Commentary: Rotated Premolars

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Dr. Stefan's interesting description of two archeological cases with severely malposed premolars (*Dental Anthropology* 2006;19(3):70-73) prompted me to review two comparable cases I have encountered. I present these here in hopes that their description will stimulate discussion from the readership.

CASE 1

Figure 1 shows an occlusal view of the mandibular dental arch of a 24-year-old American black male. All 16 permanent mandibular teeth are erupted into functional occlusion, and, as shown in this figure, there is appreciable anterior dental crowding. The notable feature, of course, is the buccolingual juxtaposition of the left first and second premolars, where the second premolar is erupted ectopically to the lingual (with ~40° distolingual rotation) and the first premolar is rotated with the lingual aspect ~40° to the mesial. The canine is ectopically positioned to the labial in the corresponding right quadrant, but the two right premolars are arranged normally in the midarch. There is good gingival height around both ectopic premolars, with normal crown-root ratios as viewed from radiographs. Premolar alignment is normal in the maxillary arch.

CASE 2

This is a 14-year-old American white girl. Figure 2 shows the buccal-lingual arrangement of her maxillary right premolars. The second premolar is displaced to the lingual with mesial rotation of the tooth's lingual aspect. The first premolar is deviated less transversely, but the lingual aspect is rotated ~80° to the lingual (lingual rotation of the second premolar is ~60°). Gingival contours are healthy around all teeth. Premolar arrangement is normal in the other three quadrants. All 32 permanent teeth are present on X-ray, though the third molars have not yet emerged.

PERSPECTIVE

It is tenuous to speculate on the etiology of these rotations and displacements just from examination of the completed dentition because several different factors may have been contributory. One possibility, of course, is that the premolars' tooth crypts formed in the wrong positions and thse teeth's erupted malpositions reflect this developmental anomaly. Figure 3 shows a panoramic radiograph of a young boy with such a problem. Instead of the premolar crypts being located in the root bifurcations of the primary molars, the crypts of both the first and second premolar are beneath (apical to) the primary first molar. In this boy, the same malposition occurs in all four quadrants rather than just one quadrant as seen in the four older cases presented by Dr. Stefan and myself.

Alternatively, the permanent first molar (that emerges well before the premolars) could be the culprit. If this molar's eruptive path were deflected to the mesial, it would have compromised the arch space available for normal premolar eruption. With inadequate space, the premolars would remain trapped within the bone, or would have erupted along whatever pathway of least resistance presented itself. One can speculate that compromised space forced the premolars into the odd positions seen in the cases presented here. This situation occasionally occurs in the maxilla because of the upper molar's normal mesial-occlusal eruptive trajectory (*e.g.*, van der Linden and Duterloo, 1976; Duterloo, 1991). It is much less common in the mandible because the lower molar normally has an essentially vertical path of eruption. Figure 4 shows the panoramic radiograph of a case where the maxillary first molars are mesially inclined and are actively lysing through the distal root of the primary second molars. In contrast, the mandibular first molars have erupted normally, distal to the primary second molars. Several clinicians have reported on the occlusal consequences of first-molar ectopia, notably in the maxilla (*e.g.*, Kurol and Bjerklin, 1986; Bjerklin, 1994; Barberia-Leache *et al.*, 2005). The scenario would be that the early-erupting first molar erupts in to the space that should be held by the primary second molar, leading to this primary tooth's premature loss, and the space for the normal emergence of the premolar is compromised, leading to failure to erupt (impaction) or, conceivably as seen in

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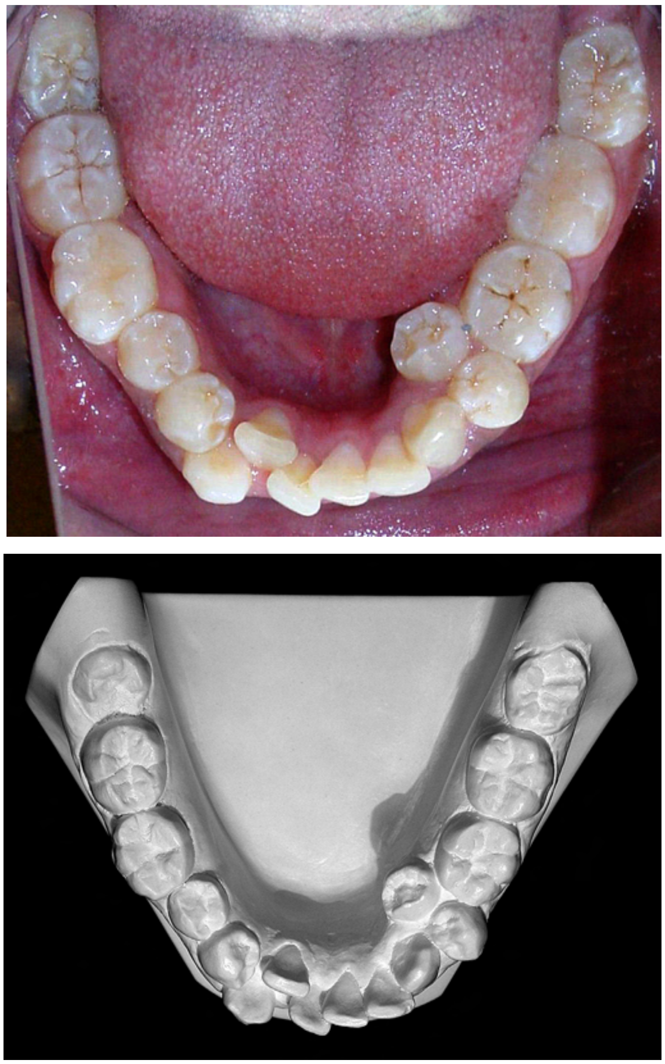

