episodes of mild pericoronitis, which has been treated by periodontal therapy, and who are able to maintain a low level of bacterial plaque (2, 8). However, as a study of 113 patients with symptoms of pericoronitis, published by Tang et al. (9), showed, the patient's opinion has to be taken into account in the therapeutic approach, as 79 of them chose to have the 3Ms removed and most of them did so because the symptoms of pericoronitis affected their normal oral function and lifestyle.

There are occasions when the absence of symptoms associated with erupted/impacted 3Ms does not equate to the absence of disease or pathology. A large number of asymptomatic 3Ms show signs of periodontal disease (10). The clinical implications of these findings suggest that patients who choose to

retain their 3Ms should undergo regular periodic clinical and radiographic examinations to detect disease before it becomes symptomatic (6, 11).

On the other hand, the factors that determine postoperative complications may depend on the patient, anatomical factors, surgical factors and the type of associated pathology (2, 12, 13). According to Chuang et al. (12), subjects with preoperative infection were 25% more likely to experience postoperative inflammatory complications (OR 1.25; 95 % CI 1, 01-1, 6) and those with associated pathology were three times more likely to develop such postoperative complications (OR 3, 0; 95% CI 2, 2-4, 3) (12).

General considerations

1. Periodontal status of the second molar

- Dicus-Brookes et al. (1), probed the 2Ms before and after extraction of the 3Ms and found that, before surgery, significantly 88% of patients had a 2M with probing depth (PD) of at least 4 mm (PD +4), but after surgery it was 46% ($p < 0.01$). Furthermore, 61% had at least a PD +4 in other teeth more anterior to the 2M before surgery compared to postoperatively (29%, $p < 0.01$). Removal of the 3Ms improved the periodontal status of the 2Ms and other more anterior teeth by decreasing oral pathogens (1).
- Other similar studies find patients with PD around 3M of 5 mm or higher with attachment loss of 2 mm and with PD < 4 mm with attachment loss of 1 mm. The presence of 3Ms in young adults was related to the presence of periodontal disease in other teeth. Extraction of mandibular 3Ms improved periodontal status on the distal aspect of the 2M (11).
- Dodson and Richardson (14) concluded that, after extraction of 3Ms, periodontal health distal to the 2Ms should remain unchanged or improve if periodontal pockets or attachment loss were previously present. However, those individuals with no associated pathology in their 3Ms (healthy periodontal status) were shown to have an increased risk of developing periodontal pockets in the distal 2M (48 %) after 3M extraction (14).

2. Pericoronitis and periodontal disease in the 3M

- The clinician has two options: remove the 3M or perform regular periodontal maintenance. Extraction of asymptomatic, non-pathological 3Ms is not recommended; however, extraction is indicated when periodontal pockets are detected, especially if the patient's compliance with oral hygiene measures is unlikely or if periodontal maintenance is not feasible. After considering all these factors, a decision will be made for each individual (2).
- Except for those 3Ms in a favourable position, which have caused one or two episodes of mild, transient and congestive pericoronitis, the remaining 3Ms, which cause more severe and more recurrent infectious pathology, are indicated for extraction. Although pericoronitis has little scientific justification for surgical treatment, it is currently the most frequent reason for removing retained 3Ms, especially because patients with actively infected pericorony tissues benefit from a long-term improvement in their quality of life, a fact that should be taken into account when considering the indication for extraction (8).
- Bradshaw et al. (15) published a study to evaluate the effect of 3M extraction on the quality of life of subjects with symptoms of pericoronitis:
 - The proportion of patients presenting severe pain before surgery decreased after extraction, from 32% to 3%. Those individuals who had very mild pain or no pain before surgery increased from 15% to 96% after extraction.
 - The proportion of patients who gave a negative response with major pain increased from 10% to 78% after surgery.
 - Patients who presented "little" or "much difficulty" in consuming and chewing food before the intervention were 22% and 18%, respectively, while only one patient reported this difficulty after 3M extraction.

They concluded that extraction of 3Ms positively influenced the quality of life in people with mild symptoms of pericoronitis (15).

- For Colorado-Bonin et al. (16) the time needed to recover quality of life in patients who underwent the surgical extraction of 3Ms was statistically significantly worse in women.

3. Postoperative morbidity after extraction of symptomatic 3Ms.

- Erupted 3Ms, with periodontal disease or other preoperative pathologies, and the prescription of chlorhexidine were associated with a shorter time to return to normal daily activity (16).
- According to Chuang et al. (12), subjects with preoperative infection were 25% more likely to have postoperative inflammatory complications (OR 1.25; 95% CI, 1.01-1.6). Subjects with associated pathology who underwent 3M extraction were three times more likely to develop postoperative inflammatory complications (OR 3.0; 95% CI, 2.2-4.3).
- According to Phillips et al. (13), clinical recovery was delayed in those patients who were symptomatic prior to 3M extraction and required at least one visit after surgery to treat postoperative complications. This delay could be related to the microbial colonisation of pathogens at the surgical site.
- Age, gender, symptomatic 3Ms prior to surgery and the surgeon's perception of difficulty were statistically significant predictors of delayed healing. Women and patients who had had symptomatic 3Ms prior to surgery were approximately twice as likely to have delayed healing (13).

Evaluation and summary of the evidence

Following a literature review, a total of seven articles were selected that are considered relevant to update the recommendations already provided by other authors and to answer this prognostic question.

- Abstinence and observation are only allowed in patients with 3Ms in a favourable position for eruption, who have had an episode of pericoronitis that could be controlled by periodontal therapy and who know how to maintain a low level of bacterial plaque (2).

Level of evidence: 1.

- After extraction of 3Ms, periodontal health in 2Ms should remain unchanged or improve if periodontal pockets or attachment loss were previously present (1,4,14).

Level of evidence: 2++.

Grade of recommendation: B.

- The extraction of 3Ms positively influences the quality of life of people with mild symptoms of

pericoronitis (15).

Level of evidence: 3.

Grade of recommendation: D.

- The extraction of 3Ms with preoperative pathology induces a delay in recovery after extraction, as it increases postoperative morbidity (12,13).

Level of evidence: 3.

Grade of recommendation: D.

- The extraction of 3Ms with periodontal disease or other preoperative pathologies, and the prescription of chlorhexidine were associated with a shorter time to return to normal daily activity (17).

Level of evidence: 3.

Grade of recommendation: D.

extraction are needed to compare with patients undergoing the extraction of 3Ms. This would help to increase knowledge about the impact on the overall periodontal health of the patient with 3M extraction or abstinence.

- Further studies are also needed to analyse the degree of postoperative morbidity according to the various types of pathology the 3M may present prior to extraction.

Drawing of conclusions

The articles consulted to update the knowledge published in previous guidance lack methodological quality and scientific consistency and are insufficient in number. There are many confounding factors that affect the drawing of conclusions. It can be concluded that **(Grade of recommendation D)**:

- Because there is a well-documented increased morbidity associated with erupted/impacted 3Ms (non-restorable caries, fracture, infection, periodontal pathology, recurrent pericoronitis, cysts and tumours), if pathology appears, extraction is indicated.
- In cases where there is no infection or other associated pathology, extraction is not indicated.
- Extraction of 3Ms with signs and/or symptoms of periodontal disease improves the periodontal health of adjacent 2Ms.
- The postoperative quality of life of patients with symptomatic 3Ms and pathology improves after surgical extraction.
- After reviewing the evidence published between 2015 and 2022, no new evidence has been found to alter the conclusions or recommendations of the previous guidance. The update is postponed until a new cycle.

Recommendations for future research

- Longitudinal studies evaluating the evolution of periodontal disease in patients with mild pericoronitis and undergoing conservative periodontal treatment without 3M

Q2. Do patients with an erupted 3M and high root development have different postoperative morbidity than those with less root development?

3Ms have a high occurrence of eruption and have been associated with a wide range of pathologies such as pericoronitis, caries in the distal aspect of the 2M or in the 3M itself, myofascial pain and certain types of cysts and odontogenic tumours (1).

The development of the 3M, in comparison to the other teeth, presents a greater variation in morphology and anatomical position. Moreover, the use of its degree of eruption and development to estimate chronological age is controversial (2): it can be accepted that the 3M starts to develop at around 9 years of age and its root is fully formed at around 18.9 years of age in males and 18.6 years of age in females (3).

If we add the fact that the 3M is the last tooth to erupt in the posterior region to the aspects caused by phylogenetic evolution of the jaws, the result is a lack of available space (osseodental discrepancy) for the third molars to erupt normally, especially the lower ones (4).

It is estimated that the average age at which an initially asymptomatic 3M is extracted has a cumulative incidence of 5% per year of active follow-up and 64% at 18 years. The final causes of extraction are caries, periodontal pathology or pericoronitis (5), indicating that, over time, the incidence of the pathology increases, which must be treated at an older age in which it is common for some other systemic risk pathology to coexist (29.2% in a study of 3,760 patients under the age of 25) such as heart disease, arterial hypertension and tobacco or alcohol consumption (6).

Age per se involves local determining factors: increased bone density, ankylosis, complete root formation with apical closure and partial resorption of the 2M. These local factors result in an increase in operative time and the aggressiveness of the surgical intervention (ostectomy and odontosection), which is clearly linked to an increase in complications: root fracture, IDN paraesthesia, LN paraesthesia and orosinus communication (7,

8).

According to a study by Phillips et al. (9), patients older than 21 years have a slower postoperative quality of life recovery following surgical extraction of the 3M. For their part, Bruce et al.

(10) reported that patients older than 25 years of age had more postoperative visits for treatment of complications after 3M extraction.

Although numerous previous studies have concluded that there is a relationship between patient age, 3M root formation and the incidence of complications or postoperative morbidity, there are very few data in which these factors are directly related (11).

General considerations

1. Degree of root development/incidence of complications

- According to the study by Chaparro-Avedaño et al. (1), there are no significant differences in the complications observed between the different age groups. The occurrence of complications in relation to the Nolla stage was higher in the group with Nolla ≤ 6 (20.2%), although this was not statistically significant ($p=0.093$).
- In 583 patients who had the 3M extracted, the overall complication rate was 4.6%. Increasing age, positive clinical history and position of the 3M in relation to the IDN were associated with an increased risk of complications ($p<0.005$). In contrast, the degree of root development was not associated with an increased risk of postoperative complications (2).

2. Nerve injury/grade of root development

- Gülicher and Gerlach (13) conducted a study to look at risk factors for LN and IDN involvement after extraction of mandibular 3Ms. In 3.6% of the operated sides, there was an alteration in IDN sensitivity and 2.1% in lingual sensitivity. The vast majority of these alterations completely subsided during the follow-up period. The occurrence of persistent sensory impairment after six months was 0.91% for IDN and 0.37% for LN. In terms of IDN alteration, patient age, root development, degree of impaction and radiographic nerve position correlated significantly with increased risk of sensory deficit.

3. Sinus perforation/grade of root development

- Rothamel et al. (14) and del Rey-Santamaría et al. (15) evaluated the risk factors for sinus perforation when extracting the upper 3Ms. The rate of sinus perforation in relation to tooth development showed two peaks: in those teeth with less root development (1/2: 19%), as well as in fully developed teeth with complete closure of the apical foramen (1/1: 13%). Both have a higher occurrence of perforation of the maxillary sinus compared to teeth at an intermediate stage of development (2/3: 9%; 3/3 with an open apical foramen: 10%). However, the results were not statistically significant. Therefore, the degree of root development does not influence the increased risk of sinus perforation (14). Del Rey-Santamaría et al. (15) relate sinus mucosal perforation to the depth of eruption without taking into account the degree of root development, and conclude that the greater the eruption and, consequently, the greater the osteotomy, the greater the probability of perforation (5.1, 95% CI): 2.2-7.3 %).

4. Recovery/degree of root development

- In a study by Noori et al. (11), data from 336 patients were analysed: 218 patients had at least one mandibular 3M with more than 50% of roots formed, but less than 100%, and 118 patients had lower 3Ms with 100% developed roots. Subjects in the group with an incomplete lower 3M root were significantly more likely to have both lower 3Ms below the occlusal plane (92% vs. 37%) with mesial/horizontal angulation (36% vs. 15%). Although there was no difference in mean surgical intervention time between the groups, bone removal for mandibular 3Ms was significantly more likely if the roots were not fully formed (84% vs. 67%). The surgeons' overall estimate of the degree of difficulty was significantly higher (14 out of a possible 28 vs. 12 out of 28 for the group with incomplete root formation). Nevertheless, this study concludes that incomplete 3M root development was not a predictor of better or worse clinical recovery and quality of life after surgery.

articles were selected that are considered as relevant to update the recommendations already provided by other authors aiming to answer this prognostic question:

- The results of studies regarding the degree of root development and the occurrence of postoperative complications are contradictory, whereby the degree of root development is not associated with an increased risk of postoperative complications in a statistically significant way (1, 12). Level of evidence: 3. Grade of recommendation: D. Other studies conclude that root development, associated with patient age, degree of impaction and radiographic position of the IDN canal, are significantly correlated with an increased risk of sensory deficit of the IDN (3).

Level of evidence: 3.

Grade of recommendation: D.

- The rate of sinus perforation in relation to root development of the upper 3M shows that with less than 50% root development or with complete root development, there is a higher occurrence of sinus mucosal perforation, although without statistically significant differences (14).

Level of evidence: 3.

Grade of recommendation: D.

- Incomplete 3M root development was not a predictor of better or worse clinical recovery and quality of life after surgery (11).

Level of evidence: 3.

Grade of recommendation: D.

- The authors consider that the frequency of complications in 3M extraction with closed apices is higher than in 3M with incomplete root development.

Grade of recommendation: D.

Drawing of conclusions

The articles consulted to update the knowledge published in previous guidance lack methodological quality and scientific consistency and are insufficient in number. It can be concluded that **(Grade of recommendation: D):**

- The degree of root development is not significantly associated with an increased risk of postoperative complications, nor does it influence the recovery period. The only complication that is increased with increasing degree of root development is injury to the IDN.

Evaluation and summary of the evidence

Following the literature review, a total of five

- The authors believe that, although no statistically significant results have been found, root development is a factor that clearly influences postoperative outcome and quality of life.
- After reviewing the evidence published between 2015 and 2022, no new evidence has been found to alter the conclusions or recommendations of the previous guidance. The update is postponed until a new cycle.

Recommendations for future research

- In order to estimate the occurrence of pathological changes in the erupted or impacted 3Ms over time, cohort studies with a large number of participants, with a long follow-up time, with well-defined demographic variables and applicability to the characteristics of our socio-cultural environment are needed.
- Further studies should be conducted to assess the implications of different degrees of root development for the extraction of 3Ms. Furthermore, in these studies, the different stages of root development should be evaluated, as in the current literature, root development is analysed in 2 or 3 degrees only.
- A consensus should be reached on a cut-off point for clinical studies evaluating the factor of "Degree of root development" in order to be able to compare results and reduce confounding factors, in addition to age.

Q3: Are there preoperative clinical and radiological criteria that relate to the degree of surgical difficulty in patients indicated for extraction of 3Ms (low operative time and low morbidity)?

The ability to predict surgical difficulty in the extraction of 3Ms guides the dentist as to the level of difficulty that will be involved in their extraction, the surgical technique to be used and the approximate operative time, as well as the minimisation of possible complications (1). This also allows adequate information to be provided to the patient and to gauge the professional's ability to perform the surgical procedure or to refer the patient to a specialist in oral surgery (2).

There are a large number of studies evaluating the surgical difficulty of 3M extraction (3-7). Most of these are based on the assessment of 3M radiographic factors and their association with neighbouring structures (3, 1). Despite differing opinions on the role of radiological factors identified as risk factors, most authors agree that they play an important role in the estimation of surgical difficulty. Patient clinical variables that may influence this aspect, such as age, gender, weight, degree of buccal opening and cheek elasticity, have also been studied (3-5, 7-9).

Since 3M extraction is one of the most common surgical procedures in dentistry, both the patient and the clinician should be provided with evidence-based information on the estimated level of surgical difficulty.

Several authors have developed preoperative scales based on radiological data in order to determine the degree of difficulty using panoramic radiography. The different scales used for this purpose are those of Pell and Gregory (1999), Winter (1926), Pederson (1999), Cáceres et al. (1998), Peñarrocha et al. (2000) and Abu-El-Naaj (2010).

(10). However, these scales have a predictive reliability that is not always consistent with the degree of difficulty encountered in the surgical procedure and a low sensitivity for predicting difficult cases (3, 9). On the other hand, Ferrus-Torres et al. (11) stated that prediction may vary according to clinical experience: the less experience, the greater the complexity in making predictions. However, other authors have not found this association (9, 12, 13). The duration of the surgical procedure is an objective and approximate measure of the difficulty of the extraction, which is why it has been used to identify the degree of surgical complexity. Other authors, for their part, have related surgical difficulty to the postoperative course (pain, swelling and trismus) (14, 15).

The radiological variables described were the depth of the eruption, the association between the 3M and the mandibular ascending ramus or upper maxillary tuberosity, the degree of 3M inclination, 2M inclination, follicle size, root shape and development, bone coverage, the size of Winter's red line and the association with the IDC. With regard to patient clinical variables, age,

gender, psychological status and degree of incisor opening have been identified.

General considerations

1. The depth of 3M eruption

There is no clear consensus on the association of this variable with surgical difficulty. Some authors report in a statistically significant way that the greater the depth, the higher the difficulty index (2, 4) and the longer the operative time (4). This could be explained by the need for a greater osteotomy in order to visualise and provide an exit route for the 3M. However, other authors do not find an association between both variables (3, 10).

2. The association between the mandibular ascending ramus or upper maxillary tuberosity.

Surgical difficulty increases as the distance from the ascending mandibular ramus to the 2M (11) and from the maxillary tuberosity to the 2M decreases, as well as when the depth of eruption of the upper 3Ms increases (16).

3. The degree of inclination of the 3M

Horizontal, distoangular and inverted positions increase surgical difficulty due to poor visibility and limited access, which in turn increases the duration of surgery (4). In contrast, mesioangular and vertical positions are associated with a significantly shorter operative time (2, 5, 6).

4. Inclination of the adjacent 2M

The inclination of the 2M may increase the retention of the erupted 3M. The dislocation of the 2M during the extraction of the 3M is more likely if the root of the 2M is conical and if the first molar is missing.

5. Follicle size and presence of the periodontal ligament

The dental follicle (reduced enamel epithelium) appears as a radiolucent image that partially or completely surrounds the 3M crown. The wider the follicle, the less surgical difficulty there is because it facilitates tooth extraction and therefore reduces the amount of bone to be removed. It has been shown that in older subjects, with a thinner periodontal ligament or completely replaced by osseodental ankylosis, the extraction of the 3M is extremely difficult. These authors

conducted a prospective study on 100 mandibular 3Ms and, of 14 radiological variables studied, only two (the depth and width of the periodontal ligament) showed a greater association with the duration of surgery. Other authors state that the smaller the follicle size, the longer the operative time and, therefore, the greater the surgical difficulty (2, 4-6).

