The American Board of Orthodontics

Calibration Kit

CALIBRATION KIT

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ONLINE RESOURCE

With Internet access, you may view the ABO's Video Demonstration for Model Measurements by clicking here.

INTRODUCTION

The ABO's Calibration Kit will assist you in making a qualitative assessment of the records that you plan to use for The American Board of Orthodontics clinical examination. Using the ABO Grading System for Dental Casts and Panoramic Radiographs, the Board requires that each examinee score their final dental casts and panoramic radiographs as part of the treatment summary contained in each case report. The ABO examiners will also be scoring these records using the same scoring system to evaluate your treatment results.

In order to provide an accurate assessment of your patient records, the Examiners spend considerable amount of time *calibrating* so their results will be consistent and reliable. The information contained here will allow you to *calibrate* your scoring efforts and compare them with a "Scoring Key." This will permit you to score your own results and be confident that you have scored accurately. You may use this scoring system at any point in the future as a vehicle for self-assessment. Not only will the results of this evaluation help to determine the quality of your treatment results, but more importantly, it will help to identify areas where improvement may be needed to maintain a high quality of treatment even after you have become a Diplomate of The American Board of Orthodontics.

INSTRUCTIONS FOR CALIBRATION

STEP ONE:
Read all the information contained in the ABO Grading System for Dental Casts and Panoramic Radiographs (a.k.a. Model Grading System). While you are reading this information, become familiar with the use of the gauge and the correct method of positioning the gauge for each of the different measurements. The online Video Demonstration for Model Measurements can also be viewed.

STEP TWO:
After you are completely comfortable with handling the measuring gauge and the method of scoring the dental casts and panoramic radiographs, print copies of the Cast-Radiograph Evaluation Scoring Sheet, and open the box containing three sets of calibration dental casts.

Begin your measurements using Calibration Cast I. Then find the Case I Radiograph in this kit and score for Root Angulation. Record your scores on the Cast-Radiograph Evaluation Scoring Sheet and compute a total score. You should score the models at least twice to determine if your scores are consistent. Do not look at the "Scoring Keys" until after you have scored Case I as consistently as possible.

STEP THREE:
When you are satisfied that your scores are consistent, go to the Scoring Keys section of this kit and select the key (Cast-Radiograph Evaluation) for Case I. This key represents the collective, agreed-upon scores of all Directors. If your scores are not in agreement with the scoring key, determine the areas where the deviations exist, then put the dental casts aside for at least one day. Score the casts again one day later and compare your results with the scoring key.

When your scores closely approximate the key, proceed to Calibration Cast II, and perform the same scoring exercise. Again, when your scores closely approximate the scoring key, proceed to Calibration Cast III. Carry out the same exercise as previously performed on Casts I and II.

STEP FOUR:
When your scores closely approximate the scoring keys for Cases I, II and III, you are ready to score patient records that you have selected for the clinical examination. By performing this calibration exercise, your scores will be reliable and you will select patients whose finished results will pass the scrutiny of the ABO Examiners.

You are required to submit a *Cast-Radiograph Evaluation with each* of *your cases.*

DISCREPANCY INDEX

The Discrepancy Index (DI) is a measure of the complexity of an orthodontic case on the pre-treatment models. It is used by the Board in determining the criteria for case presentations. As a service to you, we are including these pages in the calibration kit, along with a visual reference called Discrepancy Index Scoring System. All these items can be downloaded from the ABO website as well. With Internet access, you may view the ABO's Video Demonstration for Model Measurements by clicking here.

You are required to submit a *Discrepancy Index Report with each* of *your cases.*

The American Board of Orthodontics

Grading System for Dental Casts and Panoramic Radiographs

Grading System for Dental Casts and Panoramic Radiographs
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MODEL GRADING SYSTEM

INTRODUCTION

The American Board of Orthodontics is constantly striving to make the clinical examination a fair, accurate, and meaningful experience for examinees. In an effort to enhance the reliability of the examiners and provide the examinees with a tool to assess the adequacy of their finished orthodontic results, the Board has established a Model Grading System to evaluate the final dental casts and panoramic radiographs. This scoring system was developed systematically through a series of four field tests over a period of five years. The Board instituted the model and radiographic portions of the Model Grading System, and it has been used to grade these portions of the examinees' clinical case reports since 1999. In an effort to assist examinees with the selection of their cases, the Board is making this Model Grading System available to all examinees. The Board encourages examinees to score their own case reports with this scoring system to determine if they meet Board standards.

BACKGROUND

In 1994, The American Board of Orthodontics began investigating methods of making the clinical examination more objective. Since a major emphasis has always been placed on the final occlusion, the first efforts were directed at developing an objective method of evaluating the dental casts and intraoral radiographs.

In the past, several indices have been used to evaluate the outcome of orthodontic treatment.[1,2,3,4] Generally, these indices compare pretreatment and posttreatment records to determine the quality of the final result. However, these indices are not precise, and the validity and reliability of these indices has not been established. The Occlusal Index[5] has also been used to determine treatment quality. However, this method is tedious, and the system is more appropriate for scoring pretreatment rather than posttreatment records.

In 1987, the PAR Index[6] (Peer Assessment Rating) was developed to assess an occlusion at any stage of development. Over 200 dental casts representing various pretreatment and posttreatment stages of occlusion were used to establish this index. The PAR Index has good reliability and validity, however this measuring system is not precise enough to discriminate between the minor inadequacies of tooth position that are found in ABO case reports. Therefore, an ABO committee was formed in 1994, to begin field testing precise methods of objectively evaluating posttreatment dental casts and panoramic radiographs.

MODEL GRADING SYSTEM

At the 1995 ABO clinical examination, 100 cases were evaluated. A series of 15 criteria were measured on each of the final dental casts and panoramic radiographs. The data showed that 85% of the inadequacies in the final results occurred in seven of the 15 criteria (alignment, marginal ridges, buccolingual inclination, overjet, occlusal relationships, occlusal contacts, root angulation).

Therefore, at the 1996 clinical examination, a second field-test was initiated to verify the results of the previous test and to determine if multiple examiners could score the records reliably and consistently. In this field test, a subcommittee of four Directors evaluated 300 sets of post-treatment dental casts and panoramic radiographs. Again, the majority of the inadequacies in the final results occurred in the same seven categories, but the committee had difficulty establishing adequate inter-examiner reliability. The subcommittee recommended that a measuring instrument be developed to make the measuring process more reliable.

In 1997, a third field test was performed using the modified scoring system with the addition of an instrument to measure the various criteria more accurately. All of the Directors participated in this field test, and a total of 832 dental casts and panoramic radiographs were measured. The same seven criteria were evaluated. A calibration session preceded the examination to establish more accurate use of the measuring instrument and improve the reliability of the Directors. The results again showed that the overwhelming majority of the inadequacies in the finished results occurred in the aforementioned categories. However, the Directors decided to add interproximal contacts to the scoring system to raise the total number of criteria to eight. In addition, modifications were made in the measuring instrument to improve measuring accuracy among Directors.

In 1998, the fourth and final field test was initiated. Again all Directors participated in the evaluation process. The new and improved measuring instrument was used. An extensive training and calibration session was performed prior to the actual examination. The major objectives of this final field test were to refine the measuring and calibration process, and to gather enough data on general performance to establish the validity or cut-off for passing this portion of the clinical examination. This field test was extremely successful. Not only did it reaffirm the benefits of using an objective system for grading the dental casts and panoramic radiographs, but also it helped to establish standards for successful completion of this portion of the clinical examination.

Based upon the collective and cumulative results of these extensive field tests, the Board decided to officially initiate the use of this Model Grading System for examinees at the February 1999, ABO clinical examination in St. Louis. In order to assist the examinee in selecting cases that will successfully pass the examination process, the Board is providing the examinee with the same system used by the Directors. The Board encourages examinees to score their own dental casts and panoramic radiographs during their preparation for the clinical examination in order to select cases that will successfully pass the ABO Model Grading System.

MODEL GRADING SYSTEM

CRITERIA AND RATIONALE

The ABO Model Grading System for scoring dental casts and panoramic radiographs contains eight criteria. These are: alignment, marginal ridges, buccolingual inclination, occlusal relationships, occlusal contacts, overjet, interproximal contacts, and root angulation. The rationale for using these criteria is stated in the following section.

Alignment is usually a fundamental objective of any orthodontic treatment plan. Therefore, it seems reasonable that any assessment of quality of orthodontic result must contain an assessment of tooth alignment. In the anterior region, the incisal edges and lingual surfaces of the maxillary anterior teeth and the incisal edges and labial-incisal surfaces of the mandibular anterior teeth were chosen as the guide to assess anterior alignment. These are not only the functioning areas of these teeth, but they also influence esthetics if they are not arranged in proper relationship. In the maxillary posterior region, the mesiodistal central groove of the premolars and molars is used to assess adequacy of alignment. In the mandibular arch, the buccal cusps of the premolars and molars are used to assess proper alignment. These areas were chosen since they represent easily identifiable points on the teeth, and represent the functioning areas of the posterior teeth. The results of the four field tests show that the most commonly malaligned teeth were the maxillary and mandibular lateral incisors and second molars, which accounted for nearly 80% of the mistakes.

Marginal ridges are used to assess proper vertical positioning of the posterior teeth. In patients with no restorations, minimal attrition, and no periodontal bone loss, the marginal ridges of adjacent teeth should be at the same level. If the marginal ridges are at the same relative height, the cementoenamel junctions will be at the same level. In a periodontally healthy individual, this will result in flat bone level between adjacent teeth. In addition, if marginal ridges are at the same height, it will be easier to establish proper occlusal contacts, since some marginal ridges provide contact areas for opposing cusps. Based upon the four field tests, the most common mistakes in marginal ridge alignment occurred between the maxillary first and second molars. The second most common problem area was between the mandibular first and second molars.

Buccolingual inclination is used to assess the buccolingual angulation of the posterior teeth. In order to establish proper occlusion in maximum intercuspation and avoid balancing interferences, there should not be a significant difference between the heights of the buccal and lingual cusps of the maxillary and mandibular molars and premolars. The Directors use a special step gauge to assess this relationship. Some latitude is allowed, however in past field tests significant problems were observed in the buccolingual inclination of the maxillary and mandibular second molars.

Occlusal contacts are measured to assess the adequacy of the posterior occlusion. Again, a major objective of orthodontic treatment is to establish maximum intercuspation of opposing teeth. Therefore, the functioning cusps are used to assess the adequacy of this criterion; i.e., the buccal cusps of the mandibular molars and premolars, and the lingual cusps of the maxillary molars and premolars. If cusp form is small or diminutive, that cusp is not scored. In past field tests, the most common problem area has been inadequate contact between maxillary and mandibular second molars.

Occlusal relationship is used to assess the relative anteroposterior position of the maxillary and mandibular posterior teeth. In order to achieve accuracy and reliability in measuring this relationship, results of previous field tests have shown that the most verifiable method of scoring this criterion is to use Angle's relationship. Therefore, the buccal cusps of the maxillary molars, premolars, and canines must align within 1 mm of the interproximal embrasures of the mandibular posterior teeth. The mesiobuccal cusp of the maxillary first molar must align within 1 mm of the buccal groove of the mandibular first molar.

Overjet is used to assess the relative transverse relationship of the posterior teeth, and the anteroposterior relationship of the anterior teeth. In the posterior region, the mandibular buccal cusps and maxillary lingual cusps are used to determine proper position within the fossae of the opposing arch. In the anterior region, the mandibular incisal edges should be in contact with the lingual surfaces of the maxillary anterior teeth. In past field tests, the common mistakes in overjet have occurred between the maxillary and mandibular incisors and second molars.

Interproximal contacts are used to determine if all spaces within the dental arch have been closed. Persistent spaces between teeth after orthodontic therapy are not only unesthetic, but can lead to food impaction. In past field tests, spacing is generally not a major problem with ABO cases.

Root angulation is used to assess how well the roots of the teeth have been positioned relative to one another. Other than periapical radiographs or three-dimensional imaging, the panoramic radiograph is probably the best practical means for making this assessment. It is incumbent upon the examinee to present imaging evidence to document posttreatment root position. If roots are properly angulated, then sufficient bone will be present between adjacent roots, which could be important if the patient were susceptible to periodontal bone loss at some point in time. If roots are dilacerated, then they are not graded. In past field tests, the common mistakes in root angulation occurred in the maxillary lateral incisors, canines, second premolars, and mandibular first premolars.

MODEL GRADING SYSTEM

GUIDE FOR GRADING CLINICAL CASE REPORTS

MODEL ANALYSIS

ALIGNMENT

In the maxillary and mandibular anterior regions, proper alignment is characterized by coordination of alignment of the incisal edges and lingual incisal surfaces of the maxillary incisors and canines (fig. 1), and the incisal edges and labial incisal surfaces of the mandibular incisors and canines (fig. 2).
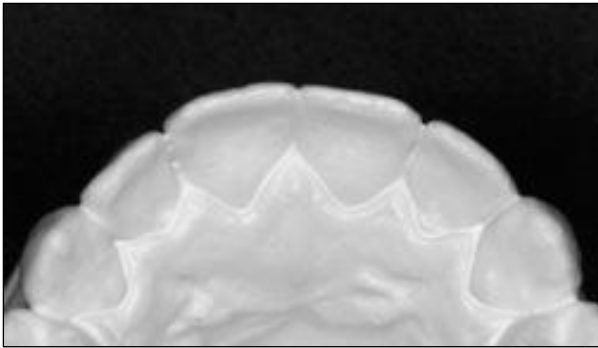

figure 1

figure 2

In the mandibular posterior quadrants, the mesiobuccal and distobuccal cusps of the molars and premolars should be in the same mesiodistal alignment. In the maxillary arch, the central grooves (mesio-distal) should all be in the same plane or alignment (fig. 3). If all teeth are in alignment, or within 0.50 mm of proper alignment, no points are scored.
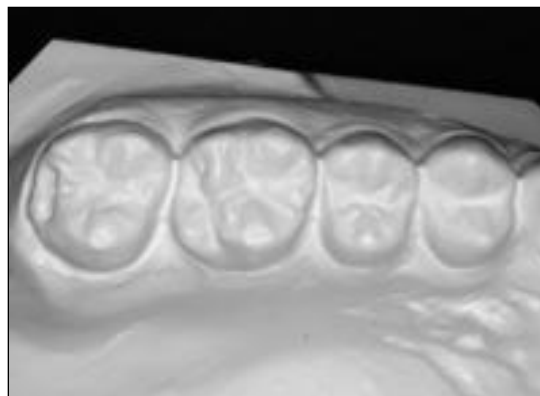
figure 3

MODEL GRADING SYSTEM

If the mesial or distal alignment at any of the contact points is 0.50 mm to 1 mm deviated from proper alignment (fig. 4a,b), 1 point shall be scored for the tooth that is out of alignment. If adjacent teeth are out of alignment, then 1 point should be scored for each tooth.
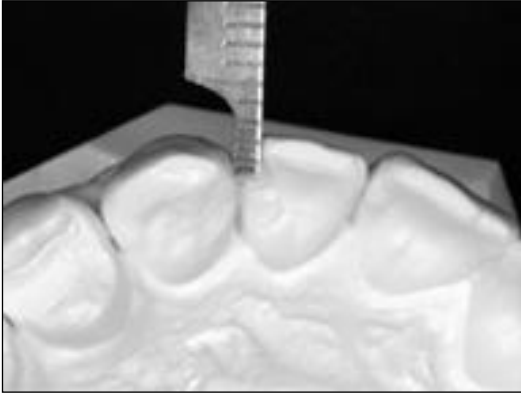
figure 4a

figure 4b

If the discrepancy in alignment of a tooth at the contact point is greater than 1 mm, then 2 points shall be scored for that tooth (fig. 5a,b). No more than 2 points shall be scored for any tooth.
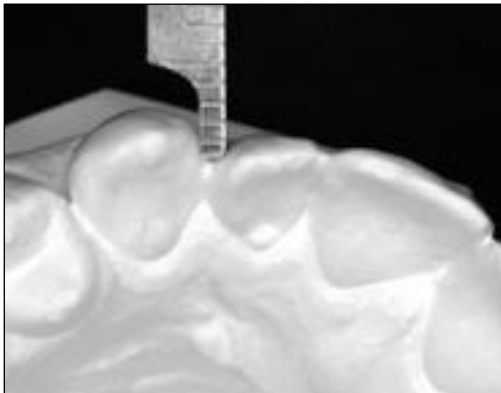
figure 5a
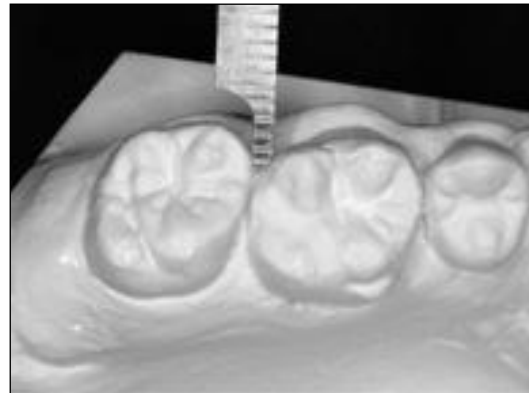
figure 5b

MARGINAL RIDGES

In both maxillary and mandibular arches, marginal ridges of adjacent posterior teeth shall be at the same level, or within 0.50 mm of the same level (fig. 6).

figure 6

In scoring, do **not** include the canine-premolar contact; and do not include the distal of lower 1st premolar.

