Some form of a dental anomaly, or at least dental irregularity is found in nearly every individual, including men, women and children. Some of these are relatively mild and simple, as in rotations of teeth, small interdental spacing and unusually shaped teeth. Others are more complex and cause more functional and esthetic concerns. Among the latter, one should include congenitally missing, impacted and severely crowded teeth and also craniofacial anomalies, such as various forms of clefts. An orthodontist, who is primarily concerned with the function and esthetic of the human dentition, sees these anomalies as a challenge in his efforts to change a malocclusion to a more normal and cosmetic occlusion.

Second to dental crowding, anomalies in the number of teeth represent a large group of primary factors causing malocclusions. This is closely followed by an anomalous position of teeth, chiefly represented by impactions and ectopic eruption, but also including transpositions and transmigrations. Therefore, these etiologic factors should also be looked at in an effort to understand and reduce or even eliminate them in the future. Consequently, it is necessary to revisit some of the salient features of these anomalies. Particularly challenging will be to summarize the recent investigative reports in this area, as well as to speculate where future research should be directed. Once we are able to substantially reduce these underlying dental anomalies, we will be well equipped and ready to tackle even more complex cranio-facial problems.
There are two basic mechanisms in creating the condition that we refer to as dental crowding. By definition, crowding is a discrepancy between the cumulative widths of the dental units or teeth, and the available space to accommodate these teeth within the alveolar bone. Thus, one can represent a ratio between the tooth size and the supporting bone size. When this ratio exceeds unity, we define such a condition as dental crowding. If the ratio is one or less than unity, we don’t speak about dental crowding, but may, in fact, identify the condition as dental spacing. Arguably, crowding exceeds spacing by a large margin, perhaps as large as 100 or more to one. The ratio of exact unity or one is so rare in real life that it can, for all practical purposes, be ignored.

Calculating this ratio is not an exact science. The numerator part of the ratio is relatively easy to measure, whether it is done directly in the patient’s mouth or on a dental study cast. Numerous studies have demonstrated that the error of measurement for human dentition is typically within the calibration characteristics of the measuring device. Consequently this error is assumed to be so insignificant that it can be ignored. Calculating the denominator of the ratio, the size of the available arch perimeter, is substantially more prone to error and inconsistency. Because various investigators hardly agree on definition of the dental arch characteristics and, therefore, are not in agreement about what should be measured, substantial intra- and inter-investigator errors are often reported. Interestingly, the stated errors do not change the ratio’s outcome in a sense of its direction i.e. positive to indicate crowding and negative to indicate spacing, but tend to add to the severity of the discrepancy or the ratio’s departure from unity.

The real question then is to analyze which of the two components of the larger than one ratio is more likely to be deviant from the average: the tooth size or the arch perimeter. While reviewing the literature on the subject, seemingly convincing arguments for either component can be found. However, one must not ignore the most logical possibility; the one suggesting that both components contribute to some degree, albeit not coequally. In order to illustrate the two separate possibilities, a study published by this writer and his coworkers in the American Journal of Orthodontics (AJO) demonstrated that both individual and cumulative sizes of crowded dentitions were larger than in the non-crowded arches. This could be interpreted as favoring the numerator to be at fault. On the other side, McNamara and coworkers have also reported in the AJO that the arch perimeters of crowded dentitions were significantly smaller than their non-crowded counterparts. Their conclusions would suggest that it is the denominator that makes the basic difference. A classic example of allowing the two factors to contribute coequally is the Moyer’s Mixed Dentition Space Analysis, where the calculated space is needed because of either overly large teeth or too little space within the dental arch.

