Risks and benefits of removal of impacted third molars

A critical review of the literature

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Abstract. A critical review of the literature about risks and benefits of the removal of impacted 3rd molar teeth is presented in 4 categories: risk of non-intervention, risk of intervention, benefit of non-intervention and benefit of inter-vention. There are well-defined criteria for removal of impacted 3rd molar teeth. Absolute indications and contra-indications for the removal of asymptomatic 3rd molar teeth cannot be established because no long-term studies exist which validate the benefit to the patient either of early removal or of deliberate retention of these teeth. The prudent course of action for the clinician to follow is based on rational clinical decision-making using traditional methods of evalu-ation to effect the optimal outcome, keeping the interests of the individual patient above all else.

The 3rd molar has the greatest incidence of impaction[12]. The clinician, therefore, is faced with the clinical dilemma of whether to deliberately retain the un-erupted asymptomatic tooth or to re-move it. What is the responsible, pru-dent course to follow for the oral and maxillofacial surgeon who wishes to keep the interest of the patient above all else by giving sound professional ad-vice?

Surgical removal of the impacted third molar tooth (M3), is the single most commonly performed operation by oral and maxillofacial surgeons, but like many other clinical problems the impacted M3 presents more a question of management than of treatment. Al-though many asymptomatic third mo-lars are discovered on routine panor-amic radiographic examination, fre-quently, pain is the sole presenting complaint. Thus one must adopt a sys-tematic, patient-oriented approach in order to maximize the therapeutic bene-fit for each individual.

What are the risks to the patient of deliberately retaining the impacted M3? What is the risk-benefit ratio of surgical removal? These 2 questions get at the pivotal task of developing clear indi-cations and contra-indications to both deliberate retention and surgical re-moval of the tooth. A strong indication

for removal should be complemented with a strong contra-indication to its retention. The converse of this state-ment is also true.

The NIH 1979 Consensus Develop-ment Conference[81] for removal of M3 reached agreement on 3 issues:

1. There are well-defined criteria for M3 removal: infection, non-restor-able carious lesion, cyst, tumor, de-struction of adjacent tooth and bone.
2. It was agreed that reduced morbidity resulted from extraction in younger patients than those in advanced adulthood.
3. Current predictive growth studies were not sufficiently accurate to form a basis on which clinical action could be justified.

At that time, the need for future ob-jective longitudinal studies was iden-tified and since then many such studies have been carried out. The debate about removal of unerupted asymptomatic M3 has been further stimulated in an article by STEPHENS et al.[127] and by re-sponses to this article published in the same journal by other dental specialists. Against the firm stand of the first group and the statement that removal of asymptomatic or non-pathologically in-volved M3 is a questionable practice, were voiced dissident opinions. SHAFER[119] stated that he is the specialist

who is ultimately called upon to take care of extractions rendered difficult by delay in removal. PRICE[93] predicted that a general conservative approach would surely increase the incidence of perico-ronitis and morbidity after late removal. HOFFMAN[48] mentioned that the issue of mandibular anterior crowding has been overlooked since articles published after the NIH conference were not mentioned in the article by STEPHENS et al.[127].

The purpose of this paper is to review the scientific literature on the M3 as it pertains to both risks and benefits of in-tervention and non-intervention of im-pacted M3 teeth. This review is organ-ized in 4 sections[133,134] as follows:

I. Risk of non-intevention:

A. Crowding of dentition based on growth prediction.
B. Resorption of adjacent tooth and periodontal status.
C. Development of pathological con-dition such as infection, cyst, tumor.

II. Risk of intervention:

A. Minor transient: Sensory nerve alteration. Alveolitis. Trismus and infection. Hemorrhage. Dentoalve-olar fracture and displacement of tooth.

B. Minor permanent: Periodontal injury. Adjacent tooth injury. Temporomandibular joint injury.
C. Major: Altered sensation. Vital organ infection. Fracture of the mandible and maxillary tuberosity. Injury and litigation.

III. Benefit of non-intervention:

A. Avoidance of risk.
B. Preservation of functional teeth.
C. Preservation of residual ridge.

IV. Benefit of intervention:

A. In relation to age.
B. In relation to different therapeutic measures.

I. Risk of non-intervention
A. Growth, development, crowding of dentition

The impacted M3 is not simply a radiographic problem, as many studies would indicate, nor is it a question of whether the surrounding odontogenic epithelium has a specific number of millimeters in thickness[23]. The presence of the impacted M3 is inextricably linked to growth and development of the jaws and teeth. BJORK[12] has shown that the impacted mandibular M3 is, in effect, due to a special type of dento-skeletal deformity involving mandibular dento-alveolar deficiency. Computations of the frequency of M3 impaction depend on the manner in which impactions are defined and also depend on the age of the examined persons and on their dental condition as a whole. Is M3 in a 14-year-old patient impacted or is it unerupted?