If adjacent marginal ridges deviate from 0.50 to 1 mm (fig. 7), then 1 point is scored for that interproximal contact. If the marginal ridge discrepancy is greater than 1 mm (fig. 8), then 2 points shall be scored for that interproximal contact. No more than 2 points will be scored for any contact point. The marginal ridge will be considered as the most occlusal point that is within 1 mm of the contact at the occlusal surface of adjacent teeth.

figure 7

figure 8

MODEL GRADING SYSTEM

BUCCOLINGUAL INCLINATION

The buccolingual inclination of the maxillary and mandibular posterior teeth shall be assessed by using a flat surface that is extended between the occlusal surfaces of the right and left posterior teeth. When positioned in this manner, the straight edge should contact the buccal cusps of contralateral mandibular molars and premolars. The lingual cusps should be within 1 mm of the surface of the straight edge (fig. 9). In the maxillary arch, the straight edge should contact the lingual cusps of the maxillary molars and premolars. The buccal cusps should be within 1 mm of the surface of the straight edge (fig. 10).
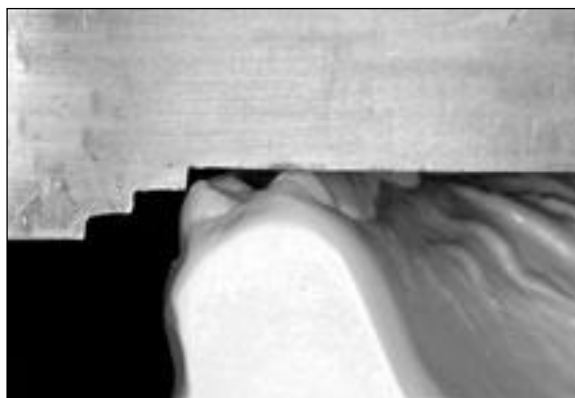
figure 9   figure 10

Do **not** score the mandibular 1st premolars nor the distal cusps of the second molars.

If the mandibular lingual cusps or maxillary buccal cusps are more than 1 mm, but less than 2 mm from the straight edge surface (fig. 11a,b), 1 point shall be scored for that tooth.

figure 11a   figure 11b
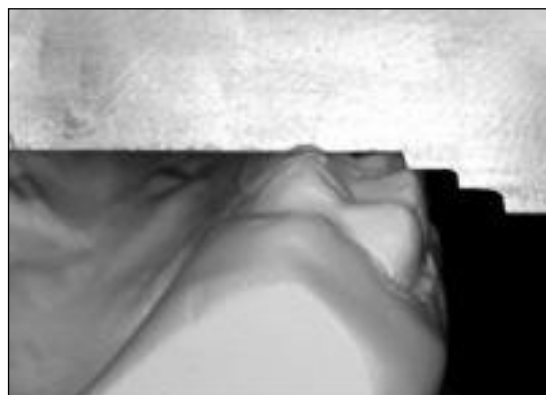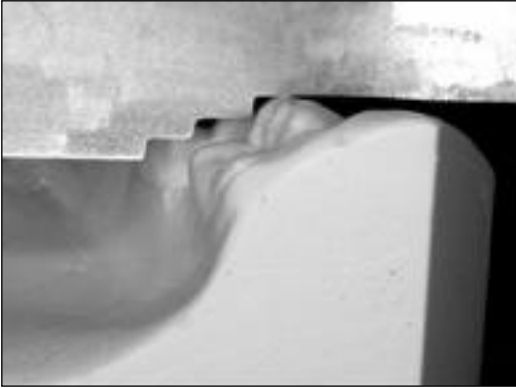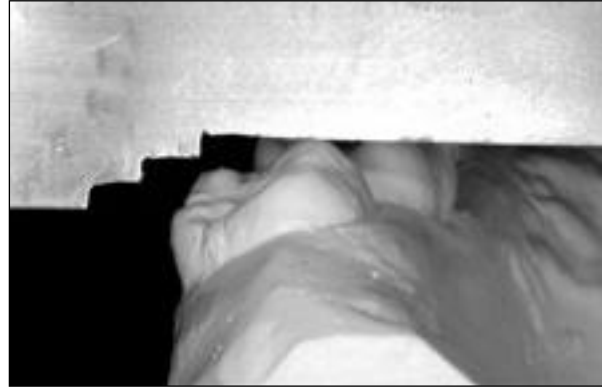
figure 12a

figure 12b

If the discrepancy is greater than 2 mm (fig. 12a,b), then 2 points are scored for that tooth. No more than 2 points shall be scored for any tooth.

OCCLUSAL CONTACTS

This section of the evaluation determines the adequacy of occlusal contact of the premolars and molars. The buccal cusps of the mandibular premolars and molars (fig. 13) and the lingual cusps of the maxillary premolars and molars (fig. 14) should be contacting the occlusal surfaces of the opposing teeth. Each mandibular premolar has one functional cusp. Each mandibular molar has two functional buccal cusps. The maxillary premolars have one functional lingual cusp. However, the maxillary molars may have only a mesiolingual functional cusp.

figure 13

figure 14

If the distolingual cusp is short or diminutive (fig. 15), it should not be considered in the evaluation. If this cusp is prominent, but does not contact with the opposing arch, then points may be scored. If the cusps are in contact with the opposing arch, no points are scored. Do not score diminutive distolingual cusps of the maxillary 1st and 2nd molars, nor lingual cusps of the mandibular first premolars.
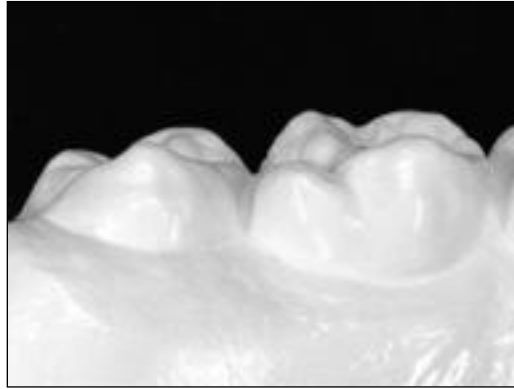
figure 15

If a cusp is out of contact with the opposing arch, and the distance is 1 mm or less (fig. 16), then 1 point is scored for that tooth. If the cusp is out of contact and the distance is greater than 1 mm (fig. 17), then 2 points are scored for that tooth. No more than 2 points are scored for each tooth.

figure 16   figure 17

OCCLUSAL RELATIONSHIP

This section of the evaluation determines whether the occlusion has been finished in an Angle Class I relationship. Ideally, the maxillary canine cusp tip should align with (or within 1 mm of) the embrasure or contact between the mandibular canine and adjacent premolar (fig. 18). The buccal cusps of the maxillary premolars should align with (or be within 1 mm of) the embrasures or contacts between the mandibular premolars and first molar (fig. 18). The mesiobuccal cusps of the maxillary molars should align with (or be within 1 mm of) the buccal grooves of the mandibular molars (fig. 18).

figure 18

If the maxillary buccal cusps deviate between 1 and 2 mm from the aforementioned positions (fig. 19), then 1 point shall be scored for that maxillary tooth. If the buccal cusps of the maxillary premolars or molars deviate by more than 2 mm from ideal position (fig. 20), then 2 points shall be scored for each maxillary tooth that deviates. No more than 2 points shall be scored for each maxillary tooth. In some situations, the posterior occlusion may be finished in either an Angle Class II or Class III relationship, depending upon the type of tooth extraction in the maxillary or mandibular arches.
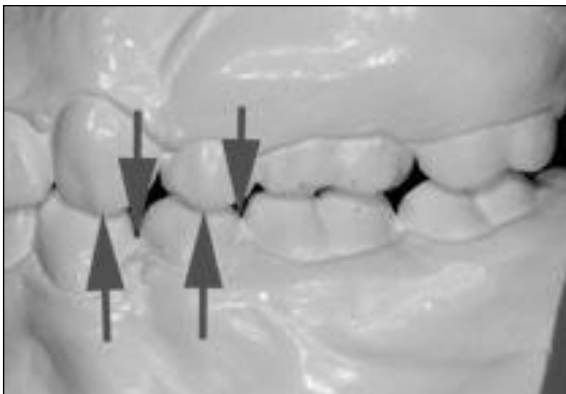
figure 19
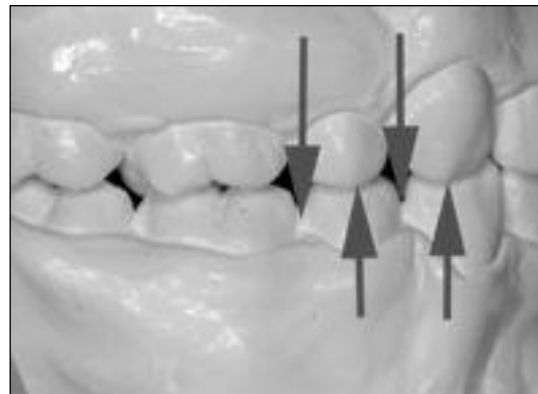
figure 20

In a Class II situation (fig. 21), the buccal cusp of the maxillary first molar should align with the embrasure or interproximal contact between the mandibular second premolar and first molar. The buccal cusp of the maxillary second molar should align with the embrasure or interproximal contact between the mandibular first and second molars. If the final occlusion is finished in a Class III relationship (when mandibular premolars are extracted), the buccal cusp of the maxillary second premolar should align with the buccal groove of the mandibular first molar (fig. 22). The remaining occlusion distal to the maxillary second premolar and mandibular first molar are adjusted accordingly.

figure 21

figure 22

OVERJET

The overjet is evaluated by articulating the models and viewing the labiolingual relationship of the maxillary arch relative to the mandibular arch. In order to determine the proper relationship of the casts, the examiner must rely on the trimming of the backs of the bases of the models. The models are set flat on their backs, in order to determine this assessment (fig. 23).

figure 23

MODEL GRADING SYSTEM

If the models are mounted on an articulator, then the articulated mounting shall determine the proper maxillary and mandibular model relationship. If the proper overjet has been established, then the buccal cusps of the mandibular molars and premolars will contact in the center of the occlusal surfaces, buccolingually, of the maxillary premolars and molars (fig. 24). In the anterior region, the mandibular canines and incisors will contact the lingual surfaces of the maxillary canines and incisors (fig. 25). If this relationship exists, no points are scored.

figure 24

figure 25

If the mandibular buccal cusps deviate 1 mm or less from the center of the opposing tooth (fig. 26), 1 point is scored for that tooth. If the position of the mandibular buccal cusps deviates more than 1 mm from the center of the opposing tooth (fig. 27), two points are scored for that tooth. No more than 2 points are scored for any tooth.
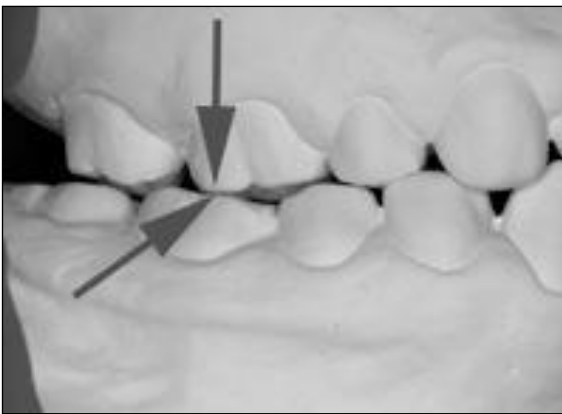
figure 26
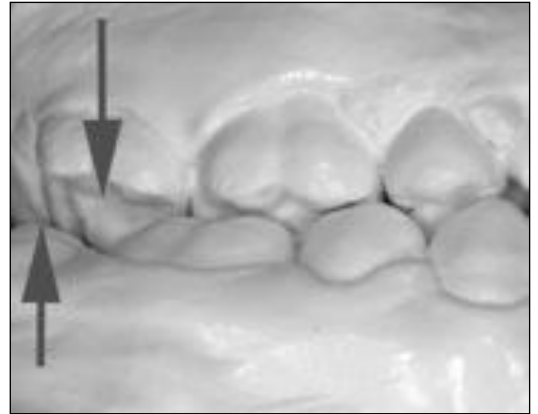
figure 27

In the anterior region, if the mandibular canines or incisors are not contacting lingual surfaces of the maxillary canines and incisors, and the distance is 1 mm or less (fig. 28), then 1 point is scored for each maxillary tooth. If the discrepancy is greater than 1 mm (fig. 29), then 2 points are scored for each maxillary tooth.

figure 28   figure 29

Note that although Overjet is typically scored by assessing contact between opposing teeth, this score is subject to examiner modification. For example, cases in which incisors display extremely acute inter-incisal angles and/or significant overlap of incisal edges may be scored an additional point.

INTERPROXIMAL CONTACTS

This assessment is made by viewing the maxillary and mandibular dental casts from an occlusal perspective. The mesial and distal surfaces of the teeth should be in contact with one another (fig. 30). If 0.50 mm or less interproximal space exists, then no points are scored.

figure 30

If greater than 0.50 to 1 mm of interproximal space exists between two adjacent teeth (fig. 31), then 1 point is scored for that interproximal contact. If more than 1 mm of space is present between two teeth (fig. 32), then 2 points are scored for that interproximal contact. No more than 2 points are scored for any contact that deviates from ideal.
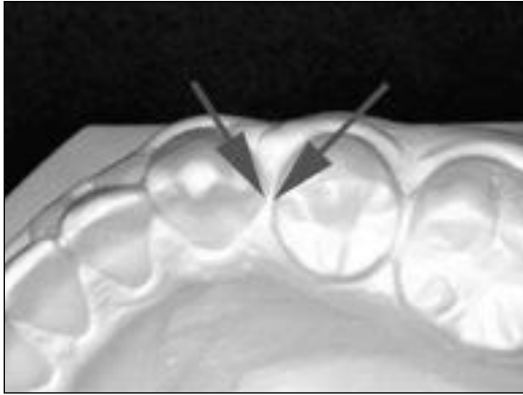
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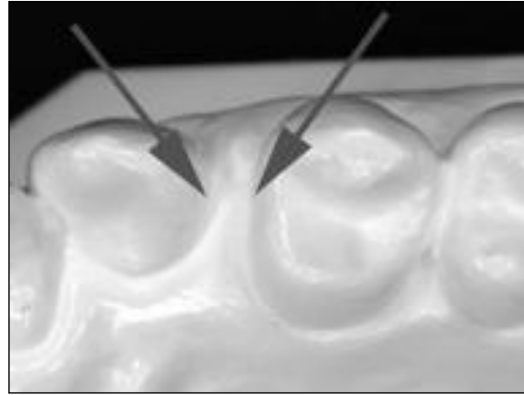
figure 32

RADIOGRAPHIC ANALYSIS

ROOT ANGULATION

The relative angulation of the roots of the maxillary and mandibular teeth is assessed on the panoramic radiograph. Although this is not ideal, it gives a reasonably good assessment of root position. Generally, the roots of the maxillary and mandibular teeth should be parallel to one another and oriented perpendicular to the occlusal plane (fig. 33). If this situation exists, then no points are scored.
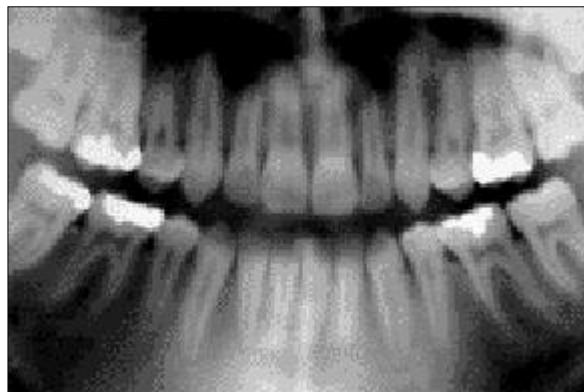
figure 33

MODEL GRADING SYSTEM

The ABO acknowledges the distortion that frequently occurs within panoramic radiographs. The Board has recommended the following:

Omit scoring the canine relationship with adjacent tooth root when using a final panoramic radiograph.