Because in most of the nature’s systems there is no bias toward any one factor, this writer currently believes that dental crowding can be equally caused by too large teeth and by inadequate bony support within the dental arch. This, however, does not preclude the use of certain “rules of thumb” in assessing the severity of dental crowding. For instance, a relatively simple summation of the 20 permanent teeth mesio-distal widths should, in average, add up to 140 mm (or a mean width of 7 mm per permanent tooth, not including the molars). If that sum exceeds 140 mm, one can safely state that the dentition is larger than normal and some degree of dental crowding is almost certain to ensue. Conversely, if one can measure the intermolar width of less than 36 mm one could safely deduce that the bone is not sufficiently developed and, thus, it is primarily responsible for the encountered dental crowding. Finally, it should be noted that the presence of one of these rules does not exclude the other from being present.

It is interesting to explore the secular changes in both components of the ratio. When one studies these long-term changes, which are probably a result of adaptive modifications to our diets and certain environmental influences, one can observe only modest variations. Individually these variations are insignificant and probably would not be able to explain the increased prevalence of dental crowding. However, because they had been occurring in the opposite direction, namely the size of dentition had increased while the available bone and thus the size of the dental arch had decreased, the ratio has steadily changed in favor of dental crowding.

This last statement brings yet another intriguing question: how does nature react to this? Should the selective adaptation mechanism not respond and make a provision to resolve this apparent inconsistency? The responsive mechanism appears to exist and it is the cover of yet another dental development theory, the so-called ‘Field theory of missing teeth’. The theory, in its simplest form, states that as dental crowding increases over the time, the last unit of the most numerous morphologic group will be gradually eliminated. Because we have three permanent molars, the theory speculates that the last in that group, or the third molar (“the wisdom tooth”) is the one that will be missing. Because there are two premolars and two incisors the picture is not that clear in terms of which tooth will be missing. It appears that in the maxillary dental arch it is the distal lorr second premolar that is likely to be the next most frequently missing tooth. In the mandible that distinction belongs to the second or distal premolar. A slight inconsistency of the Field’s theory choice is observed with the mandibular central incisors, which are congenitally missing more often than the mandibular lateral incisors.

It is interesting to explore the ways that clinicians approach and attempt to resolve the dental crowding. If one
accepts the premise that either the teeth are relatively large or the alveolar bone is relatively small, it will follow that in the former case one would consider reducing the tooth substance. This is accomplished by either extracting teeth or by reducing their natural size. Reapproximating or "stripping" enamel from the interproximal surfaces of selected teeth achieves a reduction in the natural size. Clinically, one identifies these approaches as extraction or tooth substance reduction methods. On the other hand, one can attempt to increase or "grow" the available alveolar bone and develop the needed arch periphery. This approach is clinically identified as the functionalist approach. This implies that some form of the functional appliance or method is utilized. It should be noted, however, that a great deal of controversy still exists in terms of whether or not the functional appliances can produce a real, net gain of the jaws or the alveolar bone. The alert reader readily recognizes that one method (e.g. extraction approach) is not exclusive of the other (e.g. lateral arch expansion). Indeed, in many severe cases of dental crowding, both methods are needed and are thus employed.

This entire discussion would be seriously flawed were it not for at least a brief mention of the concept promoted by Angle, stating that only the entire, uncompromised complement of teeth can function properly. Such views further state that if the integrity of human dentition is compromised by extracting, for instance, premolars, then the entire stomatognathic system malfunctions. Modern dentistry largely abandoned these views. In the 1950s and 1960s, it was quite common and almost fashionable to treat malocclusions with the help of extraction of the four first premolars. Among the notable proponents of such an approach were the most popular names of the time, including Drs. Tweed and Begg. However, in the 1980s and 1990s, the pendulum of the popular approach swung to the opposite direction and it became rather unpopular to extract teeth. In the opinion of this writer, clinicians have gone too far in adopting either philosophy. The ubiquitous extractions of one generation ago, along with the hesitation and almost a fear of extractions during the more recent decades are both too extreme. The most rational approach to resolving the problems of dental crowding could and often should consider both approaches and decide on the one, or even the combination of the two, that offer the most desirable correction of this common problem.