Tooth formation and path of eruption

"From a biological aspect the coming of the third molar teeth constitutes that part of the installment of our dental equipment which established the adulthood of our dentition"[47]. The path of eruption carries the lower M3 from a position in the ramus, visible as a crypt at age 7, to the next stage of mineralization of the crowns, (9–12 years) to a descent and inclination of the crown below other molars, to an uprighting at different positions, vertical, mesio-angular, disto-angular or horizontal as the crown is formed[13,100]. During root formation between 16 and 18 years, M3 moves rapidly forward[3,16]. Dental ma-

turity may coincide with the end of growth of the skeleton; however, a potential for eruption may be presesnt even in the upper limits of young adulthood[95,117,139,143] and even beyond into the 5th decade, especially for upper molars[35].

Prediction of final position of M3

Can we predict future available space for eruption by analysing individual growth patterns? This question is central to the issue, since accurate prediction would provide the basis for performing prophylactic extraction of M3. BJORK[12] observed that the space between ramus and the distal aspect of 2nd molar was reduced with a higher possibility of M3 impaction when (in order of importance):
1) condylar growth is vertical
2) growth in length of mandible is small
3) a backward type of teeth eruption is present
4) maturation of M3 is retarded
RICHARDSON[98] noted that M3 eruption is more related to width of M3 and lack of space than lack of space only. He observed, in certain cases, M3 impaction despite adequate space. RICHARDSON[99–103] stated that space for M3 is provided as much by resorption of ramus as by forward movement of dentition. With large ramus resorption there is less forward movement of dentition. She also concluded as did GRABER[38], that it is impossible to predict space at young age.

Radiographic measurements

RICHARDSON[102], in attempting to predict space from lateral radiographic measurements, confirmed Bjork's vertical growth factor as important since distance from condyle to pogonion correlated with M3 space. ALTONEN[3] could not correlate B angle, (long axis of M3 at crown formation with long axis of M2) with the gonial angle but found that if B angle is smaller than 10°, the conditions for eruption are favourable. RICKETTS[104] advised germectomy at 10–12 years if M3 is located halfway between the intersection of occlusal plane with the lower curvature of the anterior ramus. The clincan must guard against the application of oversimplied results from static 2-dimensional radiographs in describing an event which has both spatial and temporal components. RICHARDSON[98] noted that M3 impaction

is more frequent when the developing tooth is placed more buccally and therefore suggested the use of antero-posterior views for this evaluation. SVENDSEN[128], found that 2 frontal films, one taken at the time of root bifurcation, the next taken 2 years later, could predict increased risk of impaction with increased acuity of the angle formed by the long axis of M3 with the central vertical midline.

Crowding of the dention

Much controversy surrounds the practice of prophylactic removal of impacted M3 teeth solely to prevent anterior lower arch crowding. SHANLEY[120], found that mandibular M3 have no influence on crowding of lower incisors but the study was both small and cross-sectional. STEPHENS[127], stated "Clearly, the removal of erupting third molars to prevent crowding of lower incisors lacks scientific support and cannot be used to justify preventive extraction". Closer examination of the scientific literature seems to implicate the M3 in anterior mandibular incisor crowding. BERGSTROM[7] examined 30 dental students with unilateral aplasia of lower M3 and found that there was more crowding on the side with the M3 present as compared with the side in which it was missing. VEGO[137] studied 65 cases and found more crowding when the M3 were present than when they were absent. SCHWARZE[115] showed that M3 germectomy was associated with decreased forward movement of first molars and decreased lower arch crowding when compared with a group of patients in whom the M3 were allowed to develop. LASKIN[62] suggested that lower incisors are in an unstable position between the tongue and the lips and might also be the subject of occlusal forces causing displacement.

LINDQUIST[66] extracted M3 unilaterally and found decreased crowding on the extraction side compared with the control side in 70% of cases. Further evidence is provided by RICHARDSON[98–103] to support the implication of the presence of erupting M3 as *one* causative factor in lower arch crowding. She concluded that the presence of third molars does not preclude the involvement of other causative factors for crowding.

Recently, ADES et al.[1] studied pre-treatment, post-treatment and post-retention records of 97 patients and suggested that the recommendation for

mandibular M3 with the objective of either alleviating or preventing mandibular incisor crowding might not be justified.

B. Resorption of second molar (M2) and periodontal status
Root resorption

Horizontal and mesio-angular impacted M3 may inflict damages to the root of the adjacent tooth[5,53,54,118], but it is also acknowledged that is is difficult to distinguish between radiographic artifacts and true root resorption except in extreme cases[147,148].

