Commonly used premolar extraction pattern

When the treatment plan calls for maxillary and/or mandibular premolar extractions, it seems that many more orthodontists prefer to extract the first rather than the second premolars. In a recent (2002) survey in the US, the dominant extraction pattern was the maxillary and mandibular first premolars. The next most common pattern was extraction of the maxillary first premolars, with no extraction in the mandible. The removal of the maxillary first and the mandibular second premolars was the preferred pattern in only 7.5% of the extraction cases, and the
maxillary and mandibular second premolars in 6%. These numbers have remained remarkably similar for the past 10 years, or more.\textsuperscript{2} By tradition, an obvious reason for selecting the mandibular first rather than the second premolars for extraction is their generally poorer morphology—commonly a smaller tooth with a diminutive lingual cusp compared to the second premolar. However, when the extraction decisions are made, it is my opinion that the mandibular incisor position in space after treatment, and the predicted profile changes with different extraction alternatives, should be regarded as more important factors than the tooth morphology and the contact point relationships between the first molar and the neighboring premolar (Fig 1). Tooth morphology can, if necessary, be improved with new minimally invasive prosthetic enamel bonding techniques, whereas excessive incisor retroclination (Fig 2a) and accentuation of undesirable profile characteristics as a result of the orthodontic treatment (Fig 3) may produce irreparable damage to the patient.
Effect of premolar extractions on mandibular incisor retraction

Some recent studies have tried to quantify and compare the outcome of mandibular second versus first premolar extractions during orthodontic treatment.\textsuperscript{3–6} Crowding and profile fullness have been found to be the most significant factors influencing the extraction sequence decision,\textsuperscript{3–6} but the facial type (the ratio between posterior and anterior facial heights)\textsuperscript{3} and incisor overjet and molar relationship may also be influencing factors.\textsuperscript{4} Shearn and Woods\textsuperscript{4} reported a mean retrusive effect on the mandibular incisors of 2.4 mm with mandibular first premolar extraction and 1.0 mm with second premolar extraction. There was generally more forward movement of the mandibular molars than incisal retraction with the extraction of the second premolars than with the extraction of the first premolars. However, a specific extraction pattern did not necessarily guarantee certain amounts of incisor retraction or molar forward movement. Steyn et al\textsuperscript{5} found that the mandibular incisors were retracted, on average, by 2.1 mm relative to the N-Pog line in patients with mandibular first premolar extractions and by 1.4 mm in those with mandibular second premolar extractions. In a recent study of 70 Class II Division 1 malocclusion patients treated with premolar extractions when mandibular incisor retraction was not part of the treatment plan, Al-Nimri\textsuperscript{3} reported that the mandibular incisors were retracted in only 65% of the patients. On average, the mandibular incisors were retracted by 1.3 mm relative to the nasion-pogonion line in subjects treated with first premolar extractions; in those treated with second premolar extractions, it was 0.8 mm, but this difference was not statistically significant.

In each study,\textsuperscript{3–6} it was reported that significant individual variability exists in the response to orthodontic treatment with any of the extraction patterns investigated. Thus it seems possible to achieve a variety of incisor changes with each pattern, although there do appear to be some definite trends.\textsuperscript{4}
It should be pointed out that orthodontic treatment with extraction of mandibular premolars need not always cause mandibular incisor retraction. Mandibular incisor proclination may result from labial movement of these teeth during alignment if the mandibular canines were buccally positioned, from prolonged use of Class II traction, or if the amount of mandibular arch crowding exceeds the extraction spaces.3,4

**Prediction of profile changes with extractions of mandibular second versus first premolars**

Although it may be difficult to make accurate soft tissue profile predictions in individual cases, we still have to try to foresee what are pleasing and harmonious soft-tissue changes with the orthodontic corrections (see Figs 1 and 7), as well as those which are not (Fig 3). In my opinion, the most useful and adequately detailed advice in this regard comes from Holdaway’s soft-tissue analysis and recommendations.4 This implies that the before-treatment soft tissue thickness at point A should be used as a guide. If it is within the normal range (14 to 16 mm) in adolescents, the upper lip will follow the maxillary incisor in a one-to-one ratio once the lip strain is eliminated. However, if the tissue at point A is very thin (9 to 10 mm), the lip may follow the incisor immediately and still retain the taper. Adult lips may react similarly to that of thin lips in adolescent patients. On the other hand, if the soft tissue at point A is very thick (18 to 20 mm) at the start of orthodontic treatment, the lip may not follow the incisor movement at all.