6. Shape and development of the 3M roots

On radiographs it is important to examine the number, shape and dimensions of the roots, paying particular attention to root curvatures, angulations, divergences and the size of the interradiacal septa. A thickening or rounding of the apex should raise the suspicion of such curvatures, although this is sometimes an unpredictable factor as it is not always visible on radiographs. The shape of the roots can determine the surgical technique and the need for odontosection. For some authors (2, 3, 6-8), the type of root is significantly related to surgical difficulty: a short, incompletely formed or conical root will facilitate extraction. Conversely, long, wide and fully formed roots will make tooth extraction more difficult. However, regardless of the surgical difficulty, in the case of upper 3Ms the chances of postoperative complications (perforation of the sinus mucosa) are also increased when the degree of root development is less than 50% (17).

7. 3M bone covering

3Ms completely covered by bone or with the distal cusps covered by bone present greater surgical difficulty (2, 4).

8. Winter's red line

The longer the length of Winter's red line, the more the 3M is embedded in the bone and therefore the more difficult it is to extract. This parameter is a reliable marker of surgical difficulty, with positive and statistically significant data (2, 3, 6).

9. Association with IDC

It has not been shown that the association between the 3M and the IDC increases the difficulty of tooth extraction. Authors such as Renton (7) and Jerjes et al. (18) do report a statistically significant association between root proximity to IDC and surgical difficulty. However,

it should not be forgotten that extraction of the mandibular 3M can result in injury to the IDN the closer the roots are to the IDC (18). Therefore, panoramic radiography is the optimal method for the radiological evaluation of mandibular 3Ms prior to extraction (20).

10. Patient age and gender

Several authors find that in women and younger patients, the operative time is shorter than in men or older patients and is therefore a predictive factor in the estimation of surgical difficulty (2, 3). Specifically, in older patients, the bone tends to be denser and more mineralised, which could increase the complexity of tooth extraction. However, for some authors, neither age nor gender is related to the degree of difficulty.

11. The degree of interincisal opening

A maximum buccal opening of less than 45 mm makes 3M extraction surgery more difficult. Patients with a larger buccal opening facilitate the surgeon's work and, consequently, the duration of the procedure is expected to be shorter (9, 25).

12. Body mass index

High body mass index is a demographic variable that has been associated with increased difficulty in 3M extraction. Being overweight may adversely affect the visibility of the surgical area, which may be obscured by the thickness of the cheek (25).

13. Psychological factors

Patients with high levels of anxiety are significantly associated with a longer operative time and greater operative difficulty (27) and have prolonged postoperative pain compared to patients in the control group (28).

Evaluation and summary of the evidence

Following the literature review, 10 articles were selected and considered as relevant to update the recommendations of other authors (1, 2, 9, 13, 20-24, 26) to answer this prognostic question:

- The degree of operative difficulty is significantly related to the duration of

surgery: the higher the degree of estimated difficulty, the longer the operative time (23, 20, 21, 13).

Level of evidence: 2++.

- The demographic variables associated with a higher degree of surgical difficulty are age and body mass index (23, 25). Interventions on young patients are usually the shortest (23). In contrast, the patient's gender does not appear to be a predictor of the degree of difficulty (13, 21, 23). Greater difficulty in 3M extraction has been observed in patients with a high body mass index (overweight). Being overweight is often accompanied by increased cheek thickness and may reduce the visibility of the surgical site (25).

Level of evidence: 2++.

- Several radiographic variables have been associated with a higher degree of surgical difficulty:
 - Both the position of the 3M (distoangular and horizontal) and the depth of impaction (below the amelocemental line of the 2M) have been significantly related to greater surgical difficulty and longer surgical procedure time (13, 23).

Level of evidence: 2++.

- Surgical difficulty is greater when the 3M is in contact with the crown and root of the 2M (21).

Level of evidence: 2++.

- The number of 3M roots, their morphology and curvature have also been related to surgical difficulty (23, 21): surgical difficulty is greater when it has two roots or is a low Nolla stage gemen rather than one or two roots.

Level of evidence: 2++.

- The association between 3M roots and IDC and operative time is unclear (13, 21).

- **Level of evidence: 2++.**

- The disappearance of the image of the periodontal ligament increases surgical difficulty (21).

Level of evidence: 2++.

- In estimating the surgical difficulty of upper 3M extraction, the degree of mouth opening, the position in relation to the occlusal plane, the association with the 2M and with the maxillary sinus, and the depth of placement of the tip of the extractor to dislocate the 3M have been found to be predictive variables (20).

Level of evidence: 2++.

- A maximum buccal opening of less than 45 mm makes 3M extraction surgery more difficult. (25).

Level of evidence: 2++.

- The postoperative course is worse the greater the surgical difficulty. The 3Ms classified as low difficulty had a complication rate of 7.3%, those of moderate difficulty 23.8% and those of high difficulty 29.6%. Therefore, the complication rate was significantly higher in 3Ms of moderate and high difficulty ($p < 0.001$). (24). Moreover, the postoperative course is worse when, after extraction of the 3M, the IDN is exposed (2).

Level of evidence: 2++.

- There are conflicting results as to whether the level of clinical experience influences the estimation of surgical difficulty:
 - Postgraduate students (residents) perceived the surgical intervention as easier or more difficult than expected and was significantly different from the tutor teacher's perception. The former estimated the vertical position as less difficult (13, 23).
- For other authors, there is no correlation between experience and estimation of difficulty (22, 9).

Level of evidence: 2++.

Drawing of conclusions

- As there is evidence on the association of certain radiological factors in estimating the degree of surgical difficulty, it is necessary to perform at least one orthopantomography in all patients in order to carefully evaluate the morphology of the 3M and its position in relation to neighbouring structures.

Grade of recommendation: A.

- Younger patients have been associated with shorter and less difficult surgical interventions.

Grade of recommendation: A.

- Patients with an increased body mass index (overweight) have greater difficulty in 3M extraction.

Grade of recommendation: B.

- The buccal opening is a variable to be taken into account in the degree of difficulty, as it could affect the surgeon's work in openings of 45 mm or less.

Grade of recommendation: B.

- Although there is no evidence in the literature on the influence of the buccal

opening on the degree of difficulty, we believe that it could be a variable to be taken into account, as it could affect the surgeon's work.

Grade of recommendation: D.

- The main radiological variables related to surgical difficulty were the position of the 3M, the depth of the eruption, the association with the 2M and the number of roots, their morphology and curvature.

Grade of recommendation: A.

- The postoperative course is worse the greater the surgical difficulty. The complication rate is higher in 3Ms of high and moderate difficulty.

Grade of recommendation: A.

- There is controversy as to whether the level of clinical experience influences the estimation of surgical difficulty. It appears that both residents and experienced surgeons are able to determine the surgical difficulty of 3M extraction, but the duration of surgery is considerably shorter for the latter.

Grade of recommendation: A.

Recommendations for future research

- To assess the association between the radiological data of 3Ms and the estimation of the degree of surgical difficulty, descriptive clinical studies with larger sample sizes are needed.
- In publications, the description of each 3M radiological variable should be detailed, and not only the degree of difficulty obtained in the score.
- It would be interesting if scales for predicting surgical difficulty could take into account the anatomy of the 3M roots and other variables such as the patient's psychological state.

Q4. Do patients with a periodontal probing of 4 mm or more distal to the 2M who have (or have not) had the 3M extracted have a higher occurrence of widespread periodontitis compared to those with a periodontal probing of less than 4 mm?

Given that the vast majority of adolescents and young adults have at least one 3M and three quarters often have all four wisdom teeth, practitioners should often advise their patients on the management of these molars (1). However, the application of the term "asymptomatic" to decide the most relevant treatment (extraction vs. abstention) continues to be a source of confusion, as the fact that 3Ms

are not clinical does not imply that they are free of pathology (2).

As early as 1962, Ash et al. (3) warned of the association between the presence of 3M and the development of periodontal disease on the distal aspect of adjacent 2Ms. Consequently, they suggested that, in order to preserve the periodontal health of the 2Ms, extraction of the 3Ms should be systematically performed before their root development was complete (4). Garaas et al. (5) reported that 65% of patients, with a mean age of 25 years and with asymptomatic 3Ms, had at least one location with a probing depth (PD) > 4 mm on the distal aspect of the 2Ms or around the 3Ms, especially in the lower and/or erupted ones. In addition, 15% had a PD > 4 mm in teeth positioned mesial to the molars.

In a prospective study in patients with asymptomatic 3Ms, Blakey et al. (6) observed that, at the start of the study, more than one third of patients with asymptomatic 3Ms had at least one site with a PD > 4 mm around the 3Ms, especially in the lower, erupted, upright or distoangulated position.

Similarly, White et al. (7) documented that having a location with a PD > 4 mm around 3Ms significantly increases the risk of this worsening at the end of the follow-up period, in 3Ms as well as in all other teeth ($p < 0.01$). These findings could be justified by the combined effect of late eruption, more than any other tooth, and their anatomical position, especially at the distal aspect of the 2M, which facilitates the accumulation of pathogenic germs and the creation of an anaerobic environment that can lead to the development of periodontal disease (8). Moreover, because the eradication of these pathogens, by scaling and root planing, is technically complex in 3Ms, these locations would act as a potential reservoir of pathogenic bacteria, spreading periodontitis to the rest of the teeth (9-15).

Evaluation and summary of the evidence

- Periodontal parameters around 3Ms worsen over time (7, 10, 15-21).

Level of evidence: 2+.

Grade of recommendation: D.

- The impact on the lower 3Ms is more prevalent than that on the upper 3Ms (5,15,18-22). Level of evidence: 2- (the included studies have a high risk of bias).

- Having a lower 3M, especially in a mesioangular or horizontal position, increases the risk of developing periodontal pathology on the distal aspect of adjacent 2Ms (23,24).

Level of evidence: 2- (high risk of bias of the included studies).

- Periodontal parameters around the remaining molars (1M and 2M) worsen over time in those patients with periodontitis around 3Ms (10,15,16).

Level of evidence: 2- (the included studies have a high risk of bias).

- In general, after extraction of the erupted upper or lower 3Ms, periodontal parameters of the distal aspect of the 2M remain unchanged or even improve at the end of the follow-up period (12,13,25,26).

Level of evidence: 1+.

Grade of recommendation: A.

- However, in a subgroup of patients, with full eruption and/or >25 years of age and periodontally healthy, there is a high risk that the extraction of the lower 3M will lead to an increase in PB at the distal aspect of the 2M (12).

Level of evidence: 2++.

Grade of recommendation: B.

- If a periodontal defect appears on the distal aspect of the lower 2M after extracting the 3M, periodontal regenerative therapy can reduce the probing depth (12,26-30).

Level of evidence: 1+.

Grade of recommendation: A.

Drawing of conclusions

- Given the high risk of bias in the studies, there is insufficient evidence to determine that periodontal probing ≥ 4 mm in the regions of the 3Ms is related to an increased occurrence of widespread periodontitis.

- The periodontal status of 3Ms should be monitored regularly through the clinical attachment level and bacterial plaque index.

- A worsening periodontal status in the area of the 3Ms should be considered as an extraction criterion. Generally, after extraction of erupted 3Ms, the periodontal parameters on the distal side of the 2Ms remain unchanged or even improve in many cases.

Recommendations for future research

- Studies should be implemented to assess the evolution of periodontal parameters on the distal aspect of the 2M and on the remaining teeth if the 3M is retained.
- Studies should be conducted to correlate the position of the 3M and the risk of creating a postoperative periodontal defect on the distal aspect of the 2M.

Q5: Does extraction of the 3M produce greater benefits in the resolution of anterior crowding (with or without orthodontic treatment) than a conservative therapeutic approach?

Generally, 3Ms erupt into the oral cavity between 17 and 24 years of age (1, 2). However, more commonly than any other tooth, the eruption process of 3Ms can fail completely or partially due to a lack of space in the dental arch, the existence of an obstacle or because they develop in an anomalous position (2, 3). An erupted tooth may be completely covered by soft tissue and partially or completely covered by bone. Partial eruption occurs when the tooth is visible in the oral cavity but has not erupted into a normal functional position.

Anterior or incisor crowding, defined as any abnormality in the position of the anterior teeth, is considered to be the most common malocclusion (4). The classification of crowding, proposed by Van der Linden (5), includes:

- **Primary crowding:** caused by the discrepancy between the available arch length and the required arch length, represented by the sum of the mesiodistal diameters of the teeth.
- **Secondary crowding:** caused, for example, by the premature loss of a primary tooth, which favours the mesial migration of the neighbouring permanent teeth.
- **Tertiary crowding:** occurs between the ages of 15 and 20, coinciding with the last growth spurts and the eruption of the 3Ms.

In orthodontics, the most controversial role of 3Ms is whether their presence can contribute

to the development of malocclusion, especially in the anterior sector of the lower dental arch (6). Some authors have suggested that the eruptive forces of the 3Ms may transmit an anterior force component on the dental arch, concentrating in the canine and incisal areas, which would cause the rotation and loss of alignment of these tooth groups (7-13). Based on this theory, Niedzielska (12) suggested that when there is sufficient space in the dental arch for the eruption of the 3Ms, the tooth assumes a normal position and does not cause the loss of alignment of other teeth. Conversely, when there is insufficient space, 3Ms can aggravate crowding. Indeed, Esan and Schepartz (14) concluded that, regardless of the presence or absence of 3Ms, when there is insufficient space in the upper and/or lower dental arch to accommodate all teeth (including 3Ms), the risk of anterior crowding is significantly higher.

However, other studies seem not to confirm these findings and conclude that, although the aetiology of tertiary anterior crowding is multifactorial (dentomaxillary evolution, genetic factors, tooth size, mandibular length and width may play a major aetiological role, the presence of supernumerary teeth, axial inclinations of the incisors and first molars, muscular forces, facial growth and functional changes), the presence of 3M is neither a determinant nor an important risk factor in the occurrence of this complication. Moreover, the time of onset seems to be the only coincidence between the two entities (15-20).

Evaluation and summary of the evidence

- Although some studies observe a reduction in the degree of anteroinferior crowding after the extraction of 3Ms (11, 12), the scientific evidence is contradictory and of low methodological quality.

Level of evidence: 2.

Grade of recommendation: D.

Most authors agree that there is no cause-effect relationship (4, 11-14, 20).

Level of evidence: 2++.

Grade of recommendation: C.

The prophylactic extraction of 3Ms to prevent, limit or resolve the degree of anteroinferior crowding is not justified (6, 15-20).

Level of evidence: 2++.

Grade of recommendation: C.

Drawing of conclusions

- The extraction of 3Ms to prevent, limit or resolve the degree of anteroinferior crowding is not justified, as the available evidence indicates that there is no causal relationship.

Recommendations for future research

- Design and develop studies of higher methodological and scientific quality.
- Implement clinical studies that study the association between anterior crowding and the presence of upper 3Ms.

Q6: In patients without anterior crowding, does the extraction of the 3M contribute to maintaining the alignment of the anteroinferior teeth?

Relapse after orthodontic treatment can be defined as the tendency of the teeth, especially the anteroinferior teeth, to return to their original position (1). Therefore, the placement of fixed or removable retainers at the end of orthodontic treatment is one of the most important steps (1,2).

Certain factors may contribute to the recurrence of malposition of anteroinferior teeth. These include periodontal tissue reorganisation, alveolar bone loss, overexpansion of the dental arches, occlusal changes, the type of malocclusion treated, the presence of parafunctional habits such as dysfunctional swallowing, or the eruption of 3Ms (3).

However, the role of 3Ms in relation to the risk of recurrence of malocclusion after orthodontic treatment remains controversial, probably due to the poor methodological quality of the available studies. In fact, some authors have suggested that the eruptive forces of the 3Ms may transmit an anterior force component on the dental arch, concentrating in the canine and incisal areas, which would cause the rotation and loss of alignment of these tooth groups (4-10). However, most studies agree that, although the aetiology of late or tertiary anterior crowding is multifactorial, the presence of

the 3M is not a determining or important risk factor in the occurrence of such an eventuality; it is the time of occurrence that is the only coincidence between the two entities (11).

In a randomised controlled clinical trial on subjects undergoing orthodontic treatment, Harradine et al. (12) obtained results similar to those previously mentioned, without observing clinically or statistically significant differences between the groups (extraction of 3Ms vs. abstention). For their part, van der Schoot et al. (13) compared the degree of anteroinferior crowding in four groups of orthodontically treated patients according to whether they had erupted, formed, extracted or agenesis 3Ms. The authors found no statistically significant differences between the four groups before the start of orthodontic treatment, at the end of orthodontic treatment, and at the end of a follow-up period of at least 3 years.

According to numerous publications, the prophylactic extraction of 3Ms in order to prevent recurrence of malocclusion after orthodontic treatment would not be justified (12-16).

Evaluation and summary of the evidence

- There is no cause-effect relationship between crowding after orthodontic treatment and the presence of 3Ms (12-16).

Level of evidence: 2++.

Grade of recommendation:

B.

- Extracting 3Ms to prevent recurrence of malocclusion in the anteroinferior sector after orthodontic treatment is not justified (12-16).

Level of evidence: 2++.

Grade of recommendation: B.

Drawing of conclusions

- After orthodontic treatment, extraction of the 3Ms is not justified to prevent recurrence of malocclusion in the anteroinferior sector.

Recommendations for future research

- Implement studies of higher methodological and scientific quality.
- Design and conduct studies that correlate

crowding to the presence of the upper 3Ms.

Q7: Do dental prosthesis-bearing patients who have their 3Ms extracted have more associated morbidity than those who do not have them extracted?

3Ms are an important section of dental pathology, due to their frequency, their variety of presentation and, above all, the complications and accidents that they usually cause. In the literature, there are numerous references to cystic, infectious or mechanical pathologies associated with these erupted teeth (1, 2). As a result, extraction is necessary in a large number of cases (3). One of the reasons for opting for this surgical procedure is related to the fabrication of fixed or removable prostheses in the area where the erupted tooth is located (4). In these cases, the clinician tends to opt for a more surgical option, discarding an expectant attitude based on regular clinical and radiological controls, because any pathology associated with the adjacent 3M may compromise the prosthodontic treatment.

One of the most common clinical situations is the presence of an erupted lower 3M close to a mandibular 2M that is selected as an abutment for a tooth-supported fixed prosthesis. As discussed more extensively in other questions of this CPG, erupted 3Ms, specifically in mesioangular position, can lead to caries, periodontal pathology and even rhizolysis of the adjacent 2M (2, 4, 5). In these cases, it is essential to assess the risk factors for these complications in order to make the right decision. Most authors support the extraction of the erupted tooth, especially when the patient is young, and the 3M is partially erupted (4). On the other hand, if the prosthesis is removable and mucosa-supported, it must be taken into account that the pressure it will exert on the area of an impacted tooth will produce a certain degree of progressive bone resorption. Thus, even in cases of older patients with undisturbed 3Ms and completely surrounded by bone, the possibility of the prosthesis triggering a pathological process cannot be ruled out (4). Continued pressure on the area of a totally intraosseous 3M may result in partial exposure

of this tooth and subsequent development of locoregional infections (4).