NITZAN et al.[82] found only 4 cases of extensive M2 root resorption (2%) among 199 impacted teeth and none in the over 30 age group. Normal radiographic images of M2 were seen in a few post M3 extraction cases that had suggested minimal resorption prior to M3 removal. NORDENRAM[84], in a larger but less controlled study on indication for removal of 2,630 mandibular M3, revealed an incidence of 4.7% root resorption of M2. STANLEY[125] surveyed 11,598 panoramic radiographs and found an incidence of 3.05%. Prospective studies by VON WOWERN[139] and SEWEREN[117], carried out on dental students, reported no M2 root resorption over a 4-year term. A low incidence of < 1% of root resorption of M2 was reported in a recent and similar survey with a mean age of patients of 38 years[66]. Radiographic evaluation of 1,211 impacted M3 among middle-aged patients revealed a root resorption incidence of 1% in maxilla and 1.5% in mandible[31].

Periodontal status

A low incidence of about 1% of other periodontitis or of marked reduction of alveolar bone at the distal surface of the M2 was reported among young adults[31,68,139], and in older patients[39,41]. In STANLEY's[125] large radiographic survey, the incidence of periodontitis was 4.49%. In another study[17], periodontal considerations for removal of mandibular M3 were higher in patients over 35 years of age. GARCIA[35] found active periodontitis around *all* late erupting M3 in adult war-veteran patients. One is struck by the oral hygiene (OH) factor: the low incidence of disease in VAN WOWERN's[139] study in dental students, who presumably had meticulous hygiene, and the high incidence of disease

in GARCIA's patient population in which one would expect poor OH.

It is difficult to compare incidence rates of disease in different studies which do not use the same definitions for the same condition, or, indeed, when patients of different age groups have been evaluated, and when different populations have been studied. Thus it is normal to expect an increase of pocket depth with aging and/or poor OH. In NITZAN's[82] study, the fact that there was complete root repair of the M2 in cases of minimal root resorption after the extraction of the impacted M3 and wide discrepancies in different incidence rates reported, supports the suspicion that radiographic artifacts can often be mistaken for minimal root resorption.

ASH[4] and ZIEGLER[149] both found a high incidence of pocketing distal to the M2 both before and after M3 removal. VON WOWERN[139], however, found no signs or symptoms of pockets in dental students after removal of wisdom teeth. SZMYD[132] measured pocket depth in 75 cases of mandibular M3 extraction and observed a post-surgical reduction in the depth of pockets when compared with pre-surgical pocket depth. GRONDAHL[39], had similar observations but recent studies with implant osseointegration have called into question the probing method which was used to measure bone height[63]. KUGELBERG[59,60], concluded that when the need for extraction can be forseen, early removed of the impacted M3 favours periodontal health of the adjacent M2. More recently, in a prospective study of 176 patients, KUGELBERG[61] found that early removal of impacted M3 with large angulation and close positional relationship to the adjacent M2 proved to have a beneficial effect on periodontal health.

C. Potential for infections, cysts, tumors

STEPHENS[127] in reviewing the literature stated that the risks for developing severe infections, cysts or tumors especially the latter two, are low and have been overemphasized.

Pericoronitis

No standard definition of pericoronitis appears in the literature. MACGREGOR[71] describes the pathology of pericoronitis as infection that usually proceeds to abscess formation which may spread by

well-known anatomic routes, the exact character of the infection depending upon the predominant causative organisms. Several papers published since the NIH conference recommended that more investigation be carried out on the incidence and recurrent rate of infection around M3. In doing so, however, one must relate the incidence of pericoronitis to the type of impaction. LEONE et al.[64] reported that the vertically positioned mandibular M3 that is partially covered by soft tissue or bone is most susceptible to infection. The availability for self drainage must also be considered. PIRONEN[91], believed that large follicular spaces were not only associated with milder symptoms than deep vertical or disto-angular impactions, but he also thought that they were more inclined to spread infection into the deep fascial spaces of the head and neck. The 4-year longitudinal study of VON WOWERN[139] revealed that in this sample population with good OH, no gingival inflammation around M3 or M2 was observed, either when M3 was retained or removed. Another prospectively study[17] showed pericoronitis to be the most frequent reason (40%) for removal of impacted mandibular M3 in different age groups. LYSELL[68], reported a similar incidence of 37%, but the difference between acute and chronic symptoms, while not specified, could be inferred from the presence of pain, which reduces the incidence to 27%. This figure is similar to NORDENRAM's[84] incidence of 24% and GOLDBERG's[37] 21%, but much in contrast with OSBORN's[86] 8%. NITZAN[83], in studying age and incidence of pericoronitis and acute symptoms in the patient population visiting his university clinic, found that it occurs mainly between the ages of 20 and 29 and very rarely over the age of 40. NORDENRAM[84], in a larger survey, demonstrated a peak in incidence among the same age group but he also observed pericoronitis in older patients. GURALNICK[42], stated that the source of the acute pericoronal infection, the tooth, must be removed, and that "in general there are few indications for exposure and many more for removal". This opinion is shared by STEPHENS[127] who makes the statement: "if a severe primary pericoronitis has occurred, extraction is indicated unless the local anatomy can be improved by either the tooth achieving further eruption or by conservative management to control the local environment", although no data

are presented to suggest the efficacy of controlling the local environment.