Fig. 1. Case of a young adult American black male with buccal-lingual juxtaposition of the mandibular left premolars. ***Top***: Intraoral photograph of the mandibular arch, showing the ectopic premolars and appreciable anterior crowding. ***Bottom***: Occlusal view of the same subject's dental cast.

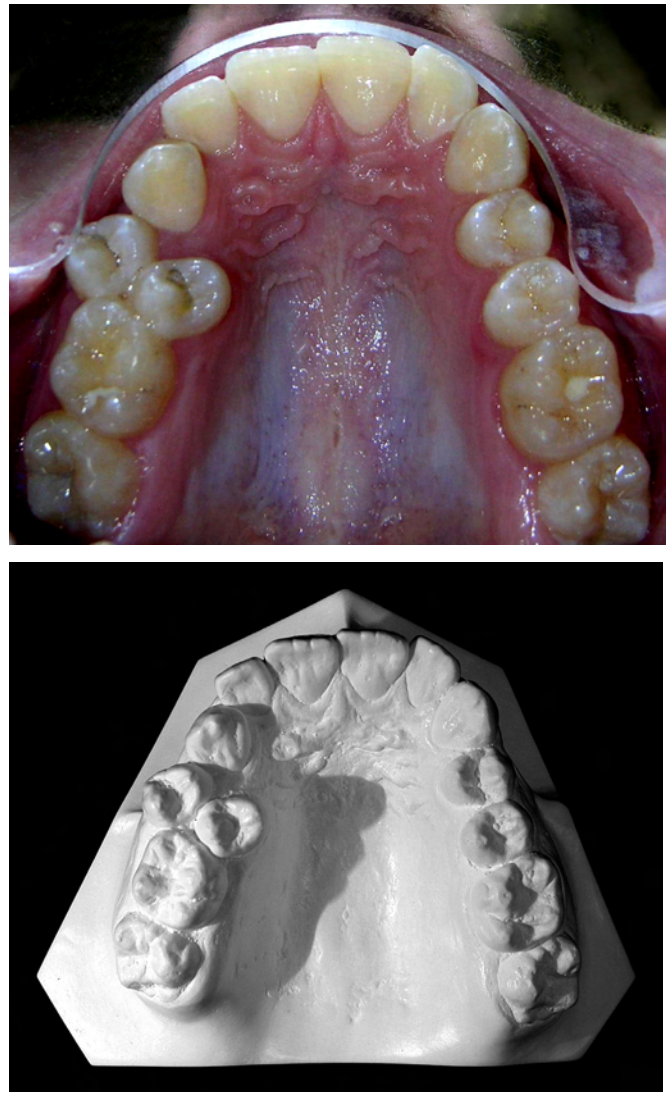

Fig. 2. Case of an adolescent American white female with buccal-lingual juxtaposition of the maxillary right premolars. ***Top***: Intraoral photograph of the maxillary arch. Aside from the ectopic premolars in the right quadrant, there is little crowding. The absence of space mesial to the first or second molar on the right illustrates the effect of mesial drift. ***Bottom***: Occlusal view of the same subject's dental cast.

Figures 1 and 2, ectopia of one or both premolars in a quadrant.

Another possibility is caries: Indeed, historically, caries was the greatest single cause of malocclusion (*e.g.*, Weinberger, 1926). The two primary molars in a quadrant can be viewed as space holders for the later-emerging premolars. If one or both primary molar is lost prematurely because of caries, the permanent first molar will drift forward, diminishing the space available for normal eruption of one or both premolars. An example of an impacted second premolar is shown in Figure 5; here the failure of eruption was due to caries and premature loss of the primary second molar, followed by mesial drift of the permanent first molar before the second premolar could erupt. Contemporary dentists have a variety of appliances that can be used to preserve the arch space of an extracted primary tooth (*e.g.*, Ngan *et al.*, 1999; Choonara, 2005), but, of course, this was not an option in the past—when caries also was a more prevalent health problem.