The placement of dental implants in areas close to an erupted 3M is considered by many clinicians as a formal indication to remove this molar. Therefore, it seems reasonable to recommend the extraction of an erupted tooth in these situations, as the flap will usually encompass the 3M area and its extraction will not significantly increase surgical morbidity.

Moreover, the possibility of an infectious or cystic pathology developing near a dental implant may necessitate extraction of the 3M.

However, it should be remembered that all teeth, including the wisdom tooth, have potential aesthetic and functional value and can be used as an abutment for a prosthesis (6-8). In cases of eruption, there are combined oral surgery and orthodontic techniques that allow the tooth to be placed in the arch. Thus, an erupted 3M can be tractioned and placed in a suitable position to be used for the fabrication of a prosthesis (9,10). Although this therapeutic option is very rare, involves a long treatment period and has associated complications, some authors attest to the use of erupted 3Ms as abutments for fixed prostheses or as anchorage elements for removable prostheses (9, 10).

The literature review carried out on this topic has highlighted the need for studies on patients with 3Ms who are candidates for or already wearing dental prostheses. The lack of clinical trials and observational studies makes it very difficult to draw conclusions that would allow us to answer the question formulated with an adequate level of evidence. In fact, the main recommendation of the authors of this section is directed towards the need for clinical studies to provide information on the morbidity associated with extraction and on the possible complications related to expectant management in patients with 3Ms and prostheses.

Evaluation and summary of the evidence

The literature review aimed to determine whether patients with fixed and/or removable prostheses benefit from 3M extraction. To answer this

prognostic question, six articles were analysed:

- 3Ms can be used as abutments for fixed or removable prostheses (6-10).

Level of evidence: 3.

Grade of recommendation: D.

- The extraction of all erupted teeth located in the edentulous area is recommended prior to placement of a fixed or removable prosthesis (4).

Level of evidence: 4.

Grade of recommendation: D.

- In patients over 40 years of age with fully erupted teeth and no pathological alterations, a watchful waiting approach with regular clinical and radiological check-ups can be adopted (4).

Level of evidence: 4.

Grade of recommendation: D.

Drawing of conclusions

- There is insufficient data in the literature to make a recommendation on the morbidity associated with 3M extraction or therapeutic forbearance in dental prosthesis-bearing patients.

Recommendations for future research

- To answer the above question with a high level of scientific evidence, randomised clinical trials comparing 3M extraction with therapeutic abstention in dental prosthesis-bearing patients would be necessary. It should be borne in mind that a considerable number of patients would need to be enrolled, as the estimated occurrence of prosthesis-associated erupted 3M complications is likely to be low. On the other hand, such complications often have a late onset (they may appear years after denture placement), which implies a long follow-up period for these patients. For these reasons, a randomised clinical trial would be difficult to conduct and would have a very high dropout rate, which would make it difficult to analyse the data optimally. Another option would be to conduct prospective studies with a long-term follow-up of patients with fixed and removable prostheses (denture and implant-supported), encompassed or supported in the 3M zone. This methodological design,

which is simpler and cheaper, would make it possible to assess the occurrence of complications and identify their main risk factors. As there is currently practically no scientific evidence available on this topic, other simpler methodological designs, such as a retrospective cohort study or a case-control study, could also provide additional information to the literature.

Q8. Does the presence of risk factors in patients undergoing 3M extraction influence their postoperative quality of life?

The term “Quality of Life” (QoL) was first referenced in the Index Medicus in 1975. Since then, over 500,000 articles have been published on this topic in numerous fields of health sciences, reflecting the growing recognition that the impact on quality of life of different pathologies or diseases is a relevant and useful fact in therapeutic decision-making (1). Opinions about personal health status are influenced by both cultural orientation and perceptions of what constitutes illness and its impact, with differences in terms of age, educational level, ability to express oneself or cultural traditions. QoL is a multidimensional concept in which the instruments used to measure it, mainly through questionnaires, have undergone significant methodological advances. In dentistry, one of the most widely used measures to quantify oral health-related quality of life (OHRQoL) is the Oral Health Impact Profile (OHIP) (2, 3). The OHIP questionnaire aims to ask about the negative impacts of oral problems on patients’ well-being, including parameters such as pain, psychosocial states, social interaction and daily activities (3).

During the second decade of life, patients with 3Ms often seek treatment from a specialist, both to prevent and treat the onset of symptomatology. The most common reason for consultation is the occurrence of pericoronitis (4), an entity that even in its mildest forms causes considerable pain (5). In a multicentre study, White et al. (6) found that 37% of patients undergoing 3M extraction reported a history of “pain and inflammation” and wanted 3M extraction to prevent the recurrence of these symptoms. However, although less commonly, other pathologies related to the

presence of 3Ms (caries or periodontitis) can also produce symptomatology.

Although the pathology associated with 3Ms has been extensively studied, the impact they have on the quality of life of patients suffering from them is poorly understood (2, 7, 8). This information is important to address several issues that must be faced by those professionals who advise, care for and treat these patients. Firstly, it is useful in understanding their pre-surgical morbidity, informing them of the impact that the symptomatology will have on their daily lives and deciding whether treatment should be discouraged or postponed. Secondly, the severity of any pre-surgical morbidity can help clinicians and patients to define the treatment plan even if the clinical signs alone do not provide a clear indication for extraction. Finally, knowledge of the impact of the surgical procedure on the patient's quality of life can allow professionals to advise and inform patients about the expected levels of morbidity throughout the postoperative course.

In a study of recovery after 3M extraction without taking into account pre-surgical OHRQoL factors, it was observed that during the first five days, the OHIP-14 score was significantly higher than before surgery, reflecting a worsening of OHRQoL. After seven days, the OHIP-14 score returned to baseline levels (9). The results of other investigations reflect a similar evolutionary pattern (7, 10, 11). Traditionally, recovery time after 3M extraction has been considered to be shorter in younger patients (9-12), especially in males under 18 years of age (13-10). Likewise, the telematic follow-up of the patient throughout the postoperative period has been associated with a better quality of life 7 days after surgery (14).

With regard to the risk of postoperative complications, although some authors have reported a higher prevalence in older patients (12-15-9), others disagree with these results and point to the surgical complexity of 3M extraction as the most relevant factor (16-18).

Evaluation and summary of the evidence

- Pain control and impairment of lifestyle and oral functions is more prolonged in patients

over the age of 21 (13).

Level of evidence: 2+.

Grade of recommendation: C.

- Pain control and impairment of lifestyle and oral functions is more prolonged in women (13).

Level of evidence: 2+.

Grade of recommendation: C.

- Postoperative follow-up with telematic follow-up visits improves patients' quality of life (14).

Level of evidence: 1-.

- The extraction of 3Ms improves quality of life in patients with previous minor symptoms of pericoronitis (13).

Level of evidence: 2-.

Drawing of conclusions

- Demographic factors such as being over 21 years of age and being female prolong the recovery time for quality of life after the extraction of 3Ms.
- There is insufficient scientific evidence to determine that other factors may affect postoperative quality of life.

Recommendations for future research

- Design and implement cohort studies that assess the quality of life of patients presenting symptomatic vs. asymptomatic 3Ms with and without associated pathology who undergo surgical extraction, taking into account pre-surgical OHRQoL levels.
- Design and implement studies on QoL in patients undergoing extraction of the upper 3Ms.

Q9. Do patients with a 3M without associated pathology benefit from extraction compared to abstention?

Partially or fully erupted 3Ms are associated with malposition of an adjacent tooth, density of alveolar bone or mucosal tissue, retention or impaction, or a combination of factors associated with lack of space in the dental arch. They can sometimes affect an individual's oral health or quality of life and, after study of their characteristics, can be treated conservatively or surgically.

In a sample of 20-year-old Finnish students, a prevalence of unerupted or partially erupted 3Ms was found to be 90% (1). Although 80% of 3Ms are asymptomatic and free of pathology (2), this is a clinical situation that the general dentist or oral surgeon must frequently manage.

The surgical treatment of a 3M with an associated pathological condition (infection, non-restorable caries, periodontal disease of the 3M and/or the adjacent molar, root resorption of the 2M, cysts or tumours) is not subject to discussion, as it is in other special circumstances: when it is located in a fracture line, in a tumour, when it is part of the oncological treatment plan of a field where it is expected to be irradiated or when it interferes with the osteotomies of an orthognathic surgery technique (3-8).

A much more complex indication for surgical extraction of the 3M is to be taken in the absence of pathology (D-) and symptoms (S-) (9). In these conditions, its extraction has been termed "prophylactic or preventive extraction" and its indication is given by the assessment of risk signs that may cause pathology or symptomatology in the future (5, 10). Anticipating the evolution of 3M eruption until it can reach its functional occlusal plane is estimated to be predictable (9, 11), even in 80-97% of cases (1). Furthermore, theoretically, it could be decided in which situations it is more likely that uneventful eruption will occur before the age of 20 years, although this is not generally agreed upon, as some authors consider eruption to be unpredictable. It has been estimated that only 25% of these molars will reach the occlusal plane (2).

The prophylactic extraction of 3Ms is a controversial practice. Different financial and health points of view are put forward for and against it, given that, as the term "prophylaxis" implies, its advantages must outweigh the risks of surgical intervention (temporary or permanent paraesthesia of the IDN or LN, haemorrhage, infection, mandibular or maxillary tuberosity fracture, buccosinus communication, dry socket, injury to the adjacent tooth or periodontal pathology on the distal aspect of the 2M) (5,12). Extraction may be indicated without a clinical picture at the time the decision is made, and therefore the patient should be involved in the decision, once informed, taking into account their preferences and lifestyle, as well as the risks of surgery and the financial costs within the risk-benefit equation (13- 14). The recommendations of the guidance of the National Institute for Health and Clinical Excellence (NICE) and those of the Scottish Intercollegiate Guidelines Network (SIGN) (3,15,16), which differ from the more extractionist tendency of the American Association of Oral and Maxillofacial Surgeons (AAOMS), the Malaysian Ministry of Health guidance and the report of the Liverpool Reviews and Implementation Group (LRiG) (2,17,18), conclude that prophylactic extraction is not indicated and should be limited to very specific situations.

With regard to the outcome of the application of this guidance, reports have been published that recalculate the cost/benefit equation, both from the point of view of the individual's health and quality of life, as well as the financial costs of prophylactic treatment or lifelong "active surveillance". The results of its implementation in different countries have also been compared through epidemiological data provided by the shared use of hospital admission codes (ICD-coding) (16). With the implementation of the NICE recommendations, in the United Kingdom (UK), initiated in the mid-1990s, according to NHS data from Hospital Episodes Statistics (HES), the decrease in the number of hospital extractions of 3Ms was 30%, although a reassessment in 2009-2010 showed an increase of 67%, with a change of scenario: the average age of patients undergoing surgery increased from 25 years to 32 years and the first cause of indication was caries or abscess, rather than impaction (70% before its application). In the same report, the financial costs were also evaluated and were higher than at baseline (8).

From this it could be concluded that, with its rigorous application, both the personal and financial benefit seems to be only in the short- and medium-term, although other variables of this increase, such as changes in health care organisation, should be assessed.

Therapeutic abstention in D-/S- cases has also been evaluated by calculating the comparative costs between performing a prophylactic surgical intervention, including the four 3Ms in one session, and actively monitoring the patient for 20 years, including an orthopantomography every two years. Observation shows that the second option is much more costly (17), without taking into account the estimated costs of treating the added morbidity of surgical intervention in an older patient. However, conflicting data have also been provided on the same issue (5).

The decision to indicate prophylactic 3M extraction based on evidence should be based on very long-term (7-10 years) Randomised Clinical Trials (RCTs) (18) or very large cohort studies in terms of number of individuals and follow-up time, and not only from a financial point of view. One RCT is available, analysed by Mettes et al. (18) in their systematic review, which is limited to the effect of extraction/non-extraction of 3Ms on anterior crowding in patients who completed orthodontic treatment. In it, the remaining related variables remain unanswered (variables dependent on complications of the surgical intervention, as well as risk factors for extraction or long-term complications during the active surveillance period).

General considerations and indications for prophylactic extraction

The assessment of each individual case should take into account local or general risk factors, both those arising from the surgical technique and those arising from the anaesthetic technique implemented.

The surgical extraction of a 3M inevitably involves morbidity, in addition to the possibility of accidents or unforeseen complications of greater severity. Therefore, there must be a compelling reason to indicate prophylactic surgical extraction of a 3M D-.

1. Indications:

- Position of the 3M potentially damaging another tooth in the dental arch, usually the 2M (6, 10, 19).
- High risk of pericoronitis (1) and plaque accumulation on the distal aspect of the 2M when the 3M is partially erupted (20).
- Orthodontic indications: alveolodental discrepancy and ankylosis interfering with orthodontic movements planned in a treatment.
- Transplantation of the 3M to the alveolus of the 1M (3).
- Systemic (1) or surgical conditions: patients undergoing heart valve surgery or joint replacement, prior to treatment with intravenous bisphosphonates, chemotherapy or radiotherapy, and patients undergoing transplantation.
- Interference with a denture, mucosal or implant-supported oral prosthesis (3).
- Orthognathic surgery: when the 3M interferes with the osteotomy line of the jaws (4).
- Incomplete root development of the 3M, whose apex is not yet closed, but which is in close proximity to the IDN (estimated prevalence of 26%) (1).

There is insufficient support to indicate or reject the routine prophylactic extraction of 3Ms in adults who have completed orthodontic treatment as a preventive measure for anterior crowding, as the cause of crowding is multifactorial.

It is suggested to monitor asymptomatic and pathology-free 3Ms as the most prudent strategy and to decide prophylactic extraction on an individual basis considering the case, the patient's preferences and lifestyle (18).

Although 80% of impacted 3Ms are S-/D-, 35% may develop pathology (2). Therefore, consideration should be given to situations that are highly likely to favour the development of pericoronitis, caries, resorption of adjacent tooth roots, or the development of cysts or periodontal pathology on the distal aspect of the 2M, as well as the progression of widespread periodontal disease over time (21, 22):

- A vertical or distoangular position of the impacted 3M close to the occlusal plane, with

half or more of the occlusal surface covered by mucosa (high risk of pericoronitis) (1, 19). If this factor is coupled with follicle thickening in patients aged 20-23 years, the estimated prevalence of pericoronitis is 36% (1).

- A partially erupted 3M in a mesioangular or horizontal position with its contact point close to the amelocementary line of the 2M (high caries risk) (23), especially if the patient's oral hygiene is poor (1,10).

In patients with borderline indication, their work and personal lifestyle (contact sports, pregnancy planning, frequent travel, type of work, etc.) should be taken into account (1,13). In the retrospective single cohort study by Kinard and Dodson (24), of the total number of patients who had a choice of treatment (extraction/abstention) after being informed of the advantages and disadvantages of extraction, 60% preferred extraction of the asymptomatic, pathology-free 3M.

2. Identification of risk factors

2.1. Age

If the indication is justified, it is recommended in patients under 24 years of age (4, 10). In patients over 25, the delay in operative wound healing increases by 50% (2). In patients over 30, the risk of morbidity increases fourfold (25). In cases where the risk outweighs the benefit, a pattern of active surveillance should be followed, meaning that if pathology occurs (estimated at 20-60%), it should be treated at an early stage and at the earliest possible age (2).

Age should be considered to influence the risk of caries and periodontal pathology (2). The persistence of pockets ≥ 7 mm distal to the 2M in patients over 26 years within four years following the extraction of the lower 3Ms was 51.9%, although in patients under 25 it was 25% and no significant changes were observed with respect to the mesial bone level of the 2M, either between the time periods studied (2 and 4 years) or between the two age groups (12). This same parameter evaluated at 1 year in the under-20-year age group was 21.1%, and 69.2% for those aged over 30 (32). Indications for 3M extraction varied with patient age, such that the indication due to pericoronitis was 49% (mean age 27.5 years), 27% for 3M caries

(mean age 31 years), and 14% of patients for 2M distal caries (mean age 32.7 years). The sum of indications for tooth extraction due to caries varied between 41% - 82% in impacted molars and 18% in functional verticals. Of the 3Ms extracted due to caries, 44% were mesioangular. Most non-impacted 3Ms are extracted due to periodontitis (3).

2.2. Gender

Women have a higher risk of complications, such as alveolitis or infection: 2.2% in men compared to 10.2% in women (4). Being female and the degree of 3M inclination and advanced age are factors that increase the risk, so in these cases prophylactic extraction is advised before reaching an advanced age (10). No association has been found with the magnitude of infrabony defects in the distal aspect of the 2M in women taking oral contraceptives (32). The association with tobacco use increases the risk of deep bone defects after tooth extraction, especially in men over the age of 30 (32).

In cases where the indication for dental extraction was prophylactic, women over 26 years of age had a higher occurrence of pain, swelling and trismus on days 1 and 7 of the postoperative period, although this complication is also associated with osteotomy and multiple extractions (4).

2.3. Depth of impaction

The IC, IIC and IIIC inclusions of the Pell and Gregory classification were associated with an increased risk of postoperative IDN paraesthesia, especially in women over 24 years of age (4, 35).

A higher depth of eruption also correlates with a higher risk of cysts (high score according to Pell and Gregory and Winter's classification) (35), although their occurrence is very low, so extraction would not be justified (5).

Low-scoring 3Ms have been correlated with pericoronitis (10), deep abscesses and mandibular fracture in patients at risk of trauma, so this type of eruption should also be assessed as a factor indicating prophylactic extraction, also considering the risk of IDN paraesthesia (0.3%) and mandibular fracture (0.3%) (35).

2.4. Position

The mesioangular (25) and distoangular positions are associated with a higher

postoperative complication rate: specifically. The horizontal position has the least surgical complications with regard to the occurrence of IDN paraesthesia or generation of a periodontal pocket distal to the 2M (4,10,25).

Probing the distal aspect of the 2M is recommended to determine its depth and whether the impacted 3M has communication with the oral cavity. Pockets larger than 4 mm pose an additional risk factor that may affect the 2M and worsen the periodontal prognosis of even the most distant teeth (2,25).

The caries risk of partially mucosa-lined 3M is associated with poor oral hygiene (5) and increases up to 80% for caries in 1M and 2M (2). The vertical position is more associated with pericoronitis, with higher risk for position A than B on the Pell&Gregory (OR) scale: 7,13; IC: 1.31-38.74, I2=93% in lower 3Ms (5).

2.5. Thickened dental follicle

The horizontal position, the close relation to the IDN of a 3M with partially formed roots and the thickened dental follicle (reduced enamel epithelium) are three features (in an estimated frequency of 25 % of all 3Ms) that constitute an indication for prophylactic tooth extraction (1).

It should be recalled that 23.2% of curetted dental follicles showed pathological changes after surgical extraction of the 3Ms D-/S- (14.1% with dentigerous cyst, 6.6% with calcifying odontogenic cyst, 2.5% with keratocystic odontogenic tumour), especially in women. Although the weight of this reason for recommending extraction is doubtful, mainly because of its low clinical occurrence, it could be considered as a long-term risk factor (5).

