Abstract

Patient with good facial esthetics require extractions to reach a stable and functional occlusion can be categorized as a borderline case. It may also be defined as the case caught in between the conflict of extraction and nonextraction. Empirical evidence of uncertainty exists with these patients. Borderline cases may also have an absence of dental or craniofacial anomalies, permanent dentition, healthy periodontium and normal anteroposterior relationship between maxilla and mandible. Therefore, the aim of this paper is to describe criteria, which should be kept in mind before deciding to go for extraction or nonextraction treatment in borderline cases.

Curve of Spee

One popular rule of thumb for estimating the resulting loss of arch circumference is that 1 mm of arch circumference is needed for each millimeter of curve of Spee depth present. Recent studies conclude the real effect to be closer to 1:3; for every 3 mm of

Table 1: Factors affecting extraction decision

<table>
<thead>
<tr>
<th>Dental factors</th>
<th>Cephalometric factors</th>
<th>Soft tissue factors</th>
<th>Other factors</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>Skeletal parameters</td>
<td>Dental parameters</td>
<td>Facial pattern</td>
</tr>
<tr>
<td>TSALD</td>
<td>FMA</td>
<td>IMPA</td>
<td>Position of upper and lower lip A</td>
</tr>
<tr>
<td>Curve of Spee</td>
<td>SN-MP</td>
<td>FMIA</td>
<td>Naso labial angle</td>
</tr>
<tr>
<td>Boltons discrepancy</td>
<td>1-A-Pog line</td>
<td>Upper lip morphology</td>
<td>Midline deviation</td>
</tr>
<tr>
<td>Peck and peck analysis</td>
<td>Upper and lower central incisor to N-A and N-B line</td>
<td>Patient's preference</td>
<td></td>
</tr>
<tr>
<td>Irregularity index</td>
<td></td>
<td></td>
<td></td>
</tr>
</tbody>
</table>

curve leveled, arch circumference increases 1 mm.\textsuperscript{[2-10]} According to Woods,\textsuperscript{[11]} the amount needed is variable depending on the type of mechanics used. The deeper the curve of Spee, the greater the need for extraction.\textsuperscript{[7-10]} Roth considered 3-6 mm of curve of Spee mild (1.5-3.0 per side),\textsuperscript{[12]} and Baldridge added that greater than 6 mm is severe.\textsuperscript{[7]}

Bolton’s discrepancy

A tooth-size discrepancy (TSD) is defined as a disproportion among the sizes of individual teeth.\textsuperscript{[13]} In order to achieve a good occlusion with the correct overbite and overjet, the maxillary and mandibular teeth must be proportional in size. Bolton (1958) noted a TSD of up-to 4 mm to be a limit of the anterior reduction.\textsuperscript{[11,14]} Extraction may be necessary to resolve a discrepancy greater than this.

Peck and peck analysis\textsuperscript{[15]}

Peck and peck analysis takes into account the labiobuccal width of the tooth rather than mesiodistal (MD) width as in Bolton’s analysis. Peck and peck analysis is calculated as MD length of mandibular incisor divided by its labiobuccal width. MD and labial (FL) index values for mandibular central incisor is 88-92 and for mandibular lateral incisors is 90-95. Patients with MD/FL indices above the desired ranges may be candidates for the reproximation. Index values lower than normal range warrant extractions.

Irregularity index

Little developed the irregularity index and mandibular anterior irregularity by adding the linear distances between the five adjacent anterior contact points. With perfectly aligned incisors, the score is zero. Little noted a score >6.5 mm indicates severe irregularity and, thus, the greater likelihood for extraction.\textsuperscript{[16-18]}

Cephalometric variables

Skeletal variables

Vertical dimension is the most important to the clinician.\textsuperscript{[19]} Two important angles for the assessment of vertical dimension are Sella-Nasion and mandibular planes (SN-MP) angle,\textsuperscript{[19]} and FMA angle.\textsuperscript{[20]} SN-MP angle formed at the intersection of the SN-MP with the average value of 33° for balanced vertical facial types, with a range of 31-34°. The normal value for the FMA is in the range of 20-30°.\textsuperscript{[20]} Values above these normal ranges are associated with skeletal open bite, whereas values below are typically associated with skeletal deep bite.

Regardless of the clinician’s form of vertical assessment, there is agreement among these measurements regarding extraction and non-extraction therapy. Treatment geared toward achieving facial balance is more likely to extract in skeletal open bite and not extract in cases with skeletal deep bite.

Dental variables

Incisor mandibular plane angle (IMPA)

Charles tweed noted a need for “upright” and “vertical” lower incisors to create facial balance and harmony. He proposed IMPA to be 90° ± 3° in normal, balanced faces. According to tweed, this value can range between 85° and 95°, and vary according to ethnicity.\textsuperscript{[20]} Values above this range are indicative of extraction to improve functional and esthetic imbalance.

