Recent reports of conflict between dentists and orthodontists over the extraction of second molar teeth prior to orthodontic treatment raise a number of questions; one of which is: *not* whether or not to extract, but *which* teeth to extract.

So that this controversial topic may be debated further, the Editor of this Journal has sought contributions from several quarters. Dr Harry Orton of the United Kingdom has written and lectured widely on this subject and recently lectured to the Western Australian Branch of the Australian Society of Orthodontists; his lecture has been summarised by Dr John Stamatis who has also compiled a review of the literature on the subject.

Both the summary and the review are printed below together with some clinical experiences of the Editor.

A REVIEW OF THE LITERATURE

Over the years, almost every tooth in the dentition has been implicated in the decisions to do with extraction in the treatment of arch length deficiencies and dentoalveolar protrusions. As early as 1939, Chapin reported on the therapeutic extraction of second molars in the surgical literature. Since then, numerous authors have either advocated or condemned the extraction of maxillary or mandibular second molars or both, as part of an ideal treatment plan.

Liddle (1977) states: “Of my present active treatment patients, 91% have undergone second molar extractions. Many of the remaining 9% would also have had second molar extractions if I could have seen them sooner.” In contrast, Haas (1986), commenting on the claim that second molar extraction results in favorable third molar eruption states: “This would be akin to someone disposing of a new Mercedes to make room in his garage for a mini import rendered asymmetric by several accidents during shipment.” [This comment contributes nothing to the debate. Ed.]

In reviewing the literature on the subject, the greatest problem is a paucity of scientific articles which use randomly selected or consecutively treated cases, and which provide quantitative, rather than qualitative, data. By far, the greatest number of reports are those which show the authors’ successful cases, suggesting that, on this basis, the reader embrace second molar extractions as part of his or her clinical armamentarium. Even in publications that do provide quantitative data, many of the important variables, such as post-treatment angulation or occlusion of the third molars, are subjectively classified as: “good”, “fair” or “poor”.

The claimed benefits of second molar extractions are:
- disimpaction of third molars, thus avoiding their surgical removal;
- prevention of excessive flattening of the profile which may occur with premolar extraction;
- reduction in amount and duration of appliance therapy;
- facilitation of removable appliance treatment;
- fewer residual spaces at the end of treatment;
- improved correction of incisor overbite;
- reduction in post-treatment temporomandibular joint dysfunction;
- reduction in relapse and late lower incisor crowding;
- greater ability to move first molars distally.

Claimed disadvantages are:
- the frequent unacceptable position of third molars, thus necessitating a second phase of treatment;
- extraction sites being located too far from the crowding thus necessitating patient co-operation in moving the entire dentition distally;
- removal of too much tooth substance – 14 mm in premolar cases compared to 22 mm in second molar cases. [Albeit, the
tooth substance removed by extraction of third molars subsequent to bicuspid extraction treatment should not be overlooked. Ed.;

- possibility of complete impaction and loss of third molars even after extraction of second molars;
- potential over-eruption of unopposed molars while waiting for third molars to erupt.

**Effects on Third Molars**

Brown (1974) concluded that following extraction of the second molar, the eruption of the lower third molar is unpredictable. Although this conclusion was based on the report of only one clinical case, it seems to have been further substantiated by subsequent workers and represents a fair summary of our current knowledge on this matter.

Smith (1958) examined 94 maxillary and 34 mandibular third molars a few years after the patient had had extraction of second molars. He found all third molars had erupted into occlusion, with 96% of upper molars and 59% of lower molars having mesial contact with the first molar. A subjective evaluation of axial inclination found this variable to be satisfactory in 96% of upper and 50% of lower third molars.

Huggins and McBride (1978) followed 27 subjects for two to four years after extraction of lower second molars. Third molar angulations were assessed on pre- and post-treatment 45 degree cephalograms. None of the third molars in their sample had a pre-treatment angulation between its occlusal surface and the occlusal plane of the erupted teeth greater than 60 degrees. Of the 50 third molars examined, 90% had "excellent" or "good" contact with the first molar, but only 10% were judged to have axial inclinations which deviated from being parallel with the second molars by less than 15 degrees.