If a root is angled to the mesial or distal (not parallel) and is close to, but not touching, the adjacent tooth root, then 1 point is scored for each discrepancy (anterior, premolar, and/or molar areas, fig. 34). If the root is angled to the mesial or distal and is contacting the adjacent tooth root (fig. 35), then 2 points are scored for that tooth.

figure 34
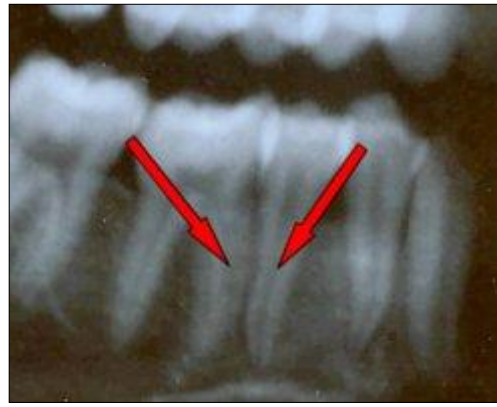
figure 35

MODEL GRADING SYSTEM

EVALUATION OF CASES

The Board's decision to evaluate an individual case as Complete or Incomplete is based upon multiple factors. Record quality and the ability to finish a case are important, but they are not the only aspects that are considered in the evaluation. Case management, a sound understanding of diagnosis, treatment planning and mechanotherapy are equally important and are discussed during the actual interview when cases are reviewed with the examinee.

A score corresponding to Complete in the Cast-Radiograph Evaluation and Case Management are determined at every clinical examination during a pre-exam calibration session of all examiners. Therefore, scores for cases evaluated as Complete will vary from exam to exam and may range from:

- 27 or less for C-R Eval
- 7 or less for CMF
- And, case meets DI and case criteria

High scores on individual segments, or combinations of individual segments, may cause a case to become Incomplete. From time to time, however, a successful interview may result in an overturn of an otherwise Incomplete case.

SUMMARY

The Directors of The American Board of Orthodontics have spent countless hours developing this system for assessing the occlusal and radiographic results of orthodontic treatment. The usefulness of this system depends not only on its objectivity, but more importantly on the validity and reliability of the measurements. After repeated comparison of both objective and subjective systems, the Directors are confident that the "cut-off" score to pass this portion of the clinical examination is valid. Reliability will be insured through the use of a precise measuring instrument, in addition to training and calibration of the Directors before each examination.   In order to be fair to all examinees, a confidence interval is established to account for interrater variability.

Although the underlying purpose of establishing this grading system is to insure reliable, objective evaluation of orthodontic records, the Board sees a much greater benefit to publishing this grading system. Now, examinees may grade their own results before the clinical examination and know if their results will pass Board standards. Furthermore, Diplomates may use this scoring system at anytime in their clinical career to determine if they are producing "Board quality" results. The Board hopes that this method of self-evaluation will help to elevate the overall quality of orthodontic care.

MODEL GRADING SYSTEM

ABO MEASURING GAUGE
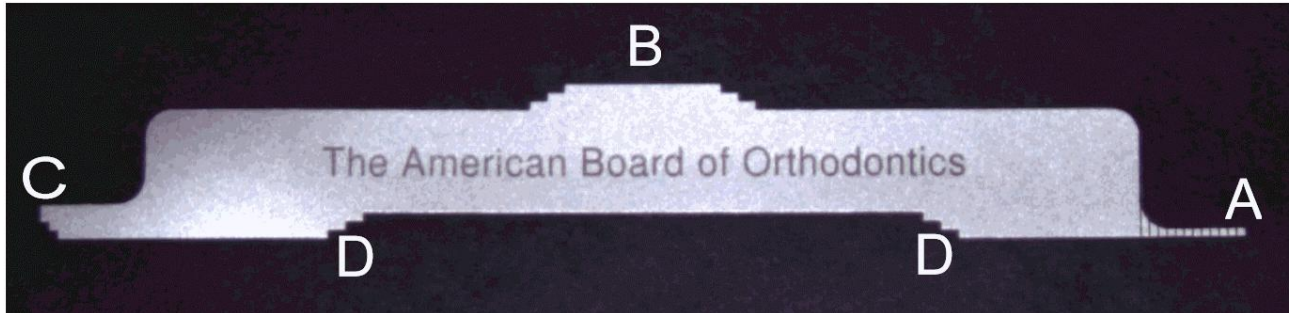
A   This portion of the gauge is in 1 mm increments and is used to measure discrepancies in alignment, overjet, occlusal contact, interproximal contact, and occlusal relationships. The width of the gauge is 0.5 mm.

B   This portion of the gauge has steps measuring 1 mm in height and is used to determine discrepancies in mandibular posterior buccolingual inclination.

C   This portion of the gauge has steps measuring 1 mm in height and is used to determine discrepancies in marginal ridges.

D   This portion of the gauge has steps measuring 1 mm in height and is used to determine discrepancies in maxillary posterior buccolingual inclination.

NOTE: Third molars are not scored unless they substitute for the second molars.

You may download the ABO Grading System for Casts-Radiographs from the ABO website > Orthodontic Professionals > Clinical Examination > Download and Print: Forms and References.

This gauge is included in the Calibration Kit along with three sets of pre-measured cases. There is a digital component to the Calibration Kit which arrives as an attachment to the email receipt of purchase. The digital component contains the grading system manual, panoramic radiographs and scoring keys.

MODEL GRADING SYSTEM

REFERENCES

1.	Eismann, D A method of evaluating efficiency of orthodontic treatment, Trans Europ Orthod Soc, 223-232, 1974

2.	Eismann, D Reliable assessment of morphological changes resulting from orthodontic treatment, Europ J Orthod, 2:19-25, 1980

3.	Gottlieb, E Grading your orthodontic treatment results, J Clin Orthod, 9:156-161, 1975

4.	Berg, R Post-retention analysis of treatment problems and failures in 264 consecutively treated cases, Europ J Orthod, 1:55-68, 1979

5.	Summers, C The occlusal index: a system for identifying and scoring occlusal disorders, Am J Orthod, 59:552-566, 1971

6.	Richmond, S., Shaw, W, et al. The development of the PAR Index (Peer Assessment Rating): reliability and validity, Europ J Orthod, 14:125-139, 1992

7.	Mckee, I., Williamson, C., et al. The accuracy of 4 panoramic units in the projection of mesiodistal tooth angulations, AJO-DO 2002, 121:166-175

8.	Peck, J., Sameshima, G., et al. Mesiodistal Root Angulation Using Panoramic and Cone Beam CT, Angle Orthodontist 2007, No. 2:206-213

9.	Owens, A. M., Johal, A. Near End of Treatment Panoramic Radiograph in the Assessment of Mesiodistal Root Angulation, Angle Orthodontists, Vol 78, No.3:475-481

MODEL GRADING SYSTEM

MAJOR UPDATES

Pre-2006   Marginal Ridges – In scoring, do not include the canine-premolar contact; and do not include the distal of lower 1st premolar.
Occlusal Contacts - Do not score diminutive distolingual cusps of the maxillary 1st and 2nd molars, nor lingual cusps of the maxillary first premolars.

2006   Language update - revise historical discussions; change "candidate" to "examinee"; change "Phase III" to "Clinical".
Root Angulation - Other than periapical radiographs or three-dimensional imaging, the panoramic radiograph is probably the best   practical means for making this assessment. It is incumbent upon the examinee to present imaging evidence to document posttreatment root position.

2007   Points will be scored in absolute value; therefore, change "deduct points" to "score points".
Language update - change "Objective Grading System" to "Model Grading System".
References – Addition of McKee; Peck, Owens articles.

June 2008   Occlusal Contacts – If cusp is out of contact, score for each posterior tooth; no more than 2 points per tooth.
Root Angulation – Omit scoring the canine relationship with adjacent root; new examples for Figures 34 and 35.

June 2010   Buccolingual Inclination –
When positioned in this manner, the straight edge should contact the buccal cusps of contralateral mandibular molars and premolars.
Do **not** score the mandibular 1st premolars nor the distal cusps of the second molars.

March 2011   Overjet – Note that although Overjet is typically scored by assessing contact between opposing teeth, this score is subject to examiner modification. For example, cases in which incisors display extremely acute inter-incisal angles and/or significant overlap of incisal edges may be scored an additional point.

June 2012   Scoring for Complete/Incomplete – new section and title replaces former discussion titled Passing Score.

Reference - ABO Cast/Radiograph Evaluation

See **Grading System for Casts-Radiographs** for entire discussion

ALIGNMENT/ROTATIONS

0.5 – 1 mm	=	1	for each tooth
> 1 mm	=	2	for each tooth

OCCLUSAL CONTACTS

0 mm	=	satisfactory	
≤ 1 mm	=	1	(for each posterior
> 1 mm	=	2	tooth out of contact)

** Do **not** score diminutive distolingual cusps of the maxillary 1st and 2nd molars, nor lingual cusps of the mandibular first premolars. **Maximum of 2 points per tooth**.

MARGINAL RIDGES

0.5 - 1 mm	=	1	(for each interproximal contact
> 1 mm	=	2	between posterior teeth)

** Do **not** include the canine-premolar contact.
Do **not** include the distal of lower 1st premolar.

OCCLUSAL RELATIONSHIP

< 1 mm	=	satisfactory	
1 - 2 mm	=	1	(for each maxillary **tooth** from the
> 2 mm	=	2	the canines to the 2nd molars)

BUCCOLINGUAL INCLINATION

0 - 1 mm	=	satisfactory	
1.1 - 2 mm	=	1	(for each posterior tooth)
> 2 mm	=	2	

** Do **not** score the mandibular 1st premolars nor the distal cusps of the second molars.

INTERPROXIMAL CONTACTS

0.6 - 1 mm	=	1	(for each interproximal
> 1 mm	=	2	**contact)**

OVERJET

Anterior teeth must be contacting.

0 mm	=	satisfactory	
≤ 1 mm	=	1	(for each maxillary
> 1 mm	=	2	tooth)

Transverse posterior teeth:
Mandibular buccal cusps are measured to the central fossa of the maxillary teeth.

ROOT ANGULATION

Parallel	=	0
Not parallel	=	1
Root contacting adjacent root	=	2 (for each **occurrence**)

Do **not** score the maxillary and mandibular canines.

NOTE: Gauge Width is 0.5 mm; Gauge Height is 1 mm
Third molars are not scored unless they substitute for the second molars.
No tooth is scored more than two points per individual parameter.

ABO Cast-Radiograph Evaluation

Case #

Total C-R Eval Score:
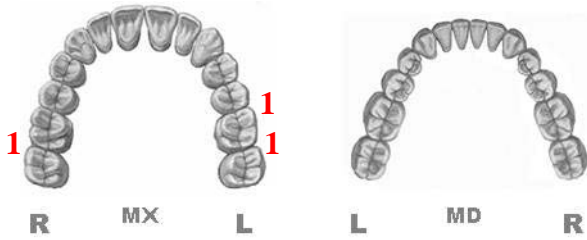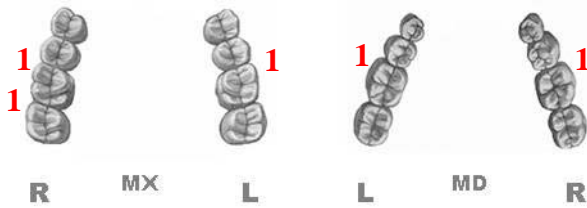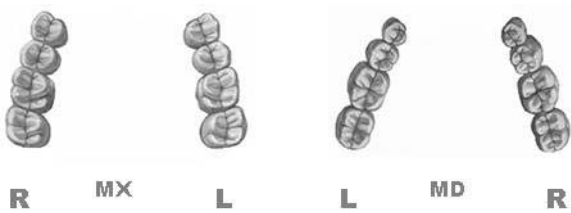
Occlusal Contacts

Alignment/Rotations

R   MX   L   L   MD   R

R   Buccal Surface   L

L   Lingual Surface   R

Marginal Ridges

R   MX   L   L   MD   R

Occlusal Relationships

R   L

Buccolingual Inclination

R   MX   L   L   MD   R

Interproximal Contacts

R   L

Overjet

R   MX   L

Root Angulation

R   L

INSTRUCTIONS: *Place score beside each deficient tooth and enter total score for each parameter in the white box. Place an "X" on extracted teeth. Second molars should be in occlusion.*

Case #3
19 yr 8 mo

ABO Cast-Radiograph Evaluation

Case #   **I**

Total C-R Eval Score: **21**
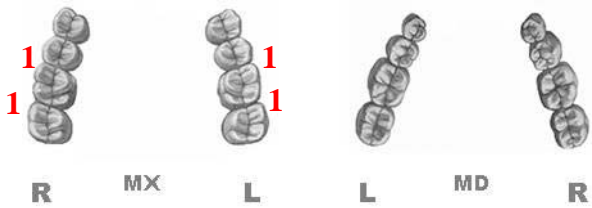
Alignment/Rotations
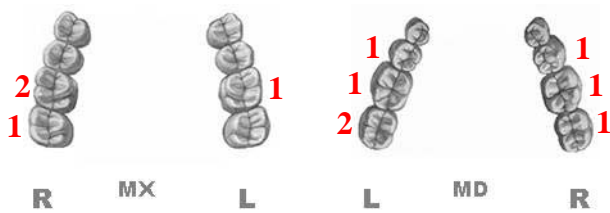
3