**Anomalies of the number, shape and position of a tooth or teeth**

While there are numerous anomalies in this broad category, this paper will elaborate on the most common ones, namely impactions, congenitally missing teeth, the so-called 'peg shaped' maxillary lateral incisors and transposition of teeth. Conspicuously absent from this discussion will be various forms of developmental anomalies of the face and the mouth. This is because there are numerous comprehensive articles and dissertations on the topics throughout the dental literature. Similarly, because this author has published numerous papers on the subject of impactions, transposition and related anomalies, instead of repeating himself, he will summarize and then speculate on the future approaches and solutions in resolving many of these anomalies.

It is generally recognized that the most common positional anomaly of a tooth is rotation. Rotations are so prevalent that it is difficult to find a modern man or woman with an occlusion that does not exhibit some degree of this common anomaly. Because this anomaly is so ubiquitous, many clinicians do not even list them as a trait of malocclusion, except when rotations are severe, e.g. a tooth rotated more than 45 degrees. From the clinical aspect, rotations are not overly difficult to correct, particularly with the use of fixed orthodontic appliances. It is important to keep in mind, however, that corrected rotations also represent the condition most likely to relapse. Various strategies have been developed to guard against, or to minimize, rotational relapse. One of the most effective ones is the procedure known as supra-crestal fiberotomy [SCFI], a minor surgical procedure in which the supra-crestal gingival fibers are severed.4

Ectopic position constitutes the second most common positional anomaly of the dentition. Within this category, the one that concerns clinicians the most is impaction. Even though any one tooth from either dental arch can be impacted, impaction of the maxillary permanent canine receives most attention. This is the case for numerous reasons, including the central role that the canine plays in the function of articulation and occlusion. A second, nearly equally important reason, is its role in facial esthetics.

There is an abundance of clinical reports on the management of impactions. The long list of related publications includes many contributions by this writer.5,6 Many years of managing treatments of the maxillary canine impaction, supplemented with information from the published work have yielded some interesting observations:

- Impactions affect approximately one out of ten individuals (based on the various reports, from 3 to 18% of population is affected);
- Excluding third molars, the maxillary canine is the most frequently impacted tooth in humans;
- There appears to be interesting gender and side differences. Females exhibit nearly twice as many maxillary canine impactions as males. Reportedly, the left side is significantly more often affected than the right side (based on the various reports, from about 2:1 up to 6:1);
- No racial predilection could be detected. Similarly, the global distribution of

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impactions seems to be quite similar. Practically no significant secular changes can be detected, even though some authors predict an increase in prevalence of impactions. This prediction is based on somewhat preliminary conclusions, stating that human teeth are increasing in size at the same time that the available bone appears to be shrinking. Note that the reader can relate this last statement to discussion on the etiology of the dental crowding.

One other positional tooth anomaly, also affecting the canines and particularly the maxillary canine, is transposition. In this anomaly, the position in which the teeth erupt within the arch is altered. The maxillary canine can change its place within the arch, properly located between the lateral incisor and the first premolar (the so called L-C-P or 2-3-4 sequence) to being transposed with either the lateral incisor and into the xC-L, or with the first premolar, into the L-P-xC sequence. The former one has more esthetic, while the latter one is of greater functional significance. Like so many dental problems, this last anomaly is best detected by radiographic examination. If detected early enough, its treatment may not be too difficult. This will reinforce the urging of a mature teacher to obtain and examine our patients’ records with care and attention to detail. A clinician faces a large variety of dental anomalies in his or her everyday work. This review dealt with only the most common ones that particularly affect an orthodontist. A better understanding of these will make the work of a clinician more efficient and perhaps a bit more enjoyable.

A brief mention will be made of yet another positional anomaly of the canines: transmigration. Transmigration is exclusive of the mandibular permanent canine. In this anomaly, the canine from one side of the arch migrates through the bone and erupts on the opposite side of the arch. For instance, the right mandibular canine migrates through the sympheseal area and erupts into the arch in the place where the left canine usually erupts. This anomaly could present a complex clinical problem, because the clinician will be facing a situation where the canine from one side appears to be missing, while the opposite side may appear to have a supernumerary canine.

References