Cysts

STEPHENS[127] points out that an enlarged follicular space should not be confused with a developing dentigerous cyst, especially in growing individuals. He attributes errors in evaluating the true prevalence of cysts to previous statements in articles that a space > 2.5 mm represents, in all probability, a cyst with an epithelial lining[23,26,80]. He questioned the value of surveys from panoramic radiographs which show major linear distortion, especially in the horizontal plane. These observations may explain the discordance of results based on different radiographic definitions for a space and a cyst. The reported incidence of cyst formation is as follows. DACHI[26] 11%; BRUCE[17] 6.2% tumors included; NORDENRAM[84] 4.5%; MOUR-SHED[80] 1.44%; GOLDBERG[37] 2% including high incidence of tumors in comparison with lower incidence of other studies; OSBORN[86] 3% including tumors; SHEAR[121] 0.001%, the latter diagnosis confirmed by biopsy. In a recent radiographic survey, ELIASSON[31] was careful to avoid naming as cysts, spaces around M3. SEWERIN[117] "could not find any widening of the pericoronal space of M3 in a group of dental students who were observed over a 4-year priod".

Tumors

The incidence of ameloblastoma formation associated with M3 has been reported as follows: REGEZI[96] 0.14%; WEIR[142] 2%; and SHEAR[121] 0.0003%, indicating that this odontogenic tumor is rare. Ameloblastoma developing from the walls of a dentigerous cyst is even less common[122], as is neoplastic tumor of dental origin. It is, however, a distinct, albeit rare, possibility as a review of the AFIP tumor registry disclosed 8 cases of ameloblastic carcinoma, 4 of them apparently arising from the lining of a dentigerous cyst[24]. WALDRON & MUSTOE[140] reported a case of primary intraosseous carcinoma of the mandible with probable origin in an odontogenic syst.

II Risks of intervention
A. Minor transient complications
Sensory nerve alteration

Reports of incidence of sensory nerve alteration following removal of M3

range from 1 to 6%[17, 33, 37, 53, 56, 86, 107, 110, 136, 138, 145]. The clinician must be aware, however, that in many studies both erupted and unerupted teeth were included and in some cases both lingual and labial paresthesia were combined. It is therefore necessary to examine the literature with some scrutiny to avoid drawing erroneous conclusions from pooled, mean data. For example, studies in which the age of the experimental population is younger, report a low incidence of post surgical altered sensation. Not only is age, *per se*, a factor, but also one must be aware that the young patient has much reduced evidence of other risk factors such as deep impaction and proximity of roots to nerve. Further, recovery potential of neural tissue itself is greater in young patients. With respect to the seriousness of nerve injury it is generally agreed that neurapraxia is a temporary failure of conduction in a nerve but that axonotmesis and neurotmesis are injuries which carry a much reduced potential for full recovery[116]. ROOD[107] has described nerve injury in clinical terms relating pressure and tension to nerve dysfunction.

Alveolitis

Alveolar alveolitis is one of the most common and least pleasant, unwanted sequellae of removal of impacted M3 teeth. The causes of alveolitis have been described both by BIRN[10] and NITZAN[83] and generally fall within 2 schools of thought:
1) the thrombus is not well formed
2) a normal thrombus is formed but is subsequently destroyed mainly due to fibrinolysis.
This latter theory is now more accepted than the former as an important etiological factor. Fibrinolytic alveolitis or dry socket in lower M3 is more frequent in patients older than 25 years[17,86,136] and in those taking oral contraceptives[18,65,114]. The overall rate greatly varies from one study to the other, from 1% to 35%[37,129]. AL-KHATEEB[2] found that the incidence of alveolar alveolitis was much higher (21.9%) when the teeth were removed for "therapeutic" reasons rather than prophylactic (7.1%). There seems to be a question of interpretation between defined clinical findings of a dry socket and the presence of pain, a subjective finding with very high variation in response threshold among individuals. Many authors have put forth methods to prevent the development of alveolitis

but none has proven to be effective in all cases. The clinician must therefore accept the fact that alveolitis will occur in about 1–5% of patients regardless of the skill of the operator or the surgical protocol.