**Excessive retraction of mandibular canines and its consequences**

The mandibular canines may sometimes be retracted too far in adolescent and adult cases with moderate crowding if retraction of the mandibular incisors is not wanted, and the mandibular first premolars have been extracted as part of the orthodontic treatment plan. This is because the combined posterior anchorage of the root surface area of the second premolar plus the first and second molars is indeed a solid block in comparison with the anterior anchorage of only 1 canine and 2 more or less crowded incisors. Excessive canine retraction can easily occur, for example, if Class II elastics are not worn properly, if there is a root resorption problem in the maxillary incisors that prevents the use of intermaxillary elastics, or if the first and second molars do not move mesially as readily as expected. Excessive retraction of the mandibular canines starts a vicious circle (Fig 4). Since the maxillary canines must occlude properly with the mandibular canines, these teeth will also be excessively retracted. Next, the maxillary and mandibular incisors will move too far back, increasing the need for labial crown and lingual root torque. Such torque is not always easy to achieve, and, at best, takes a long time. Therefore, mandibular first premolar extraction cases can end up with larger-than-intended interincisal angles (Fig 2a). The upright incisors may cause vertical relapse and mandibular incisor crowding.
Deep anterior overbite may be caused by overeruption of the maxillary incisors, overeruption of the mandibular incisors, or a combination of both. To achieve ideal functional and esthetic orthodontic results, it is important to determine, before orthodontic treatment is started, which teeth and dentition are overerupted. Except for careful analysis of the study casts and cephalograms, important information may then come from examining the maxillary central incisor display in relationship to the upper lip at speech and with the lips at rest,7–13 and by analyzing the lower lip–maxillary incisor relationship in deep overbite situations.14,15

It is also important to establish an optimal interincisal angle by obtaining adequate torque of the maxillary and mandibular incisors at the end of treatment. The long-term stability of deep overbite correction after orthodontic treatment appears to be related to the torque or axial inclination of the incisors.16–23 The deep overbite may return if the maxillary and/or mandibular incisors continue to erupt following appliance removal. When the maxillary and mandibular incisors have been positioned too upright, relative to one another after orthodontic treatment, they will have an increased tendency to overerupt following appliance removal.16–18 As demonstrated by Swain (Swain BF, personal communication), the available space for the mandibular anterior teeth will automatically decrease as the overbite increases (Fig 5).

If the deep bite returns in a treated malocclusion, the incisal edges of the mandibular incisors will occlude against a labiobuccally thicker portion of the maxillary incisors19,20 (Figs 5a to 5c). This will restrict their space and produce incisor crowding or, more rarely, spacing of the maxillary incisors with the mandibular arch intact.

**Fig 5** With relapse of deep overbite, incisal edges of mandibular incisors occlude against labiobuccally thicker portion of maxillary incisors and canines (a to c). Small pieces of wire placed where 6 mandibular teeth occlude on maxillary cast, with various degrees of overbite relapse (d). Note dramatic difference in length of wires (e) when stretched and measured (reprinted by permission of B.F. Swain).
Advantages of mandibular second premolar extraction
When mandibular premolar extractions are necessary, and little, if any, change of mandibular incisor position in space is desired, it is frequently better and safer to extract the mandibular second rather than the first premolar. The orthodontic treatment then becomes easier and more predictable with regard to anchorage control (see Figs 2b and 2c). In addition, the achievement of proper maxillary and mandibular incisor torque is more easily obtained and undesired flattening of the facial profile can be avoided (see Fig 1). Prolonged retention with fixed retainers19,24,25 is recommended in adolescents (see Figs 1e and 7g), as well as adult patients.

Overcoming the size problem of the mandibular first premolar
There is an interesting way to get around the problem of premolar size when a decision is made to extract a mandibular first premolar in a case with mild to moderate crowding and a weak profile. If the first premolar is extracted (Fig 6a), the second premolar can be moved mesially, with coil springs, against the first and second mandibular molars during the first phase of treatment (Figs 6b to 6f). The 2 mandibular molars will probably not move distally, due to lack of space and the presence of thick cortical bone in the retromolar area. When the second premolar contacts the canine (Figs 6c and 6f), the case can be treated like a mandibular second-premolar extraction case, in terms of anchorage.

A similar approach, without using anterior anchorage, can be used to move the first molars mesially (Fig 7).26 Of course, the temporary insertion of mini-implants will also allow such tooth movements.
Clinical implications

1. When mandibular premolar extractions are necessary in an orthodontic treatment plan, and maintenance of the pretreatment mandibular incisor position in space is desired, the second premolars are often a better and safer choice than the first premolars. Orthodontic treatment then becomes easier and more predictable with regard to anchorage control and achievement of proper anterior torque, and undesired flattening of the facial profile is more easily avoided.

2. If the mandibular first premolars are extracted, and incisor retraction is unwanted, it may be useful to move the second premolar into contact with the canine as the first phase of treatment, to avoid harmful effects on mandibular incisor position and facial profile.

3. To correct and maintain the correction of an excessive overbite, the orthodontist should analyze which teeth are overerupted, intrude such teeth and establish an optimal maxillary incisor to upper and lower lip relationship, and secure an adequate interincisal angle. The mechanical means may include selecting proper bracket torque, bending additional torque into rectangular archwires, and, if necessary, using auxiliary torquing springs to deliver extra lingual root torque.

4. The relationship between vertical anterior relapse and increased mandibular incisor crowding should be known and respected.
REFERENCES

Have a question you would like to see featured in this column?
Send it to: T. M. Graber, Editor-in-Chief
University of Illinois at Chicago, College of Dentistry
801 South Paulina, M/C 842
Chicago, Illinois 60612, USA
or E-mail to: tgraber@uic.edu