2.6. Type of anaesthesia

When the extraction of a 3M under general anaesthesia is indicated, the possible extraction of the remaining 3Ms should be considered prophylactically, as long as there is no operative risk of IDN paraesthesia or if it is not advisable to subject the patient to further general anaesthesia in the future (3,15).

2.7. Surgical technique

The ostectomy/odontosection combination is

the technique that most favours the development of temporary or permanent IDN paraesthesia (4). Surgical time is also associated with increased morbidity (swelling, pain and trismus) and recovery time (2), which is higher in patients over 25 years of age (26,28).

2.8. Operator experience

In terms of the risk of pre- or postoperative complications, the surgeon's experience may be a risk factor to take into account (the less experienced the surgeon, the longer the extraction time and the greater the surgical trauma) (10).

It seems that the judgement of more experienced surgeons versus those in training does not influence the indication for prophylactic extraction based on the perception of the occurrence of complications in the future.

However, there are differences in this aspect when comparing general dentists and oral surgeons, the former being more likely to advise active surveillance (10).

To update recommendations already provided by other authors, a total of eleven relevant articles (listed in the evidence table) were selected to update recommendations already provided by other authors.

Evaluation and summary of the evidence

- The decision to extract only those 3Ms that are associated with pathological conditions with or without clinical symptomatology is the lowest risk option (5).

Level of evidence: 2++.

Grade of recommendation: B.

- Active surveillance is the recommended option when prophylactic extraction is not indicated (2, 4, 5, 14, 22, 29).

Level of evidence: 1++.

Grade of recommendation: A.

- In cases where signs of risk are observed, prophylactic extraction is indicated (1, 2, 10, 27, 35, 38-40).

Level of evidence: 2++.

Grade of recommendation: B.

- Non-impacted mandibular 3Ms have an OR of distal insertion loss of the 2M of 6.2. (6)

Level of evidence: 2+.

Grade of recommendation: C.

- Impacted 3Ms, especially if mesioangulated, cause an increased risk of 2M caries between 23% and 55%, especially when they have the Pell & Gregory class I B position. Moreover, this caries is the cause of their extraction in 44% of cases, which could justify an indication for the prophylactic extraction of the 3M (3,7-15).

Level of evidence: 2++.

Grade of recommendation: C.

- Possible pathological changes in the dental follicle of the fully erupted 3M may justify prophylactic extraction (29).

Level of evidence: 4.

Grade of recommendation: D.

- To recommend the prophylactic extraction of an asymptomatic, pathology-free 3M, risk factors, lifestyle and the patient's opinion should be assessed once they have been duly informed of their situation, given that most cross-sectional studies suggest that the risk of pathology caused by an impacted 3M increases with age (3,4,10,12,16).

Level of evidence: 2++.

Grade of recommendation: C.

erupted 3Ms at the start of the study, with follow-up from adolescence to adulthood.

- Data from epidemiological studies on 3Ms should be coded so that reliable data can be obtained in the socio-cultural setting of Spain.

Drawing of conclusions

- There is sufficient clinical evidence in favour of abstention in asymptomatic and pathology-free fully or partially erupted/impacted 3Ms.

Level of evidence: 2++.

Grade of recommendation: B.

- It is well documented that there is an increase in morbidity in patients with erupted or impacted 3Ms, associated with age (caries, periodontal pathology and root resorption of 2M) and with an unpredictable level of occurrence. Therefore, they should be actively monitored and, in the case of pathology with or without clinical symptoms, extraction should be indicated.

Recommendations for future research

- Epidemiological studies on indications, treatment and complications of 3M extractions in Spain with long-term follow-up are needed.
- Further epidemiological studies are needed to record the characteristics of the evolution of the asymptomatic and pathology-free

Q10. Is age (older or younger than 25 years) a factor related to the occurrence of morbidity associated with 3M extraction?

The prevalence of fully or partially erupted/impacted 3Ms, or erupted in the occlusal plane, decreases with age (1, 2). The indication for extraction is justified in cases where there is associated or clearly foreseeable pathology, or prophylactically in well-defined situations, taking into account the patient's clinical situation, lifestyle and wishes: 3Ms erupted on a fracture line, orthognathic surgery planning, lack of space to distalise teeth in orthodontic treatments, as a treatment prior to radiotherapy and/or chemotherapy, heart valve replacement, treatment with intravenous bisphosphonates, organ transplants, etc. (2,3).

The extraction of 3Ms as a source of pluripotent stem cells, which can be stored in a tissue bank and which could be used in the hypothetical case that they are needed for regenerative or tissue engineering therapies (4,5), could be considered a new indication, not classifiable within the traditionally established parameters. In this indication, age takes on additional importance, due to the higher division potential and doubling time of these undifferentiated stem cells in subjects under 22 years of age (5).

Although bone regeneration capacity is at an optimal level in adolescents and young adults, it is acknowledged that there is insufficient evidence to indicate extraction in patients with erupted/impacted 3Ms without associated pathology or who have had only one episode of pericoronitis with an optimal response to antibiotic therapy, and who are able to maintain a low level of bacterial plaque (6).

The average time to extraction of an initially asymptomatic 3M is estimated to increase by 5% per year and by 64% after 18 years of active follow-up. In this context, the final cause indicating extraction will be caries, periodontal pathology or pericoronitis (7). This suggests that, over time, the incidence of 3M pathology increases and should be treated at an older age, an age at which coexistence with a systemic pathological risk condition is common (29.2% in a study of 3,760 patients aged over 25), such as heart disease, arterial

hypertension and tobacco or alcohol consumption (8,9). Moreover, the risk of 2M extraction due to problems with 3M in patients older than 35 years has an adjusted OR of 14.38 (10).

The cut-off point at which age is considered a risk factor for surgical complications is between 24-26 years (8,11-15), although historically cystic changes of the dental follicle have been observed, with no correlation with its size: 40.3% in patients older than 20 compared to 22.8% in those younger than 20 ($p=0.03$) (16). These data do not coincide with those found in a sample of 181 dental patients aged 79 years (± 3.9 years) with at least one fully or partially erupted 3M, where 100% had pathology, although it was only significant (cysts or tumours) in 2% (17). Other authors find an increase in cysts and tumours with age (18). There is also a significant association between chronic inflammation of pericorony tissue and squamous metaplasia ($p<0.001$) (19).

The factors that determine intra- and postoperative complications are classified as patient-dependent: age, gender, tobacco use, use of oral contraceptives and comorbidities (heart disease, arterial hypertension, some drugs, tobacco or alcohol use, psychological factors), anatomical factors (level of 3M impaction and its angulation, previous inflammatory episodes, ankylosis, number of roots and their positioning, ratio of root apices to IDN) and surgical factors (tongue flap detachment, ostectomy, odontosection, type of anaesthetic technique used, surgical time, side operated on, surgeon's experience) (9,11,12,20,23). In non-surgical extractions of upper 3Ms, the incidence of maxillary tuberosity fractures was 25% in patients over 30 years of age, and half that in younger patients ($p<0.001$) (24). Likewise, the risk of post-operative mandibular fractures also increases with age, although there are other relevant factors, such as masticatory strength, re-chewing when the bone defect has not yet ossified and the depth of the 3M eruption (25-27).

The incidence of postoperative complications in a prospective study of 3,760 patients aged over 25 was less than 1% (6). In contrast,

for other authors studying smaller cohorts, the occurrence of postoperative complications in patients over 26.4 years (± 8.4 years) was 4.6% of extractions and 9.8% of patients (28). In terms of OR, in a group of patients aged between 24.6 and over 26 years, a complication ratio between 2.25 and 2.50 was observed when compared to a group of younger patients ($p=0.14$, $p=0.007$) (11).

Given that the mortality rate in the case of 3M extraction is practically nil in all the studies consulted, morbidity appears as the reason for analysing the clinical question posed.

General considerations

1. Operative time/occurrence of complications and age

- Age per se involves local determining factors: the greater the bone density, the greater the probability of 3M ankylosis, complete 3M root formation with apex closure and partial resorption of the 2M occurrence of 66.7% in an age group aged from 25 to over 36 years assessed with Cone Beam Computed Tomography (CBCT), especially in eruptions in Pell and Gregory A and B, mesioangulated or horizontal positions, because the 3M continues to exert pressure against the adjacent tooth even with the apex closed (29).
- These local factors result in increased operative time and aggressiveness of the surgical intervention (osteotomy and odontosection), clearly linked to the increased occurrence of complications such as root fracture, paraesthesia of the IDN and LN, and buccosinus communication (17,30-32).
- Buccosinus communication during the extraction of upper 3Ms has an occurrence of 13%, is related to the depth of impaction, bone sclerosis and root fracture, and increases with age, although it is also associated with molars with a half-formed root (33).
- The operative time in a group of patients older than 26.5 years was 2.5 times longer compared to the group of younger patients ($p=0.01$) (11). In addition to age, the time factor is correlated with 3Ms in horizontal

position (OR=2.3), with the number of roots (OR=2.01) and with proximity to IDN (OR=2.09) (11).

- Increased operative time is also associated with inflammation, trismus, pain, increased/decreased quality of life and time to return to daily routine, although other studies verify that the impact on quality of life is minimal (4).
- It is estimated that for every minute the operative time is prolonged, the risk of experiencing pain with no correlation with age increases by 9% (12).

2. Alveolar osteitis (dry socket) and age

- The occurrence of osteitis in the lower 3Ms (11.9- 12.7%) is higher than in the upper 3Ms (0.2-0.3%) in patients over 25 years of age, in a review of 8,333 extracted molars (4).
- It is estimated that from the age of 21.4 years (± 3.24 years) onwards, the risk of alveolar osteitis increases by 18 % per year, although age has no positive predictive value for the "trismus" and "pain" variables (12). Alveolar osteitis is also associated with a 5 times higher risk in women than in men (11).
- The use of oral contraceptives by women of childbearing age has been linked to pain and alveolar osteitis because it may affect coagulation with the occurrence of rapid fibrinolysis of the clot (1,34).

3. Infection and age

- In two publications including 3,760 patients aged over 25 years, the occurrence of acute or chronic postoperative infections was a maximum of 1% of patients (4,8).
- Postoperative risk of infection was associated with age in the 24 to over 26 years age group, but also in women and with the degree of eruption of 3Ms when fully erupted (11).

4. Pain and age

- There is controversy regarding the level of pain perception as a function of age (assessed using a visual analogue scale (VAS) or by calculating the number of days the patient requires analgesic medication). For some authors, this is a subjective phenomenon influenced by cultural and demographic differences (11), although it also correlates with the distance of

the apices to the IDN, the depth of the eruption, the operative time (11,20,28) and age (over 21 years) (35) or gender (36). For other authors, the group of patients between 35-42 years of age have the lowest perceived sensation of pain (37).

5. 3M/periodontal disease and age

- The pathology associated with 3M in a prospective cohort of patients under the age of 25 years (65 %) who chose to keep their 3Ms was assessed every two years for a total of six years. At the end of the follow-up period, 47% of 3Ms were extracted, due to caries (33%), pain (27%) or periodontal disease (23%), and 21% had at least one PD>4 mm in both the 3M and 2M. One third of the subjects in this cohort remained free of pathology. It should be noted that these data were obtained after the loss of 53% of the initial number of patients in the study (1).
- Due to periodontal surgical sequelae (loss of bone height) at the 2M level when 3M extraction is performed in patients over the age of 30 (23) or even in patients over the age of 26 (24), especially if the 3Ms have a mesialised angulation and in close contact with the 2M, extraction before this age limit is advisable (38,40-42).
- High bacterial plaque index scores especially affect patients over 30 years of age in relation to the persistence of infrabony defects >4 mm distal to the 2M at the one-year postoperative check-up (39).
- Patients under 25 years of age repaired infrabony defects > 4 mm posterior to the 2M at the one-year postoperative check-up in 90% of cases, whereas in the group of patients aged over 30, this occurred in only 49% of cases ($p<0.001$) (24).
- Symptoms of 3M pericoronitis in non-smoking patients may reflect early periodontal disease: 55% had at least one molar with PD $\geq$ 4 mm, compared to patients without pericoronitis (38%, $p=0.03$), which could justify 3M extraction as a therapeutic measure that would prevent the onset of periodontitis at an early age (43).
- The risk of permanent IDN injury has a very low occurrence, temporary paraesthesia varies between 0.72-1.7% and is 3 to 6 times higher than that of the LN (0.15% - 0.3%) (4,8,15).
- The risk of nerve injury correlates with women aged over 25 years (15,20,28), with intraoperative vision of the IDN, tongue flap retraction and a surgical intervention time of more than 30 minutes (11). An age of over 26 years in a retrospective study of 583 patients and 1,597 3Ms extracted (OR=1.05; $p=0.03$), together with history of systemic pathology (OR=1.04; $p=0.004$) and relation to IDN (OR=1.53; $p=0.006$) present a statistically significant value for the risk of paraesthesia (28).
- Patients over 25 years old have a significantly higher OR of suffering an iatrogenic IDN injury when compared to the 17-25 age group (postoperative day 3 symptomatology $p=0.0045$ to 0.0474; 10th day $p=0.0007$ to 0.0464), according to a prospective cohort study of 6,010 patients. The probability of permanent IDN injury was 0.9% in under 16 years of age, 1.8% in the range 17-25 years, 4.2% in 26-35 years, 5.8% in 36-55 years, and 5.6% for patients older than 55 years (36).

7. 3M-2M caries and age

- In a retrospective longitudinal study of 1,011 patients, the prevalence of caries was 27%, with a mean age of 31 years and of 2M distal caries 14%, with a mean age of 32.7 years. The sum of indications for 3M extraction due to caries was 41% (82% in impacted molars, 18% in functional verticals). In the 3M extracted due to caries, 44% were in a mesioangular position (44). In an analysis of 199 cases in which therapeutic extraction was indicated due to adjacent tooth pathology, 10.8% had lost more than 1/3 of the distal bone of the 2M (mean age of 46.8). However, in the 31-40 or over 40-74 age group, these lesions of adjacent teeth were 32.4% and 68.1% respectively, compared to the 13-20 and 21-25 age groups, which had less than 10% ($p<0.0001$).

8. Bone fractures and age

- 18% of tuberosity fractures were documented, 12% in under 30 years, compared to 25% in over 30 years ($p=0.001$) (24).

6. Nerve injury and age

- The risk of early and late postoperative mandibular fracture increased with age, although this was also dependent on other factors (25-27).

Evaluation and summary of the evidence

- The cut-off point at which age is a factor increasing the risk of local complications is between 21 and 25 years (35,46,47).
- The perception of postoperative pain is lower in a group of patients aged 35-42 years (37).

Level of evidence: 3.

- After surgical extraction of the 3M, patients over 21 years of age recover their quality of life more slowly in the postoperative period, except for the degree of mouth opening (35).

Level of evidence: 1+.

Grade of recommendation: B.

- Age, as a direct risk factor with respect to the appearance of surgical complications and their severity when removing 3Ms, offers contradictory results in the literature reviews in such a way that opposing conclusions are obtained due to the fact that:

- Age by itself does not imply an increased local or general risk of the occurrence of complications associated with 3M extraction, therefore, prophylactic extraction is not justified on the grounds that the older the age, the higher the probability of intra- and postoperative complications of impacted/erupted asymptomatic and pathology-free 3Ms. The risk will be caused by the patient's comorbidities (diabetes, obesity, family history and tobacco use, among others) (6).

Level of evidence: 3.

Grade of recommendation: D or the characteristics of eruption.

Level of evidence: 2++ (36, 48).

Grade of recommendation: C.

- The risk of caries and periodontal disease of the partially or fully erupted 3M or adjacent 2M increases with age and is usually the reason for extraction (45).

Level of evidence: 2++.

Grade of recommendation: C.

- Pain, inflammation and trismus increase in relation to operative time, type of eruption (distoangular and horizontal) and advanced age (37,47,49). The risk of IDN injury is related to the degree of root formation and surgical difficulty (47,49,50) and, consequently,

influenced by the patient's age.

Level of evidence: 2+.

Grade of recommendation: C.

- Buccosinusual communication is more frequent the older the patient is, and also at very early ages, when the molars have a half-formed root (33).

- The risk of fracture of the tuberosity increases with age, although other factors are associated with an increased risk, such as root morphology (24).

Level of evidence: 2++.

Grade of recommendation: C.

- Early or late mandibular fractures are more frequent at older ages, although they are also related to other factors (25-27).

Level of evidence: 2++.

Grade of recommendation: C.

Drawing of conclusions

There are many confounding factors that affect the drawing of conclusions:

- Because there is a well-documented increase in morbidity associated with erupted/impacted 3Ms with age (caries, periodontal pathology, root resorption, etc.) with an unpredictable level of occurrence, patients with erupted/impacted 3Ms should be actively monitored throughout their lives and, in the event of pathology, extraction should be indicated at the earliest possible age in each case.

Good clinical practices.

- Given that most of the studies consulted associate surgical extraction of the 3M with increased morbidity, which increases with the patient's age, risk factors should be carefully considered in order to indicate extraction, especially in deep eruptions.

Level of evidence: 2++.

Grade of recommendation: C.

- In cases where there is no infection or other associated pathology, extraction is not indicated at an advanced age.

Good clinical practices.

Recommendations for future research

- In order to estimate the risk of pathological changes in 3Ms erupted or impacted over time, large cohort studies with a long follow-up time with well-studied demographic

characteristics and with applicability to the Spanish socio-cultural environment are needed.

- A consensus should be reached on a cut-off point for clinical studies that evaluate dental age rather than chronological age, in order to be able to compare results and reduce confounding factors.
- It would be advisable to systematise the histological analysis of tissue from alveolar curettage or follicle of 3Ms in order to document the occurrence of pathological changes and to correlate radiological images and age.

Q11. Do patients with a 3M in total intraosseous eruption benefit from extraction? What are the guidelines to be followed for patients with 3M in total intraosseous eruption in whom extraction is not performed to avoid complications?

Nowadays, there is agreement on the indications for recommending the extraction of a 3M when it is associated with or likely to develop pathology with or without symptomatology, regardless of the degree of eruption. Thus, extraction is considered appropriate when the patient presents:

- Previous history or possibility of infectious processes. It is not indicated after transient self-limited episodes of inflammation (1-5).
- Non-restorable caries (1, 3, 6-7)
- Untreatable pulpal/periapical pathology (4, 6, 8)
- Periodontal disease (3,9-12)
- Pathological lesions (cysts, tumours, etc.) (3, 6, 13- 15)
- External resorption of 3M or 2M roots (16, 17)
- Orthodontic indications (17-22)
- Certain underlying systemic pathologies (13,23)
- Mandibular fracture (7,24)
- Atypical orofacial pain (25)
- 3M erupting under a dental prosthesis (6,13)
- Possibilities of autotransplantation (23)

In these cases, it is recommended to extract the 3M given the sufficient scientific evidence available (26,27,28-40); however, there is still controversy as to how to proceed in those 3Ms that are asymptomatic and with no

associated pathology or disease, as discrepancies remain (26-37).