A to Pogonion (A-Pog) line

McNamara found the proper position of the mandibular incisor to be 1-3 mm anterior to a line from point A-Pog in a well-balanced face, regardless of age.\textsuperscript{[21]}

Maxillary and mandibular incisor from Nasion to A and B point respectively

Steiner set the ideal positions of the maxillary and mandibular incisors to be 4 mm anterior to the lines connecting Nasion and point A, and Nasion and point B, respectively.\textsuperscript{[22]} The maxillary and mandibular incisors should form angles of 22 and 25° to their respective diagnostic lines. Extraction becomes more likely as incisor positions and angles exceed these values horizontal planes.

Soft tissue

Pleasing soft tissue profile should be the main focus of orthodontic diagnosis and treatment planning.

Position of upper and lower lip

A borderline case with pre-treatment lip protrusion may be better served with extraction. Similarly, a more retrusive profile may be improved without removing teeth. Ricketts first identified the esthetic plane, relating lip position to a line from the nasal tip to soft tissue pogonion.\textsuperscript{[23]} In the aging face, lips become relatively more retruded, creating a natural difference in proper lip positions between different age groups. In the adolescent, the lower lip is about 2 mm behind the esthetic plane, or E line, with a standard deviation of 3 mm. The adult lower lip is ideal about 4 mm behind the E line with a similar standard deviation. Burstone found it advantageous to consider lip position relative to a line connecting the nasal tip to soft tissue pogonion because it is based on a “plane of minimal variation in the face.”\textsuperscript{[24]} The author noted the nose is an area of great variation, “approximately twice” the standard deviation as lower lip protrusion (2.8 vs. 1.6). Since lip protrusion can disrupt an otherwise pleasing face, extraction may be necessary the further a patient is from the ideal.

For each 1 mm of retraction of the upper incisor, the upper lip retracts 0.75 mm.\textsuperscript{[25]} Talass et al. found lower values for this ratio which is 1/0.64.\textsuperscript{[26]} On the other hand, lower lip retracts by 0.6 mm for every 1 mm of lower incisor retraction.\textsuperscript{[27]} Thus, retraction of anterior teeth for space closure makes the profile more concave.

Naso labial angle

There is a great deal of variation in the literature as to what constitutes the ideal value. According to Burstone’s evaluation of lip relation, a preferable nasolabial angle value is 73.8° ± 8°.
More recent studies find more suitable values in the range of 90-115°. Extraction of four bicuspids was noted to increase the nasolabial angle 5.2° by Drobocky and Smith. Therefore, extraction of teeth in a borderline patient with a nasolabial angle greater than the normative values should be avoided.

Lip prominence
Holdaway’s soft tissue analysis includes linear measurements to assess upper lip morphology and strain. The thickness of upper lip should be measured in two different areas: 3 mm below skeletal point A, and from the vermilion border to the labial surface of the maxillary central incisors. In normal patients, these two measurements should be approximately the same (±1 mm). If the vermilion border is thinner than the upper lip near point A, the lip are considered strained. If the upper lip is thinner than the vermilion border, the lips are considered flaccid. In borderline patients with strained lips, the incisors can be retracted without altering the soft tissue profile because the lip needs to reach normal form and thickness before retraction. In such patients, extraction is indicated. On the other hand, the lips would immediately follow tooth movement in borderline patients, with normal lips.

According to Arnett and Bergman, orthodontists should avoid extraction in patients with flaccid lips due to the lack of labial support and the potential for esthetic problems.

Midline deviation
Proper assessment of facial, skeletal, and dental symmetry is essential in orthodontic diagnosis. It is important to determine which dental segment deviation is responsible for the shift. Evaluation of the dental midline should be assessed with respect to the face, and treatment planning should be done which is compatible with the situation. A deviation of the dental midline(s) may indicate a skeletal asymmetry and require surgery for correction. Severe dental midline deviation relative to the face (especially in the lower arch) requires tooth extractions. Minor shift in midline can be corrected with the use of intermaxillary elastics or mini-implants (in some cases, unilateral mechanics), asymmetric extractions, stripping. In few situations, orthodontists will have to settle for completing orthodontic treatment with a little midline deviation. Dental and facial midlines deviations are more noticeable in the maxillary arch and appear unsightly. Midline deviation can be the main reason for patients to seek orthodontic treatment. The literature provides little data on the quantity of deviation relating to the borderline of extraction.

Growth status
It is very important to keep in mind the facial growth status of the young patient; particularly those with malocclusions of skeletal origin. Growth of the soft and hard tissues has a significant influence on the facial results of orthodontic treatment. With age due to growth of soft tissues of the face, the profile of an individual becomes more convex. Gross facial imbalance can be caused by additional growth of the nose after the appliance removal. Extractions should be avoided in growing patients. These cases show favorable results with growth response (growth redirection). If further growth is unlikely to alter facial profile, extraction decision will be safer.

Conclusion
A Borderline case may be treated by either extraction or non-extraction methods. Dichotomy exists with these cases. Further, borderline cases may also have absence of dental or craniofacial anomalies, permanent dentition, healthy periodontium and normal anteroposteriorly relationship between maxilla and mandible. Therefore; precise treatment planning is a must for borderline cases to provide best possible esthetics and stability of the results to the individual.

References
16. Little RM, Wallen TR, Riedel RA. Stability and relapse of mandibular anterior alignment-first premolar extraction cases