Infection and trismus

GOLDBERG[37] reported a post surgical infection rate of 4.2% but made no distinction between immediate and late infection. OSBORN[86] found a post surgical infection rate of 2% but curiously there was a higher incidence of infection in younger age groups and the majority of these infections occurred more than 15 days after surgery. Although BRUCE[17], did not report specifically on incidence of post surgical infection he did find increased incidence of excessive swelling and trismus in older age groups. Close scrutiny of his data reveals that the youngest age group had < 15% distoangular and horizontal tooth position compared with 43% in the oldest age group. This might explain his findings on the bases of tooth position and age.

Hemorrhage

BRUCE[17] reported a 5.8% incidence of excessive bleeding during surgery. This intra-operative complication occurred more frequently in older age groups who had deep impactions. GOLDBERG[37] reported excessive post surgical bleeding in 0.6% of 500 patients whose mean age was 19 years.

Dento-alveolar fractures – displacement of tooth

Alveolar fracture associated with removal of an impacted M3 is a relatively rare complication, especially in the mandible. BRUCE[17] found lingual plate fracture to occur in 2% of total cases, 4% in older age groups. Lingual displacement of the mandibular tooth can accompany lingual plate fracture. No rates of frequency for this complication or for fracture of the maxillary tuberosity have been reported. Although maxillary impacted M3 have been displaced into both the maxillary sinus and the infratemporal space, the frequency with which this happens has not been studied, except by OBERMAN[85], who reported on a series of 250 oral-antral fistulae of which 3 were related to displacement of maxillary M3 into the sinus.

B. Minor permanent complications
Periodontal injury

KUGELBERG[59] found that in 215 cases of mandibular M3 extraction, 43% had a pocket at the distal of M2 exceeding 7 mm and 32% in excess of 4 mm. A case for early extraction was made as an almost 50% reduction of pockets was seen in the younger group with only a few cases in the older group. ASH[4] found pockets in 30% of cases before removal and 50% 1 year after M3 removal and stated that after the early twenties the risk of loss of periodontal support of M2 seemed to be significantly greater in extraction than non-extraction cases. WOOLF[146], STEPHENS[126], CHIN QUE[22], and SCHOFIELD[113] could not find a relationship between periodontal pocket incidence and type of flap used in removal.

Adjacent tooth injury

BRUCE[17] reported an incidence of 0.3% overall damage to adjacent tooth. This measurement was made by inspection at surgery.

Temporo-mandibular joint injury

PULLINGER[91], reported a slightly higher incidence of TMJ symptoms in patients who had M3 surgery, but the incidence and severity of TMJ injury related to M3 removal remains to be established.

C. Major complications
Dysesthesia

Fortunately, most injuries to the 5th cranial nerve are either neurapraxia or axonotmesis, neither of which cause perineural structure disruption. For this reason these injuries most often heal with only temporary sensory dysfunction. Neurotmesis results in separation of axonal structures and can produce a permanent sensory deficit over the distribution of the nerve. Sensory deficiency beyond 6 months is likely to be permanent[71]. Many studies indicate an incidence of this problem of approximately 1%. Although permanent nerve injury is associated with deep impactions, it cannot be predicted solely from canal-root proximity[71,111]. Further, rigid criteria for sensory testing have not been applied in the studies which are most frequently cited in the literature. It is therefore reasonable to suspect that the incidence of permanent labial anesthesia has been understimated to date.

Lingual anesthesia has been studied subjectively by FERDOUSI[33], ROOD[106], MASON[73], and VON ARX[138]. They reported recovery rates similar to those for inferior alveolar nerve which contradicts the accepted notion that lingual nerve is less likely than inferior alveolar nerve to recover following injury. Most general information about repair of cranial nerves is based on studies of the 7th nerve, not on the mandibular nerve which possesses an intrabony location and is almost exclusively sensory in function. Several methods have been proposed for repair of the mandibular nerve, including observation, nerve graft and tubular repair[32]. It remains undetermined as to which method optimizes return to normal function. DON-OFF[28] has suggested that if there is continued deterioration at monthly sensory examination or no improvement after 6 months, microneurosurgical repair of the nerve is indicated. MEYER[75] recommends operating painful nerve injuries as soon as it can be determined that progress toward recovery has ceased, preferably by 6 months after surgery.

Vital organ infection

OTTEN[87] found a 40% incidence of bacteremia after removal of partially impacted teeth with mixed strains of aerobic and anaerobic microorganism, both capable of producing endocarditis or abcesses in the brain, liver and lungs. The advent of antibiotics has drastically reduced major systemic complications from removal of infected teeth such as cavernous sinus thrombosis or bacterial endocarditis, but it should be kept in mind that the potential for such complications exists. HEAD[46] and OTTEN[87] found that penicillin and metronidazole were adequate coverage for high risk patients and that clindamycin was superior to erythromycin if penicillin and metronidazole could not be used.