1   1   1

R   MX   L   L   MD   R

Marginal Ridges

5

1   1   1   1
1

R   MX   L   L   MD   R

Buccolingual Inclination

0

R   MX   L   L   MD   R

Overjet

0

R   MX   L

Occlusal Contacts

3

R   1 1 1   Buccal Surface   L

L   Lingual Surface   R

Occlusal Relationships

7

R   1 1 2   2 1   L

Interproximal Contacts
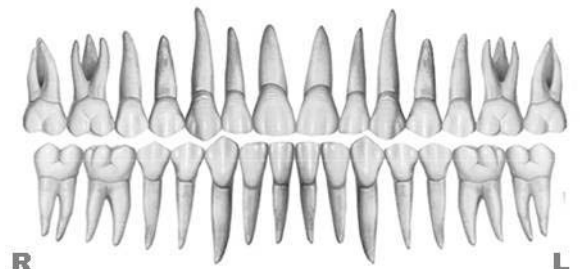
0

R   L

Root Angulation

3

1   1

R   1   L
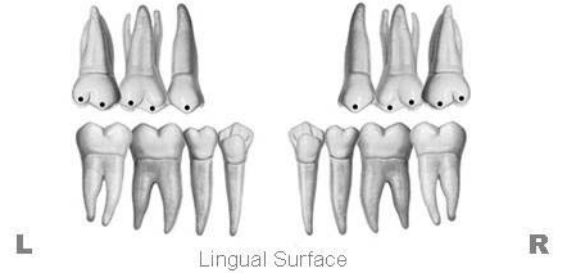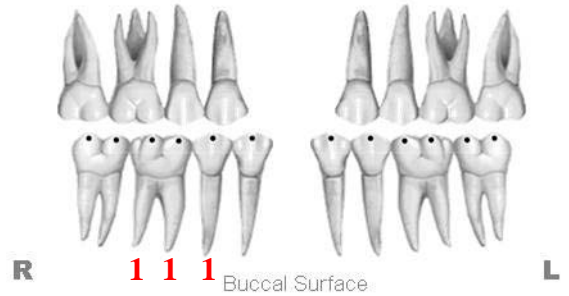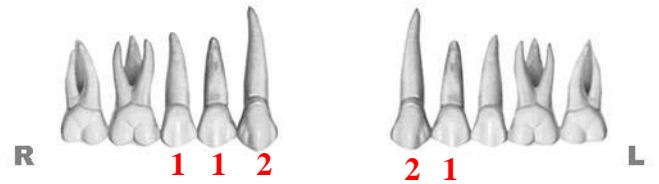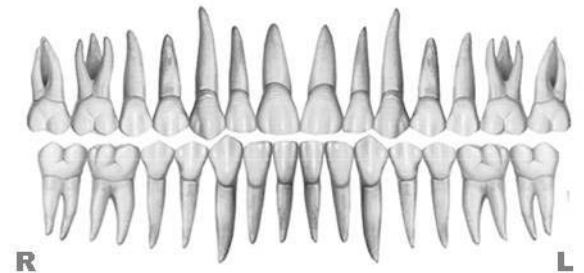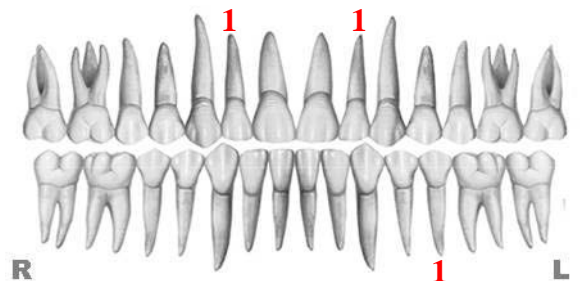
INSTRUCTIONS: Place score beside each deficient tooth and enter total score for each parameter in the white box. Place an "X" on extracted teeth. Second molars should be in occlusion.
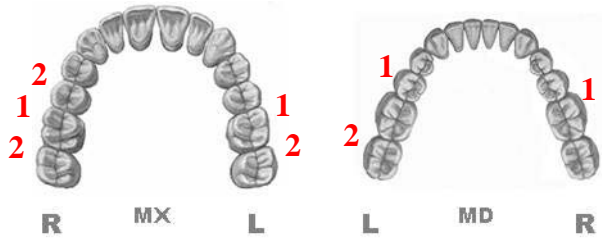
ABO Cast-Radiograph Evaluation
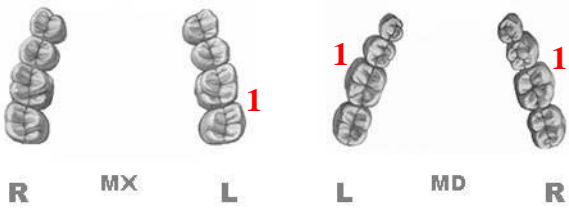
Case #   **II**

Total C-R Eval Score: **25**

Alignment/Rotations

4
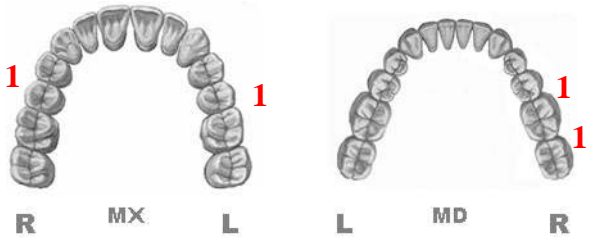
1   1   1   1

R   MX   L   L   MD   R

Marginal Ridges

4

1   1   1   1

R   MX   L   L   MD   R

Buccolingual Inclination

11

2   1   1   1   1   1
1   2   1

R   MX   L   L   MD   R

Overjet

2

1

1

R   MX   L

Occlusal Contacts

0

R   L
Buccal Surface

L   R
Lingual Surface
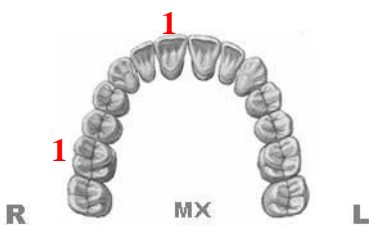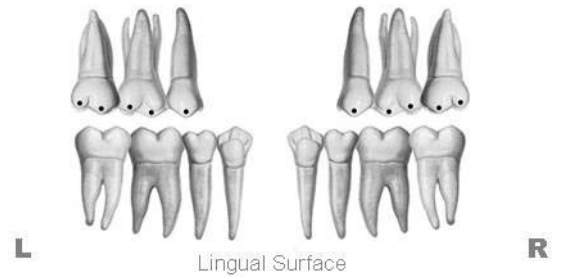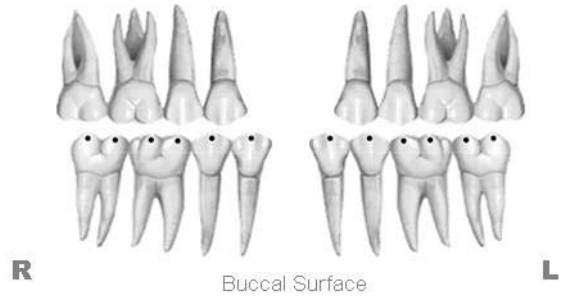
Occlusal Relationships

4

1   1   1   1

R   L

Interproximal Contacts

0

R   L

Root Angulation

0

R   L
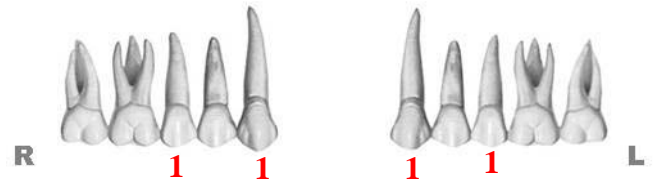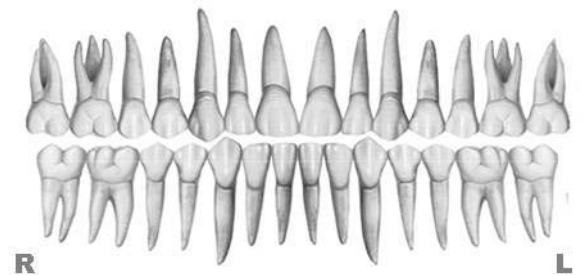
INSTRUCTIONS: Place score beside each deficient tooth and enter total score for each parameter in the white box. Place an "X" on extracted teeth. Second molars should be in occlusion.

ABO Cast-Radiograph Evaluation

Case #   **III**

Total C-R Eval Score: **40**
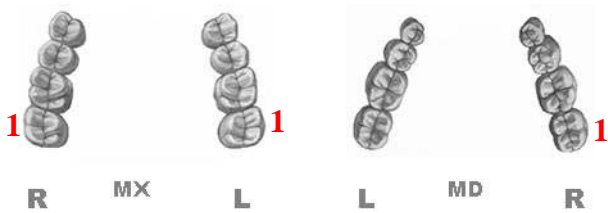
Occlusal Contacts

5
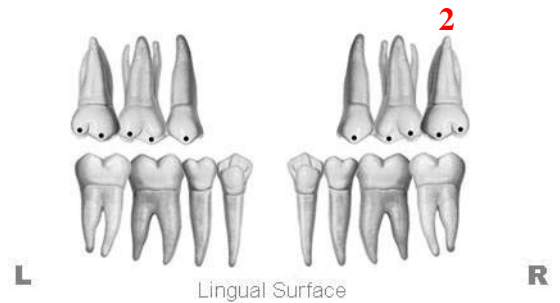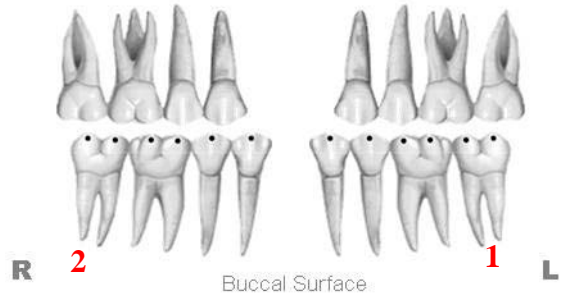
2   1

R   2   1   L

Buccal Surface

2

L   R

Lingual Surface

Alignment/Rotations

12

2
1   1
2   2
2

R   MX   L   L   MD   R

Occlusal Relationships

6
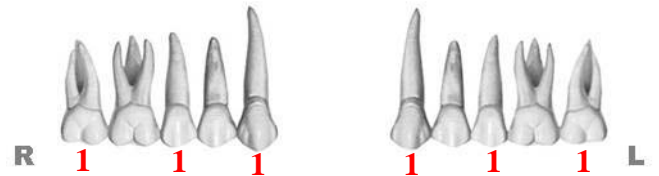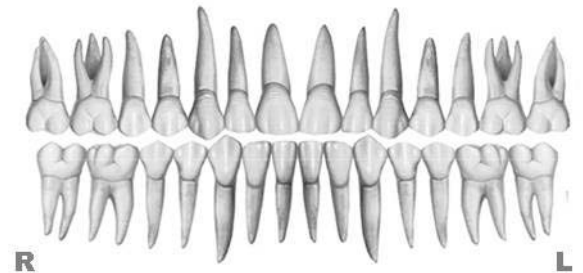
R   1   1   1   1   1   1   L

Marginal Ridges

3

1   1
1

R   MX   L   L   MD   R

Interproximal Contacts

0

R   L

Buccolingual Inclination

3

1   1   1

R   MX   L   L   MD   R

Root Angulation

5

1   1   2

R   1   L

Overjet

6

2   2

2

R   MX   L
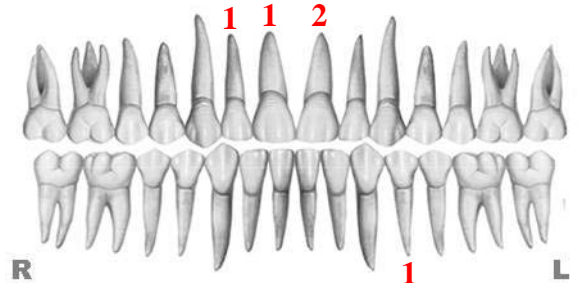
INSTRUCTIONS: Place score beside each deficient tooth and enter total score for each parameter in the white box. Place an "X" on extracted teeth. Second molars should be in occlusion.

TOTAL D.I. SCORE

[ ]

For mm measures, round up to the next full mm.
Examiners will verify measurements in each category.

OVERJET

≥ 0 to < 1 mm (edge-to-edge)	=	1 pt
≥ 1 to ≤ 3 mm	=	0 pts
> 3 to ≤ 5 mm	=	2 pts
> 5 to ≤ 7 mm	=	3 pts
> 7 to ≤ 9 mm	=	4 pts
> 9 mm	=	5 pts
Negative Overjet (x-bite):		
1 pt per mm per tooth	=	___ pts

Total [ ]

OVERBITE

> 1 to ≤ 3 mm	=	0 pts
> 3 to ≤ 5 mm	=	2 pts
> 5 to ≤ 7 mm	=	3 pts
Impinging (100%)	=	5 pts

Total [ ]

ANTERIOR OPEN BITE

0 mm (edge-to-edge), 1 pt per tooth	=	____ pts
then 1 pt per mm per tooth	=	____ pts

Total [ ]

LATERAL OPEN BITE

≥ 0.5 mm, 2 pts per mm per tooth

Total [ ]

CROWDING (only one arch)

≥ 0 to ≤1 mm	=	0 pts
> 1 to ≤ 3 mm	=	1 pts
> 3 to ≤ 5 mm	=	2 pts
> 5 to ≤ 7 mm	=	4 pts
> 7 mm	=	7 pts

Total [ ]

OCCLUSAL RELATIONSHIP

Class I to End On	= 0 pts	
End-to-End Class II or III	= 2 pts per side	____ pts
Full Class II or III	= 4 pts per side	____ pts
Beyond Class II or III	= 1 pt per mm additional	____ pts

Total [ ]

LINGUAL POSTERIOR X-BITE

> 0 mm, 1 pt per tooth   Total [ ]

BUCCAL POSTERIOR X-BITE

> 0 mm, 2 pts per tooth   Total [ ]

CEPHALOMETRICS (See Instructions)

ANB ≥ 6° or ≤ -2°	@4pts	= ___
Each full degree > 6°	___ x 1 pt	= ___
Each full degree < -2°	___ x 1 pt	= ___
SN-MP		
≥ 38°	@2pts	= ___
Each full degree > 38°	___ x 2 pts	= ___
≤ 26°	@1pt	= ___
Each full degree < 26°	___ x 1 pt	= ___
1 to MP ≥ 99°	@1pt	= ___
Each full degree > 99°	___ x 1 pt	= ___

Total [ ]

OTHER (See Instructions)

Supernumerary teeth	___ x 1 pt	= ___
Ankylosis of permanent teeth	___ x 2 pts	= ___
Anomalous morphology	___ x 2 pts	= ___
Impaction (except 3rd molars)	___ x 2 pts	= ___
Midline discrepancy (≥3 mm)	@ 2 pts	= ___
Missing teeth (except 3rd molars)	___ x 1 pt	= ___
Missing teeth, congenital	___ x 2 pts	= ___
Spacing (4 or more, per arch)	___ x 2 pts	= ___
Spacing (mx cent diastema ≥ 2 mm)	@ 2 pts	= ___
Tooth transposition	___ x 2 pts	= ___
Skeletal asymmetry (nonsurgical tx)	@ 3 pts	= ___
Addl. treatment complexities	___ x 2 pts	= ___

Identify:

Total Other [ ]

30130315

ABO DISCREPANCY INDEX INSTRUCTIONS

Occlusion for plaster models is determined by placing the separated, properly trimmed study casts (Mx/Mn) on a flat surface and then bringing them together into maximum intercuspation. All measurements must be made from this position. For digital models, measurements will be made from a standard 3D orientation that is described in ABO Operational Definition for Digital Model Orientation.

OVERJET: Overjet is a measurement between two antagonistic anterior teeth (lateral or central incisors) comprising the greatest overjet and is measured from the facial surface of the most lingual tooth (Mx or Mn) to the middle of the incisal edge of the more facially positioned tooth (Mx or Mn).

- For ≥0 to <1 mm, score 1 pt (edge-to-edge)
- For ≥1 to ≤3 mm, score 0 pts
- For >3 to ≤5 mm, score 2 pts
- For >5 to ≤7 mm, score 3 pts
- For >7 to ≤9 mm, score 4 pts
- For >9 mm, score 5 pts.
- In addition, if there are teeth with negative overjet (canine to canine in anterior crossbite >0 mm),
    - Measure from the middle of the incisal edge of the maxillary tooth to the facial surface of the mandibular tooth
    - Round up each measure to the next mm
    - Then score 1 pt per mm per anterior tooth in crossbite.

OVERBITE: Overbite is a measurement between two antagonistic anterior teeth (lateral or central incisors) comprising the greatest overbite.

- For >0 to ≤3 mm, score 0 pts
- For >3 to ≤5 mm, score 2 pts
- For >5 to ≤7 mm, score 3 pts
- If any one of the lower incisors are impinging on the palatal tissues or there is 100% overbite (a complete vertical overlap of antagonistic incisors), score 5 pts.

ANTERIOR OPEN BITE: For each anterior tooth (canine to canine) in an open bite relationship with an opposing tooth, measure from the incisal edge of the Mx tooth to the incisal edge of the Mn tooth.

- For each anterior tooth in edge-to-edge relationship (0 mm), score 1 pt per tooth.
- For each anterior tooth in open bite (> 0 mm), round up the measure to the next full mm
- Then add 1 pt per mm per tooth in open bite.
- No points are scored for any anterior tooth that is blocked-out of the arch due to space deficiency or not fully erupted.

LATERAL OPEN BITE: For each maxillary posterior tooth (from the 1st premolar to 2nd molar) in an open bite relationship ≥ 0.5 mm from its opposing tooth,

- Round up each measure to next full mm
- Then score 2 pts per mm of open bite for each tooth.
- No points are scored for any tooth that is blocked-out of the arch due to space deficiency or not fully erupted.

CROWDING: Measure the most crowded arch (only one arch) from the mesial contact point of the right first molar to the mesial contact point of the left first molar.

- For ≥0 to ≤1 mm, score 0 pts
- For >1 to ≤3 mm, score 1 pt
- For >3 to ≤5 mm, score 2 pts
- For >5 to ≤7 mm, score 4 pts
- For >7 mm, score 7 pts.