Completely intraosseous wisdom teeth (erupted/impacted)

Most of the clear indications for 3M extraction are preferentially in partially or fully erupted 3Ms (5) where there is communication with the oral environment, which implies a 22-34 times higher risk of complications (38). However, the total covering of mucosa and bone ("silent eruption") constitutes an effective barrier against bacterial invasion, so the risk of infectious complications is much lower, although symptoms or pathologies resulting from other aetiologies may occur (3Ms associated with tumours or cysts, for example).

In order to make the decision to prophylactically remove an erupted 3M or to leave it embedded in the alveolar bone with a vigilant attitude, it is interesting to differentiate between the two types of situations: whether the 3M is completely covered or not by bone, as in many cases the associated symptoms or pathology is different and/or occurs with different frequency. However, delimiting the type of pathology and the frequency associated with these two groups is not always an easy task.

In this regard, 3Ms are differentiated according to the presence or absence of symptoms and pathology. A useful classification has been proposed to clearly and systematically assess 3Ms, taking into account, on the one hand, whether patients with a 3M had symptoms (S+) or not (S-), and, on the other hand, the presence or absence of clinical or radiological signs of disease (D+ or D-). Based on these parameters, four groups are distinguished:

- **Group A: (S+) (D+)**
- **Group B: (S+) (D-)**
- **Group C: (S-) (D+)**
- **Group D: (S-) (D-)**

The S-,D- group, made up of those patients who at the time of the examination did not present symptoms or evidence of associated pathology, is the group about which there is a great deal of controversy regarding the guideline to be followed: to extract the molar to avoid future problems or to leave it erupted and extract it

when symptoms or signs of pathology appear. The term asymptomatic is insufficient to assess the pathological state of a 3M, as clinical and/or radiological examination would allow the casual identification, for example, of a cyst that would indicate its extraction.

Within this group, there will be partially and fully erupted and fully formed 3Ms, which, in turn, may be totally or partially intraosseous, or only covered by soft tissues. However, the problem is further complicated by the fact that there is little evidence to predict whether a 3M will eventually erupt (40-42).

In the case of 3Ms (S-) (D-), especially those in complete intraosseous eruption ("silent eruption"), the choice is between prophylactic extraction or non-extraction. The latter decision is an unresolved challenge at present, there is still controversy surrounding it, and it would be important to have scientific evidence to support which approach to take.

To help make this decision, there are a number of factors that should be taken into account, and the evidence on which each is based should be assessed.

Factors involved in the treatment of intraosseous 3Ms (D-)

1. Indications for the extraction of 3Ms (S-) (D-)

There are cases of 3Ms, including those in the intraosseous situation, in which, despite not presenting symptoms or being associated with any pathology, there is scientific evidence that advises their extraction. These are those in which problems can be anticipated and in which the risk of extraction is minimal (46-51):

- In patients who, due to their work, lifestyle, etc., need to prevent the possible appearance of clinical and/or symptomatology of a 3M, as they would be an inconvenience or discomfort (43).
- For orthodontic indications or in orthognathic surgery (44).
- In tumour resections.
- In wisdom teeth that are in the line of a mandibular fracture.
- In wisdom teeth whose root development, due to their position, causes proximity to the lower dental canal.
- In cases where a prosthesis is placed above

the erupted 3M, to prevent exposure of the erupted 3M by the pressure of the prosthesis.

- In cases of dental autotransplantation in which the 3M may be the donor tooth.
- In patients who will be starting treatment with radiotherapy, chemotherapy, antiresorptive, antiangiogenic or immunosuppressive drugs.

2. Risk of future pathology

Among the arguments put forward by advocates of prophylactic extraction, any 3M that may be associated with periodontal disease (49,52-54) or caries, both of the 3M itself and of adjacent molars (45-51), stands out.

The results of the 1990 application of the NICE guidance in the United Kingdom, which reduced the number of prophylactic extractions by 30%, have been published. However, when the results were evaluated 20 years later, the number of extractions increased, the average age of patients increased from 25 to 32 years, and the cause of extractions turned out to be caries or infectious problems (59-60). However, none of the studies differentiate between partially or fully erupted and fully intraosseous 3Ms.

However, as previously stated, there is controversy surrounding the prophylactic extraction of asymptomatic wisdom teeth with no signs of disease (13,61-63). Numerous studies question whether the risk of disease is high enough to justify prophylactic extraction (62-71). There are numerous local factors (root development, proximity to the lower tooth canal, root dilacerations, depth of the inclusion, etc.) and systemic factors (age, pathology, medication, immunosuppression, etc.) that must be taken into account when making decisions about an asymptomatic, pathology-free erupted wisdom tooth (48). Current data are insufficient to refute or recommend prophylactic extraction versus active surveillance in those 3Ms that are asymptomatic and free of pathology (27,72,73).

As far as the prevention of periodontal disease is concerned, it is important to probe the 3M to determine whether or not it communicates with the oral cavity, because if there is communication, it will be contaminated and present a high risk of developing periodontal disease. Therefore, totally intraosseous 3Ms will be safeguarded from this

problem, as it is from a probing depth >4 mm that the risk of progression of periodontal disease increases (42,52). On the other hand, the surgical extraction of an erupted wisdom tooth, especially if it has a deep intraosseous inclusion, may lead to the development of a periodontal defect on the distal aspect of the second molar (74). This issue has been addressed in depth in question 4 of this CPG.

The prophylactic extraction of 3Ms has also been advocated to prevent the development of caries in the second molar. However, this complication will be omitted in this section as it has not been associated with fully erupted wisdom teeth (75).

The mandible, despite its strength, suffers from numerous fractures compared to other facial bones. There is controversy surrounding the role of 3Ms in mandibular fractures, as there are authors who defend a direct association between the presence of an impacted 3M and a higher probability of fractures of the mandibular angle (a risk between 2 and 3 times higher). On the other hand, a higher risk of fractures of the mandibular condyle has been described in patients with an absence of inferior 3Ms. There is also a prevailing debate as to whether or not prophylactic extraction of an asymptomatic 3M should be performed in patients at risk of facial fractures (for example, contact sports practitioners), as treatment of mandibular condyle fractures is technically more difficult than those of the mandibular angle, due to issues of access, visibility, reduction and fixation, which often present complications (64,65,76,77).

The latest update of the Cochrane review (27) on surgical extraction of wisdom teeth (S-) (D-) concludes that there are still insufficient data to determine whether or not these 3Ms should be extracted. Therefore, clinicians need to accurately weigh the risks and benefits of both treatment options and determine the indication for surgical extraction of the wisdom tooth based on the local and systemic risks presented by the patient. At this point, it is important to consider that most primary studies and systematic reviews conclude that with increasing age, the number of pathology-free 3M decreases (42,70).

3. Risks of 3M extraction.

The extraction of a 3M is not without the risk of potential complications requiring additional

treatment to resolve them (42,81-83). These possible occurrences will result in a change in patients' quality of life in the immediate postoperative course, therefore, treatment with a significant risk of morbidity, if not actually indicated, should be ruled out (57-84).

Erupted 3Ms completely covered by bone usually present a higher degree of difficulty in extraction. Therefore, the risk of postoperative complications is higher, and their systematic prophylactic extraction is even less recommended. In this same regard, the extraction of these 3Ms involves a significant risk of losing the periodontal support of the adjacent 2M. In these cases, it is indicated to leave the molar in situ, except if the 3M is partially erupted, as in these cases the possibility of symptoms is high (5,17,29,35,61,85).

In a comparative study on the risks of pathological changes in erupted 3Ms and the occurrence of complications after surgery, the complication rate after extraction was different according to age. Specifically, it was 11.8% in a group of patients aged 12-29 and 21.5% in patients aged 25-81. Different studies have shown that the risks of pathological changes in adults range from 0 to 12%, so it can be estimated that there will be more complications after the prophylactic extraction of 3Ms without pathology than after the extraction of only those with pathological changes (86,87).

Based on the above, different CPGs argue in their conclusions that the results of surgical extraction may be worse than a wait-and-see approach (29,88).

4. Cost-benefit analysis

Two decision analysis studies assessed the cost-benefit ratio and concluded, on the one hand, that the percentage costs of prophylactic extraction of an erupted mandibular 3M were 33% higher than those of abstention (89) and, on the other hand, that the optimal strategy would be to extract only those 3Ms with pathological changes, because the expected costs were lower (90). Several studies have addressed this point, concluding that, from a financial cost point of view, it would be acceptable to remove only those 3Ms with well-defined indications (77,91-93).

A Norwegian study concludes that it is most cost-effective for the oral surgeon to perform a prophylactic extraction of partially erupted 3Ms without symptoms at the age of 20-25 years, while the most expensive alternative is surgical extraction by a general dentist when the patient is older than 44 years (94). In this line, a systematic review conducting a cost analysis concludes that prophylactic extraction may be the most cost-effective strategy (95).

5. Patient's opinion

Patients should be actively involved in the decision to undergo prophylactic extraction or abstinence with active surveillance. To do so, they must be aware of the risks that may arise in the case of leaving the 3M in, of those arising from the surgical procedure itself, of the possible complications in the event that the extraction has to be performed later, as well as of the risks that prophylactic extraction also entails. Therefore, patients should be involved in the process of deciding which treatment option to choose (36,83,96-98).

6. Monitoring

When in cases of 3Ms (S-) (D-), abstention (no extraction) is chosen, active surveillance with clinical and radiological checks and scheduling of follow-up visits and/or re-evaluation at regular intervals is always recommended, especially when dealing with an impacted 3M totally covered by bone, because there may be a change in position and/or development of pathology. The relative risk of abstaining and delaying extraction should always be considered (8,13,45,99).

The need for regular monitoring of these patients, through clinical and radiological checks, is based on the fact that there is no completely safe way to predict the pathological changes that may occur in association with the erupted 3Ms (58,100).

If therapeutic abstinence is decided in the presence of an erupted 3M, patients should be monitored. In the same case, it is recommended that asymptomatic patients be clinically monitored every two years, including orthopantomography. 3Ms completely covered by bone probably do not require such frequent follow-up (101).

In case of a wait-and-see approach for (S-) (D-) patients, there are two possible strategies: a) wait and follow up until symptoms appear or b) perform what is known as "active surveillance". The former seems to be a poor choice, as the absence of symptoms does not always mean the absence of disease. Therefore, Dodson (42,102) and Dodson and Susarla (103) advocate active surveillance, which consists of a follow-up plan with monitoring of the patient through a programme that includes a review of the patient's history and a thorough and careful physical and radiological examination. The latter option is associated with higher costs than simply waiting for symptoms and the possibility of future extraction of the 3M. In this way, the pathology can be detected at an early age, at an early stage, and dealt with appropriately. It is recommended that patients in these circumstances should be seen every two years, or sooner if any symptoms of pathology appear. The reason for biannual visits is especially to monitor for the development of periodontal disease and because postoperative morbidity increases with age. It is recommended that follow-up is performed by clinicians experienced in the assessment and treatment of 3Ms.

Golden et al. (104) have addressed the issue of follow-up in periodontal pathology related to 3Ms. For this purpose, they assessed the periodontal status of asymptomatic 3Ms without evidence of pathology for six years, with check-ups every two years. In total, 129 individuals were evaluated, with probing >4 mm at any point of the 3M or adjacent areas being considered pathological. They found that, at six years, one third of the patients maintained a periodontal status similar to the initial one, without developing any pathology. Although they recognise that there is no data to support the two-year period for monitoring, following their results, they recommend this period for periodontal check-ups in order to be able to detect any pathological changes that may occur in time.

7. Appropriate methodology

The validity of the prophylactic extraction of 3Ms (S-) (D-) versus the non-intervention option should be evaluated by comparing their results. However, there is a problem in assessing both strategies: the great methodological difficulty of such a comparison.

Thus, the results of 3M extraction can be measured by the pre- and postoperative complication rate. However, in addition to the consequences of deliberate abstention, the occurrence of the various pathological changes that may occur, plus the rate of complications following delayed surgical extraction of the 3M, must be included (13,42).

In order to make the results of these two strategies directly comparable, it would be desirable to have a common method of assessment. To this end, decision analyses have been suggested that assess concepts such as “standard days of discomfort” (DSD) (105-107) or the biological, physical, sociological and psychological parameters that influence “feeling well” (37,106,107).

Evaluation and summary of the evidence

- No scientific evidence focuses exclusively on whether or not the prophylactic extraction of asymptomatic totally intraosseous 3Ms is of benefit compared to the abstentionist attitude of leaving it in the mouth.
- The decision to extract or conduct active surveillance of an asymptomatic wisdom tooth in intraosseous eruption will depend on the local and systemic factors related to the patient. Given that there is no evidence that the risk of disease is so high as to justify prophylactic extraction of totally intraosseous 3Ms, the decision should be made on a case-by-case basis, weighing the risks and benefits of each 3M, with great weight given to the patient's opinion in this decision (27,42,65,77,95,98,108).

Level of evidence: 2++.

- There is scientific evidence that in cases of 3Ms without signs of pathology or symptoms, therapeutic abstention should be accompanied by an attitude of active surveillance with monitoring; that is, implementing a programme that includes a complete and careful physical and radiological examination, which is suggested to be done every two years in order to detect the development of pathology as soon as possible (39,42,79,109).

Level of evidence: 1++.

- There is scientific evidence of a high frequency of mandibular angle fractures in

patients with an erupted 3M, as well as a higher risk of mandibular condyle fractures in cases with an absent 3M (71,76,110-112).

Level of evidence: 2+.

Drawing of conclusions

Although several publications have been published on the indication for extraction of the asymptomatic and pathology-free third molar, none of these specify the management of the asymptomatic and intraosseous erupted third molar. Moreover, the scientific literature reviewed during the process of updating this CPG has not succeeded in raising the level of the recommendations made in question 11.

- Asymptomatic 3Ms in total intraosseous eruption should only be extracted in the event of signs or symptoms of pathology.

Level of evidence: 2+.

Grade of recommendation: B.

- The decision to extract a totally intraosseous asymptomatic 3M should be evaluated on a case-by-case basis, taking into account the risks and benefits, as well as the patient's own opinion.

Level of evidence: 2++.

Grade of recommendation: B.

- There is no indication for prophylactic extraction of the 3M in cases of patients at risk of mandibular fractures (contact or risk sports, for example), given that, although the presence of an erupted 3M favours fractures of the mandibular angle, its absence favours fractures of the mandibular condyle, which are much more complex to treat.

Level of evidence: 2+.

Grade of recommendation: C.

- Totally intraosseous asymptomatic 3Ms that are left in place should be subject to a process of active surveillance or monitoring throughout the patient's life, to detect the possible appearance of pathologies.

Level of evidence: 1++.

Grade of recommendation: A.

- Monitoring of these cases should include a review of the medical history, careful clinical examination and radiological examination by a clinician competent in the assessment and management of 3Ms.

Level of evidence: 4.

Grade of recommendation: D.

- In those patients for whom abstinence is

indicated, active surveillance is recommended with a clinical check-up every six months/one year, coinciding with routine dental check-ups, and a radiological check-up by orthopantomography every two years. Good clinical practice.

Recommendations for future research

- It would be ideal to carry out a well-designed long-term RCT (at least 10 years), comparing the evolution of asymptomatic intraosseous 3Ms with the other eruptions. Given the difficulty of such long-term studies, it might be more feasible to conduct large-scale, long-term observational studies to detect the evolution of these 3Ms over time.
- Studies using the decision analysis model are needed to adequately compare the outcomes of both strategies, assessing the physical, sociological and psychological parameters that influence the patient's quality of life, which would also incorporate well-designed cost-benefit concepts.

Q12: In patients with an erupted 3M, when is a CT scan recommended to prevent clinical and/or surgical complications?

During the extraction of a mandibular erupted 3M, there is a risk of injury to neighbouring nerve structures such as the inferior dental nerve (IDN) or the lingual nerve (LN), which are the most serious and frequent complications of this surgical procedure. While the LN runs through the retromolar area and the lingual cortex between the soft tissues, which prevents it from being detected with radiological techniques, the IDN runs through the inferior dental canal located below the permanent 3Ms with a close association with the roots of the 3M (average 0.88 mm) and its path can be detected with different radiological techniques (1-4).

The occurrence of IDN injury in the extraction of 3Ms varies between 0.35% and 8% of cases for temporary damage (5, 6) and from 0% to 1% for permanent injury (7, 8). The overall risk of permanent damage to the IDN during extraction of the erupted 3M is low, although the high frequency of this surgical procedure

means that the number of patients who are eventually affected is significant.

Several studies have evaluated the risk factors influencing the incidence of IDN injury after extraction of the erupted 3M and agree that, in most cases, the 3M roots were in close contact with the IDC (9-11). In these circumstances, the nerve can be damaged directly by surgical instruments (handling of drills, uncontrolled dislocation manoeuvres, deep or abrupt curettage, etc.) (9,12), or indirectly by manipulation of the nerve during extraction movements, always motivated by the anatomical proximity of the 3M to the IDN (9).

Therefore, the anatomical association between the IDN and an erupted 3M is one of the fundamental points to be assessed when diagnosing and planning its extraction in order to minimise the risk of injuring this nerve structure, as this proximity is the most obvious risk factor. The assessment of the risk of injury to the IDN will allow the patient to be adequately informed and/or the decision for extraction to be reconsidered (9-11).

The risk of IDN injury can be reduced by a proper preoperative assessment of the actual position of the 3M roots and their association with the inferior dental canal (IDC). This will allow the surgeon to adapt and/or modify the surgical technique in a way that minimises intraoperative risk. For this purpose, the following imaging techniques are essential:

- Orthopantomography (OPG)

The OPG is a first-rate radiographic test that offers a general examination of the teeth, the maxillary bones and other neighbouring anatomical structures.

Before the incorporation of 3D radiological techniques in dentistry, OPG has been used to assess the association between the 3M and the IDN canal. In cases where the OPG image was unclear or uncertain, it was advisable to complement it with other radiological projections such as lateral, occlusal or periapical techniques, especially the latter because they provide more detailed local information and are very accessible to the dentist. However, the OPG has significant limitations as it is a 2D technique, meaning that it does not show the vestibulolingual position

of the IDNC and its greater or lesser proximity to the roots in this dimension. For these reasons, clinicians have had to resort to various signs that shed light on the vestibulolingual position of the 3M and its greater or lesser proximity to the IDN (13).

Thus, numerous clinical studies have tried to find the most reliable radiological signs to suggest the intimate association between the IDN and the 3M root or the exposure of the IDN during surgery and its possible correlation with the appearance of symptoms of nerve damage after surgery (1, 14-19). The radiological signs most suggestive of a close association between the IDN and the 3M, and therefore of a risk of nerve damage during surgery, are (14,17,19,20):

- Darkening of the root: darker (radiolucent) band of the root where it is crossed by the IDN.
- Loss of the cortices of the IDC: the radio-opaque lines representing the cortices of the canal are interrupted when crossed by the root.
- Change in the direction of the IDC: the path of the nerve silhouette changes abruptly in direction as it approaches the root.
- Narrowing of the IDC: it narrows as it overlaps or comes into contact with the root.
- Thinning of the root: the root narrows at the points where it is crossed by the IDC.
- Root deviation: dilaceration or abrupt change in the shape of the root where the IDC overlaps or contacts the root.
- Forked apex: darkening and forked shape of the root apex where the IDN crosses it.
- Overlapping: the root overlaps with the IDC.
- Contact with the IDC: the root is in contact with the IDC.