Fracture of the mandible and maxillary tuberosity

Fracture of the mandible is an extremely rare complication of M3 in an otherwise normal jaw. Displacement of the maxillary M3 into either the maxillary sinus or the infratemporal space is also extremely rare[144]. While it is evident in the case of the fractured mandible that immediate reduction and fixation is indicated, the risk-benefit ratio of either

leaving the displaced maxillary M3 in the sinus or the infratemporal fossa has not been established. Convention dictates retrieval and removal of the tooth on the grounds that the tooth can cause infection if left in its displaced position, but no data are available to confirm or refute this practise.

Injury and litigation

A steady increase in malpractice litigation, especially from lower lip sensory deficit, has taken place both in Canada and the United States[130] and is part of the risk that a surgeon assumes when he/she agrees to treat a patient. Although failure to inform the patients of the nature of the proposed surgery and the attendant risks represents poor practise: "The courts appear to be taking the attitude that if a particular treatment is one which cannot reasonably be avoided either because of constant pain or serious complications, the average, reasonable person in the patient's position would consent to the treatment even if he had known the risks"[108]. From this statement is seems reasonable to conclude that in addition to addressing the issue of valid informed consent, there is another important concept related to the procedure being one which cannot reasonably be avoided. The case for either the removal or retention of the asymptomatic M3 in many instances appears not to be clear cut. In summary, the NIH consensus conference recommended that patients be informed of potential surgical risks including any transitory condition that occurs with an incidence of 5% and any permanent condition with an incidence rate > 0.5%. These included *pain, hemorrhage, swelling, alveolar osteitis, trismus, and nerve injury.* In light of more recent epidemiological studies, possible *periodontal problems* such as a plaque, gingivitis and pockets on the distal surface of the M2 should be added to the list.

III Benefit of non-intervention

It appears that, as yet, for many patients insufficient evidence exists to permit development of absolute indications and contra-indications for either deliberate retention or surgical removal of the impacted M3. Nevertheless, unless the clinician can demonstrate that the benefit of intervention in each particular case clearly outweighs the associated attend-

ant risks, the benefit of non-intervention is self evident.

Notwithstanding avoidance of complications associated with intervention, non-intervention may allow the patient the greatest possible opportunity to realize the full potential of growth and development of the teeth and jaws. Full eruption and functional position of M3 teeth (with healthy periodontium) permits the maximum occlusal table. Further, the advantage of retention of M3 for either future eruption or transplant in the case of premature tooth loss elsewhere in the arch, cannot be overlooked.

IV Benefit of intervention
A. In relation to age

All studies point out that the younger the age of the patient when the teeth are extracted, the less morbidity there is. On the other hand, there are no studies which describe precise methods for predicting growth of jaws. Late eruption in early adulthood is a definite possibility for vertically or mesio-vertically oriented M3. A prospective approach to asymptomatic mandibular M3 can be developed from 2 different concepts of treatment. One is *preventive* in the broadest sense of the word with germectomy at late childhood[104] and lateral trephanation and removal at either early adolescence[14,53] or late adolescence[62,69,86]. The other is *curative* but includes conservative measures such as exposure of the crown when the tooth position is acceptable or ablative ones in late adolescence when the lack of space for eruption is evident. Extraction is also indicated in young adulthood when the potential for eruption is either terminated or there is partial eruption of the tooth with the presence of periodontal pocket distal to the second molar[17,31,41,42,68,92]. The decision-making strategy with respect to possible courses of action depends to a great extent on the patient's OH and the general state of the dentition (see Fig. 1). As stated by VON WOWERN[139] "the risk/benefit factors plead for an early removal of ectopic impactions and against a routine removal later when the risk for severe postoperative complications exceeds the risk for pathological development around the M3". The same conclusion is reached by ELIASSON[31] who stated: "when an impacted third molar is deliberately retained, the patient should always be informed and the

condition checked at regular intervals". LYSELL[68], supported the contention of ASH[4], that deeply impacted M3 without evident pathology are probably best left in place until they cause symptoms. One further, important benefit of the early removal of M3 is the provision of transplant material. The preservation of the periodontal membrane of the transplanted tooth is critical since destruction of the desmodontal cells leads to root resorption and transplant failure. It has been shown that the most important factors in preservation of the periodontal membrane seem to be stage of development of the root and root form[112]. These findings favour transplantation of incompletely formed teeth and discourage attempts to transplant mature fully developed teeth.

B. In relation to different therapeutic measures

There is no shortage of literature on the subject of operative technique, pharmacotherapeutics and patient management during surgery. Few of these actually compare, in well-controlled studies, variations in surgical protocols and so the relative values of this or that technique remain obscure[48].