OCCLUSAL RELATIONSHIP: Models must exhibit the patient's maximum intercuspation. The Angle molar classification is used.

- If the mesiobuccal cusp of the maxillary first molar occludes with the buccal groove of the mandibular first molar or anywhere between the buccal groove and the mesiobuccal or distobuccal cusps (Class I to End On) - Score 0 pts.
- If the mesiobuccal cusp of the maxillary first molar occludes with the mesiobuccal (Class II end-to-end) or distobuccal (Class III end-to-end) cusps of the mandibular first molar – Score 2 pts per side.
- If the relationship is a full Class II or III - Score 4 pts per side.
- If the relationship is beyond Class II or III, measure the additional distance, round up to next full mm - Score 1 addl. pt per mm per side.

LINGUAL POSTERIOR CROSSBITE: For each maxillary posterior tooth (from the 1st premolar to the 2nd molar) where all the maxillary buccal cusps are > 0 mm lingual to the buccal cusp(s) tip of the opposing tooth - Score 1 pt per tooth.

BUCCAL POSTERIOR CROSSBITE: For each maxillary posterior tooth (from the 1st premolar to the 2nd molar) where all the maxillary palatal cusps are > 0 mm buccal to the buccal cusp(s) of the opposing tooth - Score 2 pts per tooth.

CEPHALOMETRICS: (See [Construction of Mandibular Plane](#))
- If the ANB angle is (6° or greater) OR (-2° or less) - Score 4 pts.
  - Also, for each full degree above 6° or below -2° - Score an additional pt.
- If the SN-MP angle is between 27° and 37° - Score 0 pts.
- If the SN-MP angle is 38° or greater - Score 2 pts for each full degree above 37°.
- If the SN-MP angle is 26° or less - Score 1 pt for each full degree below 27°.
- If the Lower Incisor to MP angle is 99° or greater - Score 1 pt for each full degree above 98°.

OTHER: (List number of occurrences and total points.)

- **Supernumerary** teeth – Score 1 pt for each extra tooth.

- **Ankylosis** of permanent teeth – Score 2 pts per tooth.

- **Anomalous morphology** of tooth size & shape (e.g. natural and/or iatrogenic) - Score 2 pts per tooth.

- **Impaction** of teeth (except 3rd molars) – Score 2 pts per tooth.

- **Midline discrepancy** – The midline for each arch equals the mid-point between the Mx central incisors and the Mn central incisors demonstrated by two vertical reference lines. The discrepancy is the difference between the two vertical reference lines measured in the horizontal plane – Score 2 pts for ≥ 3 mm.

- **Missing teeth** (except 3rd molars) -
  - Non-congenital – Score 1 pt per tooth.
  - Congenital – Score 2 pts per tooth.

- **Spacing** –
  - For generalized spacing per arch in which there is ≥ 0.5 mm of space on both sides of any 4 teeth or more - Score 2 pts per arch.
  - For Mx central diastema of ≥ 2 mm - Score 2 pts.

- **Tooth transposition** – Score 2 pts for each event.

- **Skeletal asymmetry** (treated nonsurgically) – Score 3 pts (appropriate diagnostic information recommended)

- **Additional treatment complexities -** Score 2 pts each and identify.

FOR ADDITIONAL VISUAL REFERENCE, SEE "[DISCREPANCY INDEX SCORING SYSTEM](#)"
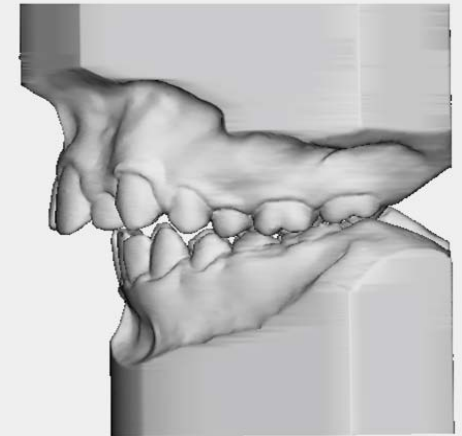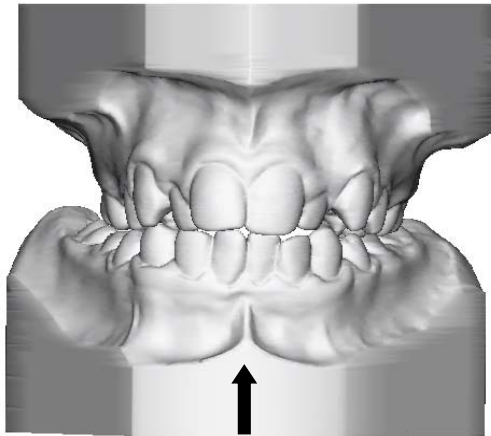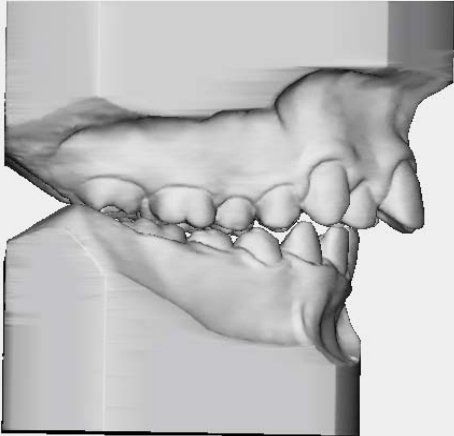
The ABO Discrepancy Index (DI)
A Measure of Case Complexity
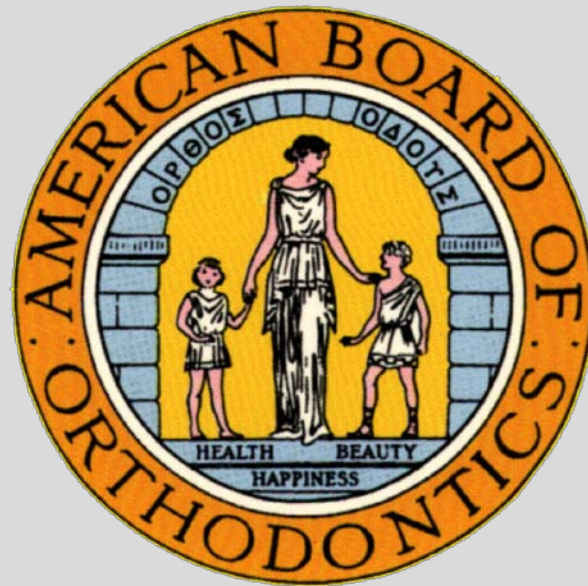
# Target Disorders for Discrepancy Index

1. Overjet

2. Overbite

3. Anterior Open Bite

4. Lateral Open Bite

5. Crowding

6. Occlusal Relationship

7. Lingual Posterior Crossbite

8. Buccal Posterior Crossbite

9. ANB Angle

10. SN-MP Angle

11. Lower Incisor to MP

12. Other

# Occlusal Relationship
Position of the Models

Occlusion for plaster models is determined by placing the backs of properly trimmed casts (Mx/Mn) on a flat surface and then bringing them together into maximum intercuspation. All measurements must be made from this position. For digital models, measurements will be made from a standard 3D orientation that is described in ABO Operational Definition for Digital Model Orientation.

Overjet (horizontal overlap) Relationship
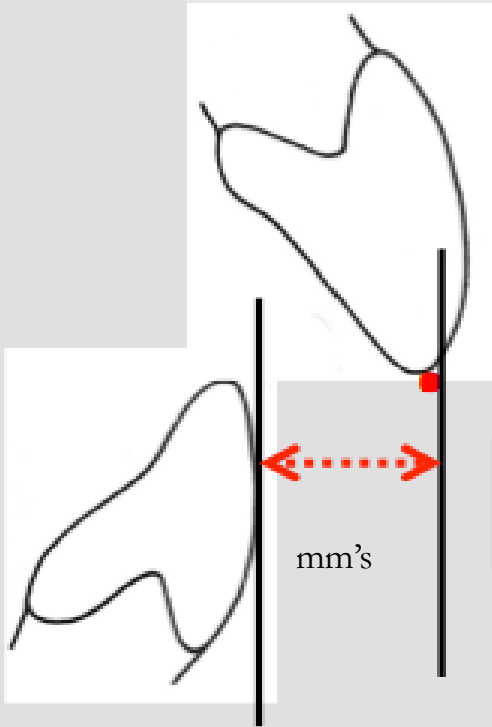
mm's

Overjet is a measurement between two antagonistic anterior teeth (lateral or central incisors) comprising the greatest overjet and is measured from the facial surface of the most lingual tooth (Mx or Mn) to the middle of the incisal edge of the more facially positioned tooth (Mx or Mn).

Negative Overjet Relationship

mm's
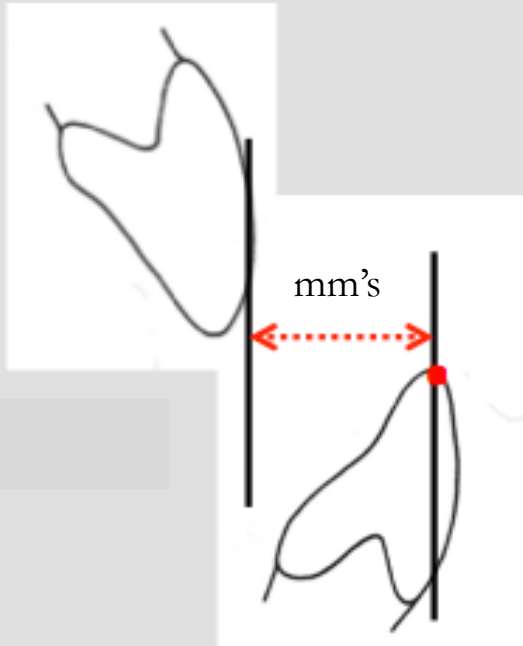
 If there are teeth with negative overjet (canine to canine in anterior crossbite > 0 mm), round up each measure to the next mm, then score 1 point per mm per anterior tooth in crossbite. This is measured from the middle of the incisal edge of maxillary tooth to the facial edge of the mandibular tooth.

Overbite (vertical overlap) Relationship

B. Represents an overlap of greater than <u>5 mm</u> therefore **3** points are given

B.

A.

1.5 mm overlap yields <u>no</u> points

100% Overbite

Vertical Tissue Impingement

C.

C. Represents 100% overbite or vertical tissue impingement therefore **5** points are given
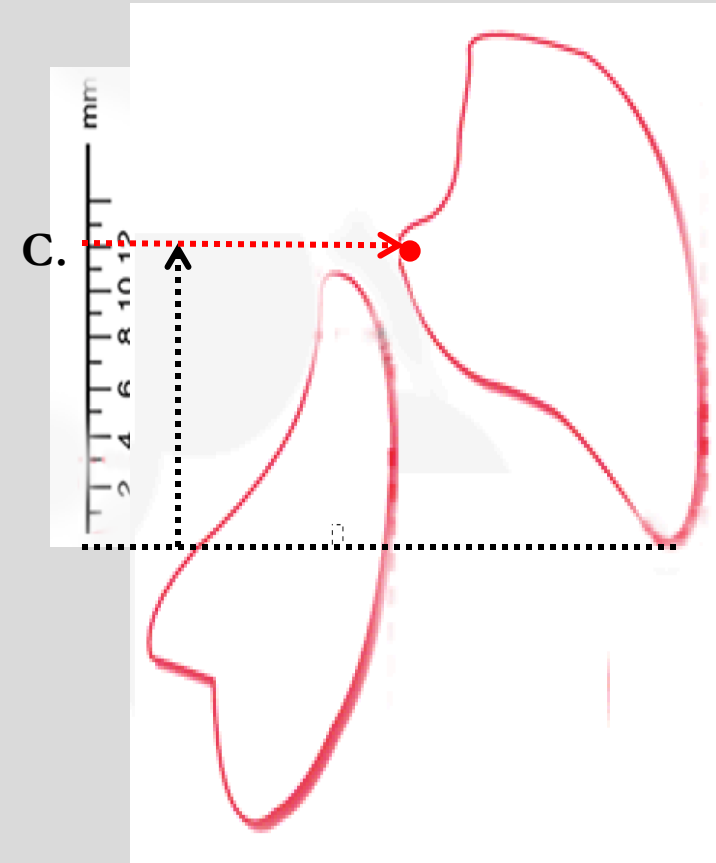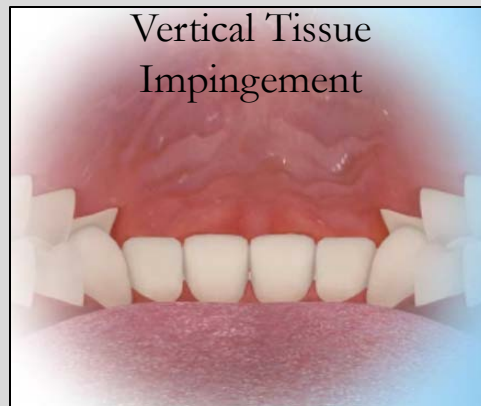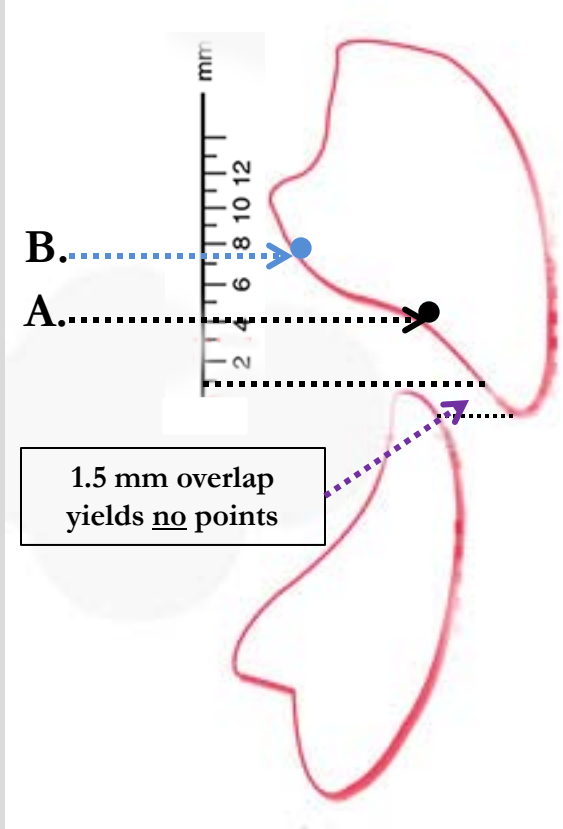
A. Represents an overlap of greater than <u>3 mm</u> therefore **2** points are given

Anterior Openbite Relationship

Per Opposing Tooth
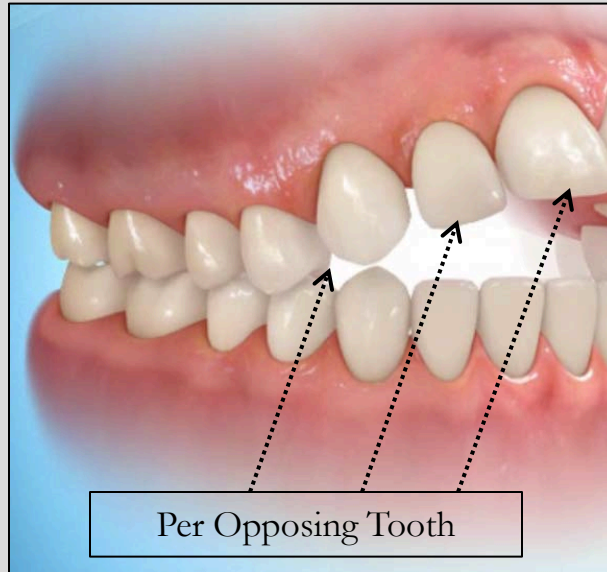
4.6 mm= 5.0 pts.