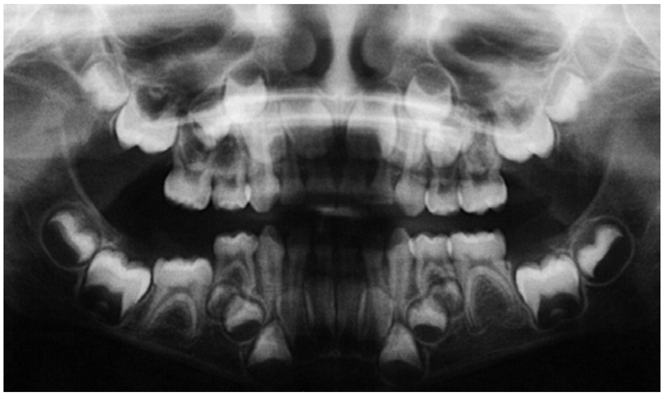

Fig. 3. Panoramic radiograph of young boy with ectopic development of the second premolars in each quadrant. Instead of the second premolar crypts forming in the bifurcation of the primary second molar's roots, as is normal, they are ectopically malpositioned apical to the primary first molars. Malpositions of the succedaneous tooth crypts is one possible cause of the malocccluded premolars seen in cases 1 and 2, though here—with all four quadrants involved—the problem probably is systemic rather than local.

A quick review of the literature shows that premature loss of a primary tooth affects the eruption tempo of its successor, but the effects reported are contradictory, some stating that premature loss accelerates eruption of the replacement tooth, others that loss delays eruption (reviewed, *e.g.*, by Ronnerman, 1977, Loevy, 1989). Fanning (1962), though often overlooked, was among the first to make sense of the situation, and my elaboration of her findings is this: When a primary tooth is lost at an early age, the supporting alveolar bone has plenty of time to heal and remodel (often atrophying to a narrow ridge) and the successor's root is too immature to initiate eruption (though the true "initator" of eruption is poorly understood). Eruption of the successor is delayed in such cases, which increases the opportunity and extent of drift of teeth adjacent to the extraction site (*e.g.*, Ronnerman, 1977; Ronnerman and Thilander, 1978; Northway, 2000). In contrast, if the primary tooth is lost at an older age, the successor is more mature and closer to its normal eruption age, so the alveolar bone remains less remodeled and more cancellous (Boyne, 1995; Diedrich and Wehrbein, 1997; Hasler *et al*., 1997), and eruption is hastened. When the successor erupts soon into the extraction space, there is little opportunity for drift of the adjacent teeth, thus enhancing chances of normal occlusal position.

Although uncommon, it is useful to mention pathological conditions that can retard exfoliation (of the primary tooth) and/or eruption (of the succedaneous tooth). An odontoma—a generally benign developmental hamartomatous lesion often coronal to an unerupted tooth—consists of tissues that resist tooth eruption as well as the normal migration

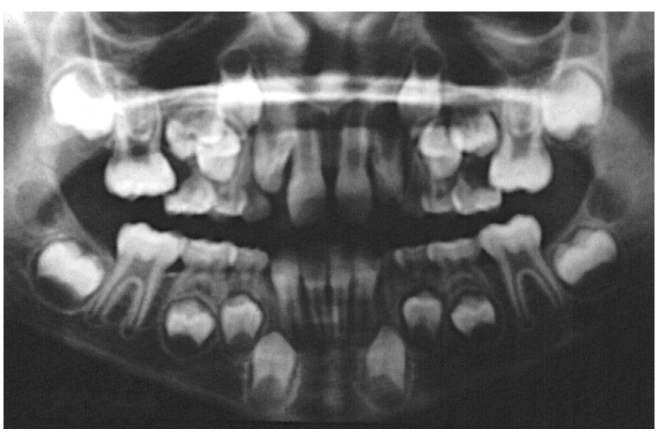

Fig. 4. Panoramic radiograph of a child in whom the maxillary permanent first molars have accentuated mesial crown tipping, with eruptive paths that have lysed the distal roots of the primary second molars. This leads to premature loss of the primary molars, followed by mesial drift of the permanent molars that, in turn, reduces space in the midarch that precludes normal eruption of the second premolars. Mesial inclination of the permanent first molars is appreciably more common in the maxilla.