Local measures against alveolitis

BIRN[11] showed that the pathology of dry socket was related to increased local fibrinolytic activity in the alveolus and a release of kinins causing pain. Fibrinolysis is part of a series of interdependent biochemical events that can be initiated by tissue damage[71]. It is more frequent in females especially those taking oral contraceptives[65,114]. Certain bacteria, such as *Treponema denticola*[83], may stimulate fibrinolysis activators. Various local medications designed to prevent alveolitis have been investigated. Antifibrinolytic cones were unsuccessful in reducing the condition[36,105]. Better results have been obtained with the use of tetracycline, either in cones[43], or in suspension on a gelatin sponge[131]. The latter double blind study showed a marked decrease in alveolar alveolitis when compared with the untreated side. Other measures such as copious lavage after extraction have also been successful in reducing residual bacteria in the alveolus at the time of clot formation[18,36]. BERWICK[8], found that chlorhexidine and cetylpyridium were not more effective in the reduction of al-

veolar osteitis than postextraction irrigation with normal saline. Systemic administration of tenidazole[74] reduces the incidence of "dry socket". In general, studies about alveolar alveolitis support anaerobic infection as an important etiological factor in its development.

Local measures against pain, swelling and trismus

MACGREGOR[71] presented an excellent discussion on difficulties of measuring subjective and individual symptoms like pain, despite advances in evaluating methods, such as the McGill Pain Questionnaire. Attempts have been made at measuring intensity of buccal swelling with facial calipers[49,124,135], or with stereo-photography[89]. VAN GOOL[135] tested this method against double-blinded subjective appreciation which showed that observers cannot discriminately evaluate swelling of low intensity. Trismus, defined as a restriction in mouth opening, can be accurately measured by the distance between upper and lower incisors, but in spite of this no study has established numerical standards.

Studies on the reduction of pain, swelling, and trismus by administration of dexamethasone at the time of M3 removal have demonstrated a profound effect on the speed of recovery of the patient[9,89]. Dexamethasone inhibits phospholipase A2 which is responsible for conversion of membrane phospholipids into arachidonic acid. Prostaglandins, thromboxane A2, prostacyclin and leukotrienes are in turn inhibited in their production. Leukotrienes are considered to have hyperalgesic effects, which are even greater than prostaglandins[34]. It is reasonable to assume, therefore, that the administration of steroids prior to the removal of impacted third permanent molar teeth would reduce both postoperative swelling and pain. Prophylactic corticosteroid therapy has been shown to be effective in reducing the postoperative complications of swellings, trismus and pain[30,40,44,50,51,74,76]. MONTGOMERY[76] confirmed the findings of BYSTEDT[19], that short-course, low-dose oral glucocorticoids were less effective than a short-course, high-dose parenteral regimen.

Non-steroidal anti-inflammatory agents, NSAIA, also affect both pain and swelling. Postoperative pain can be reduced by controlling the extent of the inflammatory process[123]. NSAIA have

Table 1. A decision analysis of intervention for impacted third molars using 4 strategies according to whether there is good or poor oral hygiene

Decision analysis of intervention for unerupted mandibular M3

Scale 1·3·5 low high	Strategy 1 Remove most unerupted asymptomatic by age 14		Strategy 2 Remove some unerupted asymptomatic by 14 majority before 22		Strategy 3 Monitor patients, remove only symptomatic before 22		Strategy 4 no monitoring, remove only symptomatic	
	Good OH	Poor OH	Good OH	Poor OH	Good OH	Poor OH	Good OH	Poor OH
Risks (−)								
Psychological shock	−4	−5	−2	−4	−1	−1	−1	−1
Future useful tooth	−1	−3	−1	−2	−1	−2	−1	−1
Minor transient complications	−1	−2	−2	−3	−1	−2	−4	−5
Minor permanent complications	−1	−2	−1	−3	−1	−2	−3	−4
Major complications	−0.5	−0.5	−1	−1	−1	−3	−2	−4
Subtotal	*−7.5*	*−12.5*	*−7*	*−13*	*−5*	*−10*	*−11*	*−15*
Benefits (+)								
Arch space gain	+4	+3	+5	+3	+2	+1	+1	+1
Prevention of infection, cyst tumor	+2	+3	+4	+4	+2	+1	+1	+1
Promotion of periodontal health	+2	+3	+2	+4	+1	+1	+1	+2
Subtotal	*+8*	*+9*	*+11*	*+11*	*+5*	*+3*	*+3*	*+4*
Total	**+0.5**	**−3.5**	**+4**	**−2**	**+0**	**−7**	**−8**	**−11**

been demonstrated to be effective for relief of pain after removal of M3. Pre-operative administration of NSAIA results in post surgical analgesia which is superior to that experienced with narcotic analgesics irrespective of whether the narcotic was administered pre or postoperatively[27]. Postoperative administration of NSAIA has also been shown to be superior to mild narcotic analgesic combinations when given postoperatively. The use of NSAIA rather than narcotic analgesics represents a real therapeutic gain in that the patient benefits from both superior analgesia and reduced unwanted effects associated with the drug. Use of long-acting local anesthetic agents such as bupivicaine can also reduce the postoperative requirement for analgesics[20,21].