A review of the different studies shows that the darkening of the root where it intersects the IDN image, the interruption of the radio-opaque lines of the IDC as it crosses the root and the deviation of its trajectory at root level are the three signs that are most reliably related to the risk of possible injury to the IDN as there is a very close association of proximity to the 3M (17,21). This was found by Rood and Shehab after analysing the association between OPG signs of 1,560 3Ms and potential nerve injury (17). Nakagawa et al. (19) emphasise the importance of the absence of radio-opaque

lines of the IDC in the OPG as a sign of increased risk of contact between the 3M and the IDN. They add that women are the most likely to have contact between the IDC and the 3M when the absence of radio-opaque lines from the IDC is seen on the x-ray.

The thinning of the IDC has also been suggested, in addition to the above three. There seems to be general agreement that the absence of positive radiographic signs on the OPG is more useful than the presence of such signs (higher specificity than sensitivity). Thus, in the absence of these signs, the risk of nerve injury would be minimal, whereas the presence of one or more signs would be indicative of closer proximity but is not a good predictor of post-surgical nerve damage (1,11,13).

- Computed tomography (CT)

The greater diagnostic accuracy offered by CT in cases where there is intimate contact between the IDN and the 3M improves pre-surgical diagnosis prior to removal of erupted 3Ms (13, 20). However, there are few studies correlating CT findings with clinical outcomes. Only the study by Maegawa et al. (15) offers such a correlation and finds a low predictive level, around 30%, between the clinical finding of IDN exposure at surgery and the finding of contact on the CT image. These results could indicate that CT is not a very reliable tool for predicting intraoperative IDN exposure. In contrast, a recent meta-analysis showed that although Cone Beam Computed Tomography (CBCT) was better at predicting IDN exposure during 3M extraction, both radiographic scans, CBCT and OPG, had high sensitivity and specificity (23).

The CBCT emits a lower radiation dose than CT: while CT emits a dose between 280 and 1410 μ Sv (micro Sievert: unit measuring the radiation dose absorbed by living matter), according to a systematic review published in a specific clinical guideline (SedentexCT), the radiation dose from the CBCT, which varies according to the type of device and the field of view (FOV) used, is between 11 and 674 μ Sv (61 μ Sv on average) for dento-alveolar FOVs, and between 30 and 1,073 μ Sv (87 μ Sv on average) when the field of view is craniofacial

(24). In other words, the doses produced by CT scans are reduced by 11 to 37 times. Given that doses depend on the type of equipment and the selected field of view, low-dose protocols reduce radiation significantly. However, it should not be forgotten that the radiation from a CBCT is higher than that of an OPG, which is around 4-30 μSv , so it is important to consider when to use CBCT as an adjunct to OPG to avoid the risks of extra and unnecessary exposure to ionising radiation (25,26). According to Petersen et al. (27), if a CBCT was a routine diagnostic tool prior to extraction of wisdom teeth, the annual risk of cancer would increase by 0.46 times. Furthermore, it should not be forgotten that CBCT is a more expensive radiological technique than panoramic radiography (27,28).

Therefore, as new tomographic techniques are not exempt from the possibility of harming the patient, due to the irradiation involved, CBCT examinations should be justified on a case-by-case basis and demonstrate that the potential benefit of the technique for that patient outweighs the risks. Using CBCT routinely or as screening imaging is an unacceptable practice (24). It is widely agreed that the decision to perform any preoperative radiographic technique should be based on the ALARA (as low as reasonably achievable) principle, that is, to achieve the goal at the lowest risk reasonably achievable (24).

- Clinical efficacy of CBCT

The choice of any diagnostic test should depend, among other factors, on parameters such as sensitivity, specificity, negative predictive value and positive predictive value. Several publications have compared the predictive value of OPG and CBCT in lower dental nerve exposure or disruption after the surgical extraction of the erupted 3M (29).

CBCT has been widely applied in dentistry in fields such as implantology, endodontics, periodontics and oral surgery as it facilitates diagnosis and planning. However, few studies exist. However, there are few quality studies assessing its real clinical utility compared to other techniques (24-26,30-32). The European Academy of Dentomaxillofacial Radiology updated the SedentexCT guidance (24) to include new scientific evidence on the use of CBCT in

treatment and the risk of nerve damage after third molar extraction (29).

Although panoramic radiography allows for a correct classification of the position of the wisdom tooth in relation to the occlusal plane, it seems to underestimate the eruption space of the third molar compared to CBCT (33). Furthermore, the OPG, being a 2D technique, does not allow the identification of the vestibulolingual position of the IDC in relation to the roots of the erupted 3M. This problem has been overcome with 3D imaging techniques, including CBCT. However, the frequency of 3Ms that in panoramic images show an overlap of the IDN with the roots is quite high (over 40 %) (34), together with the aforementioned risks and drawbacks of the technique, means that its systematic use cannot be considered for the diagnosis of all 3Ms, a role that the OPG has been fulfilling up to now. However, its actual utility in the extraction of 3Ms is a controversial issue.

Although there is some literature concluding that having a CBCT may change surgical planning (35), in most cases, having a CBCT does not usually change neither the diagnostic decision to remove 3Ms nor the surgeon's surgical technique (29,36-39).

On the other hand, the actual ability of a CBCT to predict IDN injury after mandibular third molar extraction has also been evaluated. Despite the advantages of having a 3D diagnostic technique, there is very little evidence on the actual efficacy of its use in the preoperative study to reduce IDN injury after 3M extraction or its severity (40). Most primary studies and systematic reviews and meta-analyses comparing the number of nerve injuries after surgical extraction of the 3M with a previous CBCT or OPG conclude that the risk of nerve injury is similar (19,41-46). In fact, one of the most significant problems encountered in this type of study is the calculation of the sample: the low prevalence of nerve injury in 3M extraction means that the sample size must be much larger than those usually used in this type of work. This would require the promotion of multicentre studies to ensure an adequate volume of patients (41,47,48). On the other hand, Petersen et al. conclude that the availability of a CBCT image does not reduce the duration of surgery, the number of postoperative analgesics or other complications related to surgery (28).

Although these 3D techniques make it possible to see the vestibular or lingual position of the IDC in relation to the 3M roots, there is disagreement as to which position is more frequent. Percentages vary among authors: while some find the lingual position to be the most common (49-51), others find the vestibular position of the IDC to be more prevalent (14, 15, 22). This information may be of great relevance, as there seems to be a higher risk of nerve damage when the IDC is positioned lingually (15,35,49).

The risk of IDN injury is related to the degree of contact with the 3M roots, specifically when the bony cortex of the IDC is absent. The absence of this cortex leads to exposure of the neurovascular bundle when the 3M is removed, although it has been reported that in these cases the incidence of temporary IDN injury can be as high as 30% (1,16,52-54). Thus, the preoperative prediction of exposure of the vasculonervous bundle by imaging techniques could predict the risk of nerve damage during surgery and allow, if possible, modification of the surgical technique to try to avoid such injury (55).

As for the OPG, few studies have been performed to predict nerve exposure after extraction of the inferior 3M. Certainly, in the work of Sedaghatfar et al. (1) it was concluded that the darkening and thinning of the root, sharp angulation and loss of the cortices of the IDC, when the two structures intersect, would be significantly associated with exposure of the vasculonervous contents upon extraction of the 3M, although they did not determine optimal diagnostic criteria for predicting exposure.

(1). Maegawa et al.

(15) advise requesting a CT when the OPG shows an apex in the lower half or below the lower wall of the IDC, or its radio-opaque line disappears as it crosses the root.

The importance of performing a CBCT has been strongly emphasised in the presence of a notch in the lingual area of the root when the IDC is in this position, as a sign of high risk of nerve damage, which coincides with the darkening of the root in the OPG (30).

Once the high risk of nerve exposure and thus possible intraoperative IDN injury has been detected, the clinician should adequately inform the patient of the risks of this surgical

intervention, and the patient should be engaged in the therapeutic decision to go ahead with the extraction or to defer it. Since the number of IDN nerve disruptions will not be reduced by the use of CBCT, the decision whether or not to request CBCT will largely depend on the clinician's opinion and experience. The CBCT may be warranted if, despite the examination performed, the clinician has concerns that may cause them to change their surgical technique to avoid nerve injury (24,41,49).

In these high-risk cases, the clinician may suggest the possibility of opting for more conservative techniques such as coronectomy or orthodontic extrusion (56-59). However, there is controversy surrounding the indication of a coronectomy as a useful long-term technique. Moreover, orthodontic extrusion has the disadvantage of extending the treatment time, which would considerably increase the cost of treatment (48). If a coronectomy were to be performed, the request for a CBCT would be questionable (24,59).

- Imaging techniques for the diagnosis of other pathology related to the erupted 3Ms.

In a study assessing the external root resorption of the 2Ms associated with the erupted 3Ms, a CBCT was able to significantly increase the number of diagnosed cases compared to OPG, and thus it was recommended for the diagnosis of this pathology in order to avoid future complications if allowed to evolve. However, in addition to having a small sample size, this study does not compare CBCT with other more reliable techniques for the diagnosis of this pathology, such as periapical radiography (68). The SedentexCT guidance states that a CBCT may be indicated to assess the location of an erupted tooth, as well as the resorption of an adjacent tooth, when the information cannot be adequately obtained by radiographic techniques that emit less radiation. Grade of recommendation: C (24).

CBCT has also been used to identify the so-called "retromolar duct" or "anatomical variation of the IDN", which represents an accessory branch of the IDC arising distal to the 3M. Although it participates in the innervation of the retromolar area and the 3M, it is usually of little clinical relevance. However, it is often associated with possible inadequate preoperative anaesthesia, intraoperative local bleeding or altered postoperative local sensation (69-71). Although it is

most commonly diagnosed using CBCT, its low clinical relevance does not justify the routine use of this technique to diagnose it.

The use of CT has also been suggested to diagnose different pathologies such as cysts and tumours in the 3M region. However, the emergence of new technologies such as CBCT has made it possible to visualise these types of lesions in 3D, better showing their associations with neighbouring structures, especially with the IDN. This radiological technique allows an image diagnosis of the existing pathological lesion and at the same time provides valuable information for surgical excision (24).

In this sense, all the recommendations given on how to approach imaging techniques in the proximity of the IDN/3M would be useful. Thanks to CBCT, numerous cases of maxillary tumours have been diagnosed and published in the form of individual cases or case series, hence it seems reasonable to state that this technique is very useful for assessing bone pathology of the jaws, although at the moment there is no scientific evidence to support the diagnostic superiority of this technique in this type of lesion (72-82).

Evaluation and summary of the evidence

- There is evidence that, in cases of the extraction of erupted 3Ms with moderate risk of IDN injury, a CBCT is no better than an OPG in predicting potential postoperative nerve complications (60).

Level of evidence: 2++.

Grade of recommendation: C.

- There is some evidence that, in cases of extraction of an erupted 3M in close association with the IDC on an OPG, a conventional CT scan is no better than an OPG in predicting possible postoperative nerve complications (28).

Level of evidence: 1+.

Grade of recommendation: A.

- There is conflicting evidence on which technique (CBCT or OPG) is safer for predicting intraoperative IDN exposure, in terms of risk signs of potential nerve injury, after extraction of erupted 3Ms in close association with the IDC (23,41,49,61,86).

Level of evidence: 2+.

Grade of recommendation: C.

- There is evidence that a CBCT is more

reliable than an OPG in detecting the lingual or vestibular position of the IDN with respect to the 3M root, as well as in detecting the number of roots and apical divergence (49-60).

Level of evidence: 2++.

Grade of recommendation: C.

- There is evidence that in some cases, a CBCT allows the surgical technique to be modified, although on many occasions the surgical planning coincides with the OPG and CBCT (35-38,87).

Level of evidence: 2++

- There is evidence that the lingual position of the IDN and the presence of a root notch (grooving), detected by CBCT, are significantly associated with nerve damage after 3M extraction (49).

Level of evidence: 2++.

- There is some evidence that, in cases of close contact with the IDC, a CBCT may help modify the surgeon's surgical approach and technique to try to prevent nerve injury to the IDN (33).

Level of evidence: 2++.

- There is evidence that two signs present on an OPG, disruption of the cortical lines of the IDC and root darkening, are significantly associated with exposure of the IDN in the extraction of an erupted 3M (1,49,54,61,65-67,86).

Level of evidence: 2++.

- There is some evidence that darkening of the 3M root where it intersects the IDC in the OPG correlates with the thinning or loss of the lingual mandibular cortex (86).

Level of evidence: 3.

- There is some evidence that radiological assessment by practitioners prior to surgery was significantly associated with exposure of the IDN during surgery and an elevated risk of nerve injury (1).

Level of evidence: 3.

- There is some evidence that the absence of imaging of the cortices of the IDC on a CBCT is a sign that correlates with the occurrence of nerve injury (54,64).

Level of evidence: 3.

- There is limited evidence that a CBCT is better than an OPG in detecting external resorption of the second molar root caused by 3M eruption (49 68,88,89).

Level of evidence: 3.

- There is insufficient evidence on when it is justified to use CBCT in cases of bone pathology in the area of the erupted 3M (cysts,

tumours, osteonecrosis, etc.) to avoid clinical and/or surgical complications.

Drawing of conclusions

- A CT is not routinely indicated in cases of the extraction of erupted 3Ms.

Level of evidence: 1+.

Grade of recommendation: A.

- A CT is no better than an OPG in predicting postoperative nerve complications in cases of extraction of erupted 3Ms with risk of IDN injury.

Level of evidence: 1+.

Grade of recommendation: A.

- A CT is not routinely indicated in cases of coronectomy of erupted 3Ms.

Level of evidence: 3.

Grade of recommendation: C.

- A preoperative CT does not reduce the number of postoperative IDN nerve lesions compared to OPG.

Level of evidence: 1+.

Grade of recommendation: A.

- The presence on the OPG of darkening of the 3M root at the point where it intersects the IDC and the interruption of the white line of the cortices of the IDC as it crosses the root are very reliable signs, indicating a close association between the two structures and therefore an increased risk of nerve injury during extraction.

Level of evidence: 2++.

Grade of recommendation: B.

- A CBCT may be indicated when the surgeon needs to know the location of the IDN-IDC in order to modify the surgical approach and technique to try to prevent nerve injury.

Level of evidence: 2++.

Grade of recommendation: B.

- A CBCT may be indicated in cases of different types of intraosseous pathology located in the 3M region (tumours, cysts, osteonecrosis, etc.), especially when the imaging techniques usually used do not allow the lesion to be adequately seen or there is a high risk of injury to the IDN during surgery.

Good Clinical Practice.

- A CBCT allows the 3D reconstruction of the 3M, which allows us to know exactly the anatomy of the roots of the 3M, facilitating the decision of the type of odontosection to be performed.

Good Clinical Practice.

Recommendations for future research

- Given the low frequency of nerve damage after surgical extraction of erupted 3Ms, studies conducted to assess the intraoperative risk of nerve damage should have a large and adequately calculated sample, a bias that most of the reviewed articles present, given the difficulty of obtaining very large samples.

Multicentre studies would be a possibility in order to obtain an adequate number of patients with sufficient power.

- There is a need for randomised controlled studies where the different findings of the OPG and CBCT examination are analysed in relation to the results of the surgical intervention, that is, the reduction of nerve damage after extraction. In this way it could be determined in which cases OPG would be sufficient and in which cases the additional help of CBCT would be needed.
- Randomised controlled clinical trials are needed to evaluate whether having a preoperative CBCT can reduce postoperative complications of lower third molar extraction.
- There is a need for randomised controlled clinical studies that focus on high-risk patients, while avoiding the ethical and methodological problems that this may pose.

Q13: In which patients can the position of the 3M be related to the likelihood of future clinical symptomatology or presence of pathology compared to those who remain asymptomatic?

The anatomical position of the 3M in its natural location can vary greatly in both depth and angulation. As suggested, this may have both clinical implications (depending on the type and degree of symptomatology and the possibility of postoperative complications) and therapeutic implications (the position will influence the degree of difficulty of extraction and the type of extraction technique used) (1-5).

In an attempt to categorise the position of the 3M in the retromolar trigone or maxillary tuberosity, both in depth and angulation, different classifications have been described, with varying degrees of success. Of these, the most widely used are Winter's and those of Pell and Gregory, which are described below.

Winter's classification (6) is based

fundamentally on the inclination of the 3M in relation to the 2M, assessing the degree of angulation of the longitudinal axis of the 3M with respect to the erupted 2M. Depending on the inclination, the 3M may be in the following position:

- **Vertical:** the axis of the 3M is parallel to that of the other molars.
- **Horizontal:** the axis of the 3M is perpendicular to that of the other molars.
- **Mesioangular:** the axis of the 3M is directed towards the 2M, forming a variable angle with it, around 45°.
- **Distoangular:** the axis of the 3M is directed towards the ascending mandibular ramus/maxillary tuberosity.
- **Vestibuloangular:** the crown of the 3M is directed towards the vestibular and its axis of orientation is perpendicular to that of the other molars.
- **Linguoangular:** the crown of the 3M is directed lingually and its longitudinal axis is perpendicular to the orientation plane of the other molars.

Pell and Gregory's classification (7) is based on two parameters: the first is the position of the 3Ms in relation to the anterior border of the ascending mandibular ramus or the maxillary tuberosity. Thus, three typologies can be distinguished:

- **Class I:** there is sufficient space between the anterior border of the ascending ramus of the mandible and the distal face of the second molar (3Ms completely outside the ascending ramus).
- **Class II:** the erupted 3M has a mesiodistal diameter larger than the space available between the 2M and the ascending ramus of the mandible (3M partially covered by the ascending ramus).
- **Class III:** there is no space and the 3M is completely covered by the ascending mandibular ramus. With the second parameter, the relative depth of the 3M in the bone is assessed and three positions are described:
 - **Position A:** the occlusal face of the 3M is at the same level or above the occlusal line passing over the adjacent erupted 2M.
 - **Position B:** the 3M is located below the occlusal line of the 2M, but above the cervical line of the 2M.

- **Position C:** the highest part of the 3M is at the same level or below the cervical line of the adjacent erupted 2M.

Although widely used, the Pell and Gregory classification has been found to have low intra- and inter-examiner agreement. This implies that there is a need to look for new methods of measurement to minimise the risk of bias due to subjective interpretation by the observer. In contrast, intra- and inter-examiner agreement were very high when applying Winter's classification (8,11).

Moreover, as these classifications have been used to try to determine the degree of difficulty of 3M extraction, different indices or degrees of difficulty have emerged that also include the different clinico-radiological factors involved in extraction (10). However, in recent years, several authors have made contributions on the difficulty scales, such that there is evidence in the literature that the classic classification of Pell and Gregory (7) does not reliably predict the difficulty of extraction of a 3M, as other factors involved must be taken into account (12-14).