Lawler (1978) recalled 60 patients five years after their lower second molar extraction had been recommended to them. Not all had proceeded with this treatment and thus were used in control and experimental groups. In the group that proceeded with second molar extractions, 83% of third molars were erupted, while 17% were unerupted. In the group that did not have second molar extractions, 37% of third molars erupted, while 63% failed to erupt. It is interesting of note that successful eruption of the third molar was defined as: "adequate proximal contact with the first molar and occlusal contact with its opposing tooth; no consideration of axial inclination was mentioned."

Rindler (1977) examined 78 patients treated with lower second molar extractions and varying forms of appliance therapy. Of the 118 third molars assessed on study models and lateral oblique radiographs, 77% were considered to be of "very good" or "good" overall post-treatment status; when mesial tipping was considered separately, 84% showed "no" or "slight" tipping. The subjective assessment rather than a quantitative measure of third molar position is a clear weakness in this study.

Richardson (1974) compared patients with erupted and unerupted third molars over a seven-year period. She found that in the group with erupted third molars, 59% of extractions carried out were in the molar region, and only 19.5% of the extractions were in the premolar region. This finding lends support to the claim that the incidence of third molar impaction is reduced more by molar than by premolar extraction. In a subsequent study, Richardson (1975) studied 160 subjects aged 9 to 11 years for a period of 7 to 10 years. She found the incidence of third molar impaction to be 34% in the group that did not undergo any extractions; 26% in the group that underwent premolar extractions; and zero in the group that underwent molar extractions.

Gaumond (1985) reported on 11 consecutive cases treated by early enucleation of lower second molar buds and found that 87% of third molars had erupted into "excellent", "very good", or "good" positions. He suggests that a high pre-treatment angulation of the third molar bud is predictive of unfavourable eruption, and advocates surgical repositioning of such steeply angled third molar buds at the time of second molar enucleation.

Magness (1966) states that: "the upper third molar has a much more predictable eruption pattern than the lower third molar does". He felt that this predictability, along with the technical ease of moving upper first molars distally, makes upper second molars far better candidates for extraction than lower second molars. [Dr E. Williamson often recommends the extraction of upper second and lower third molars. Ed.]

Whitney and Sinclair (1987) report that maxillary third molar angulation tended to improve following second molar extraction, while mandibular third molar changes were variable. As their study was of a short-term only, they did not report on eruption outcomes for the third molars.

Staggers (1990) compared 22 cases in which upper and lower second molars were extracted, to 22 cases in which upper and lower first premolars were extracted. When the third molar angulations were considered, she found that upper third molar angulations improved, while lower third molar angulations deteriorated with both treatment modalities; she also found no evidence of statistically significant differences.

Gooris et al. (1990) evaluated 140 mandibular quadrants on OPGs taken before, and about 3 years after, lower second molar extraction. All subjects received treatment from the same orthodontist. The lower third molar invariably erupted into a mesially angled position, and in contrast to Gaumond's results, established a satisfactory contact with the first molar in only 46% of cases. The pre-treatment angulation of the third molar bud was found not to be a reliable predictor of final third molar inclination.

In summary, the bulk of scientific evidence suggests that extraction of second molars does not expedite eruption of the third molars; but a substantial percentage of these third molars will erupt with poor axial inclinations, thus necessitating subsequent treatment.

If this conclusion is accepted, the obvious question is: what is more desirable: impacted third molars which may require surgical removal or mesially angulated third molars which may require orthodontic uprighting? Undesirable side effects related to the removal of impacted third molars include haemorrhage, pain, swelling, alveolar osteitis, trismus, nerve injury, and minor gingival recession around the second molar. The incidence of such complications varies greatly between
reports, but with modern surgical and anaesthetic techniques the predictability of such treatment must be considered much superior to the predictability of mandibular third molar eruption subsequent to second molar extraction. Cryer stated twenty-six years ago: "Modern surgical techniques and antibiotics make it unnecessary to avoid the probable need for later surgical removal of the third molars." Since then, there does not appear to have been any convincing evidence to challenge the validity of this statement.

Effects on Profile

Many of the proponents of second molar extraction claim that this treatment modality is less likely to cause a flattening of the profile than is the extraction of bicuspids. Such claims are usually supported by the showing of several cases with pleasing post-treatment profiles.

Only one objective report could be found in the literature: namely, the study by Staggers (1990), outlined earlier. In this study, retraction of upper and lower incisors was greater in the premolar extraction group than in the second molar extraction group; but changes in the lips were more variable. The average movements of upper and lower lips are shown below.