One (1) point for each anterior tooth in an edge-to-edge relationship

For each tooth in openbite, round up the measure to the next full mm., then add one point per/mm/tooth in open bite

Lateral Openbite Relationship

For each maxillary posterior tooth (from the 1st premolar to the 2rd molar) in an open bite relationship ≥ 0.5 mm from its opposing tooth:
• Round each measure up to the next full mm
• Then score 2 points per mm of open bite for each tooth.
•No points are scored for any tooth that is blocked out of the arch due to space deficiency or not fully erupted.
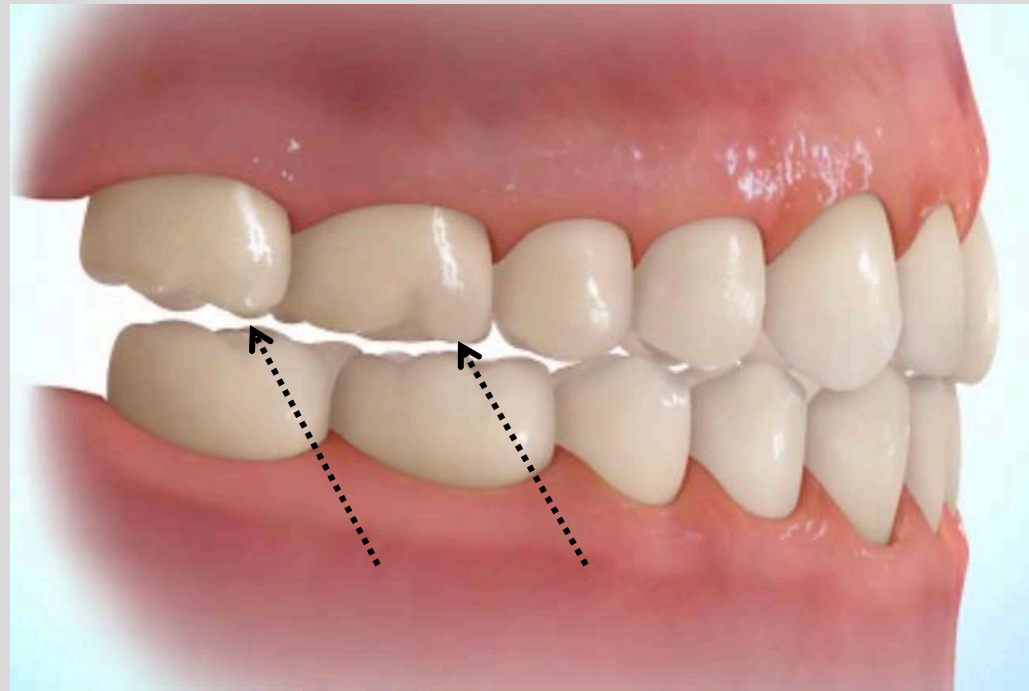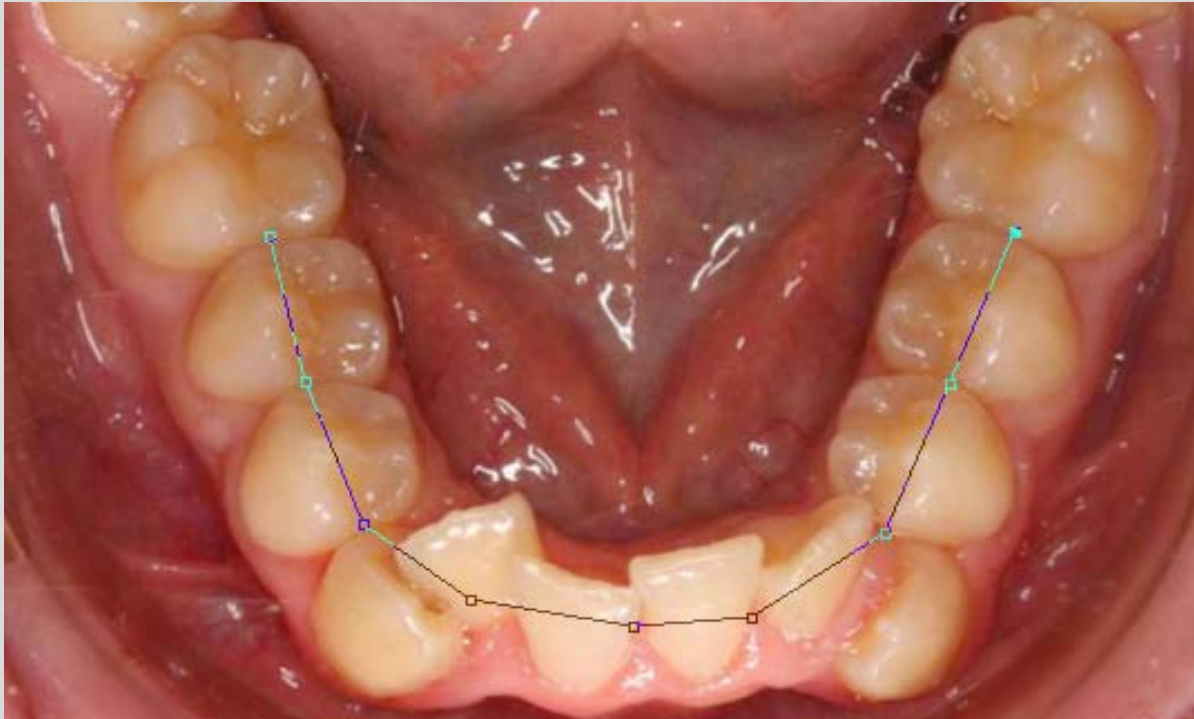
Crowding

Measure the most crowded arch (only one arch) from the mesial contact point of the right first molar to the mesial contact point of the left first molar.

Estimated Amount of Dental Crowding

14.0 mm crowding
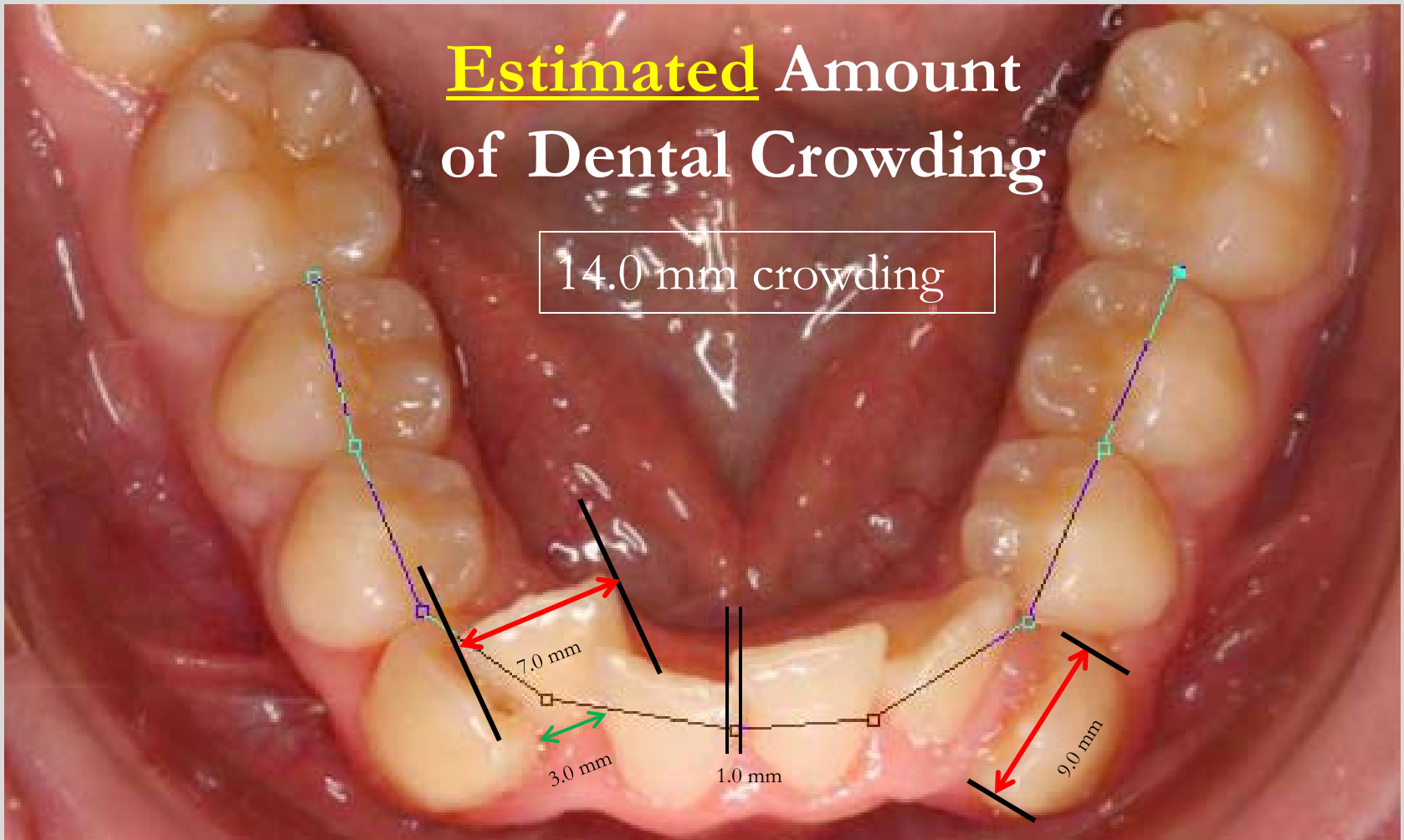
7.0 mm

3.0 mm

1.0 mm

9.0 mm

1. Md. right lateral incisor= 7.0 mm.
2. Md . space= 3.0 mm.
3. Md. right central incisor= 1.0 mm. of crowding
4. Md. left canine= 9.0 mm.
5. 0.0 space available for md. left canine
6. Therefore crowding irrespective of arch form position __is estimated__ at 14.0 mm of dental crowding

Occlusal Relationship

When scoring occlusal relationship, models must exhibit the patient's maximum intercuspation. The Angle molar classification is used.

Molar classification is then determined for each side of the arch:
- Locate the mesio-buccal cusp of the maxillary first molar. -demonstrated by red dot.
- Locate the two buccal cusps and two interproximal contact points of the mandibular first molar – demonstrated by blue dots.
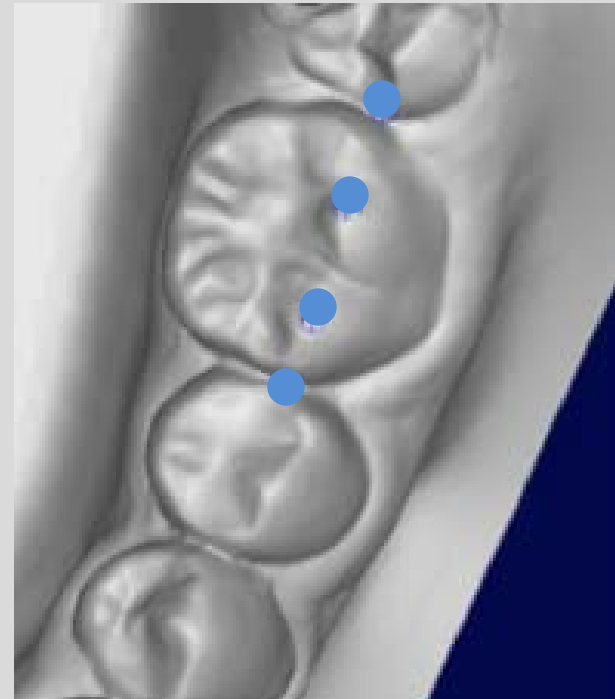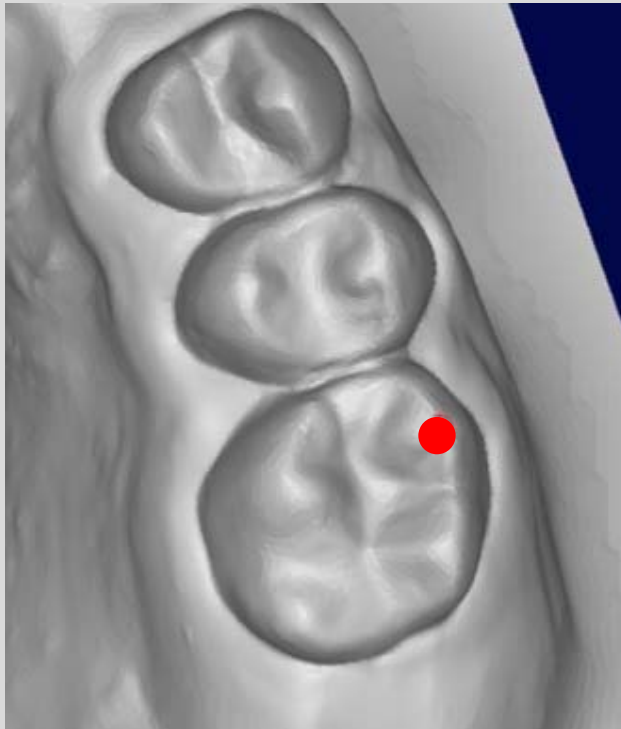
Occlusal Relationship

ABO Operational Definition for Molar Relationship

Beyond CIII
Full Cusp CIII
End On CIII
Class I
End On CII
Full CII
Beyond CII

B6
B5
B4
B3
B2
B1
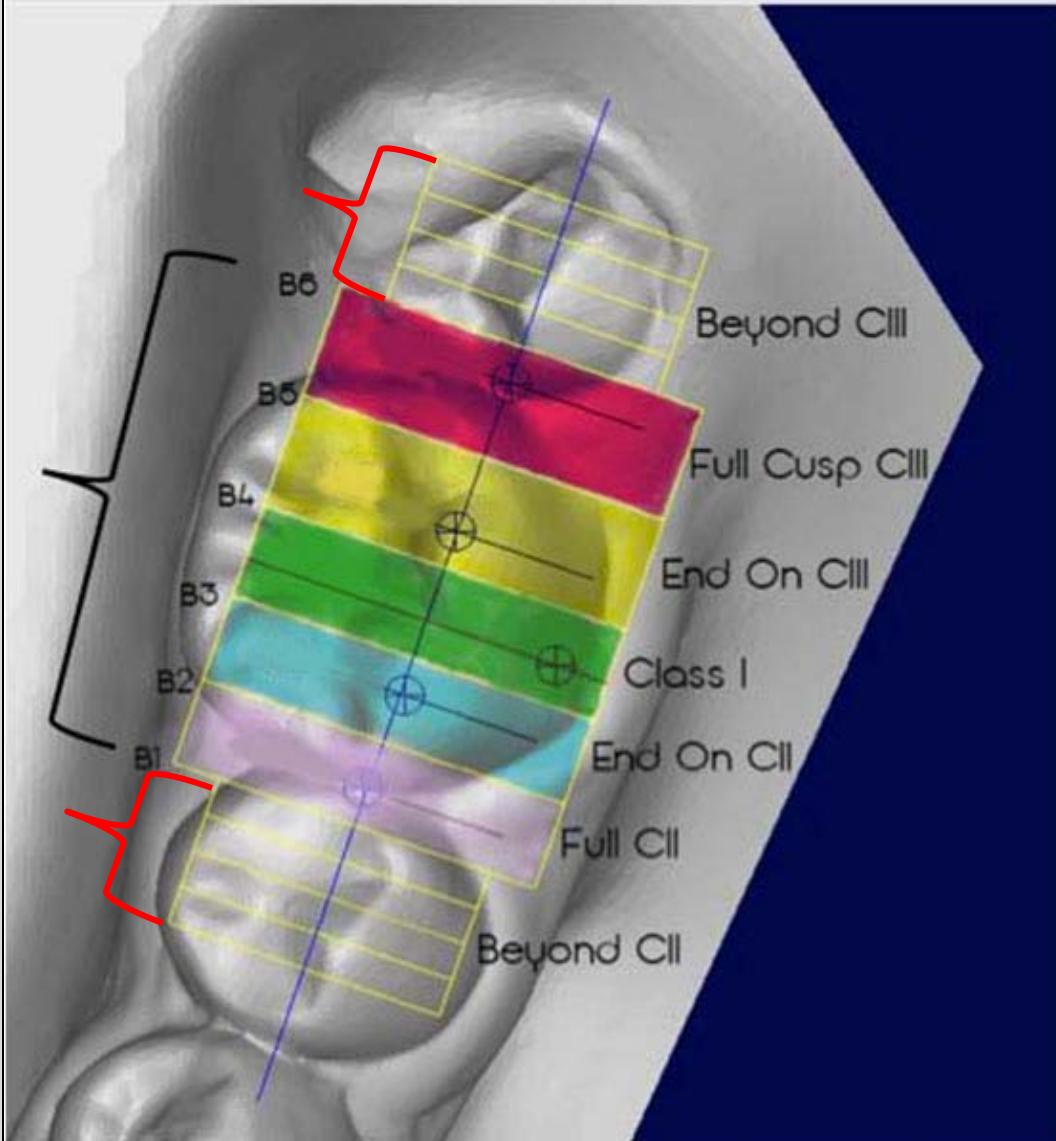
For DI scoring per side, the location of the cusp within the zones is an estimation

1. B1-B2- Full Cusp Class II- Lavender- 4 pts.

2. B2-B3- End to End Class II- Aqua- 2 pts.

3. B3-B4- Class I- Green- 0 pts.

4. B4-B5- End to End Class III- Yellow- 2 pts.

5. B5-B6- Full Cusp Class III- 4 pts.

6. One (1) point is awarded for each additional zone mesial to B1 or distal to B6

If the relationship is beyond Class II or III, measure the additional distance, round up to next full mm, then score 1 addl. point per mm per side

Lingual Posterior Crossbite

For each maxillary posterior tooth (from the 1st premolar to the 2rd molar) where all the maxillary buccal cusps are >0 mm lingual to the buccal cusp(s) tip of the opposing tooth, score 1 point per tooth.