Nevertheless, these scales are important, as the greater or lesser difficulty of 3M extraction will affect the number and severity of postoperative complications and, therefore, the patient's quality of life in the postoperative course. Almendros-Marqués et al. (15) conclude that the position of the erupted mandibular 3M may be related to the occurrence of complications after extraction; specifically, vertical 3Ms in position IIA and IIB of the Pell and Gregory classification are the most susceptible to complications.

Symptomatology associated with the position of the 3M

- Pericoronitis:

Inflammation of the pericorony tissues of the 3M can be responsible for the appearance of pain, swelling, bleeding, suppuration, etc., as it is the most frequent pathology of mandibular 3Ms. There is new scientific evidence corroborating that 3Ms in the vertical or distoangular positions close to the occlusal plane, whose surface is half or more covered by soft tissue, as well as partially erupted 3Ms with

an enlarged dental follicle and those in position A of the Pell & Gregory classification, have a greater possibility of producing pericoronitis than those located in other positions or levels. In these cases, prophylactic extraction of the former is advised, especially in young patients between 20 and 30 years of age (5, 10,16-23).

- Periodontal disease:

The two circumstances in which a 3M can cause periodontal lesion on the distal aspect of the 2M are described below:

- The presence of the 3M in an area that is difficult to clean and especially in patients with poor oral hygiene can facilitate the development of periodontal lesions. When an erupted 3M has a close association with the 2M, its distal epithelial attachment is compromised, weakening or eliminating the interradicular bony septum that separates them due to aggression from periodontopathogenic bacteria (4,18- 20). When the 3M is semi-erupted with a mucosal cap (operculum), by favouring food retention and making hygiene of the area difficult, it represents an active source of bacterial contamination in the area distal to the 2M. In long-standing cases, an inflammatory rim usually develops covering the distal surface and part of the occlusal surface of the 2M. If allowed to evolve, deep periodontal pockets with loss of attachment will develop, favouring the development of an anaerobic microbiota in the area, which can lead to, on the one hand, repeated episodes of acute infection and, on the other, chronic infection with loss of bone support on the distal aspect of the 2M (18-20). In these circumstances, removal of the 3M improves the periodontal status of all teeth present in the mouth, especially the attachment level at the distal aspect of the adjacent 2M (24-27).

- After extraction of a 3M, periodontal sequelae may appear on the distal aspect of the adjacent 2M as a consequence of the restorative process itself. Cases of partially erupted 3Ms in deep mesioangular or horizontal position, with a contact point close to the amelocemental junction of the 2M, show a large contact area between the two and, consequently, a higher risk of

periodontal lesion. The larger the contact area and the less bone septum between the two molars, the more the postoperative periodontal healing is affected. The prophylactic extraction of these 3Ms before the age of 25 years may prevent these periodontal lesions, as spontaneous bone regeneration occurs (27-30).

Current scientific literature has evaluated the occurrence of 3M-related pathological findings on orthopantomography (OPG) and cone beam computed tomography (CBCT) and attempts have also been made to identify risk factors for 3M impaction. An OPG underestimates the presence of pathology, in this case distal 2M bone loss, compared to a CBCT. Mesioangulated or horizontal 3Ms and those whose image overlaps with the 2M on an OPG, as well as relatively deep positions, show a significant increase in marginal 2M bone loss (22,31-33). Moreover, age was also significantly related to the marginal bone loss of 2Ms (32). Therefore, the authors suggest that these factors may favour the indication for extraction of these 3Ms, despite the absence of symptoms and bone loss on an OPG (33).

There is little literature on the upper 3M. A statistically significant association was found between the level of impaction of the upper 3Ms and 2M bone loss. However, no association was found between 3M angulation and upper second molar marginal bone loss. Knowing the natural history of impacted upper 3Ms may help to more accurately estimate the risk of associated complications and to indicate their prophylactic extraction (34).

- Caries in 2Ms and 3Ms:

3Ms are prone to developing caries early after eruption, a risk that increases when caries are present in neighbouring teeth (35-37). Moreover, partially erupted 3Ms increase the amount of salivary bacteria that promote caries and plaque accumulation in neighbouring teeth. Therefore, the prophylactic extraction of 3Ms with these characteristics reduces visible plaque, the amount of caries-causing bacteria and periodontal pathogens on neighbouring teeth (25,34,38-40). On the other hand, age is a significant factor for increased caries risk on the distal surface of the 2M (41).

Caries on the distal aspect of the mandibular

2M is more frequent if the 3M is partially or fully erupted and in a mesioangular or horizontal position. In these cases, prophylactic extraction is recommended, as there may be an increased risk of developing caries (22,24,26,37,42-48).

Campbell et al. (45) studied the microbiome on the distal surface of the 2M and correlated it with the angulations of the 3M. They concluded that there are evident differences in microbial diversity in the group of 3Ms in horizontal and mesial inclusion, with a higher abundance of *Veillonella* ASVs (amplicon sequential variations) in the horizontal inclusions, as well as a higher association with the presence of caries.

Some authors also suggest that the vestibular or lingual position of 3Ms may pose a new risk factor for distal caries in 2Ms, compared to the medial position (49).

- Mandibular fractures:

The mandible, despite its strength, suffers from a large number of fractures compared to other facial bones. These injuries are influenced by many clinical factors, such as prominent location on the face, nature and intensity of impact, biomechanical properties of the mandible, bone density, presence of anatomical or pathological structures that may weaken the mandible, etc. The role of mandibular 3Ms with this type of fracture has been widely debated in the literature. For example, there are various authors who find a direct association between the presence of an erupted 3M and a greater probability of fractures of the mandibular angle (risk between two and three times greater). Similarly, other authors find an increased risk of mandibular condyle fractures in patients without lower 3Ms. However, controversy remains as to whether or not prophylactic extraction of an asymptomatic, pathology-free 3M should be performed in patients at risk of facial fractures (50-55).

The high risk of mandibular angle fractures in the presence of the erupted 3M could be justified by the weakening of the area due to the space occupied by the 3M. However, in its absence, the mandibular angle area would be more resistant and would cause the force of an

impact to be transmitted to a more fragile area (the mandibular condyle) (56-62). Some authors suggest that this risk would also increase when the 3Ms are erupted, as in this situation the mandibular external oblique line is intact and resistant (63).

The treatment of condylar fractures is technically much more complex than those of the mandibular angle, due to issues of access, visibility, reduction and fixation, which can lead to significant complications and sequelae. Although prophylactic extraction of 3Ms has been proposed in young athletes involved in contact sports to reduce the risk of mandibular angle fractures, this would increase the risk of condylar fractures, more complex to manage, and controversy remains on this point (59,64,65).

Given that the risk of mandibular angle fractures has been associated with the position of the 3M, it seems that unerupted 3Ms are more frequently related to this type of pathology (50,66-68). In this sense, some authors postulate that deep 3Ms are more frequently associated with this type of fracture than superficial 3Ms (55,68,69) as the angle is weakened by the presence of the 3M. However, other authors argue that, as the integrity of the cortex is lost, creating a zone of weakness, there would be more risk in the superficial 3Ms (partially erupted or superficially impacted), without there being any association between the increased probability of fracture and the Winter classification of 3Ms (53,54,59-63,70-74).

On the other hand, some authors suggest a close association between mandibular fractures (especially condylar) with the presence of occlusal contact in the molar area, stating that correct occlusal contact could absorb part of the force transmitted from a blow to the mandible, and prevent it from propagating to fragile areas, such as the mandibular condyle (58,60).

- Cystic lesions:

There is little information in the literature on the association between the position of the lower 3M and the occurrence of cysts. Werkmeister et al. (75) published a retrospective case-control study relating the depth and angulation of the 3M to the occurrence of pathological lesions such as

cysts. They found that the highest risk factor (86 % of cases) was that the cysts were related to a fully erupted 3M. In contrast, more superficial 3Ms were associated with fractures or deep abscesses. Knutson et al. (18) found, on the one hand, that horizontal 3Ms completely covered by soft tissue are more likely to induce cystic changes than those in other positions and, on the other hand, that they were more frequent between the ages of 20 and 29 years.

Recent studies suggest that a widened follicular space may be related to different pathologies, including cystic lesions (76). In addition, Matzen et al. (77) found that 3Ms impacted in a distoangular or vertical position are at an increased risk of having a larger space and this enlargement could lead to a dentigerous cyst, which would indicate their extraction.

- 2M root resorption

The possibility of root resorption in the distal 2M root has been described especially in cases of 3M in a mesioangular or horizontal position, especially in molars completely covered by soft tissue. There is new scientific evidence to corroborate this (34,77-80).

Matzen et al. (77) conclude that the prevalence is higher in mesioangulated 3Ms (71%) and 3Ms in horizontal position (26%). However, Camargo et al. (81) conclude that the prevalence of root resorption on the distal surface of 2Ms is associated with horizontal angulation and Pell & Gregory's IB position.

However, this pathology is rare in the published series compared to other types of lesions mentioned above. Although it is usually found in the 2nd or 3rd decades of life, cases have been documented in older patients (15,18,82,83). Hu et al. (80) conclude that the risk of resorption of the adjacent second molar is increased in those over 25 years of age.

Evaluation and summary of the evidence

- There is evidence that 3Ms in a distoangular or vertical position are more associated with the development of pericoronitis than those in other positions, especially those that are partially covered by soft tissue and close to the occlusal surface (18,21,22,83,84).

Level of evidence: 2++.

Grade of recommendation: C.

- There is evidence that horizontal or severely mesioverted 3Ms favour the appearance of periodontal pathology on the distal aspect of 2Ms, complicating the healing of soft tissues after 3M extraction if this is performed after the age of 25-30 years (18,22,29- 33,85).

Level of evidence: 2++.

Grade of recommendation: B.

- There is evidence that partially or fully erupted 3Ms in a mesioangular or horizontal position are associated with an increased risk of caries on the distal surface of the 2M (18,22,24,37,42-46,48,86).

Level of evidence: 2++.

Grade of recommendation: C.

- There is evidence that the presence of erupted 3Ms increases the risk of mandibular angle fractures, without being influenced by the position of the 3M (59-63,71-75,87-89).

Level of evidence: 2+.

Grade of recommendation: C.

- There is evidence that the absence of erupted 3Ms increases the risk of mandibular condyle fractures (58-63,87,88).

Level of evidence: 2+.

Grade of recommendation: C.

- There is evidence that 3M-related cysts occur more frequently when 3Ms are fully impacted and in a horizontal position (18,75).

Level of evidence: 2+.

Grade of recommendation: C.

- There is some evidence that root resorption on the distal aspect of the 2M is more frequently associated with the presence of a 3M in a mesioangular or horizontal position, especially in those 3Ms completely covered by soft tissue (18,77,79-81).

Level of evidence: 2++.

Grade of recommendation: C.

Following the evidence update, there are no changes in the recommendations.

Drawing of conclusions

- 3Ms in a vertical or distoangular position, partially covered by soft tissue and close to the occlusal plane, are at increased risk of developing pericoronitis, therefore, their prophylactic extraction would be indicated.

Level of evidence: 2+.

Grade of recommendation: C.

- In cases of 3Ms in a horizontal or mesioangular position in patients between 25-30 years of age, prophylactic extraction would be indicated to avoid the appearance of periodontal pathology in the distal aspect of the 2M and post-surgical sequelae typical of extractions performed after this age.

Level of evidence: 2++.

Grade of recommendation: B.

- In partially or fully erupted 3Ms, in a mesioangular or horizontal position, prophylactic extraction would be indicated given the higher occurrence of caries in the distal aspect of the 2M.

Level of evidence: 2+.

Grade of recommendation: C.

- Prophylactic extraction of erupted 3Ms is not indicated in patients at high risk of mandibular fractures (practitioners of contact sports, for example), despite the fact that the presence of 3Ms may increase the risk of fractures of the mandibular angle, as their absence increases the risk of fractures of the mandibular condyle.

Level of evidence: 3.

Grade of recommendation: D.

Recommendations for future research

- Given the importance for the clinician of having an adequate protocol for action in order to make a decision on the therapeutic approach to follow when faced with an asymptomatic erupted 3M, it would be necessary to have multicentre, prospective studies with an adequate sample size and control groups. This would allow for an adequate assessment of the association between the different positions and angles of an erupted 3M, as well as the different pathological entities described, especially caries, pericoronitis, periodontal disease, cysts and tumours, fractures and root resorption.
- If different measuring instruments are used, the results cannot be properly compared. It is therefore essential to unify the measurement systems of the variables involved, especially the classifications used to assess the position and angulation of the 3M. In this way, valid criteria can be established on how to act when faced with an asymptomatic 3M depending on the position it occupies, that is,

to adopt an interventionist attitude and remove it prophylactically, or a wait-and-see attitude, depending on the risk of pathology that its location may potentially generate.

Q14: In patients at high risk of intraoperative lower dental nerve injury, does coronectomy have less morbidity than complete 3M extraction?

The extraction of 3Ms is one of the most frequent surgical procedures in dentistry. For this reason, there are numerous studies published on the intraoperative and postoperative complications that can occur. Undoubtedly, one of the most relevant complications of this surgical procedure is injury to the IDN, as it leaves significant sequelae in patients.

For example, two cohort studies conducted in Spain (1, 2) found occurrences slightly higher than 1%: 1.1% in a retrospective study with a sample of 4,995 extractions of 3Ms (1) and 1.3% in a prospective study of 1,117 extractions of 3Ms (2). Although these figures appear to be very low, the high number of 3Ms extractions performed on a daily basis must be taken into account. In fact, it is estimated that nearly 10 million 3Ms are extracted each year in the United States (3). For this reason, the absolute number of possible patients affected by this type of injury can be very relevant.

The age of the patient, the position of the 3M and the experience of the surgeon seem to be important variables in assessing the possibility of an IDN injury (4-6). However, the radiographic proximity between the roots of the 3M and the IDC is the main risk factor to be considered. Numerous studies have described radiological signs in OPGs suggesting an intimate association between the 3M and the IDN (6-8). According to a meta-analysis published in 2015, of the seven commonly analysed signs, root darkening appears to be the most relevant (8). A CT is another radiological test whose main advantage is that it allows a three-dimensional observation of the area (9). Several articles have been published on this subject and most authors agree that this complementary test is indicated when an intimate association between the lower 3M and the IDC is suspected (10-13). The CBCT has facilitated a more systematic use of

three-dimensional radiological examination because, with a lower ionising dose, it allows a detailed observation of the anatomy of the 3M, as well as its association with adjacent anatomical structures (11).

The main issues raised by the surgical technique for the extraction of 3Ms have been reviewed by the Cochrane Database Systematic Review and are of great interest to the oral surgeon (14, 15).

Several authors have investigated a surgical technique called “coronectomy”, which consists of intentionally leaving the roots of the 3M in the alveolus. After performing a complete coronal odontosection (avoiding injury to the lingual cortex), the crown should be avulsed. It is advisable to avoid mobilising the roots, precisely because the aim is to avoid root luxation, which increases the risk of injury to the IDN (16). Subsequently, the most coronal portion of the remaining root is removed so that it is 2 to 3 mm below the alveolar ridge levels (17). A complete removal of tooth enamel is recommended, as the presence of residual enamel has been associated with the development of complications and symptoms during the postoperative period (18,19). Although the tooth pulp is exposed to the oral cavity, no endodontic treatment is necessary (20,21).

According to the conclusions of three randomised clinical trials (RCTs) and four prospective non-randomised studies, a coronectomy can significantly reduce the incidence of IDN injuries compared to the extraction of a 3M in high-risk cases (22-28). Several systematic reviews have confirmed these conclusions (16,29-35) but it has also been shown that the available scientific evidence is still insufficient and that more well-designed randomised clinical trials are needed (15,29,31-34,36). On the other hand, a coronectomy does not seem to increase the risk of early-onset postoperative complications, such as postoperative infection, dry alveolitis and pain (22-25,27,31). In fact, some authors claim that a coronectomy may reduce the likelihood of developing dry alveolitis compared to a complete extraction of the 3M (22,25,34). It should be noted that a coronectomy, like 3M extraction, results in a profound alteration of patients’ quality of life, especially during the

first 72 hours (37).

Another aspect that could be debated is the possibility that the roots may become displaced over time, leading to complications. Numerous recent studies have addressed this issue (18,19,28,38-52). Most studies agree that root migration is a very frequent finding, which is more evident during the first postoperative months (28,40,50-52) and seems to be more prominent in young patients (40,43,47,49,50). To reduce this migration, some authors have recommended performing guided bone regeneration procedures on the root (53), leaving root remnants with a length of less than 7.6 mm and having a minimum distance of 5 mm between the root and the bone level (47). However, this coronal migration does not usually cause complications and only a low percentage of cases require a second surgical procedure to remove the 3M roots (19,39,42,44,46,48,52,54,55).

In these cases, injury to the IDN is unlikely, as the root remnant has moved away from the IDC (30). Although the migration rate drops significantly after 24 months (40), a regular clinical and radiological follow-up of these patients seems advisable (29,30,46).

Three prospective studies, two of them with a long follow-up (36 and 93 months) have demonstrated an improvement in periodontal parameters of the 2M adjacent to a coronectomy (56-58).

Finally, it is interesting to note that a document from the Royal College of Surgeons of England (60), states that a coronectomy should only be indicated in healthy, immunocompetent patients. This recommendation, based on expert opinion, seems to contradict the results of a series of 6 oncological patients successfully treated with 3M coronectomies. (61).

Evaluation and summary of the evidence

Following the literature review, a total of thirty-two articles were selected that were considered relevant to support the recommendations:

- A coronectomy is a technique to reduce the occurrence of IDN injuries compared to the complete extraction of inferior 3Ms that

present an intimate radiological association with the IDC (16,22-35).

Level of evidence: 1+.

- A coronectomy does not increase the risk of early-onset postoperative complications (infections, dry alveolitis, pain, among others) relative to complete 3M extraction following the conventional technique (22-25,27,28,31,35).

Level of evidence: 1+.

- The studies published on this topic are still insufficient and more randomised clinical trials with a low risk of bias are needed (15,29,31- 34,36).

Level of evidence: 1++.

- In the vast majority of cases, a coronal migration of the root debris occurs (28,40,44,50-52,54). For this reason, a regular clinical and radiological follow-up of these patients is recommended (29,30,46). This movement is more evident during the first year (28,40,44,50-52,55,59) and in young patients (40,43,47,49,50).

Level of evidence: 2++.

- A small percentage of cases, ranging from 0.1% to 12.5%, require a second surgical procedure to remove the residual roots of the 3M (39,46,48,52,55).

Level of evidence: 2++.

Drawing of conclusions

- In cases of mandibular 3Ms identified preoperatively as high risk for IDN injury, the coronectomy technique (removing the 3M crown and intentionally leaving the root) reduces the occurrence of the referred injuries (23,26,30,31,35).

Level of evidence: 1+.

Grade of recommendation: B.

- Performing a coronectomy does not significantly increase the risk of postoperative complications such as dry socket, postoperative infections or pain compared with a complete extraction of a mandibular 3M (23,31,35).

Level of evidence: 1+.

Grade of recommendation: B.

- The coronal migration of 3M root remnants after coronectomy is frequently observed, especially during the first year and in young patients. This migration may require the extraction of residual roots in a small percentage of cases. For this reason, it is

advisable to schedule a regular clinical and radiological follow-up for these patients (30,47,52,54,55).