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<thead>
<tr>
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<th>Second Molar Extractions</th>
<th>Premolar Extractions</th>
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<tbody>
<tr>
<td>Upper Lip to SN-POG</td>
<td>-1.4mm</td>
<td>-1.8mm</td>
</tr>
<tr>
<td>Lower Lip to SN-POG</td>
<td>0mm</td>
<td>-1.6mm</td>
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The difference between the two groups reached statistical significance only in the lower lip values.

In the above data it appears that there is some difference in the resulting profile between the two treatment modalities, but further quantitative studies are required before firm conclusions can be drawn. It is worth noting that the extraction pattern in the lower, not the upper, arch is what will determine the final profile result; and it is in the lower arch that the unpredictability of third molar behaviour makes second molar extractions less appealing.

Effects on Incisor Irregularity

It has been suggested that removal of mandibular second molars results in greater stability of lower incisor alignment and a reduced tendency to late lower incisor crowding. This is closely related to the theory that the impaction of lower third molars is one of the primary causes of later lower incisor crowding. The latter theory, although not totally discounted, lacks any conclusive proof to date.

The results clearly suggest that reduction in late lower incisor crowding may be a benefit of second molar extraction; but further studies are needed to confirm these results.

Effects on Treatment Timing

The claim that second molar extractions lead to a reduction in treatment time was not confirmed by Staggers' study (1990), in which the second molar extraction group actually had a slightly longer treatment time than did the premolar extraction group. The difference was not statistically significant. The author points out that at the time of debonding, third molars had erupted in only a few patients and, therefore, that the total treatment time for the second molar group did not take into account the time needed for positioning the third molars after they had erupted. Thus, the actual treatment time for the second molar extraction group may have been longer than indicated in this study.

Quinn (1985) reports reduced treatment time with second molar extractions, but this is not quantified, and is based solely on his clinical experience.

The idea of extracting second molars as a way of avoiding any mechanotherapy can be embraced only if mesially inclined third molars are accepted as part of the final result. Extraction of second molars in order to reduce time in mechanotherapy cannot be justified by any scientific data currently available.

Effects on the Temporomandibular Joint (TMJ)

Premolar extractions have been blamed for causing TMJ pathology for numerous reasons; for example:

- loss of vertical dimension due to the closing rotation of the mandible during treatment (Bowbeer 1987)
- over-reaction of incisors, leading to distal positioning of the condyles in the glenoid fossae (Witzig 1987).

Neither of these theories has been substantiated in any of the scientific literature; indeed, many studies show the incidence of TMJ dysfunction in premolar extraction to be the same as, or lower than, that in the general population.

Staggers (1990) has shown that changes in the vertical dimension during treatment are not significantly different between premolar and second molar extraction groups. It appears that even though the molars moved forward in the premolar extraction group, the vertical dimension was maintained by dental extrusion.

Gianelly et al (1991) showed that condylar retroposition during treatment does not occur more frequently in patients treated with premolar or incisor extractions than in those treated without extractions. Although this study did not include a group of patients treated by second molar extractions, the findings fail to lend any support to the hypothesis that second molar extraction is associated with less condylar retroposition than is premolar extraction.

Clinical Recommendations

From the above review, it appears that the only positive advantage of second molar extraction is the high probability of avoiding third molar impaction. In addition, there is a small body of evidence to suggest that better profiles and the stability of the lower incisors may be further advantages.

As already stated, prediction of third molar behaviour is a major challenge. If second molar extraction is to be undertaken, the patient must be fully informed of the possible need for third molar uprighting.
The search for variables that will predict with high accuracy favourable third molar behaviour has not yet yielded any satisfactory results. Based on their clinical experience, the consensus of most authors is that lower second molars should be extracted as soon as third molar crowns are formed; but before root formation has commenced. With respect to upper second molars, most authors recommend their extraction when the occlusal surface of the third molar is at the level of half the second molar. It should be reiterated that these clinical recommendations have little scientific evidence.

References

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Cryer BS. Third molar eruption and the effect of extraction of adjacent teeth. Dent Pract 1967; 17: 405-416.
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A SUMMARY OF THE LECTURE BY DR HARRY ORTON

The Western Australian Branch of the ASO held its annual clinical day in November 1993. The guest lecturer, Dr Harry Orton OBE spoke on a number of subjects, including growth modification therapy and the use of removable appliances. Of considerable interest was his lecture on second molar extractions - a subject that has generated a great deal of controversy.