With respect to swelling, NSAIA are effective in reducing swelling by blocking prostaglandin synthesis. NSAIA have an advantage over steroids in that they do not affect the hypothalamic-hypophyseal-adrenal axis and therefore do not suppress the adrenal cortex. In rats, meclofenamate sodium, an NSAIA, has been shown to be superior to hydrocortisone in suppressing leukocyte infiltration and therefore in controlling the inflammatory response following surgical injury[55].

Antibiotics

KREKMANOV[58] has shown that a regimen of systemic penicillin V and wound lav-age is more effective in reducing trismus than either lavage only or no lavage. Similar reduction in morbidity using antibiotics was reported by MACGREGOR[70] and GOLDBERG[37], but CURRAN[25] did not find any advantage in the routine use of penicillin. HAPPONEN[45], in a placebo controlled clinical study, was unable to demonstrate any difference in outcome following M3 removal in the use of penicillin, tinidazole or placebo.

Buccal vs lingual approach

Controversy exists regarding the relative merits of the buccal approach technique and the lingual split-bone technique. This method was first proposed by FRY, described by WARD in 1956[141], and then reevaluated by RUD[110] in 1970. WARD[141] states that the advantages of the split-bone technique when the tooth is in linguo-version are: 1) speed, 2) elimination of dead space, 3) better bone healing.

VAN GOOL[136], however, found less trismus with the buccal approach. Very few unbiased studies have compared the buccal approach with the lingual split technique, with respect to postoperative sequellae. MIDDLEHURST[76] was unable to demonstrate significant difference in postoperative pain and swelling with either method. VON ARC[138], reported a high incidence of lingual nerve (22%) and mandibular nerve (5%) paresthesia with the lingual approach. Although the author does not detail the evaluation method he reported that the majority of these paresthesias resolved within 1 week.

Wound management

To suture or not is an old debate. RUD[109], noted more rapid healing in unsutured wounds. Many authors have attempted to demonstrate a beneficial effect on wound healing by placement of different materials in the alveolus. Notwithstanding the positive effect of local antibiotics and lavage on the incidence of alveolar alveolitis, no firm conclusions can be drawn from these studies[15,78,90]. HOLLAND[49] in a study of 70 patients, compared the influence of complete closure with partial closure and the effect of BIPPS paste dressing in lower M3 sockets on postoperative pain, swelling and healing. He concluded that complete closure of the wound resulted in more pain and swelling postoperatively but that the presence of a dressing delayed healing in some patients. BRABENDER[6], however, was unable to demonstrate any difference between placement or not of a petroleum gauze drain with regard to postoperative pain and swelling. DUBOIS[29], concluded from a study of 56 pateints that secondary closure with healing by secondary intention appears to minimize immediate post-operative edema and pain when compared with that seen in primary closure techniques.

Summary

"Criteria have not yet been developed to make satisfactory predictions as to which teeth will become infected and in their absence lies the crux of the problem of cost-benefit analysis."[72] It is evident that if the clinician is to be able to give the patient sound, prudent advice regarding intervention or non-intervention in the case of asymptomatic M3 teeth, it is necessary to adopt some systematic approach which attempts to take into account all of the factors which impact both on the clinical condition specifically and most important of all, the patient in general. The decision analysis chart, (Table 1), is an example of such an approach for the asymptomatic unerupted mandibular M3. Four strategies are presented, both for good and poor oral hygiene. Risks of intervention are assigned negative values on a scale of 1–5, where 1 is low and 5 is high. Similarly, the benefits of intervention are assigned positive values. The subtotals for risks and benefits are summed algebraicly, giving the surgeon an indication of which strategy is optimal. This exercise cannot be taken as a strict mathematical formula because the scores for risks and benefits are of unequal value and number. The values suggested by the authors are based on evaluation of the scientific literature which was reviewed. It appears that the best general approach to adopt by the surgeon who is consulted for removal of the unerupted mandibular M3 in growing individuals, is to remove, on the basis of clinical judgement, some teeth before the age of 14 and others before the age of 22, when chances of eruption are minimal. The best strategy after this age is periodic examination of a patient who has been fully informed of the relevant risks and benefits. Ultimately, as in every treatment decision, the surgeon must weigh the facts and put the interests of the patient above all else. This is our professional responsibility.

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