Level of evidence: 2++.

Grade of recommendation: B.

Recommendations for future research

- Prospective cohort studies are needed, with a large sample size and long-term follow-up (more than 10 years), to provide insight into the occurrence of late-onset complications.
- Double-blind, randomised clinical trials with large sample sizes, low risk of bias, low dropout rates and intention-to-treat analysis are needed to compare the risk of nerve injury and other complications using a coronectomy or the complete extraction of the 3M in terms of the occurrence of nerve injuries and other associated complications.
- Further studies are needed to determine whether a coronectomy is a safe procedure in patients with relevant systemic pathologies.

Q15: What is the variation in financial costs of 3M extraction in relation to the level where patient care occurs (primary care versus hospital care)?

3M extraction is a very common procedure both in general dental practice in the dental office and in the hospital setting (1).

Cost analysis represents a key point in terms of prioritisation in the healthcare sector, where resources are increasingly limited. The risks of surgical intervention and the cost-effectiveness of prophylactic extraction of asymptomatic impacted 3Ms should play a prominent role in decision-making. Recently, studies covering the costs of extracting these 3Ms indicate the need to restrict this type of surgical intervention (2), as extracting asymptomatic and pathology-free 3Ms that will remain pathology-free indefinitely generates unnecessary costs that have a negative impact on healthcare resources (3).

Appropriate indications for 3M extraction are vital to reduce costs from a social perspective. Tilley et al. (4) published a study on the financial evaluation of the implementation of the SIGN guidance, which found that it is more efficient in asymptomatic, or "low signal", patients than in patients with associated

symptomatology, or “medium signal”. An “efficient health service” is defined as one that appropriately refers patients from primary care to a hospital or secondary outpatient facility (5).

Even so, differences in the indication to remove 3Ms have been observed between general dentists and oral and/or maxillofacial surgeons, resulting in unnecessary costs (3,5). In other words, the referral of patients to an inpatient or outpatient secondary care centre for 3M extraction, where the specialists ultimately decide to keep the tooth under regular check-ups, represents a cost that could have been avoided (5).

In many developed countries, the surgical extraction of erupted 3Ms is performed by oral and/or maxillofacial surgeons in a hospital setting under general anaesthesia (6). A study by Renton et al. (7) details the approximate costs of 3M extraction according to different healthcare providers or centres. The average cost in a primary care centre ranges from £40 to £130, in a hospital from £65 to £120 under local anaesthesia, and from £400 to £800 under general anaesthesia. The same care in a private centre costs between £200 and £450 (which includes the professional fees but does not include the hospital cost of the centre where the surgery was performed). Along this same line, Sadler et al. (8) report that the costs of 3M extraction are higher in the hospital setting than in private practice with a specialist dentist.

Other articles indicate that in the United Kingdom, during 1993-1994, the financial expenditure by private health insurers for the extraction of 3Ms exceeded £22 million and for the United Kingdom’s National Health Service (NHS), £35 million (9). Subsequently, between 1995 and 1996, the total expenditure by the NHS in England and Wales was £11.8 million, with an average cost of £97.06 per 3M removed (4).

The sum of indirect costs or the social cost of such an intervention (time off work, loss of productivity and patient travel) increases the total cost of the procedure and is therefore also a parameter that will justify its prioritisation (2). Furthermore, a study by Inverso et al. (10) shows that making

postoperative follow-up visits by telephone reduces costs for both the professional and the patient, in terms of transport and time off from school or work.

Evaluation and summary of the evidence

Following the literature review, a total of six articles were selected that were considered as relevant to update the recommendations already provided by other authors:

- The cost of 3M extraction in a hospital setting is higher than the cost of extraction in a specialised private dental clinic (8).

Level of evidence: 2+.

Grade of recommendation: C.

- The cost of 3M extraction is higher than that of abstinence, although it becomes equal after seven years of visits with clinical and radiological controls (11).

Level of evidence: 2-.

A grade of recommendation cannot be established.

- In public healthcare, a patient referred from the primary care centre to a hospital-based oral and/or maxillofacial surgery department for the extraction of a 3M that is not treated according to the surgeon’s criteria incurs unnecessary costs (5).

Level of evidence: 1+.

Grade of recommendation: B.

- The patient’s travel to the hospitals where they are to undergo surgery and days off work are an additional indirect cost that increases the cost of 3M extraction (2).

Level of evidence: 2+.

Grade of recommendation: C.

- Postoperative follow-up by the specialist after 3M extraction costs more than a phone call by an assistant or nurse. There is no difference in the number of postoperative complications detected (10).

Level of evidence: 2-.

A grade of recommendation cannot be established.

- Continuous education courses, with or without the simultaneous development of assistive computer software, have proven to be the most cost-effective methods for implementing CPGs. Both methods allow practitioners to increase the number of asymptomatic patients receiving an evidence-based treatment plan (4).

Level of evidence: 2+.

Grade of recommendation: C.

Drawing of conclusions

- The overall costs are much higher in the hospital setting because, among other reasons, there are more healthcare staff, the surgery is sometimes performed under intravenous sedation or general anaesthesia, and the patient has to travel to the hospital, usually further away than the primary care centre.

Level of evidence: 2+.

Grade of recommendation: C.

Recommendations for future research

- It is necessary to promote financial evaluation studies that calculate the average cost of 3M extraction comparing primary care, hospital care or a private centre and assessing different types of patients (presence or absence of pathological signs and/or symptoms and other variables such as sick leave, transport costs, etc.).

Q16: What is the variation in the financial costs of 3M extraction in relation to the training (generalist or specialised) of the professional?

It has been observed that there are wide variations in the indications for extraction of 3Ms between general dentists and oral and/or maxillofacial surgeons (1-4). Indeed, an efficient health service is one that appropriately refers patients from primary to secondary care (4).

There is a tendency for experienced oral and/or maxillofacial surgeons to propose fewer 3M extractions, whereas this is not the case among general dentists. This may be due to the learning curve, as the surgeon may have developed a broader view of the potential benefits of extraction versus the associated surgical risks (2). It should be noted here that a professional's clinical practice is determined by their knowledge, previous training and skill, in addition to their clinical experience (1). A study by Fuster-Torres et al. (3) found that in patients over the age of 30, general dentists advised prophylactic

extraction in 54.3% of cases, whereas oral surgeons justified extraction due to the presence of clinical symptoms in 59.5% of cases. Kim et al. (5) published a prospective study to assess patients with an indication for removal of 3Ms referred by a general dentist to different oral and/or maxillofacial surgery departments. It was found that 72% of the referrals met the criteria of the NICE guidance. The agreement between both groups of professionals was 69% overall and 79% when only referrals with a specific indication for extraction were taken into account. Importantly, only 6% of these indications were for pathology-free 3Ms, indicating good acceptability and compliance with the NICE guidance.

If the aim is to influence the clinical decisions of professionals, the passive dissemination of the indications for extraction of 3Ms via a CPG is rarely effective (6). Therefore, a randomised clinical trial published by Bahrami et al. (6) compared different dissemination methods of the SIGN guidance among 51 general practitioners with the aim of estimating the proportion of patients treated according to that CPG. Specifically, four methods of dissemination were designed: a) receiving a copy of the SIGN guidance by e-mail and attending a training course, b) attending a course and feedback, c) providing a computer with a tutorial in CD format, and d) conducting a course, feedback, plus a tutorial in CD format. The main conclusion of this study is that the most cost-effective option was to send the CPG by e-mail. In a similar study (7), the implementation of the SIGN guidance in primary care was found to benefit a small group of patients; in particular, those with asymptomatic pathology-free 3Ms. Therefore, the financial cost of disseminating the guidance outweighed the benefits and savings.

With regard to the difference in financial costs depending on the professional's training, a study by Friedman (8) estimated the average cost per extraction of an upper and lower 3M to be US\$500 if performed by an oral and/or maxillofacial surgeon, and US\$300 if performed by a general dentist. In accordance with the NICE guidance, this work highlights the need to curb prophylactic extractions of 3Ms, as overuse of these surgical interventions increases the

financial cost and possible associated complications, which could be avoided. According to Inverso et al. (9), 3Ms that are not extracted and kept under regular check-ups would cost less if these visits were made to a general dentist instead of a specialist.

On the other hand, a retrospective study conducted in a private clinic in North Carolina (USA) evaluated the difference in operative time between a surgeon also performing sedation or teaming up with a dentist-anaesthesiologist. The results showed that a team-up between a dentist and an anaesthetist results in a reduction of operative time for extractions of moderate to high difficulty (measured preoperatively according to the jaw and degree of eruption), which could have a positive financial impact (10).

The prophylactic extraction of pathology-free 3Ms is still common practice, although there is controversy surrounding its practice. Some authors justify that this type of surgical intervention removes a tooth with no function in the mouth, minimises the risk of pathology (cyst, tumour, etc.), fracture of the mandibular angle, and avoids making extractions more difficult in older patients (2, 11,12).

Even so, we do not have a reliable formula that can predict the clinical course of asymptomatic 3Ms; therefore, all clinical decisions must be made in accordance with the literature and existing CPGs.

Evaluation and summary of the evidence

- Patients with asymptomatic, pathology-free 3Ms benefit most from the implementation of a CPG (6).

Level of evidence: 1++.

Grade of recommendation: A.

- The most cost-effective way to disseminate a CPG is to receive a copy by e-mail and attend a training course with or without the simultaneous development of assistive computer software (6).

Level of evidence: 1++.

Grade of recommendation: A.

- The usual clinical decisions to refer or not to refer are usually correct, although there are many patients referred by general practitioners who, at the discretion of the

oral and/or maxillofacial surgeon, will subsequently not be treated. The use of a decision algorithm allows for more accurate detection of patients who are not candidates for 3M extraction, thus eliminating false positives (4).

Level of evidence: 1+.

Grade of recommendation: B.

- Check-ups of 3Ms by general dentists (where extraction is not indicated) are less costly than those carried out by a specialist (9).

Level of evidence: 2-.

A grade of recommendation cannot be established.

The collaboration between dentists and anaesthetists reduces the operative time for 3M extractions of moderate to high difficulty (10).

Level of evidence: 2++.

Grade of recommendation: B.

- Specialists tend to recommend the prophylactic extraction of 3Ms to a greater extent than general dentists. It has been found that this decision is not related to the salary conditions in their employment contract (11).

Level of evidence: 3.

Grade of recommendation: D.

Drawing of conclusions

- We do not have enough articles to draw definitive conclusions on this PICO question.

Recommendations for future research

- More internationally randomised clinical trials comparing the differences in the costs of 3M extraction depending on whether it is performed by a general dentist or an oral and/or maxillofacial surgeon should be promoted.
- A cost analysis should be prepared and published by regional or national public bodies, as well as by insurance companies.

Q17: What is the variation in cost-benefit of prophylactic 3M extraction versus therapeutic abstention based on regular clinical and radiographic check-ups?

There is little controversy surrounding the extraction of a 3M that is associated with infection, extensive caries, cysts, tumours,

adjacent tooth damage and/or bone destruction on the distal aspect of the 2M. However, there is no reliable evidence to support the prophylactic extraction of asymptomatic, pathology-free 3Ms (1). According to a systematic review published by Song et al. (1), the available evidence suggests that the abstentionist option of not extracting 3Ms is more effective and cost-effective than prophylactic extraction, at least in the short to medium term. For the National Health Service (NHS) in the United Kingdom, 3M extraction is estimated to cost £30 million per year and around £20 million per year in the private sector. Approximately 90% of patients on waiting lists for Oral and/or Maxillofacial Surgery services are awaiting 3M extraction (1).

In the decision analysis by Edwards et al. (2) they found that the average cost for prophylactic 3M extraction was 33% higher than the cost of therapeutic forbearance (£226 vs. £170).

The literature recommends monitoring asymptomatic and pathology-free 3Ms. Likewise, given the low occurrence of complications (1-2%) that erupted 3Ms develop such as odontogenic cysts or tumours and fractures of the mandibular angle, their extraction is not justified on the grounds of preventing future pathologies (3). Thus, prophylactic 3M extraction remains a controversial issue, as there are no randomised controlled clinical trials available to provide information on the pathological conditions that may arise from retaining 3Ms versus the risks and costs associated with their surgical procedure (4-8).

Between 1995-1996, in England and Scotland, 43.9% of 3M extractions performed were prophylactic, at a cost of £97.06 per molar. Therefore, the 2000 SIGN guidance aimed to establish clear indications and contraindications for the surgical management of 3Ms, presenting clinical information to support these decisions. The main recommendation of this guideline was that asymptomatic and pathology-free 3Ms should not be extracted. Tilley et al. (9) published a financial evaluation study to assess the implementation of the SIGN guidance and concluded that the

implementation of this guidance was more effective in asymptomatic, or “low signal”, patients than in patients with associated symptomatology or “medium signal”. Therefore, the impact of the different implementation strategies of the guidance depends on the type of patient treated. Likewise, a prospective audit published by Kim et al. (10) showed that the NICE guideline was 100% compliant in three departments of Oral and/or Maxillofacial Surgery in England, that the agreement between general dentists and surgeons was 79%, and only 6% of 3Ms were prophylactically extracted.

Patients who undergo prophylactic extraction are subject to unnecessary pain, surgical risk and avoidable financial expense (5). Extreme age, the presence of systemic pathology and high intraoperative morbidity are conditions that favour regular 3M check-ups, but not extraction. On the other hand, 3Ms that cause pain, infection, caries, bone pathology, affect adjacent teeth, prevent eruption of a 2M, interfere with orthodontics or may cause problems under a prosthesis should be considered as tributary to extraction (1,5). However, an evaluation by McArdle et al. (11) conducted 20 years after the implementation of the NICE guidance showed that, while in 1995 impaction/inclusion was the main diagnosis indicating extraction (70%), over the following 15 years it has become caries and periapical abscess.

However, we lack epidemiological information on the overall occurrence of complications in relation to the evolution of erupted 3Ms (4). A study published by Kunkel et al. (4) evaluated patients hospitalised for complications associated with prophylactic, symptomatic or retained 3M extraction. Among all hospitalisations, 3M-associated hospitalisations accounted for 2%, and at least 85% of patients had infectious complications. For the analysis, they classified patients according to whether they had undergone a prophylactic extraction, a symptomatic extraction or had a complication associated with a retained 3M. However, they found no significant differences in clinical and economic outcomes between the three groups. No differences were detected when comparing surgical (prophylactic or symptomatic 3M extraction) and non-surgical (retained 3M)

complications, nor when complications of prophylactic extraction were compared with the others. This study estimated that the average cost per patient was €2,827.

In Australia, most third molar extractions (85%) are prophylactic, and are performed under general anaesthesia. Patients tend to be young and come from health insurers. Thus, in the absence of evidence regarding the appropriateness of prophylactic extraction, a cost analysis published in 2015 estimated the cost difference between extraction and therapeutic abstinence under active controls up to 20 years of follow-up. The authors proposed an active surveillance plan that included a clinical examination and a panoramic X-ray performed every 2 years, with a baseline of 15 years of age. An individual cost per extraction of a 3M was estimated at up to AU\$5,664, and a significantly lower cost of AU\$1,077 for the 20-year active follow-up. The authors concluded that this strategy is more cost-effective in the Australian context (12).

An OPG offers fast and inexpensive imaging of both jaws. When features suggesting a high risk of injury to the IDN are found on this test, additional imaging tests such as a CBCT are required to assess the anatomical association (5). Performing a test such as a CBCT incurs an additional cost that varies by healthcare system. Christell et al. (13) conducted a study to assess variations in the cost of a CBCT in Romania, Belgium, Sweden and Lithuania and to answer the question whether the benefits of a CBCT justify the additional costs. The cost depends not only on economic welfare, but also on the configuration of the health service in terms of equipment used, staff, service, location and health policies related to patient payment. The authors concluded that the variation in costs was mainly due to differences in the purchase price of CBCT equipment. A financial evaluation in Denmark (14) estimated that the costs of a CBCT were 3 to 4 times higher than those of panoramic radiography and depended on the capital cost and the number of tests implemented on an annual basis. Specifically, the estimated cost of a routine CBCT for the extraction of a mandibular third molar from 17 clinics in different regions of Denmark was estimated to be €6,638,400 (15).

Evaluation and summary of the evidence

Following the literature review, a total of seven articles were selected that were considered as relevant to update the recommendations already provided by other authors:

- In the short-term, therapeutic forbearance is less costly, more effective and more cost-effective than prophylactic extraction (1,2).

Level of evidence: 2++.

Grade of recommendation: B.

- In the medium-term (after seven years of control), the cost of regular visits is equated with the cost to extract all four 3Ms (16-17).

Level of evidence: 2-.

A grade of recommendation cannot be established.

- In the long-term, therapeutic abstinence under active surveillance for more than 20 years is more costly than the prophylactic extraction of two 3Ms or the extraction of one 3M after 10 years of monitoring (18). Although when indirect costs (transport and time off work) or insurance costs are taken into account, prophylactic extraction under general anaesthesia and in a hospital setting may be more costly (12).

Level of evidence: 2++.

Grade of recommendation: B.

- There is no clinical evidence to justify prophylactic extraction as the best treatment option (8). However, if the patient has a high likelihood of 3M impaction and the onset of symptomatology, prophylactic extraction is more cost-effective in these cases (7). Therefore, decision-making should be individualised and include patient preferences. It should be decided on a case-by-case basis and take into account the patient's opinion (7,8).

Level of evidence: 1++.

Grade of recommendation: A.

- Therapeutic abstinence may favour the development of caries or periapical abscess after 15 or so years of follow-up (11).

- **Level of evidence: 2++.**

Grade of recommendation: B.

- The risk of complications in symptomatic extractions and erupted 3Ms is higher than in prophylactic extractions (4).

Level of evidence: 2-.

A grade of recommendation cannot be

established.

- Performing a CBCT on patients who have undergone extraction of the lower 3Ms involves an additional cost to the surgical procedure and should therefore not be performed routinely but should be reserved for cases in which there is a close association between the roots of the third molar and the lower dental canal (13, 14).

Level of evidence: 1++.

Grade of recommendation: A.

- CBCT is a technology that is not available at all health centres. This could force the patient to travel to another centre, resulting in additional costs (13).

Level of evidence: 2-.

A grade of recommendation cannot be established.

Drawing of conclusions

- Therapeutic abstention with regular clinical and radiographic check-ups outperforms prophylactic extraction in the short and medium term, as it avoids unnecessary intervention that could lead to discomfort, disability for a few days, intra- or postoperative complications and unnecessary expense.

Level of evidence: 2++.

Grade of recommendation: B.

- However, prophylactic extraction should be considered, indicated according to the individual risk of pathology and/or symptomatology during the follow-up period, or the need for medical treatment that subsequently contraindicates the procedure or increases the risk of complications. This decision-making should be reassessed at each visit during clinical and radiological follow-up.

Level of evidence: 1++.

Grade of recommendation: A.

- It is important to individually assess the risk of pathology development. Patients more likely to develop pericoronitis, periodontal disease and caries should undergo extraction.



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