1 pt.   1 pt.   1 pt.   1 pt.
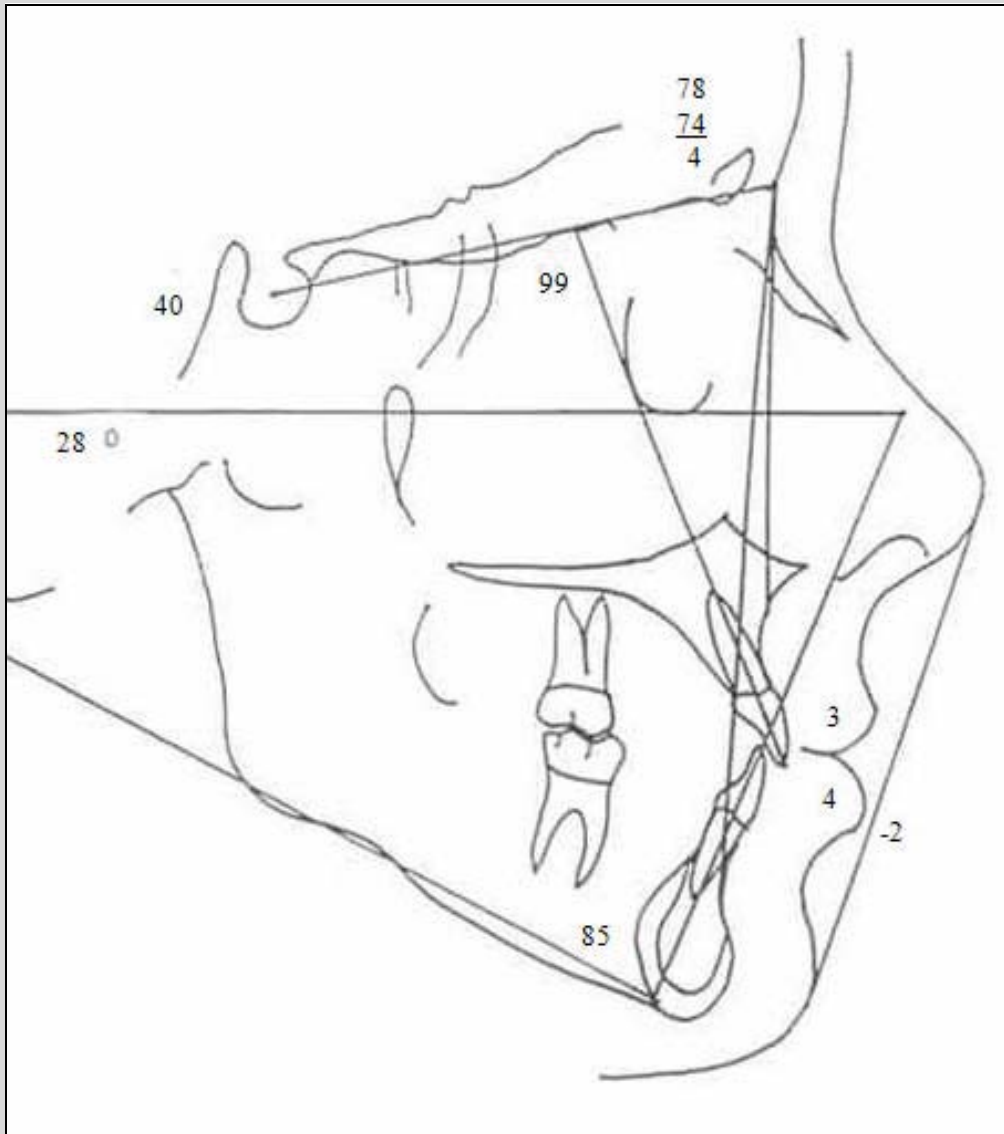
Total of 4 pts.

Buccal Posterior Crossbite

For each maxillary posterior tooth (from the 1st premolar to the 2rd molar) where the maxillary palatal cusp(s) are > 0 mm buccal to the buccal cusp(s) of the opposing tooth, score 2 points per tooth.
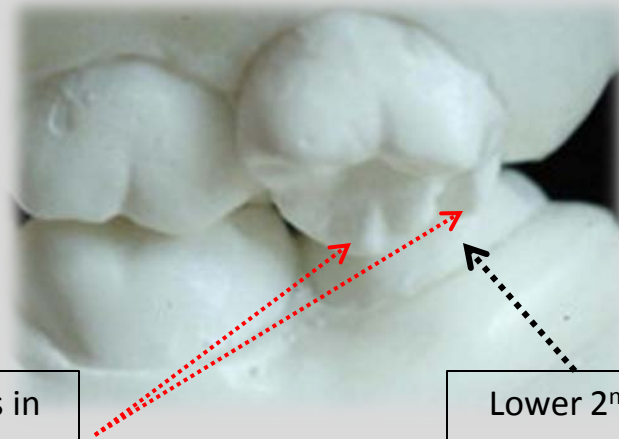
2 pts.

Upper 2nd molar lingual cusps in buccal crossbite

Lower 2nd molar buccal surface

Cephalometrics

ANB $\geq$ 6° or $\leq$ -2°   = 4 pts
    Each full degree > 6°   add 1 pt
    Each full degree < -2°   add 1 pt

SN-MP
    $\geq$ 38°   = 2 pts
    Each full degree > 38°   add 2 pts
    $\leq$ 26°   = 1 pt
    Each full degree < 26°   add 1 pt

$\overline{1}$ to MP $\geq$ 99°   = 1 pt
    Each full degree > 99°   add 1 pt

Other Classification Exemplars

Because it is not possible to include every clinical entity in an index, the additional category of "Other" is included to permit scoring of other conditions which may add to treatment complexity.

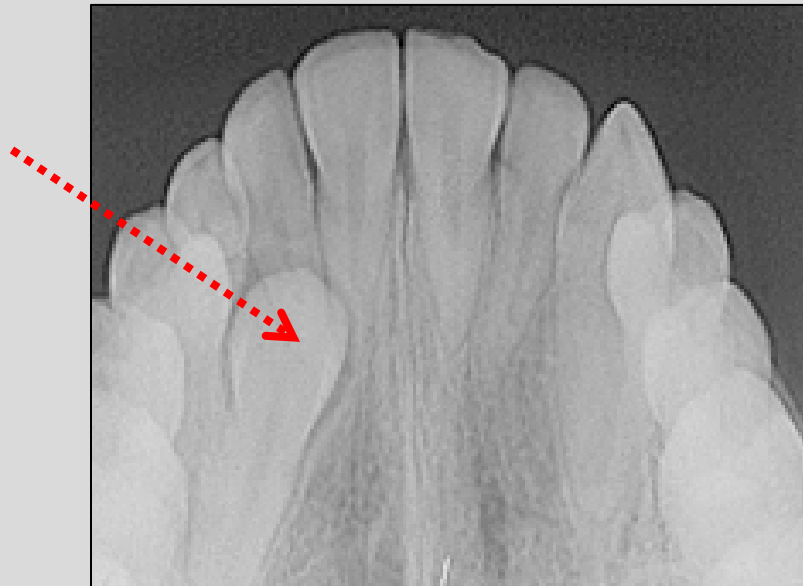Other: Supernumerary teeth- one (1) point each
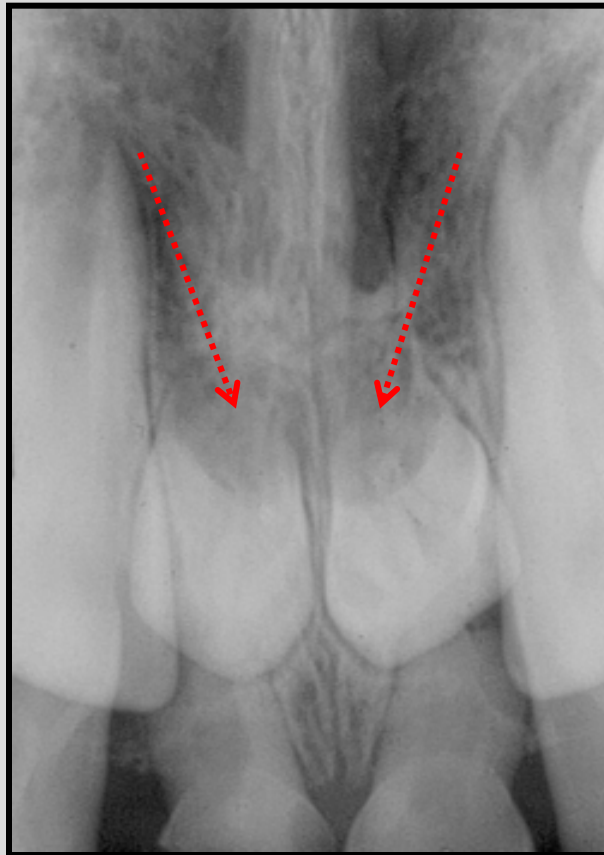
Other: Ankylosis of permanent teeth - two (2) points per tooth
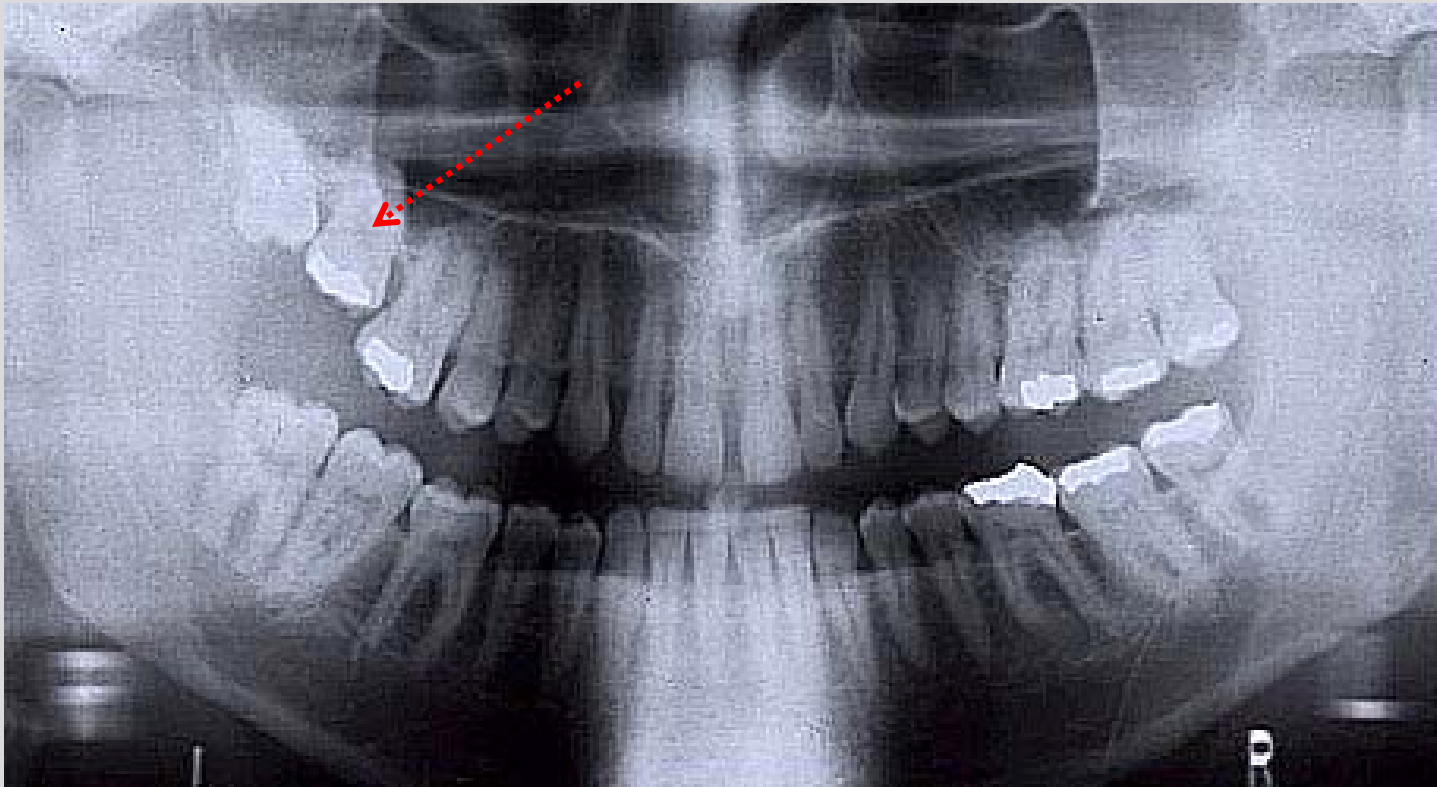
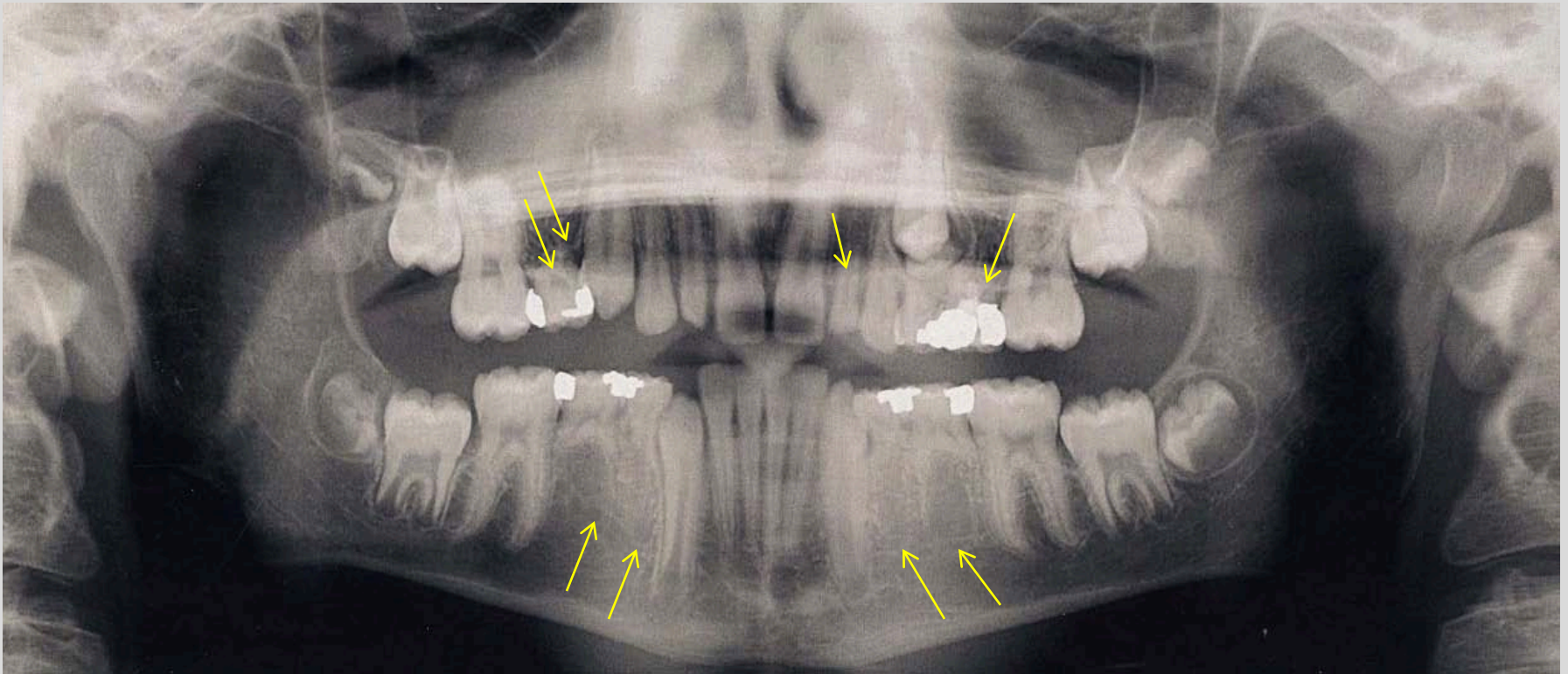Other: Anomalous Morphology of tooth size and shape (e.g. natural and/or iatrogenic)- two (2) points per tooth