Dr Orton explained that his interest in the extraction of second molars began early in his career when, with only limited resources and a heavy case load, he was forced to search for a more efficacious means of treating his patients than by the extraction of premolars. At the suggestion of a colleague, he experimented with second molar extractions and has since found it an invaluable "tool" in his clinic.

It was noted that many orthodontists who consider that they have treated their patients on a non-extraction basis are frequently referring them for removal of impacted third molars at the completion of orthodontic treatment. Dr Orton showed epidemiologic data from surveys in the United Kingdom which demonstrated that removal of impacted third molars is a heavy financial burden on the public health system. This fact, coupled with the morbidity experienced by patients, leads him to favour the extraction of second molars to that of third molars.

He suggested that the following criteria should be present before an inexperienced "debutante" sic clinician contemplates extraction of second molars:

1. third molars present and at full crown calcification;
2. third molars at least four fifths the width of second molars;
3. second molars not malformed (this would indicate a significant risk of third molar malformation);
4. third molars that on standard radiographic views do not appear to be rotated.

He then outlined that criteria that pertain specifically to upper second molars:

1. upper third molars high, and distally inclined;
2. upper second molars accessible for extraction;
3. ability to retract and expand the upper buccal segments;
4. mild to moderate upper crowding;
5. relatively aligned upper buccal segments;
and the criteria pertaining to lower second molars:
1. lower third molars mesially tipped by not more than 30 degrees;
2. lower third molars in contact with, or overlapping, second molar roots;
3. no visibility of the occlusal surface of the third molar on radiographic images which, if present, suggest buccolingual tipping of the third molar in its socket;
4. mild lower anterior crowding, or moderate buccal crowding.

Dr Orton recommended that clinicians follow these criteria rather stringently until they are more experienced in the use of second molar extractions. As more confidence is gained with the technique, the selection criteria may be relaxed somewhat.

In regard to the prognosis of the third molars following second molar extractions, Dr Orton finds that, provided good selection criteria are adhered to:
- upper third molars rarely give problems;
- lower third molars never severely impact;
- and five out of six lower third molars have either an excellent, good or acceptable prognosis to be brought into functional occlusion.

For the one in six lower third molars which requires further intervention, Dr Orton noted that ten to fifteen degrees of uprighting is usually all that is necessary. This can usually be readily carried out with either a lower removable appliance or a partial lower fixed appliance. Lower third molars that erupt with a significant mesial inclination following second molar extraction will often show spontaneous improvement over the ensuing two to three years; presumably under the influence of occlusion with the upper third molars. Because of this he recommended that clinicians observe third molar behaviour for several years prior to commencing uprighting.

Dr Orton ascribed several benefits to the use of second molar extractions over mid-arch extraction.
1. He routinely observes spontaneous resolution of a half unit Class II molar occlusion following second molar extractions.
2. On average, there is a slight reduction in anterior overbite following second molar extractions.
3. The loss of incisor root length during treatment appears to be less in cases treated with posterior extractions than in those treated with mid-arch extractions.
4. Posterior arch extractions give an average of 2mm more lip fullness than mid-arch extractions. In addition, extraction of second molars may readily be combined with functional appliance therapy, further enhancing the facial result.

In conclusion, Dr Orton notes that: “Extraction of four second permanent molars frequently halves treatment time and frequently doubles [the chance of a favourable] prognosis”.

Comment from the Editor

In the opinion of this writer the advantages of second molar extraction, based on clinical experience, are:
1. conservation of tooth substance: in the writer’s experience, no second molar extraction cases required further extractions as did many “non extraction” and bicuspid extraction cases. However, some did require minor inter-proximal reduction;
2. simplification of treatment: in Class II cases, following the extraction of second molars, upper first molars may be moved distally using one of several methods. Once a Class I molar relation has been achieved, the patient can then be treated accordingly. Further, less, and often no, lingual root torque is required to achieve the desired inter-incisal angles;
3. improved aesthetics: cases are finished with a complete bicuspid display and a more prognathic profile;
4. reduced treatment time in the majority of cases: a survey revealed that six of 120 second molar extraction cases required orthodontic uprighting of third molars as a second phase of treatment. (Some clinicians use a surgical elevator to upright mesially-inclined third molars); and
5. the avoidance of major dental surgery to remove impacted third molars.

B.L