Fig. 5. Radiograph of an adolescent in whom the primary second molar exfoliated prematurely due to caries. Without dental intervention to hold the space, the permanent molars drifted mesially, resulting in the second premolar being impacted because its eruptive path was occluded by the earlier-emerging adjacent teeth.

of erupted teeth. Some odontomas form enamel and dentinal structures that look like miniature teeth ("toothlets"), but others leave no readily-discernible skeletal evidence of their existence. Morning (1980) reviewed tooth impactions secondary to odontomas (also see Amado Cuesta *et al*., 2003; Tomizawa *et al*., 2005). The case reported by Kupietzky and coworkers (2003) is relevant here because it details the ectopic displacement of a second molar consequent to an odontoma. In a similar vein, molecular biologists have discovered genes that influence tooth eruption, notably, mutant alleles that interfere with the normal lysis of bone ahead of an erupting tooth, which can lead to impaction (*e.g*., Tiffee *et al*., 1999; Nishino *et al*., 2001; Ida-Yonemochi *et al*., 2004).

The commonality of these various scenarios involves the similarity of developmental timing of the first and second premolars (and canine) in each quadrant. These three teeth erupt during what van der Linden and Duterloo (1976) term the "second transition"—roughly 10 to 12 years of age (Fig. 6). Hurme (1949, 1951, 1957) published syntheses of eruption studies, and his classic works are still among the most common citations on the subject. Hurme (1951) found that, modally, the second premolar erupts roughly 9 months later than the first premolar, though there is some inter-individual variation (Kent *et al*., 1978; Smith ad Garn, 1987; Diamanti and Townsend, 2003). Liversidge recently (2003) has collated the extensive literature from the 20th century. The data (based on various collection strategies and various statistical methods) show that the second premolars characteristically emerge later than the first, but, again, these averages hide the considerable variability among individuals. Inspection of the four cases reported by Dr. Stefan and myself show that, in each instance, the second premolar's position is more aberrant than the first—and this is consistent with the later-emerging second premolar moving into a more-constrained space (because, statistically, the first premolar probably emerged slightly earlier and commandeered space for itself). It may be relevant too that in all four cases presented by Dr. Stefan and myself, the malposed premolars are restricted to one quadrant—suggesting that the etiology generally is anatomically localized rather than systemic.

Importantly, modal eruption ages can camouflage the variability in eruption sequences, though published reports of just the former are far more common. Sato and Parsons (1990) documented the appreciable variation seen in eruption sequences, particularly when the subjects can be followed longitudinally. The first premolar emerges ahead of the second (P1→P2) in most children (80% in maxilla; 96% in mandible), which agrees with the findings of Smith and Garn (1987) who, using cross-sectional data, found P1→P2 in about 90% of their children. Diamanti and Townsend (2003) also assessed data cross-sectionally, and found

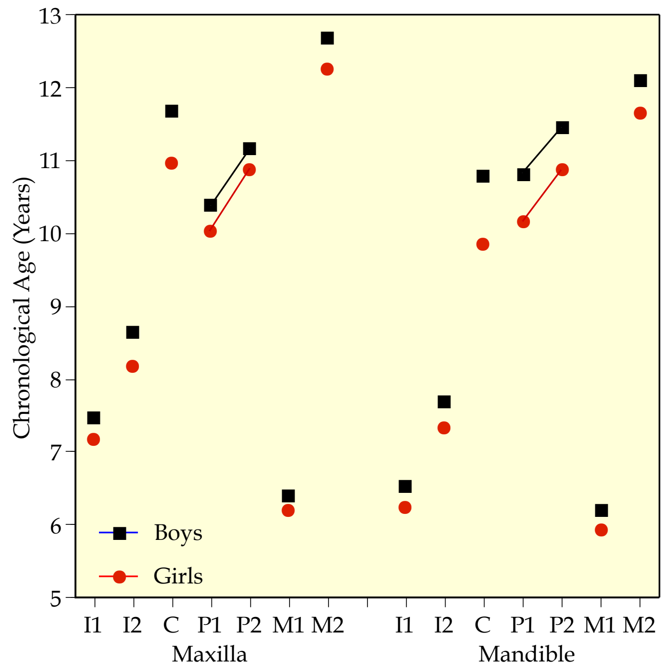

Fig. 6. Graph of median emergence ages in Caucasions (data from Hurme, 1951). Data are presented by sex, with gingival emergence being precocious in girls. The key issue is the similarity in emergence ages for the two premolars in a quadrant (*i.e*., the pairs of symbols connected by lines); while the first premolar is characteristically developmentally advanced over the second, the times are so similar that these teeth are obliged to compete for limited arch space.

somewhat higher frequencies for P1→P2, about 97% in both arches. The relevant point here is that the data agree that the first premolar is quite likely to emerge before the second, thus putting P2 at greater risk for impaction or malposition—and this is what is seen in all four of the cases reviewed here.

These comments do not detract from Dr. Stefan's presentation. Instead, they are meant to emphasize the dynamic sequence of events that, gone awry, can lead to the observed malplacements of later-forming teeth. Indeed, in addition to the broad criteria developed by Butler (1939) and Dahlberg (1945), a premolar field can be assessed by a variety of other measures, such as crown and root size and morphology, and similarities in formation, eruption, and emergence times and sequences.

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