Peg-shaped lateral incisor
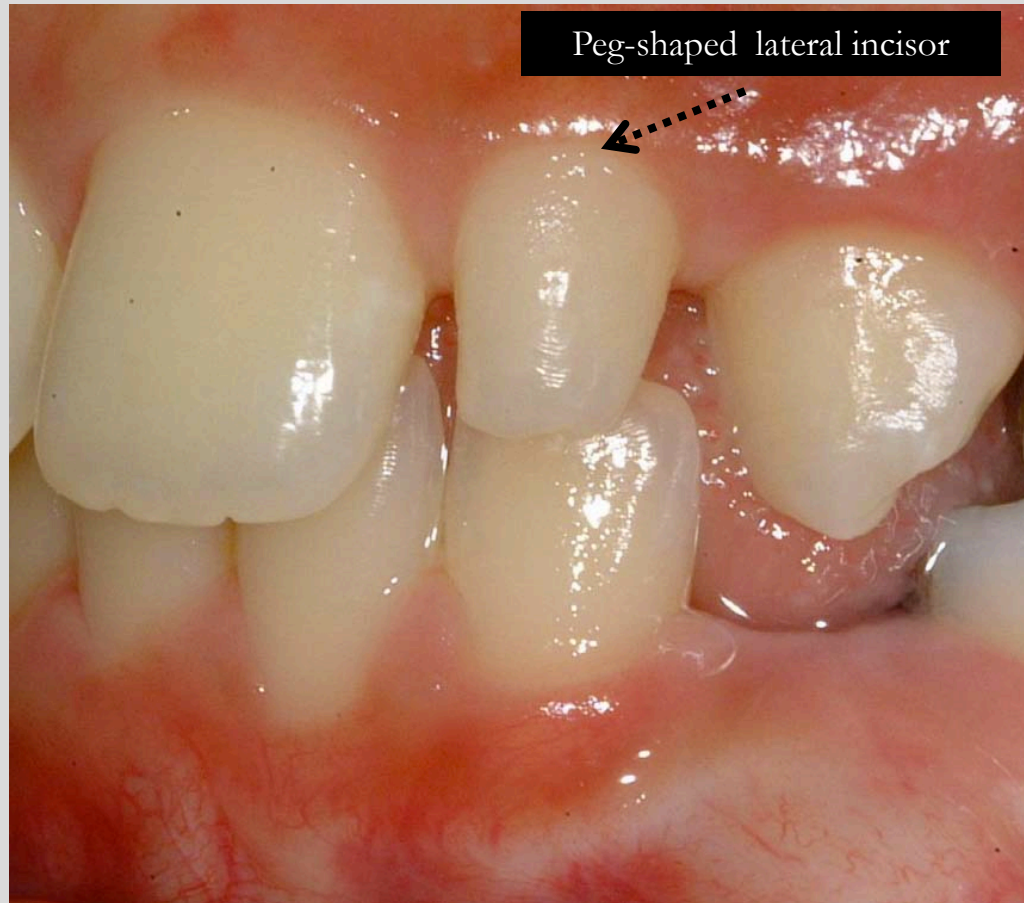
Other: Impaction (except 3rd molars) of teeth - two (2) points for each tooth

Other: Missing teeth (except 3rd molars):
## - Non-congenital - one (1) point per tooth
- Congenital - two (2) points per tooth

In this example, there are eight congenitally missing teeth, therefore 16 points are allocated.

Other: Midline Discrepancy

The midline for each arch equals the mid-point between the Mx central incisors and the Mn central incisors demonstrated by two vertical reference lines. The discrepancy is the difference between the two vertical reference lines measured in the horizontal plane. Score two (2) points for 3 mm or more.
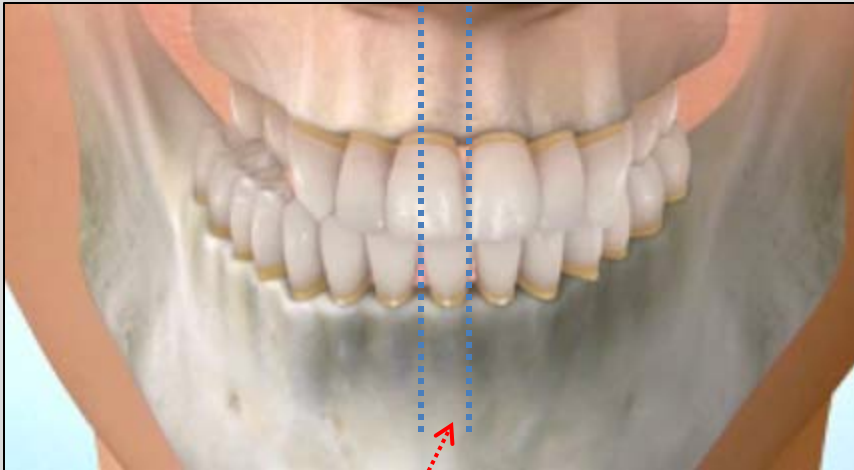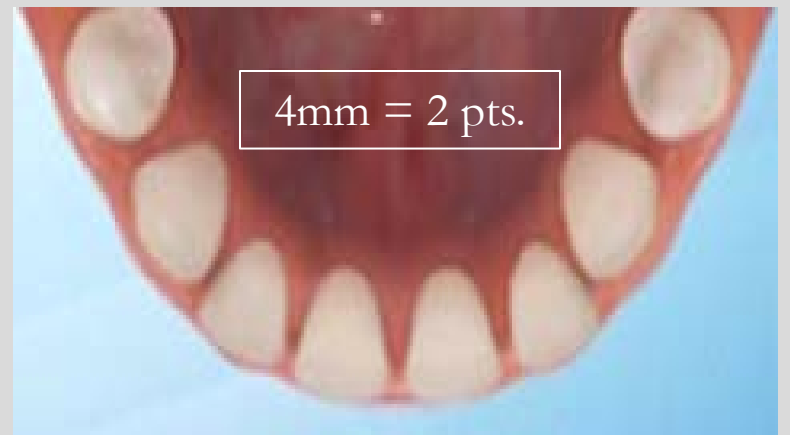

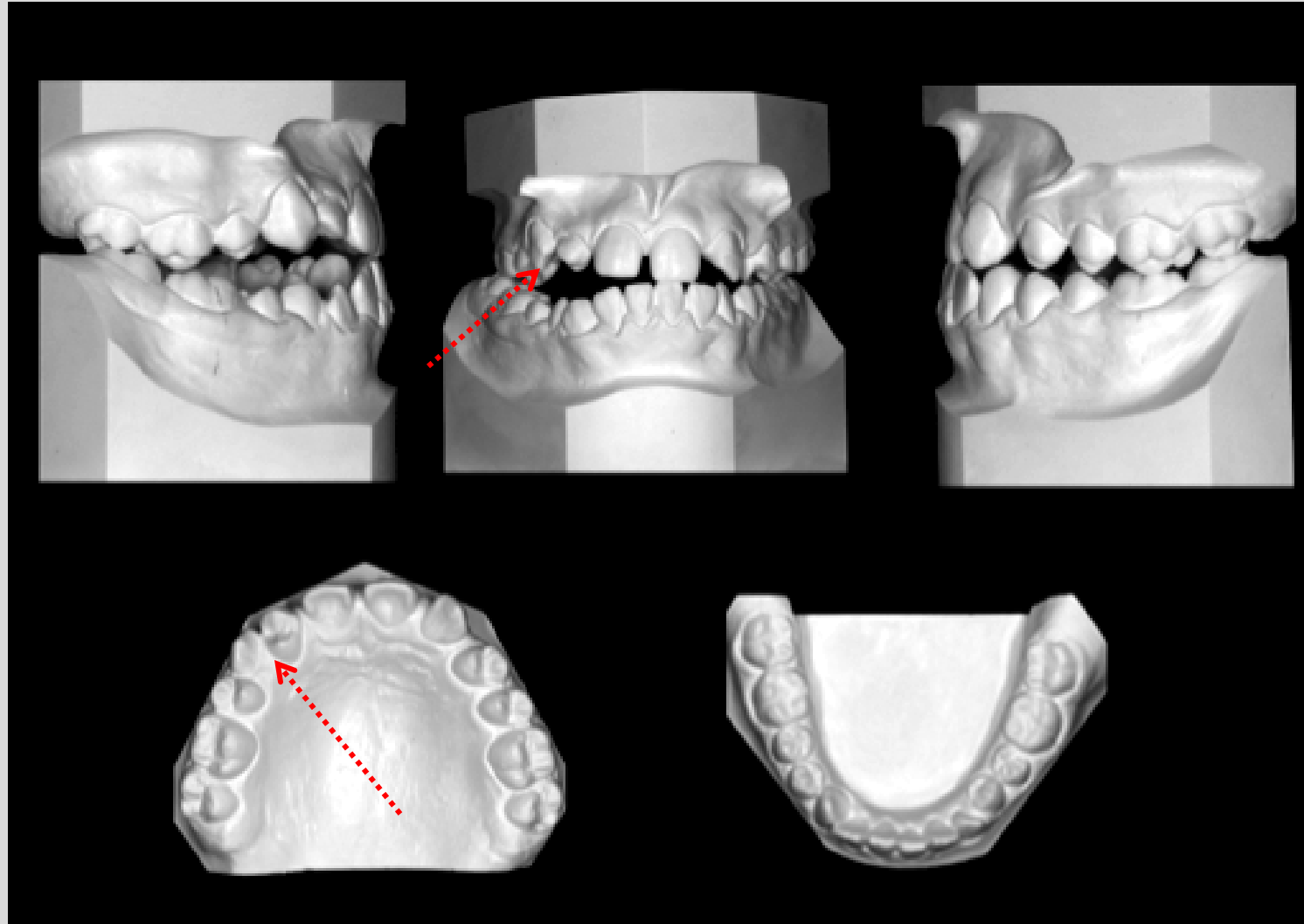4.0 mm midline discrepancy = 2 pts.
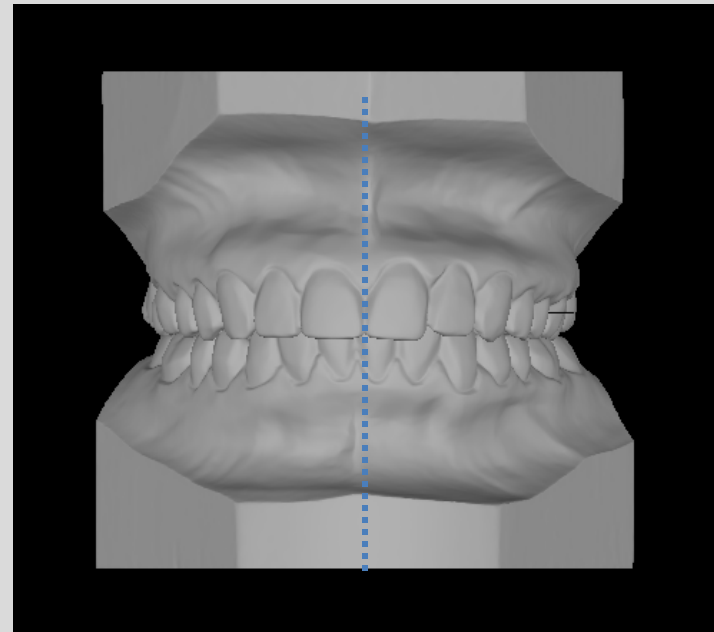
Midline coincident = 0 pts.

Other: Spacing

For **generalized spacing** per arch, in which there $\geq$ 0.5 mm of space on both sides of any 4 teeth or more, score two (2) points per arch.
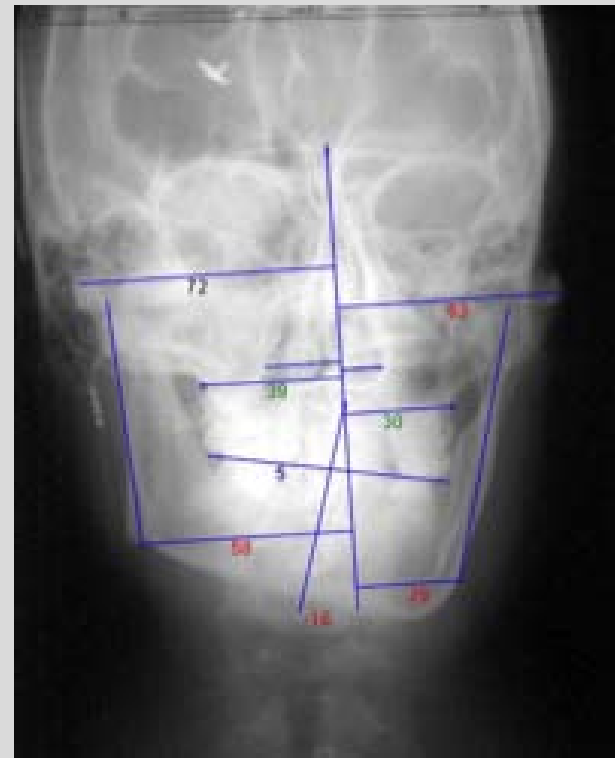
For a maxillary central incisor space **(diastema)** of $\geq$ than 2.0 mm. score 2 points

4mm = 2 pts.

4mm = 2 pts.

Other: Tooth transposition- score two (2) points for each event

Other: Skeletal asymmetry (treated non-surgically) –
score three (3) points
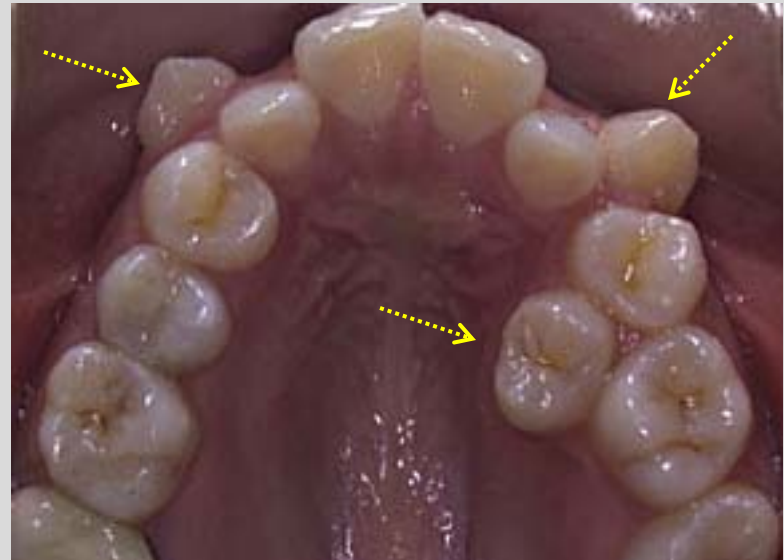(appropriate diagnostic information is recommended)

Other: Additional treatment complexities-
Score two (2) points for each occurrence

Example: ectopic eruption-
two(2) points

Example: ectopic eruption-
possible six(6) points

Examples of <u>Potential</u> Treatment Complexities

Not to be considered all-inclusive

- Significant Bolton Discrepancy (3 mm or greater)

- Severe enamel wear

- Multiple areas of shorten roots

- Deep curve of Spee

- Associated traumatic injury to multiple teeth

- Periodontally labile condition

- Severely angulated roots

- Severe bi-maxillary protrusion (critical anchorage case)

- Cleft lip and palate